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The Effect of Industrial Textile Effluent Interaction with both Laterite Soil and Expansive Soil

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ABSTRACT

Industries are important role in the growth of the country on technology and economy part of it, at the same time it disposal hazards waste effluents after industrial processing, this may lead to environmental pollution and it is very dangers to human health, hence an attempt is made to control the environmental pollution by using industrial waste product into useful work, this is done by mixing the waste industrial effluent or particularly textile effluents to expensive and laterite soil in order to increment of strength characteristics of the soil, in this research work the Atterburg limit, free swelling, compaction values, optimum moisture content(OMC), and maximum dry density(MDD) and also Unconfined Compressive Strength (UCS) for both expensive soil and laterite soil have been evaluated by mixing various percentage (0%, 20%, 40%, 60%, 80% and 100%) of textile effluents with a time period of zero to fifteen days, based on the experimental results made a comparative study in order to conclude the better performance soil for usage. From the investigation, it is observed that textile effluent is more effective for laterite soil compares to the expensive soil. Industries are important role in the growth of the country on technology and economy part of it, at the same time it disposal hazards waste effluents after industrial processing, this may lead to environmental pollution and it is very dangers to human health, hence an attempt is made to control the environmental pollution by using industrial waste product into useful work, this is done by mixing the waste industrial effluent or particularly textile effluents to expensive and laterite soil in order to increment of strength characteristics of the soil, in this research work the Atterburg limit, free swelling, compaction values, optimum moisture content(OMC), and maximum dry density(MDD) and also Unconfined Compressive Strength (UCS) for both expensive soil and laterite soil have been evaluated by mixing various percentage (0%, 20%, 40%, 60%, 80% and 100%) of textile effluents with a time period of zero to fifteen days, based on the experimental results made a comparative study in order to conclude the better performance soil for usage. From the investigation, it is observed that textile effluent is more effective for laterite soil compares to the expensive soil.

Keywords: Laterite Soil, Expensive Soil, Textile Effluent, Liquid Limit, Plastic Limit, Compaction Test, UCS.

INTRODUCTION

Industrial activity is necessary for the socio-economical progress of a country but at the same time, it generates a large amount of liquid and solid wastes.
Disposal of solid or liquid effluents, waste by- products over the land and operations cause alterations of the physical and mechanical properties of the ground in the vicinity of industrial plants.
In many situations, soils in nature state do not present adequate geotechnical properties to be used as road services layers, foundation layers and as a construction material.

In order to adjust their geotechnical parameters to meet the requirements of technical specifications of the construction industry, studying soil stabilization is more emphasized.
Hence an attempt is made in this investigation to study the effect of certain industrial effluents such as textile effluent on plasticity, Differential free swell index, compaction and strength characteristics of an expansive soil and lateritic soil.

LITERATURE REVIEW

Phani Kumar Vaddi et al, (2015) have studied the leakage of industrial effluent into subsoil directly affects the use and stability of the supporting structure. The study of the impact of the textile effluent sample at various concentrations on expansive soil and to find the engineering, index properties of virgin and textile effluent contaminated soil.
Dr. A V Narasimha Rao and M Chittaranjan (2012) studied the effect of three effluents of industrial wastes (Textile, Tannery, and Battery effluent) on soil properties of silty clay soils.
F.O.P. Oriola and A. Saminu (2012) studied the effect of Textile effluent on the compaction characteristics of laterite soil. They reported an increase in the dry unit weight as well as the thixotropic strength of the treated laterite soil with higher chloride content. Water-soluble calcium chloride ($CaCl_2$) has been used simultaneously with cement to stabilize laterite soils containing appreciable amounts of organic matter.
R.K. Srivastava and Ayush Mittal (2012) studied the impact of textile dye sample at various concentrations (35g/kg, 52.5g/kg & 70g/kg) on the silty soil. The dye is a mixture of Matalan Orange and Matalan Yellow dye which is mixed in equal quantities to achieve the above concentration levels. The Engineering and Index properties of virgin and dye contaminated soil.
Saikia and Goswanli (2000) studied the effect of three industrial effluents (from a soap Factory, pharmaceutical factory and a proper mill waste and crude oil from oil pumping station)on a natural soil samples from Assam Engineering College Campus. Permeability, direct shear and consolidation tests were carried out on the soil samples.

