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Experimental Evaluation of Dye Effluent Contaminated Soil

S. Sushmitha[1], G. Guru Prasad[3], M. Jayaprakash[4]
[1, 3, 4], UG Student,
Civil Engineering Department,
Jansons Institute of Technology,
Coimbatore, Tamil Nadu, India

R. Jagadeesh Kumar[2],
[2,] Assistant Professor ,
Civil Engineering Department,
Jansons Institute Of Technology,
Coimbatore, Tamil Nadu, India

Abstract: **Soil, a most common material exists over the entire earth surface, even below the water bodies. It plays a major role in the field of Civil Engineering as it is the only medium available for supporting any infrastructure. The properties of soil are the influencing factors and has its ability to withstand loads coming over it and remain unchanged until any external agents react on it. Geotechnical Engineering is the branch of Civil Engineering that deals with the engineering behaviour of earth materials. Soil plays a major role in this field. The properties of soil are altered by various geotechnical methods. Changes in properties of the soil are due to various external factors. The addition or subtraction of external agencies into the soil causes drastic difference in the characteristics of the soil. Dye water from textile industries is a major pollutant when it gets mixed with the water bodies, thereby polluting the soil. In this project, it is aimed at evaluating and inspecting the influence of dye effluent from a Textile industry on red soil and thus how it has influenced the soil. The local soil has been collected from Annur(11.23˚N, 77.1˚E), Coimbatore District, Tamil Nadu and the dye effluent was collected from nearby Dyeing Unit in Tiruppur. The soil is subjected to initial tests and the results are gathered. Then the soil is mixed with the dye effluent, tested again to ensure variations in soil properties, after 5 days curing period. Curing is done by adding varying percentages of effluent as 5%, 10%, 15%, 20%. The influence of dye effluent on soil is been studied and the results thus obtained after the tests are summarized to bring out the changes in soil parameters. Thus it is concluded in such a way if the contaminated soil could be utilized for construction purpose if possible, or if it could be utilized for any other purposes like incase of agriculture, backfilling or can be treated and reused. The results obtained shows that there is a reduction in soil strength and it is advised to treat the effluent before disposal into the environment.**

Keywords: ***pollutant, dye, effluent, curing period, soil strength***

1. INTRODUCTION

A dye is a coloured substance that gets in contact with which it is applied thus forming chemical bondage between them. Dye water from textile industries is a major contaminant to the water bodies. They are a wide range of organic pollutants to the water bodies. In particular, the discharge of dye effluent into the water is undesirable because of release of toxic, carcinogenic substances. Generally the industrial wastes are discharged either treated or untreated into water bodies. These industrial wastes if let over soil or incase of accidental spillage of chemical substances, it may lead to changes in soil properties, causing either improvement or degradation of engineering behaviour of soil, sometimes leading to functional or structural failure of structures resting on it. Without any proper treatment these dyes can remain same in the environment. For example, the half-life of Diamond Black PV 200 dye was 13h at pH 9. The tests are carried out separately for soil to determine its engineering properties and for the effluent to determine its pH, COD, BOD values. Combined result is issued on the utilization of such dye water contaminated soil. If there is degradation in soil properties, the dye effluent could be mixed with the soil for drip irrigation purpose, to ensure the flow of water in the drip. On the other hand, if there is an improvement in soil properties, the result could serve the purpose of safe effluent disposal and conservation of soil.

Several research works (Ayush Mittal, R.K. Srivastava) reveals that the UCC value of soil is increasing continuously as the concentration of dye/kg increases, which shows that soil gets stabilized with dye mixing. In addition some investigators (H. N. Bhatti, S. Sadaf and A. Aleem, 2015) indicated that Sugarcane bagasse, corncobs and cotton stick biomass showed maximum removal efficiency for dyes from textile wastewater and also they were considered best option for treatment of textile effluents.

Furthermore studies (Reza Ansari*,et al 2011) reveal that, application of sawdust obtained from carpentry workshops using walnut seems to be a very economical and promising adsorbent for treatment of textile industries wastewaters. Few other researchers (Ozlem Ceyhan and Demet Baybas, 2001) found that no sorption of textile dyes occurred on non-bentonite, the textile dyes were strongly sorbed on HDTMA-Bentonite.

1.1 OBJECTIVE OF THE STUDY

The objective of this experimental investigation is to study the reaction of dye effluent from the textile industry on the physical and engineering properties of red soil. Discharge of textile dye effluent into the environment is a major concern for Civil Engineers. About 50% of treated dye reach the environment and about 2-20% of untreated dye reach the environment.

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2. MATERIALS

2.1 SOIL

The red soil sample for the current study was collected from Annur, Coimbatore District. The dye effluent was collected from nearby dyeing unit in Tiruppur.

2.2 PROPERTIES OF RED SOIL

Various laboratory tests were conducted to determine the properties of red soil. The various properties of red soil are given in Table 1.

