International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 03 | Mar 2019 www.irjet.net p-ISSN: 2395-0072

EFFECT OF CHROME TANNING EFFLUENT ON COHESIVE SOILS

S. Sathish[1], K. Thamaraiselvan[2], P.A. Theenesh[3], C. Venkatesh[4], T.R. Banu Chander[5]

[1,2,3,4]UG Student, Department of Civil Engineering, Valliammai Engineering College, Tamil Nadu, India
[5]Assistant Professor (S.G), Department of Civil Engineering, Valliammai Engineering College, Tamil Nadu, India

---

Abstract- *In the developing countries, the unchecked and unnoticed disposal of industrial effluents is very common malpractice nowadays. The effluents from the tannery industries which are not treated have affected the soil characteristics. In the modern world there is a rapid increase in population which leads in large quantity of land for the habitats, if the effluents are untreated the land is unfit for many purposes. The properties of such soil vary accordingly to atterberg's limits tests, unconfined compression tests, differential free swell tests. The results show significant reduction in plasticity of soil and changed the moisture content with increased in shear strength. This soil characteristics can be changed by adding waste stone powder and lime caused an increase in value of UCS .The added waste stone powder ranges from 0% to 6% and lime content range from 0% to 3% .The tannery effluent collected from chromepet was mixed with cohesive soils and tested to evaluate various properties of soils. Hence, we adopted 3% - 6% of waste sand powder and 3% of lime to increased the UCS of the soil.*

Key words: Clay soil, Tannery effluent, Shear strength, Shrinkage, Waste stone powder ,Lime

1. INTRODUCTION

India is a leading in production of leather in the world. There are numerous tannery industries located in India. These industries are releasing tons of waste including toxic contents and heavy metals into the adjacent land water sources, which alter the shape and composition of the soil structure based on the chemical reaction involved in it. Already, thousands of hectares of land and many valuable of water sources have been contaminated with tannery effluent. Soil properties get modified when they mix with these effluents, the modification in soil properties may lead to changes in the engineering behavior of the soil. In recent years, a varies number of studies have been carried to investigate the effect of pore water chemistry on the soil strength characteristics.

However, the effect of tannery effluent on soil is different and engineering behavior of soil are to be varied depending upon the chemical composition of the stability of the structure resting upon it. Also stability of slopes, foundations and piles to get affected when the soil surrounding them gets contaminated. A geotechnical engineer's responsibility become cumbersome as conventional geotechnical principles and theories fail to account for the contaminated soils behaviors and it is necessary to modify design methodologies to the effects of contaminants on soil properties to ensure accurate design of foundation and structures in underground in the era of evolution of industrial. Lime stabilization refers to the stabilization of the soil by the addition of limestone products such as calcium oxide, CaO and calcium hydroxide, $Ca(OH)_2$. Quicklime is the most frequently used lime products for lime stabilization in Europe. The well established industrial by products like waste stone powder, fly ash, slag, Rice Husk Ash have been obtained and mixed with lime and cement to improve geotechnical properties of affected soil and properties of pozzolanic stabilized materials.

2. SCOPE

- The water resources depletes because to intrusion of industrial pollution. The major contamination of leather tanning causing industry which uses a lot of water and discharges it with toxic effluents.
- The penetration of heavy metals from tannery effluent has toxic effect on soil and ground water.
- Stabilization of contaminated ground and enhanced behavior of soil. Use of contaminated ground for safe construction.

3. LITERATURE REVIEW

Das and Das (2003) reported the analysis of effluents released from different source and characteristics of soil ground water near to the source of contamination. In a case study the area selected for investigation comprises a food processing industry in Bangalore and Karnataka. The collected samples of effluent and groundwater where analysis for parameters like pH, nitrate, chloride, phosphate etc…. Groundwater samples are analyses for facal coli form. Results shows that discharge of waste water on the land, effectively reduce the contaminence due to the absorption/chemical reaction in the soil media.

Shiva pullaiah et.al (2000) have illustrated the effectiveness of lime treatment of soil in the presence of sulphate. It has been concluded that the presence of sulphate in soils considerably reduces the shear strength of lime treated

black cotton soil after curing for long periods. However for short curing periods, the effect of sulphate is marginal.

Gosh et.al (2000) investigated the behavior of soil using NaCl, has the contaminant at concentration in high level. It is found that permeability increases appreciably with increase in concentration of contaminence, porosity of soil has no substantial effect on the increase in permeability of soil due to contamination, transport of contaminence through soil sample can be treated as advective - diffusive flow.

Mallikarjuna Rao et al., (2008) studied the influence of spent orange dye effluent from a Textile industry on a clayey soil. The soil was mixed with spent orange dye effluent and tested for index properties and geotechnical properties after various periods of curing. The dye effluent and its constituents were to be induced to bonding and flocculation to the soil which results in food engineering properties.