OBJECTIVES of the Work

1. The objective of the present investigation is to study the influence of textile effluent used in equal proportion on engineering and index properties of both expansive and laterite soil.
2. Currently, more than 9000 different types of effluents belonging to various applications and chemical classes are in use in the textile operations and other industrial processes like food-processing, tannery, paints, plastics, pulp, and paper.
3. Most of the effluents used in the textile industry end up on finished fabric and grand 10 to 20 percent are lost in the residual effluent of which about 50 percent may reach the environment even after treatment, Only a few investigations considered the influence of textile waste water on soil properties.

MATERIALS USED

1. B.C soil
2. Laterite soil
3. Textile effluent

Expensive soil

1. The expansive soil contains predominant montmorillonite clay mineral and lime segregation. These soils are highly expensive, sticky, plastic clays formed from residual weathering of deposits derived from volcanic rocks.
2. The Black cotton soil has a potential for shrinking or swelling under changing moisture conditions and the primary problem that arises with regard to expansive soils is swelling and compressibility.
3. The Expensive soil was collected from an open excavation, at a depth of 1.5m meter below the natural ground surface from Marur road at Bhalki Taluk.

LATERITIC SOIL

1. Lateritic soils can be described as a product of tropical weathering with red, reddish brown, or dark brown color, with or without nodules and that generally found below hardened ferruginous crusts or pan.
2. The soil sample is collected from the industrial area of bidar. The soil passing through 4.75mm IS sieve was taken for this experimental work. The properties of lateritic soil and Expansive soil are as below in the table.

Table 3.1: Physical properties of Expensive soil.

Sl No	Property	values	
1.	Grain size distribution		
	a. Gravel(%)	04	3.5
	b. Sand(%)	77.6	90
	c. Silt and Clay(%)	18.4	6.5
2.	Atterburg limits		
	a. Liquid limit(%)	64	39
	b. Plastic limit(%)	35	22
	c. Plasticity Index(%)	29	17
3.	Differential free swell Index(%)	191	…..
4.	Specific Gravity	2.7	2.63
5.	P^H value	9.33	7.23
6.	Compaction characteristics		
	a. Maximum dry density (KN/m^3)	16.13	18.2
	b. Optimum Moisture Content (%)	21.8	13.5
7.	Unconfined Compressive Strength((KN/m^2)	293.60	413.60

Textile industrial wastewater effluent

The textile dyeing industry consumes large quantities of water and produces large volumes of wastewater from different steps in the dyeing and finishing processes.

Wastewater from printing and dyeing units is often rich in color, containing residues of reactive dyes and chemicals and requires proper treatment before being released into the environment.

The main challenge for the textile industry today is to modify production methods, so they are more ecologically friendly at a competitive price, by using safer dyes and chemicals and by reducing the cost of effluent treatment or disposal.

Textile effluent is a colored liquid and soluble in water. The chemical compositions of the effluent are in given table.

Chemical Composition of the Textile effluent

Sl No	Parameters	values
1.	Colour	Blue
2.	P^H	8.80
3.	Sulphates	300mg/l
4.	Chlorides	420mg/l
5.	Alkalinity	2500mg/l
6.	Acidity	0
7.	Suspended solids	1200gm
8.	Total solids	13.00gm
9.	BOD	140mg/l
10.	COD	6500mg/l

Procedure for mixing

The dried and pulverized and sieved through a sieve of 4.75mm to eliminate gravel fraction if any. The dried and sieved soil is stored in air tight containers and ready to use for mixing with effluents.

The soil sample so prepared is then mixed with solutions of different concentrations (20 to 100% in increment of 20 %.)Of Textile effluent.

