# A Review on Variation of The Geotechnical Properties of Lithomargic Clay Subjected to Contamination

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***Abstract*: Dispersive soils are soils that are easily erodible and segregate in water, pose serious problems of stability of earth and earth retaining structures. One such soil is Lithomargic clay, which constitutes an important group of residual soils existing under lateritic soils and is found along the western coast of southern India below hard lateritic soil varying in large depth. Contamination of these soils, which has been probed in recent years, gives rise to unexpected structural failure when exposed. Geotechnical properties of soils are greatly influenced by interaction with the wastes discharged from industries as well as a result of developmental activities. Here, the variation in geotechnical properties of lithomargic clay when subjected to contamination are reviewed and discussed.**

***Keywords: Lithomargic clay, Contamination, Geotechnical Properties***

## 1. INTRODUCTION

Lithomargic clay is a product of laterization and underlies the top hard and porous lateritic crust. The lithomargic clay behaves like a dispersive soil. The lithomargic clay is present between the weathered laterite at top and the hard granitic gneiss underneath. Lithomargic clays (shedi soils) are also used for construction purposes, for backfilling purposes in low lying areas. The top laterites are used as bricks for construction purposes. A lot of engineering problems are being faced due to the presence of this shedi soil, either naturally or due to backfilling. Lateritic soils have an amorphous blend of Al2Si2O5(OH)4. Soils with 50-90% lateritic constituents, and less of the lithomargic constituents, are known as lithomargic laterites. Soils with 25-50% laterite content, and more of the lithomargic constituents are known as lateritic lithomarges.

The most common method of waste disposal in India is dumping on land, because it is the cheapest method of waste disposal. The bulk wastes generated during various activities is let over the soil which leads to contamination. When rainwater percolates through these wastes, it is mixed with organic and inorganic chemicals. Especially, we the human beings produce a large quantity of wastes in various forms, often making our environment filthy and unhealthy.

Leachate from the solid waste dump has a significant effect on the chemical properties as well as the geotechnical properties of the soil. Leachate can modify the soil properties and significantly alter the behaviour of soil (Rao and Shantaram, 2011). The effect of interaction of shedi soil containing alkali on various geotechnical properties such as the index properties, compaction characteristics, volume change behavior, strength characteristics and hydraulic conductivity (Ramakrishnegowda et al., 2011). It was seen that though the plasticity index of soil decreases and optimum moisture content increases with increasing concentration of alkali content in the fluid, the shear strength of soil decreases essentially due to decrease in the cohesion of the soil particles. Srivastava et al. (1992) observed increase in consistency limit, permeability and coefficient of compression and decrease in shear strength and bearing capacity of a soil specimen permeated with fertilizer plant effluent. This is due to decrease in cation content and increase in hardness of leaching water after interaction. This study presents a review of recent research on the geotechnical properties (consistency limits, hydraulic conductivity, shear strength, swelling, and compressibility) of lithomargic clays on contamination.

## 2. SOIL CONTAMINATION

It is typically caused by industrial activity, agricultural chemicals or improper disposal of waste. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals. Contamination is correlated with the degree of industrialization and intensity of chemical substance. The concern over soil contamination stems primarily from health risks, from direct contact with the contaminated soil, vapour from the contaminants or from secondary contamination of water supplies within and underlying the soils.

Assa'ad(1998) investigated tilting of phosphoric acid storage tanks in chemical fertilizer factory in Jordan. Yaji et al. (1996) have investigated the influence of phosphoric acid contaminant on shedi soil. The shear strength decreases with increase in percentage of phosphoric acid. Barbour & Yang (1993) reviewed the influence of clay-brine interactions on geotechnical properties on soils from western Canada. Brine is the high salt content and was obtained from the ground water existing in saline soils. Decrease in plasticity, increase