Narasimha Rao and Chittaranjan (2012) investigated the effect on textile, tannery and battery effluents on expensive clay soil and showed that when soil is treated with textile and battery effluent separately has decrease in maximum dry density and optimum moisture content has increased by their observation. But when it is treated with effluent opposite trend is observed. Hence strength characteristics like CBR and UCS, Triaxial shear strength parameters are obtained at optimum pore fluid content and maximum dry unit weight are influenced strongly by these types of these industrial effluents.

4. OBJECTIVES

- To study the behavior of virgin clay soil and clay contaminated with tannery effluent.
- To measure the basic index properties of contaminated soil.
- To identify the shear strength and static response of contaminated soil using unconfined compressive strength.
- To increase the stability of the contaminated soil by using industrial by products such as lime with waste stone powder.

5. MATERIALS TO BE USED

- Natural clay soil
- Chrome tanning effluent
- Lime
- Waste stone powder

5.1 Natural clay soil

Clay is a natural rock which is finely gained soil materials that combines one or more minerals of clay with possible phrases of quartz, metal oxides and organic matter. Geologic clay deposits are mostly composed of minerals of phyllosilicate.

5. 2 Chrome tanning effluent

A large quantity of water is used in tannery process of which 90% of the water is discharge as effluent. During the chrome tanning process 40% of unused chromium salts are usually discharge in the final effluent.

5.3 Lime

It is commonly known as quick lime or burnt lime, is a widely used chemical compound. It is a white, caustic, crystalline solid at room temperature. It is used as a binding material as a replacement for cement.

5.4Waste stone powder

It is a waste product produced during the process of crushing which is used to extract stones it is like sand but mostly grey in colour.

6. EFFLUENT PROPERTIES

The tannery effluent used in our study has been collected from pallavaram. It was black jn colour with high viscocity and was generated during the process of finishing and dying of leather. The properties of effluent are shown in Table !

Table 1: Properties of tannery effluent

PARAMETERS	VALUE
Colour	Black
pH	3.5
Chromium	9899 mg/l
Sulphate	112754 mg/l
Chlorides	112455 mg/l
Sodium	116717 mg/l
Calcium	5525 mg/l
Total dissolved soilds	59819 mg/l

7. RESULTS AND DISCUSIONS

7.1 Effect on liquid limit

Natural clay soil, collected from potheri, kanchipuram district, was used for the study. The clay was black in colour and quite stiff. It was when dried, crushed and sieved in IS sieve and its property where determined as given in Table2.

Table 2: Properties of clay soil

Property	Value
Liquid limit (%)	71
Plastic limit (%)	29.27
Plasticity index (%)	21.74
Shrinkage limit (%)	17.95
Free swell index (%)	27.27
Toughness index (%)	1.36
Unconfined compression at 18% water content kN/m^2	207

The liquid limit of clay soil was determined by incrementally adding tannery effluent to the soil at various percentage. The pore fluid was effluent has it was tested immediately after mixing. The liquid limit values are increased from 75 % to82% with increase in tannery effluent.

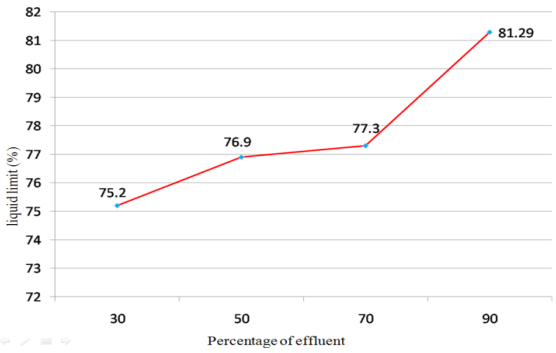

Fig.1 Percentage of effluent variation with liquid limit of soil

The effect of contamination period on the clay soil, samples were prepared by mixing clay soil with the effluent and stored in air tight bag for a period of 7 and 28 days. It was observed that a slight increase in liquid limit from 75% to 76% for dry states and 77% to 81% for wet states.

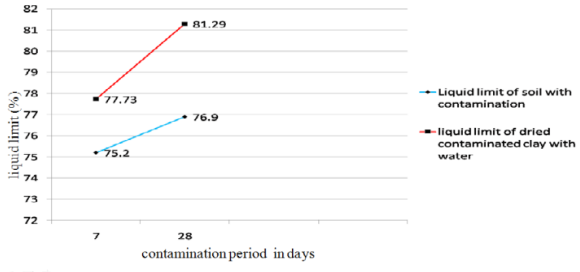

Fig.2 Liquid limit of soil with contaminated period and dried contaminated clay with water as pore fluid

7.2 Effect on plastic limit

The plastic limit of the soils were also determined by testing the specimens after drying contaminated effluent. It was observed that a slight increase in plastic limit from 30% to 31% for dry states and 32% to 34% for wet states.