Tests Conducted on treated soil

The index properties are those properties of soil, which are used in their identification and classification. Those properties comprise determination of:

1. Water content
2. Specific gravity
3. Particle size distribution
4. Consistency limits

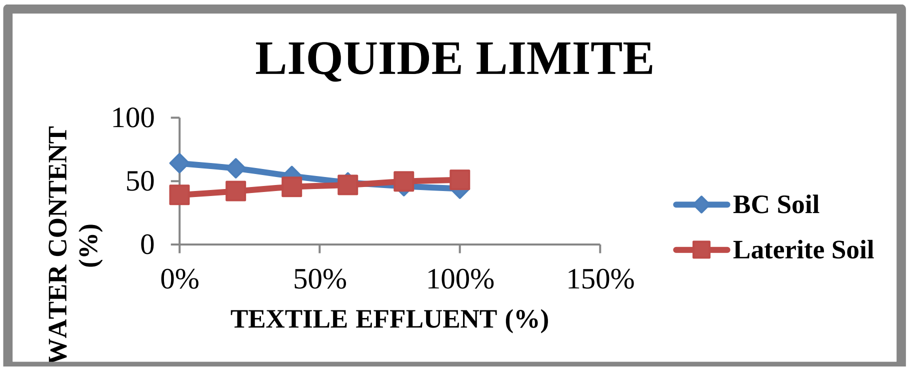
The engineering properties evaluated are:

1. Unconfined Compressive Strength Test
2. Compaction characteristics

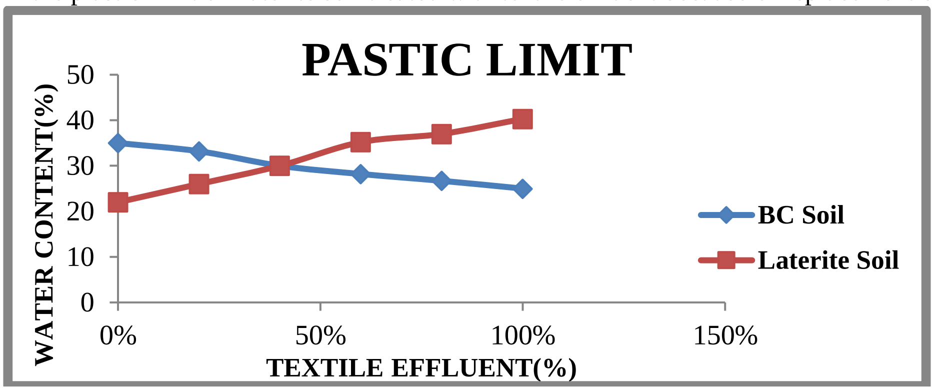
Experimental Program for Black Cotton Soil and Laterite Soil with Textile effluent

Mixture		Test conducted
BC Soil alone	Laterite Soil alone	Index and Engineering Properties of soil
BC Soil+ 20% Textile effluent	Laterite Soil+ 20% Textile effluent	
BC Soil + 40% Textile effluent	Laterite Soil + 40% Textile effluent	
BC Soil + 60% Textile effluent	Laterite Soil + 60% Textile effluent	
BC Soil + 80% Textile effluent	Laterite Soil + 80% Textile effluent	
BC Soil + 100% Textile effluent	Laterite Soil + 100% Textile effluent	

Effect of Textile Effluent on Liquid Limit of Black Cotton Soil and Laterite soil.
In BC soil addition of textile, effluent decreases the liquid limit of black cotton soil instantly due to replacement of exchangeable ions particularly monovalent ions by calcium ions and decreases the thickness of the diffused double layer leading to decrease in the water holding capacity.
In laterite soil, there is a sharp rise in the liquid limit from 39 to 51 immediately. Because of the chemicals added may lead to the replacement of cations, or surface held anions getting into the solution possible changes in diffused double layer thickness.



