SOIL STABILIZATION USING TAMARIND KERNEL POWDER

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ABSTRACT

This study looks into the stabilization of weak clayey soil using Tamarind Kernel Powder (TKP), which is an agro-waste material. Clayey soil, with its poor geotechnical properties, generally requires stabilization for improved strength and durability. By the addition of TKP at varying percentages (1%, 3%, and 5%) was analyzed through Unconfined Compressive Strength (UCS) and compaction tests. Results show a materially increase in soil strength with the addition of TKP, indicating its potential as an eco-friendly, cost-effective stabilizer. This method offers a sustainable approach to soil stabilization, enhancing soil properties for construction applications.

Keywords: Soil Stabilization, Eco-friendly Stabilizer, TKP

1. INTRODUCTION

Soil stabilization is a main technique used in construction to enhance the properties of weak soils, ensuring they provide a robust foundation for construction projects. Soils that are too wet, sticky, or lacking in strength often need modification to improve their geotechnical properties. Among these, clayey soils present particular challenges due to their plasticity, shrink-swell behavior, and weak shear strength. A range of stabilizers, including some industrial wastes, are used to deal with the issues at hand. This study examines Tamarind Kernel Powder (TKP), which comes from the seed of a tamarind tree and is relatively cheap and biodegradable, for its effectiveness as a stabilizer for clayey soils. TKP is a polysaccharide and is known to absorb a great deal of water, which should enhance the strength and compaction characteristics of the soil. This objective of this research work is to assess the effectiveness of TKP on the strength and compaction behavior of clayey soil. To understand the efficiency of TKP in enhancing soil properties, various laboratory tests, including UCS and compaction tests, were performed at different percentages of TKP.

2. LITERATURE REVIEW

Attempts have been made on soil stabilization using different agro waste products, including Tamarind Kernel Flour. Tanuja et al [1] show that black soil was stabilized by the application of combined TKP with banana leaf ash. Their results indicate that a compressive strength

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significantly improved with high percentages of TKP. Usar and Lin [2], along with their students, used Waste Marble Powder (WMP) for soil stabilization and found dependable results with increases in soil density as well as decreases in liquid limit with an increase of WMP content. Other research has been done by Yogeshwa and Sonthwal [3] who concentrated on Guar Gum as a biopolymer for stabilization as it was found that soil treated with 1% Guar Gum had the optimum value for geotechnical properties. While there are such researches that focus on TKP as a stabilizer for clayey soils, not much focus has been put on TKP's utilization which is the missing piece in the existing literature. This is the gap that our research aims to fulfill by analyzing the effects of TKP on strength and compaction characteristics of clayey soil.

3. OBJECTIVES

a. To examine the effect of Tamarind Kernel Powder on the compaction behavior of clayey soil.

b. To assess the improvement in the strength properties of clayey soil upon adding different percentages of TKP.

4. METHODOLOGY

Clayey soil samples were collected from Parassala, which is located at the Kerala Tamil Nadu border. Water content, specific gravity, and plasticity tests were conducted for the soil state studies. Tamarind Kernel Powder was purchased from local vendors in Trivandrum where its initial properties were also determined. TKP was blended with clay soil at three different ratios: 1%, 3%, and 5%. Laboratory tests including Unconfined Compressive Strength (UCS) test and standard Proctor compaction test were done to assess the modified properties of the soil.

Fig 1. Soil with TKP placed in UCS Testing machine

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Fig 2.Pycnometer filled Soil with TKP