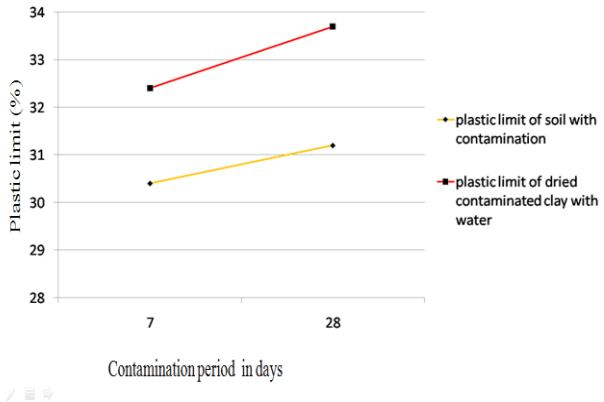

Fig.3 Plastic limit of soil with contaminated period and dried contaminated clay with water as pore fluid

7.3 Effect of shrinkage limit

The contaminated sample was dried and mixed with water, shrinkage limit decreased from 17.16% to 15.25% for dry state and 13.7% to 11.42% for wet state. Represented in fig5

7.4 Effect on Differential free swells

Differential free swell tests was processed out on the contaminated clay sample after dried. The values of contaminated clay soil where increased from 27 % to 127% with contamination. The free swell of contaminated clay soil with pore fluid as effluent shown a higher increase in free swell upto about 127%. It indicates the effect of tannery effluent is severe on the swelling characteristics of soil. Represented in fig6

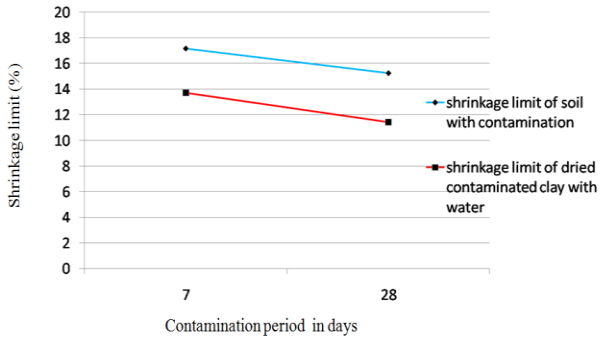

Fig.5 Shrinkage limit o f soil with contaminated period and dried contaminated clay with water as pore fluid

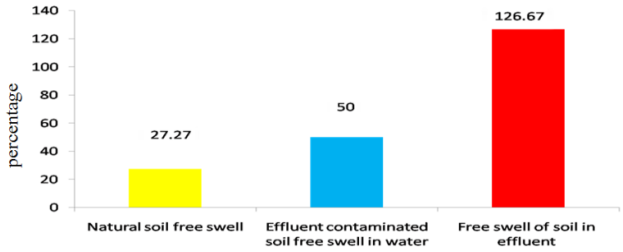

Fig.6 Differential free swell of contaminated soil in Water and effluent

7.5 UCS of contaminated soil

Unconfined compressive strength of tannery effluent contaminated clay soil samples were determined by conducting test on samples prepared at an optimum moisture content of 18%.

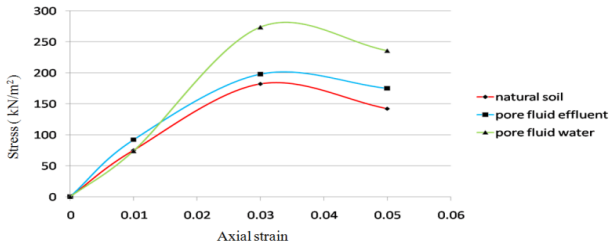

Fig.7 Stress- strain curves for contaminated samples with effluent and water as pore fluid effluent

8. TREATMENT OF CONTAMINATED SOIL

8.1SAMPLE PREPARATION

The predetermined quantities of lime and waste stone powder is added to the contaminated clay soil in dry state. The contaminated soil was crushed, sieved and mixed with water for atterbergs limits and unconfined compression tests. Initially the test was carried out on the industrial by products such as lime (3%) and waste stone powder (0 - 6%).

Fig.8 Sample preparation for contaminated soil with WSP and lime

8.2 STABILIZATION OF ATTERBERG LIMITS

The results of the atterbergs limits test on the contaminated sample n dried state when mixed with 3% of lime and 0 to 6 % of waste stone powder as shown in figures. From the results there is a decrease in liquid limit and increase in shrinkage limit and plastic limit with waste stone powder and lime. The reduction of each of these properties is obviously change in water content due to increase in waste stone powder content.