Effect of Textile Limit on Plastic Limit of Black Cotton Soil and Laterite soil.
The decrease in plastic limit immediately after the addition of textile effluent treated Black Cotton Soil due to increase in diffused double layer thickness, leads to decrease in shearing resistance.
The increase in the plastic limit of Laterite soil treated with textile effluent because of replacement of cations.



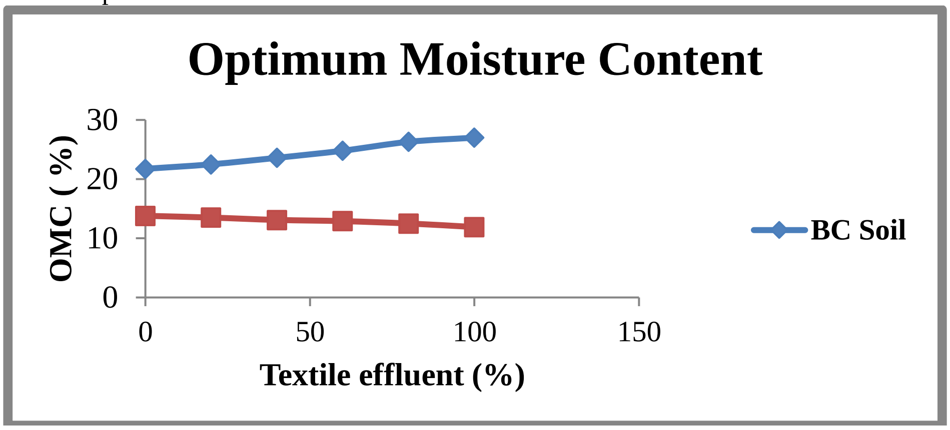
Determination of Compaction Characteristics

% EFFLUENT : % WATER	Expansive Soil		Laterite Soil	
	MDD in KN/m^3	OMC in %	MDD in KN/m^3	OMC in %
0:100	1.613	21.74	18.2	13.80
20:80	1.580	22.50	18.4	13.50
40:60	1.530	23.60	18.6	13.10
60:40	1.523	24.80	18.8	12.90
80:20	1.500	26.30	18.90	12.50
100:0	1.482	27.00	19.00	11.90

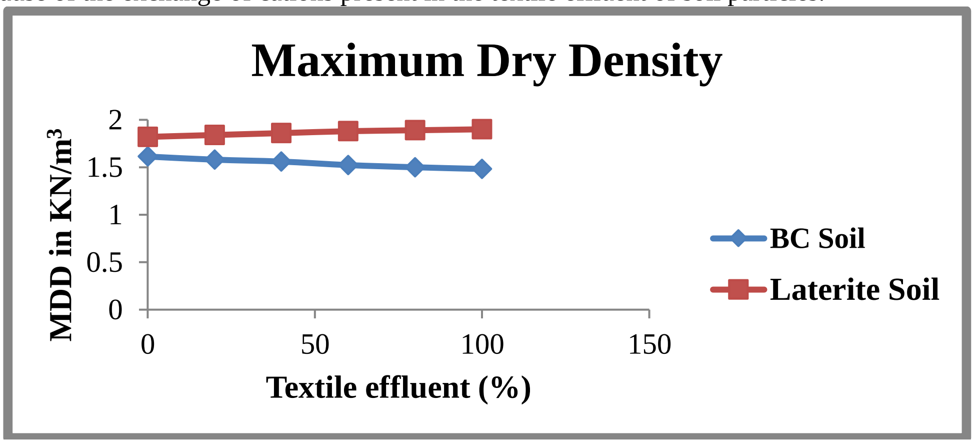
Effect of Textile Effluent on Optimum Moisture Contents for Expansive Soil and Laterite Soil.
Optimum pore fluid Content plays a vital role in changing the strength characteristics of an Expansive soil and laterite soil.

the optimum moisture content of expensive soil increases with respect percentage of textile effluent is about 21.74% to 27% from zero to 100% of textile effluent respectively this is because of activities of clay particles

The laterite soil slightly decreases with respect to varying percentage of textile effluent is about 13.80% to 11.90%, for zero to 100% of textile effluent respectively this is because of low hydration and no water movement to or from textile effluents past solid surfaces.