Table 1: Properties of Red Soil (Unaltered)

S. NO	PROPERTIES	RESULT
1	SPECIFIC GRAVITY	2.66
2	SIEVE ANALYSIS % OF GRAVEL % OF SAND % OF SILT	 15.8 % 76.9% 7.3%
3	FREE SWELL INDEX	0
4	LIQUID LIMIT (W_l)	23%
	PLASTIC LIMIT (W_p)	71.2%
	SHRINKAGE LIMIT (W_s)	27.78%
	FLOW INDEX (I_f)	22
	TOUGHNESS INDEX (I_T)	0
5	OPTIMUM MOISTURE CONTENT	8%
	DRY DENSITY	0.0016g/mm^3
6	CALIFORNIA BEARING RATIO	2%
7	UNCONFINED COMPRESSIVE STRENGTH (Q_U)	0.027 N/mm^2
	COHESION (C)	0.0135 N/mm^2

2.3 PROPERTIES OF DYE EFFLUENT

Table 2: Properties of dye effluent

S. NO	PROPERTIES	RESULT
1	pH	
	4.01 buffer solution	8.26
	9.18 buffer solution	8.85
2	TURBIDITY	42.1 NTU
3	COD	20mg/l

2.4 PROPERTIES OF EFFLUENT CONTAMINATED SOIL

Table 3: Properties

S. NO	PROPERTIES	RESULT
1	LIQUID LIMIT (W_L)	
	5% effluent	20%
	10% effluent	17%
	15% effluent	13%
	20% effluent	11%
	PLASTIC LIMIT (W_P)	
	5% effluent	78%
	10% effluent	81.4%
	15% effluent	84.4%
	20% effluent	88%
2	OPTIMUM MOISTURE CONTENT	
	5% effluent	6%
	10% effluent	4.2%
	15% effluent	2%
	20% effluent	2%
3	UNCONFINED COMPRESSIVE STRENGTH (Q_U)	
	5% effluent	0.027 N/mm^2
	10% effluent	0.023 N/mm^2
	15% effluent	0.023 N/mm^2
	20% effluent	0.02 N/mm^2
	COHESION (C)	0.0135 N/mm^2
	5% effluent	
	10% effluent	0.0115 N/mm^2
	15% effluent	0.0115 N/mm^2
	20% effluent	0.01 N/mm^2

3. EXPERIMENTAL TESTS

3.1 ATTERBERG'S LIMIT – LIQUID LIMIT

The graph shown below indicates the liquid limit values for varying percentages of effluent into the soil.

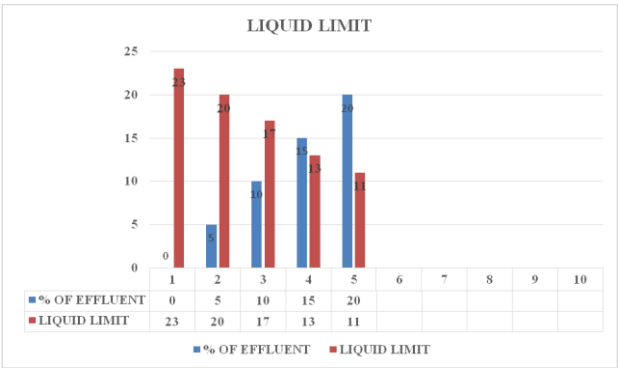

Figure 1: Liquid limit for varying % of effluent

3.2 STANDARD PROCTOR COMPACTION TEST

The graph attached below shows the percentage variations of addition of dye effluent into the soil, and thus the optimum moisture content is obtained at every increase in percentage.

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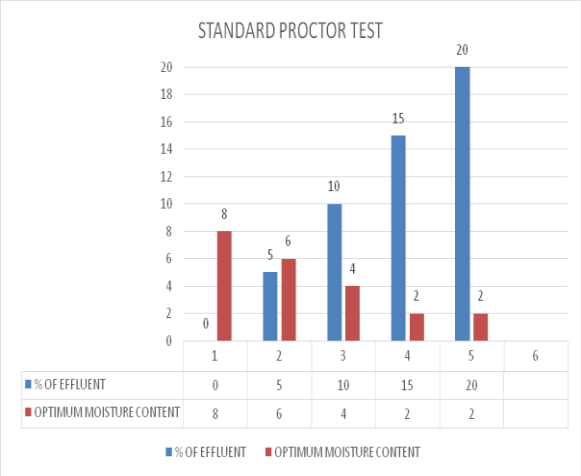

Figure 2: Optimum moisture content for varying % of effluent

Figure 2.a: Standard proctor compactor

3.3 UNCONFINED COMPRESSIVE STRENGTH

The graph shown below indicates the varied values of UCC for different percentages of effluent added.

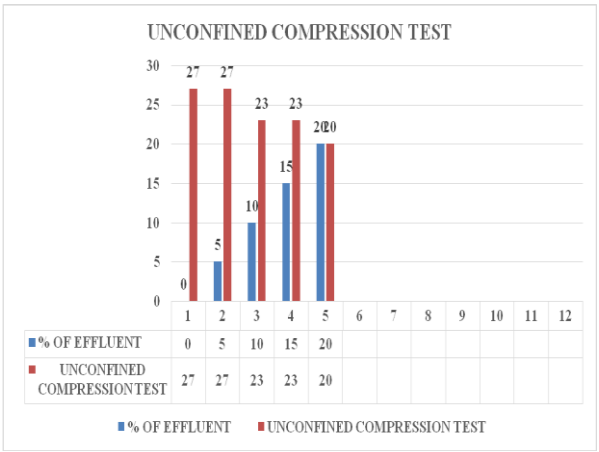

Figure 3: UCC values for varying % of effluent

Figure 3.a: Unconfined Compression Tester

4. RESULTS AND DISCUSSION

The various test results have shown that the soil strength parameters are considerably reduced on addition of dye effluent into the soil.

5. CONCLUSION

The experiments undergone are taken into consideration to evaluate the variations in soil parameters. Results have shown considerable decrease in the soil strength values. Thus, it is concluded in such a way that the contaminated soil is unfit for foundation aspects and thus could only be utilized after proper treatment of the dye effluent.

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