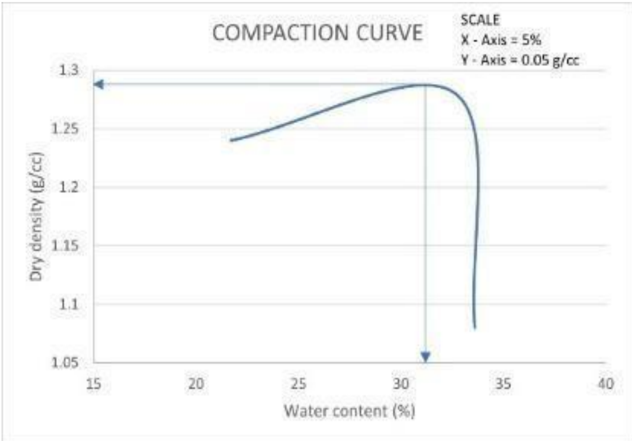

Fig 3 Compaction curve at 1% TKP

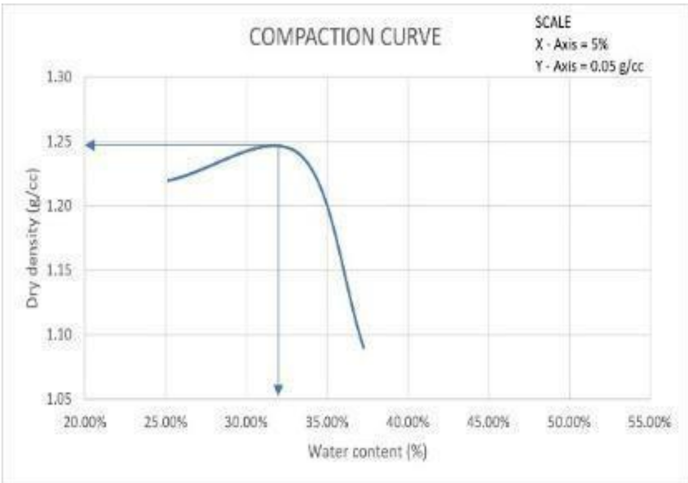

Fig 4 Compaction curve at 3% TKP

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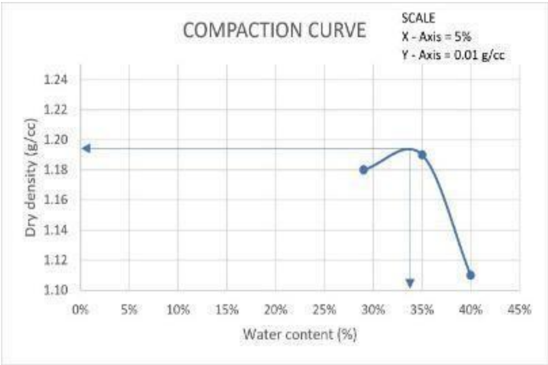

Fig 5 – Compaction curve at 5% TKP

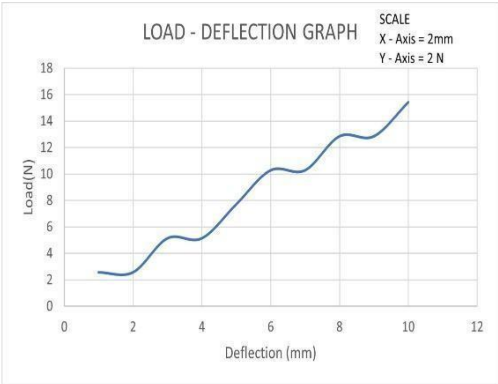

Fig 6- Load-Deflection graph at 1% TKP

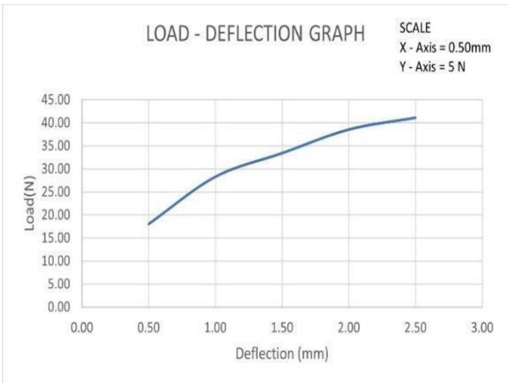

Fig 7- Load-Deflection graph at 3% TKP

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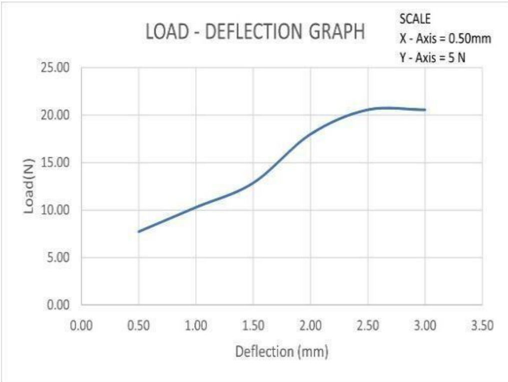

Fig 8- Load-Deflection graph at 5% TKP

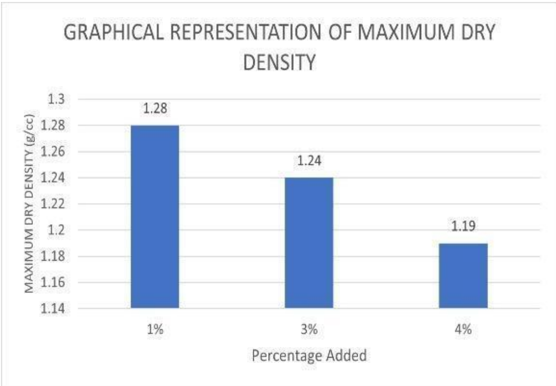

Fig 9 – Graphical representation of Maximum Dry Density(MDD)

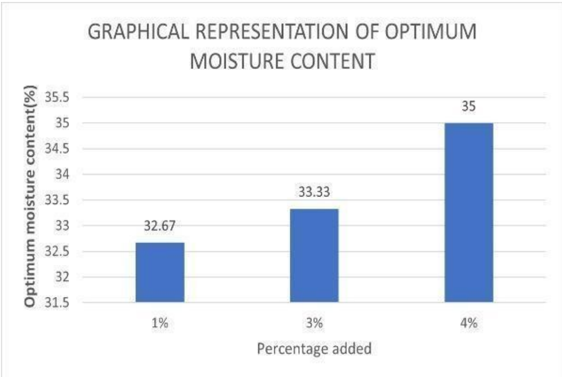

Fig 10- Graphical representation of Optimum Moisture Content(OMC)

