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Effect of Contamination on Geotechnical Properties of Clay Soil

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ABSTRACT: Contamination can significantly alter the geotechnical properties of clay soil, affecting its shear strength, compressibility and overall stability. The effects depend on the type and concentration of the contaminant, the mineral composition of the clay, and environmental conditions.This study examines the engineering properties of clayey soils, specifically unconfined compressive strength and compressibility. Soil samples were subjected to contamination for 3, 6, and 9 weeks, after which their engineering properties were retested and analyzed in this paper.

KEYWORDS: Contamination, geotechnical properties, shear strength, compressibility

I. INTRODUCTION

The soil contamination through organic pollutants and heavy metals are increasing day by day. Soil pollution affects soil fertility, groundwater and so on. It also poses risks to human health both indirectly through the consumption of contaminated food and drinking water, and directly through exposure to contaminated soil.Additionally, in the long term, the index and geotechnical properties of the soil deteriorate significantly.Contaminants like acids and heavy metals can break interparticle bonds (electrostatic forces and van der Waals forces), reducing cohesion. Compressibility is the soil's tendency to deform under load, primarily governed by compression index (Cc) and coefficient of consolidation (Cv).Contaminants increase double-layer thickness, leading to expansion and higher compressibility.

II. METHODOLOGY

The methodology is presented here .Soil samples were collected from the stretches of river delta.Nearly 5kg of soil were collected. The sample was thoroughly dried and tested to find all basic and engineering properties . The soil samples were contaminated for 1, 2 and 3 weeks .The sample soil which was added with 16% weight of soil is labeled as soil sample 1, 33% dosage labeled as Soil sample 2 and that with 50% is termed as Soil sample 3.

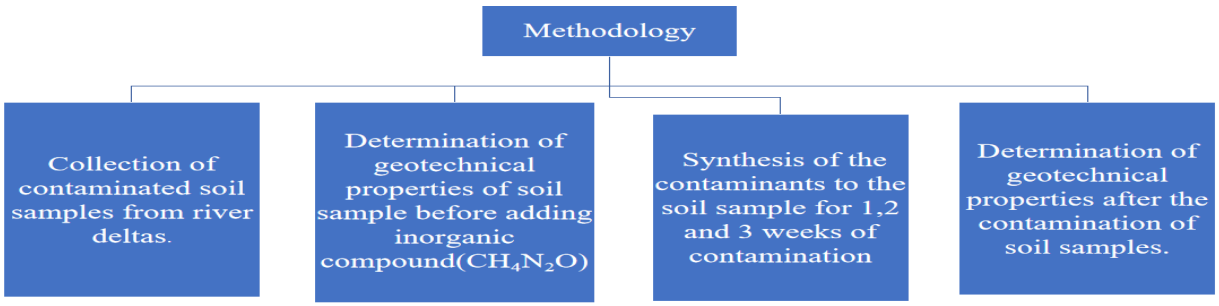

Figure 1

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III. RESULT AND DISCUSSION

The characteristics of soil sample(Raw soil) collected from river delta portion are as follows

Sl. NO.	PARAMETER	VALUES
1	Natural Moisture Content (At the time of collection)	19.54%
2	Specific gravity	2.76
3	Free swell index	30%
4	Unconfined compressive strength	39.8 kN/m^2
5	Coefficient of consolidation	0.848 cm^2/min
6	Consistency limits	LL=45%, PL=17.90%
7	ISC System	CI (Clay of intermediate compressibility)

Table 1 .Properties of collected raw soil

The variation in un compressive strength is as follows for soil sample 1, 2 and 3 respectively with 16,33, and 50 % of CH_4N_2O addition respectively

Sample 1

Property of comparison	Raw soil	Soil Sample1 (1 week contamination)	Soil Sample 1 (2 week contamination)	Soil Sample 1 (3 week contamination)
Unconfined Compressive Strength	39.8 kN/m^2	35.6 kN/m^2	34.8 kN/m^2	34.8 kN/m^2
Cohesion	19.9 kN/m^2	17.8 kN/m^2	17.4kN/m^2	17.4kN/m^2

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Sample 2

Property of comparison	Raw soil	Soil Sample2 (1 week contamination)	Soil Sample 2 (2 week contamination)	Soil Sample 2 (3 week contamination)
Unconfined Compressive Strength	39.8 kN/m²	32.6 kN/m²	30.8 kN/m²	30.8 kN/m²
Cohesion	19.9 kN/m²	16.3 kN/m²	15.4kN/m²	15.4kN/m²

Sample 3

Property of comparison	Raw soil	Soil Sample3 (1week contamination)	Soil Sample 3 (2week contamination)	Soil Sample 3 (3week contamination)
Unconfined Compressive Strength	39.8 kN/m²	28.6 kN/m²	26.4 kN/m²	26.4 kN/m²
Cohesion	19.9 kN/m²	14.3 kN/m²	13.2kN/m²	13.2kN/m²

The soil sample 1, 2 & 3 was subjected to were subjected to consolidation test and coefficient of consolidation were determined , which are represented below

SI NO	SAMPLE	Coefficient of Consolidation(cm²/minute)
0	RAW SOIL	0.848
1	SAMPLE 1(3 week of contamination)	0.816
2	SAMPLE 2(3 week of contamination)	0.802
3	SAMPLE 3(3 week of contamination)	0.792

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IV. CONCLUSION

Studies clearly indicated that the unconfined compressive strength of clay soil was significantly impacted by varying contaminant dosages. For the given soil quantity, a two-week contamination period led to a 12.56% reduction in the unconfined compressive strength of soil sample 1 (16% contaminant dosage), with no further decline observed in the third week. This suggests that contamination was complete within two weeks, during which the contaminants disrupted interparticle bonds (electrostatic and van der Waals forces), reducing cohesion. A similar trend was observed in soil samples 2 and 3.Regarding consolidation characteristics, the coefficient of consolidation decreased as the concentration of inorganic contaminants increased, leading to slower consolidation.

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