in shear strength, reduction in volume and alteration of hydraulic conductivity have been reported. Soils receive high pH solutions such as caustic alkali(sodium hydroxide)from a variety of geotechnical environments as well as from industries using alkalis as processing fluids such as caustic soda manufacture industry, pulp and paper, aluminium, petroleum and textiles(including rayon), nuclear weapons manufacturing plant, soap and synthetic detergents, etc. These contaminants can cause significant changes in behaviour in some soils. The effect is particularly drastic at higher concentration of alkali interaction as it can produce changes such as formation of new compounds and/or mineralogical changes prompted by dissolution and precipitation reactions. Fuel oil contamination brings adverse effect on basic geotechnical properties of foundation soil. Shah et al. (2003) reported that the petrochemical complex near Vadodara city affects the geotechnical properties at site in Gujarat State, India. Here, the fuel oil contaminated soil samples exhibit drastic changes in their geotechnical parameters. Yaji et al. (1996) have investigated that the shear strength decreases with increase in percentage of urea.

## 3. GEOTECHNICAL PROPERTIES OF LITHOMARGIC CLAY

Due to the formation of organic acid as a byproduct of decaying organic matter and also due to the acidic nature of the waste, pH of contaminated soil decreases as the concentration of chemicals increased.

Conductivity is a measure of ability of a material to transmit charges. Increase in dissolved salts of sodium and magnesium in soil increases the electrical conductivity but that initially later decrease to maximum extent of chemical content. The hardness of the control sample was found to be much higher than the hardness of the polluted samples.

Specific gravity of the soil sample which was treated with contaminated was higher than that of the control sample. Soil with higher specific gravity usually contain organic matter and as such are very compressible.

Atterberg limits remain constant for a given soil, but these properties are subject to change when the pore fluid changes. The changes in Atterberg limits depend on intensity, duration, type of contaminant and type of interaction or reaction which happens in soil. The liquid limit decreases with increasing contaminant concentration due to the presence of salts in the contaminants whereas plastic limit of the soil sample increases upon increasing concentration in soil.

Soil hydraulic conductivity decreased significantly caused by reduction of the effective porosity due to pore clogging The unconfined compression test (UCS) is one of the most widely used laboratory tests in soil strength applications and it increases with increasing contaminant percent till small percentages after that a significant decrease in the unconfined compression strength with increasing concentration. Also, contamination induces a reduction in permeability and shear strength for all soil samples.

Consolidation is the process of reducing the voids ratio of soil by application of long term static loads. The study of compressibility is important for safe engineering design and for determination of probable settlement of structures. The consolidation properties of soil, such as, coefficient of consolidation (Cv), compression index (Cc) and swelling index (Cr). Depend upon many factors like type of soil, void ratio, degree of saturation, soil structure, stress history, nature of pore fluid etc (ASTM D2435). Swell and compressibility were evaluated by oedometer test using various concentrations. Swell potential (SP), swell time, swell pressure, and volume compressibility decreased with increasing of chemical concentrations. Arasan et al.(2007) reported that the swelling pressure decreased when the concentration of salt solutions increased for high plasticity clays.

## 4. CONCLUSION

Lateritic lithomarges and lithomargic clays are very sensitive to moisture variations, especially when there is no confinement. They behave like dispersive soils. Problems of dealing with shedi soils for highway engineers and foundation engineers, are loss of shear strength on wetting and removal of confinement, erosion problems, landslides, slope stability problems etc. Rapid growth in population and industrialization lead to waste disposal problems. Geotechnical properties both the index and engineering properties are modified when the waste is mixed with the ground and are closely related to the chemistry of the contaminants. This study presents a review of recent research on the geotechnical properties (consistency limits, hydraulic conductivity, shear strength, unconfined compressive strength and compressibility) of lithomargic clay subjected to contamination. The following conclusions are made:

(i) Chemicals significantly affect the geotechnical properties of soil.
(ii) Limited information is available on the shear strength of soil interacted with chemicals. However it could be said that the shear strength of soil decreases with chemicals.
(iii) The specific gravity and plastic limit showed an increasing trend upon addition of chemicals, whereas the hydraulic conductivity and liquid limit decreased.
(iv) Contaminants has some effect on the engineering and chemical properties of soil. Not only does, it reduces the overall soil strength and consequently its usefulness as a foundation material, it also can result in pollution of ground water sources due to percolation of toxic and hazardous chemical.

Adequate geo-technical evaluation of the contaminated sites and understanding of the various implications of the behaviour of the contaminated soil is necessary.

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