Effect Of Textile Effluent on Maximum Dry Density For Expansive Soil And Laterite Soil.
The expansive soil MDD value has decreased from 1.613KN/m^3 to 1.482KN/m^3 for zero to 100% textile effluent percentage respectively, this is because of the exchange of anions present in the textile effluent of clay particles. The laterite soil MDD value increase from 1.80KN/m^3 to 1.9KN/m^3 for zero to 100% textile effluent respectively. This is because of the exchange of cations present in the textile effluent of soil particles.



Determination of Strength Properties

Unconfined Compressive Strength of Expensive soil and Laterite soil treated with various percentages of Textile effluent with various percentages of Textile effluent.

Mixtures		Curing period in days
BC Soil alone	Laterite soil alone	0,1,3,7,15
BC Soil+ 20% Textile effluent	Laterite soil + 20% Textile effluent	0,1,3,7,15
BC Soil + 40% Textile effluent	Laterite soil + 40% Textile effluent	0,1,3,7,15
BC Soil + 60% Textile effluent	Laterite soil + 60% Textile effluent	0,1,3,7,15
BC Soil + 80% Textile effluent	Laterite soil + 80% Textile effluent	0,1,3,7,15
BC Soil + 100% Textile effluent	Laterite soil + 100% Textile effluent	0,1,3,7,15

Summary of Strength characteristics of Expensive soil and Laterite soil

% EFFLUENT : % WATER	UCS values in Kpa									
	0 days		1st day		3rd day		7th day		15th day	
	Expensive Soil	Laterite Soil	Expensive Soil	Laterite Soil	Expensive Soil	Laterite Soil	Expensive Soil	Laterite Soil	Expensive Soil	Laterite Soil
0:100	293.60	413.27	298.89	504.10	308.56	517.90	323.60	548.55	332.40	556.33
20:80	306.40	488.70	312.68	535.17	328.01	612.70	332.37	625.87	339.13	634.56
40:60	342.84	521.55	348.41	685.60	359.90	719.98	362.90	751.10	376.13	788.54
60:40	357.47	612.80	365.98	754.20	374.50	776.86	382.47	808.40	392.51	834.50
80:20	363.34	657.40	374.50	805.69	385.70	885.20	388.43	938.80	398.01	973.58
100:0	374.50	685.60	388.43	834.18	391.30	949.51	399.98	990.60	401.60	1100.24

Effect of Textile Effluent on the Unconfined Compressive Strength of Expensive Soil

The results indicate that the concentration of cation has very significant effect on unconfined compressive strength. The curing period also influenced the strength of soil. Textile effluent do contain Cl_2 and SO_4 are leaving group enabling the dye to bond takes place between clay minerals and dyes. The chemical bonding may be responsible for the increase in UCS with it is treated with textile effluent with different curing period.