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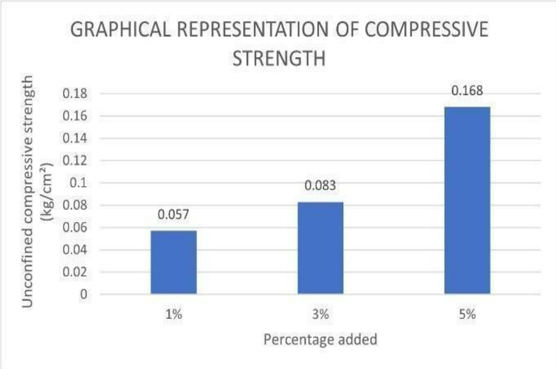

Fig 11- Graphical representation of Compressive strength

5. RESULTS AND DISCUSSION

The results of initial property tests of soil are obtained as:-

Table 1 – Initial properties of soil

1.Water content	26.12%
2.Specific gravity	2.67
3.Wet sieve analysis	97%
4.Hydrometer analysis	68%
5.Liquid limit	43%
6.Plastic limit	22%
7.Shrinkage limit	11.57%
8.Compaction	MDD=1.42g/cc ,OMC=11.53%
9.Swelling	No swelling
10.UCS	q_u=0.098kg/cm^2,Shear strength=0.048kg/cm^2

The results of initial properties of Tamarind Kernel Powder are obtained as below:-

Table 2- Initial properties of TKP

Specific gravity of Tamarind Kernel Powder	1.133
Water Content of Tamarind Kernel Powder	6%

The results of UCS at varying percentages of tamarind kernel powder are obtained as follows:-

Table 3- UCS Results

Percentage added	**Result Unconfined compressive strength (q_u)**
1%	qu=0.114kg/cm^2,Shear strength=0.057kg/cm^2
3%	q_u=0.17kg/cm^2,Shear strength=0.083kg/cm^2
5%	q_u=0.337kg/cm^2,Shear strength=0.168kg/cm^2

The results of compaction are obtained as:-

Table 4 – Compaction Results

Percentage added	**Maximum dry density(MDD) &Optimum moisture content(OMC)**
1%	MDD=1.28g/cc OMC=32.67%
3%	MDD=1.24g/cc OMC=33.33%
5%	MDD=1.19g/cc OMC=35%

The primary characteristics of the clayey soil include:

Water Content: 26.12% Specific Gravity (SG): 2.67 Liquid Limit (LL): 43%,Plastic Limit (PL): 22%,Shrinkage Limit: 11.57%,The maximum dry density of soil (MDD): 1.42 g/cc,Optimum,Moisture Content (OMC): 11.53%,UCS: 0.098 kg/cm^2; Shear strength: 0.048 kg/cm^2.

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Significant changes were observed when Tamarind Kernel Powder (TKP) was added in various percentages. At 1% TKP, with an increase in the UCS to 0.114 kg/cm², and also with the shear strength increasing to 0.057 kg/cm². The increase of 3% TKP gave another increase in UCS to 0.17 kg/cm², with the shear strength being 0.083 kg/cm². Maximum increases of 5% TKP yielded the UCS of 0.337 kg/cm² and shear strength of 0.168 kg/cm². This confirms that the addition of TKP has greatly enhanced the strength properties of clayey soil.

Compaction results show that the MDD decreased with increasing TKP content, implying reduced plasticity of the soil. The OMC increased with the addition of TKP due to its water-absorbing properties. At 5% TKP, the soil exhibited optimum compaction characteristics, with MDD of 1.19 g/cc and OMC of 35%.

These findings corroborate those from earlier studies that show other agro-waste materials such as TKP stimulate soil stabilization [1][2][3]. The performance observed for UCS and shear strength matches that recorded for other stabilizers, such as Guar Gum [3]. However, with TKP, there was a higher strength increase at the lower percentages, indicating that it could be a more effective stabilizing agent in clayey soils.

6. CONCLUSION

The study elaborated that the incorporation of Tamarind Kernel Powder (TKP) significantly enhances the strength and compaction characteristics of clayey soil. The soil under study has shown considerable improvement in unconfined compressive strength (UCS) and shear strength with TKP additions, especially at 5%, where UCS readings of 0.337 kg/cm² and shear strength readings of 0.168 kg/cm² were recorded. Simultaneously, there was a decrease in maximum dry density (MDD) and an increase in optimum moisture content (OMC), indicating a less plastic condition of the soil. These results underline the potential of TKP as an economically viable and naturally favorable stabilizing material for clayey soils involving construction. The findings of this study suggest that TKP would serve as a good alternative to conventional stabilization agents and advance sustainable techniques for upgrading geotechnical properties of clayey soil. Further studies can analyze the durability of TKP-treated soils and possible combinations of TKP with other stabilizers to improve soil performance effectively.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest in this study.

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