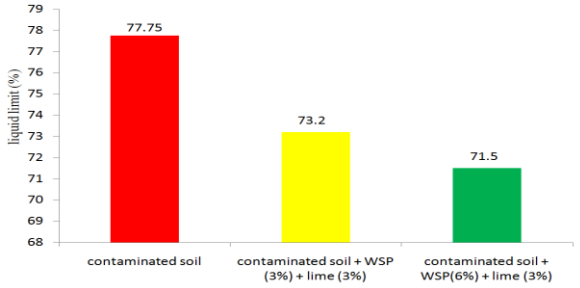

Fig.9 Comparison of liquid limit of soil and industrial by products

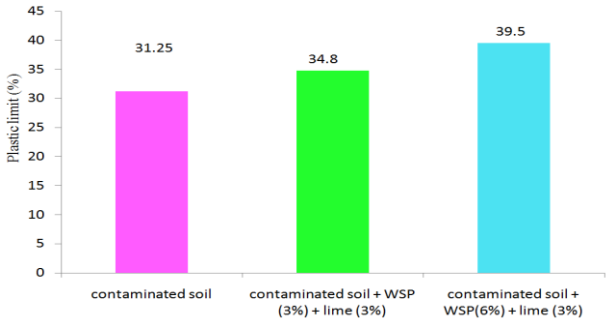

Fig.10 Comparison of plastic limit of soil and industrial by products

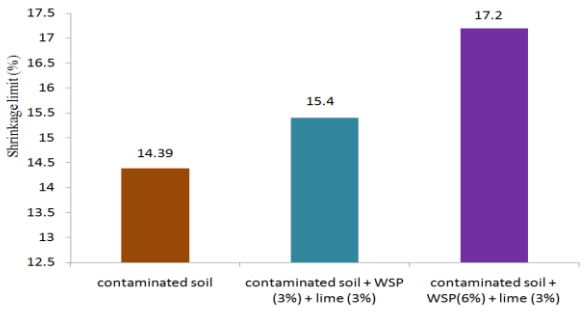

Fig.11 Comparison of shrinkage limit of soil and industrial byproducts

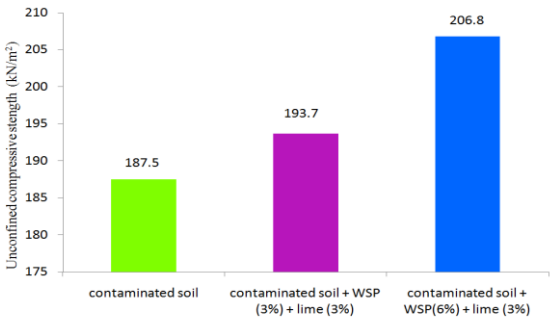

Fig.12 Comparison of UCS of soil and industrial byproducts

9. CONCLUSIONS

In this project, we focused on evaluating the effects of tannery effluent on geotechnical characteristics of cohesive soils. In general, geotechnical behaviour of cohesive soils were observed to deteriorate upon contamination of the effluent there by causing potential risks to future as well as present at the effluent contaminated construction site. The analysed summary of the effects on the individual soil characteristics are presented in the following conclusions:

1. Both liquid limit and plastic limit of tannery effluent contaminated soil showed an increasing trend with contamination.
2. The shrinkage limit of contaminated clay soil reduces with increase in contamination.
3. The swelling nature of contaminated soil were increased from 27.27% to 127%. So, it indicates the tannery effluent is severe on the swelling characteristics of clay.
4. The unconfined compressive strength of soil when contaminated with tannery effluent, kept on decreasing further in days.
5. The second of this study focused on possible stabilization of effluent contaminated soil through addition of waste stone powder of 0% - 9% and lime contents of 3%.
6. There is a decrease in liquid limit value of contaminated soil when stabilized with addition of waste stone powder of 3% - 6% and lime content of 3%.
7. The UCS of treated soil sample with lime and stone powder was increased.

REFERENCES

1. Rao A.V.N., Naik K.V.N.L. and Bali Reddy S. (2012) A Study on the Geotechnical Properties of Tannery Effluent on black cotton soil mixes Proceeding of Advances in Civil Engineering and Infrastructure Development.
2. Rao , A.V.N. and Chittaranjan M., (2012) Effect of industrial effluents on the compaction characteristics of expansive soil- A comparative study , International Journal of Engineering inventions.
3. Rao A.V.N., Chittaranjan M ., and Naik K.V.N.L. (2012) , Undrained shear strength characteristics of an expansive soil treatment with certain industrial effluents at different pore fluid content ratios.
4. Journal of Innovative Research in Science, Engineering and Technology.
5. Muthukkumaran K. (2010), Effect of Liquid Waste on the Index and Engineering Behavior of Cohesive Soils, Indian Geotechnical Journal.
6. Gibbs, H.J., Bara, J.P. Stability problems of collapsing soil. J. Soil Mech. Found (1967).