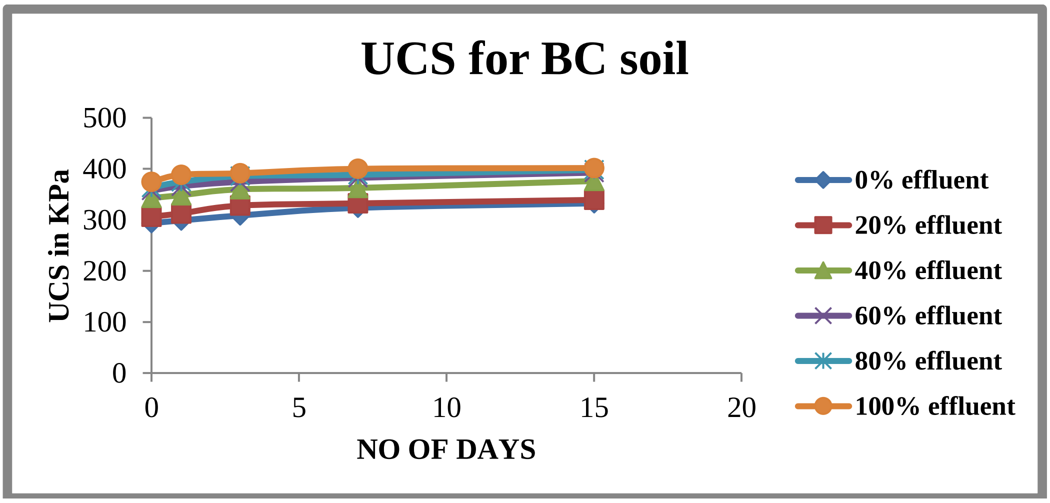


Fig.4.22: Unconfined compressive strength of Expensive soil treated with various percentages of Textile effluent with various curing period

Effect of Textile Effluent on the Unconfined Compressive Strength of Laterite Soil

The increase in UCS values due to a textile effluent mixture containing rich in Cl_2 and SO_4 ions. These ions change the sensitivity are dissipated flocculent of soil particles increase the curing period as shown in fig.4.29. The gain in strength with age was due to chemical bonding may be responsible for the increase in UCS with it is treated with different concentration of textile effluent with different curing period.

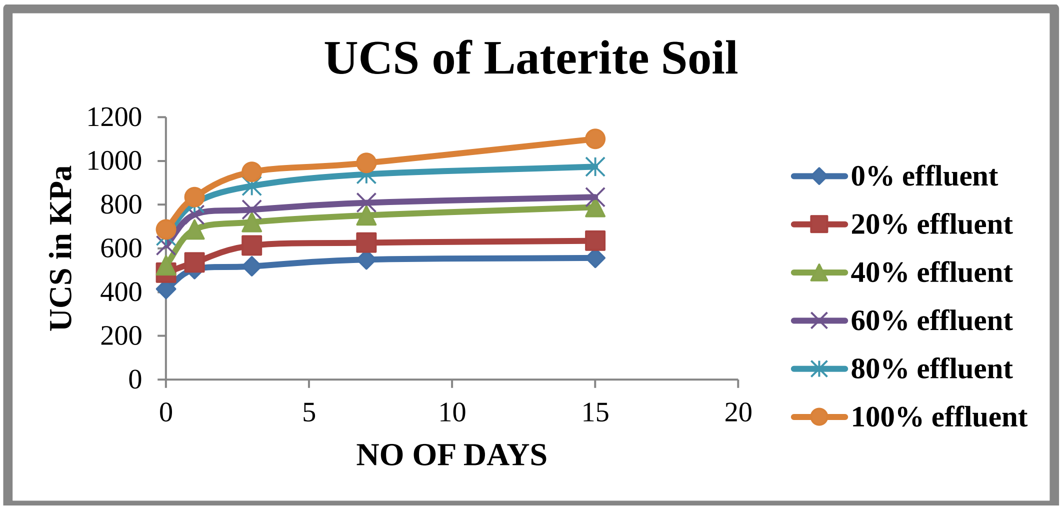


Fig.4.29: Unconfined compressive strength of Laterite soil treated with various percentages of Textile effluent with various curing period

CONCLUSIONS

1. The Liquid limit and plastic limit values of expensive soil are decreases and increases in laterite soil treated with various percentages of textile effluent.
2. The optimum moisture content of expensive soil increase with treating the different percentages of textile effluent whereas decreases in laterite soil.
3. There is a slight reduction in MDD for expensive soil and slightly increases for laterite soil addition with various percentages of textile effluent.
4. The UCS of the both soils increases with treated with different concentration textile effluent with respective curing period.
5. The UCS of the laterite soil gradually increases with textile effluent with respective curing period.
6. For lesser curing periods more quantity of textile effluent is required to achieve the same strength.
7. The stability of soils mass is increased due to the addition of textile effluent.
8. Finally, concluded that textile effluent is more effective for laterite soil.