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Correlation Analysis of Shear Strength with Index Properties of Soft Soil

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ABSTRACT: This journal presents a comprehensive study on predicting the shear strength of soft soil using regression analysis techniques. Soft soil poses significant challenges in construction projects, making accurate predictions essential for ensuring structural stability and safety. Soil mainly possess two properties namely engineering properties, considered broadly are physical, chemical and biological characteristics that are observable, measurable and influence behavior to the extent that they are important in engineering analysis and design and index properties which facilitate identification and classification of soils for engineering purposes. As the analysis of engineering properties require much time, index properties are analyzed. For the regression analysis a dataset of 100 samples were collected from various parts of Kuttanad. Kuttanad, situated in the Southwest of Kerala, India, features soft soil, which possess challenges for various Civil Engineering projects due to its low shear strength and high compressibility. The research integrates various soil parameters and applies regression analysis to develop predictive models. Data from extensive laboratory tests and field observations are utilized to validate the accuracy and reliability of the proposed models. The results demonstrate the effectiveness of regression analysis in estimating shear strength, offering valuable insights for engineering applications and risk mitigation strategies in geotechnical projects. For this experiment linear regression and multiple regression were considered. In linear regression two models were generated (model 1: liquid limit vs shear strength, model 2: plastic limit vs shear strength). The graph showing shear strength and plastic limit indicates that plastic limit adjacent to shear strength shows greater accuracy with an R^2 value of 0.9 likewise liquid limit and shear strength shows an R^2 value of 0.8 and multiple regression model shows an R^2 value of 0.94.

KEYWORDS: Shear strength, Regression, Engineering properties, Index properties, R^2 value.

I. INTRODUCTION

Soft soils present significant challenges in construction and engineering projects due to their complex behavior and low shear strength characteristics. Understanding the relationship between shear strength and index properties is crucial for effective soil stabilization and foundation design. This journal aims to investigate and analyze the correlation between shear strength parameters and various index properties of soft soils. By examining this correlation, engineers and researchers can gain valuable insights into predicting and managing the mechanical behavior of soft soils, ultimately enhancing the efficiency and safety of infrastructure projects.

II. OBJECTIVES

To identify and evaluate the key index properties commonly used to characterize soft soils, such as moisture content, Atterberg limits, and specific gravity. To assess the shear strength parameters of soft soils through laboratory testing methods, including direct shear and unconfined compression test. To establish correlation models between shear strength and index properties, aiming to quantify the relationship between them.

To investigate the influence of various factors, such as soil composition, loading conditions, and environmental factors, on the correlation between shear strength and index properties. To provide practical implications and recommendations



for engineers and geotechnical professionals in utilizing the correlation analysis results for soil stabilization, foundation design, and construction management in soft soil environments.

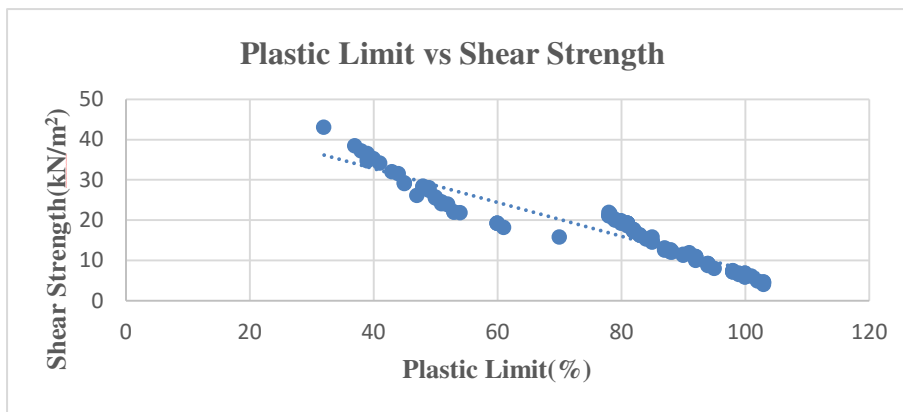
III. METHODOLOGY

- i) Sample Collection
- ii) Testing of samples
 - Natural moisture content
 - Specific Gravity
 - Liquid Limit
 - Plastic Limit
 - Shear Strength
- iii) Regression Analysis
 - Linear
 - Multiple

IV. EXPERIMENTAL RESULTS

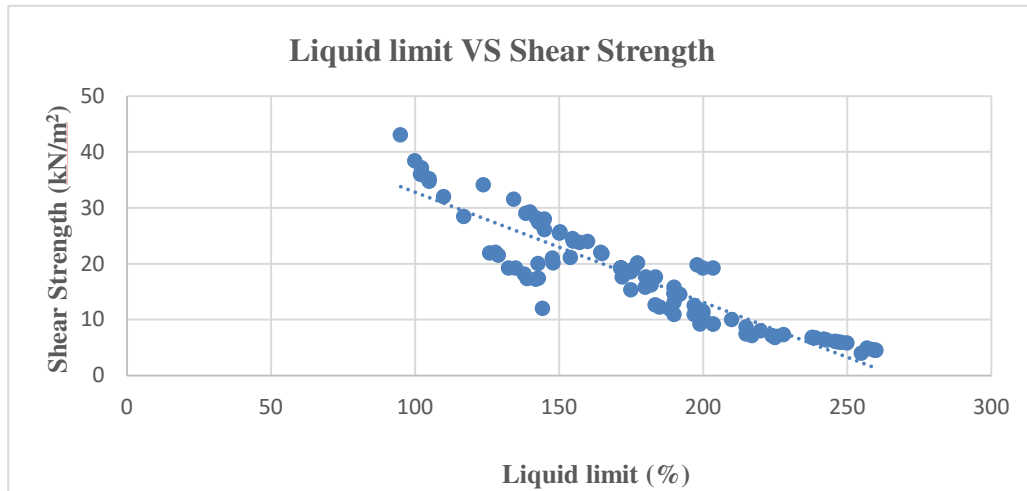
1. LINEAR REGRESSION

a) Model 1 (Plastic Limit vs Shear Strength)



b) Model 2 (Liq

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.95393							
R Square	0.90998							
Adjusted R Square	0.90906							
Standard Error	2.79972							
Observations	100							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1	7765.29	7765.29469	990.6717549	4.86857E-53			
Residual	98	768.165	7.838413331					
Total	99	8533.46						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	49.6325	1.05613	46.99475653	5.00895E-69	47.53663061	51.7283343	47.53663061	51.72833425
PLASTIC LI	-0.42055	0.01336	-31.47493852	4.86857E-53	-0.44706034	-0.39403031	-0.447060341	-0.394030308



SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.91697							
R Square	0.84083							
Adjusted R Square	0.8392							
Standard Error	3.72294							
Observations	100							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	1	7175.15	7175.153472	517.6780366	6.82018E-41			
Residual	98	1358.31	13.86026249					
Total	99	8533.46						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	52.4147	1.57563	33.26585306	3.40204E-55	49.28790603	55.541481	49.28790603	55.54148102
LIQUID LIM	-0.19646	0.00863	-22.75253913	6.82018E-41	-0.21359971	-0.17932865	-0.213599705	-0.17932865

2 MULTIPLE REGRESSION (Moisture Content, Liquid Limit, Plastic Limit vs Shear Strength)

SUMMARY OUTPUT								
<i>Regression Statistics</i>								
Multiple R	0.97297							
R Square	0.94668							
Adjusted R Square	0.94501							
Standard Error	2.17713							
Observations	100							
<i>ANOVA</i>								
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>			
Regression	3	8078.427634	2692.809211	568.1137444	5.9811E-61			
Residual	96	455.0315616	4.7399121					
Total	99	8533.459196						
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	52.486	1.179635979	44.49338859	7.00239E-66	50.1444431	54.82756092	50.1444431	54.82756092
MOISTURE	-0.01697	0.022811261	-0.744077016	0.458647293	-0.06225333	0.02830666	-0.062253331	0.02830666
LIQUID LIM	-0.06872	0.017832891	-3.853550796	0.000210309	-0.10411796	-0.033321942	-0.104117958	-0.033321942
PLASTIC LI	-0.27076	0.023486011	-11.52844871	8.13091E-20	-0.31737663	-0.224137906	-0.317376631	-0.224137906

Equations obtained from Regression Analysis are

$$S_s = -0.196 LL + 52.414$$
$$S_s = -0.420 PL + 49.632$$
$$S_s = -0.0169 MC - 0.0872 LL - 0.2707 PL + 52.486$$

LL - Liquid Limit
PL - Plastic Limit
MC- Moisture Content
Ss - Shear Strength

V. CONCLUSION

The conclusion of the journal on the correlation analysis of shear strength with index properties of soft soil likely summarizes the key findings regarding the relationship between shear strength and various index properties such as moisture content, Atterberg Limits, Specific gravity. It may also discuss the significance of these correlations in geotechnical engineering practice and suggest potential implications for soil characterization and engineering design in soft soil conditions.

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