Textile Effluent Interaction with the Geotechnical Properties of Clayey Soil

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Abstract - *Industrial effluents released by various industries is a major problem today. These effluents are disposed either treated or untreated over land. Then it interacts with the soil and environment. This causes variation in geotechnical properties of soil. This variation can affect the construction and safety of building structures. So it is necessary to study the effect of various industrial effluents on soil properties. In this paper, an attempt is made to study the effect of textile effluent on clayey soil. Textile effluent is added in varying percentages from 25 to 100% with an increment of 25% to study the effect on plasticity index, pH and unconfined compressive strength.*

Key Words: **Textile effluent, Plasticity index, OMC, MDD, UCC, pH.**

1.INTRODUCTION

Textile Industry is one of the growing industries in our country. The effluent released by this industry is deposited on river and land areas. Many researchers have suggested that textile effluent can cause river pollution and thereby affecting the balance of the environment. But the effluent deposited on land may add some benefits to the soil properties. If so, then it is beneficial and supports the stability of the structures. But it is necessary to study the interaction between the soil and the industrial effluent. Hence in this study, an attempt is made to study the interaction between textile effluent and high plastic clay. Textile effluent is added in varying concentrations from 0 to 100% with an increment of 25%.

A lot of research works have been carried out on expansive soils to study the effect of textile effluent. Vaadi, et al., (2015) studied the effect of textile effluent on geotechnical properties of expansive soil. They have observed an increase in compressive strength due to the textile effluent. Rao, et al., (2009), studied the effect of textile effluent on geotechnical properties of black cotton soil. The result was decrease in differential free swell index. Similar works were done by so many researchers and they have suggested that textile effluent can minimize the problems in an expansive soil. Ayush, et al., (2010), studied the interaction of silty soil with textile dye. They observed an increase in optimum moisture content and unconfined compressive strength. Similar works were conducted by so many researchers and most of them observed an improvement in soil properties.

With respect to both the quantity and composition, the textile processing wastewater is recorded as the most polluted sources among all industrial sectors.The bulk effluents generated from textile industries are discharged either treated or untreated over the soil leading to changes in soil properties causing improvement or degradation of engineering behavior of soil. If there is an improvement in engineering behavior of soil, there is a value addition to the industrial wastes serving the three benefits of safe disposal of effluent, using as a stabilizer and return of income on it. The change in geotechnical properties due to effluent contamination must be studied before any construction work is started. Otherwise it may cause problems to geotechnical engineer. Textile effluent interaction with high plastic clayey soil is discussed here.

2. MATERIALS AND METHODS

2.1 Clay

The soil was collected from Coimbatore. The sample was classified as high plastic clay (CH) as per IS classification. The scanning electron microscopic image of the soil sample is given in fig 1. The physical properties of soil sample are given in table 1.

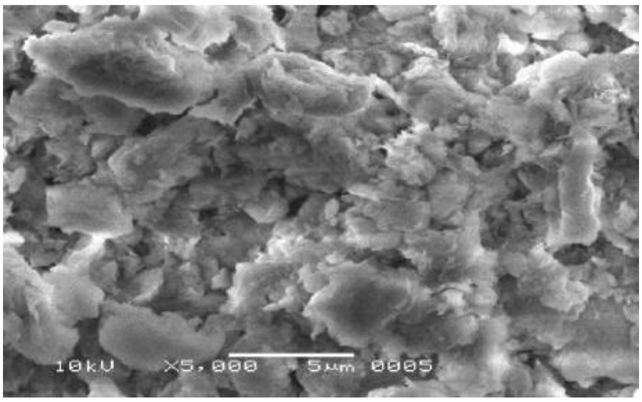

Fig-1: SEM image of Soil sample

Table-1: Properties of soil

Soil Properties	Value
Specific Gravity	2.26
Liquid Limit (%)	110
Plastic Limit (%)	50
Plasticity Index (%)	60
IS Classification	CH
OMC (%)	19.4
Dry density (g/cc)	1.46
UCC Strength (kN/m²)	91.35
% clay	77.5
% silt	14.5
% sand	8
Free Swell Index	1.6

2.2 Textile Effluent

The contaminant used in this study is textile effluent. It was collected from Palakkad district. The effluent is colored and is soluble in water. The characteristics of textile effluent are given in table 2.

Table-2: Characteristics of textile effluent

Analytical Parameters	Real Sample (avg.)
COD (mg/l)	750
BOD (mg/l)	192
Turbidity(NTU)	119
Sulphide (mg/l)	126
Chloride (mg/l)	1200
Hardness (mg/l)	410
Alkalinity (mg/l)	1140
Total suspended solids (mg/l)	460
Total dissolved solids (mg/l)	2180

The soil was mixed with the textile effluent and was stored in an airtight container for one day before testing.

3. RESULTS AND DISCUSSIONS

The textile effluent was mixed with the soil sample in varying percentages from 0 to 100% with an increment of 25%. The resulting mixture was tested to determine the change in geotechnical properties such as liquid limit, compaction characteristics, UCC strength and curing strength.

3.1 Liquid Limit

The liquid limit of the soil sample decreases with increase in concentration of textile effluent. The liquid limit decreases with increase in concentration of textile effluent. This may be due to the decrease in diffused double layer thickness. The chlorides in the additives reacted with lower valence metallic ions in the clay microstructure and causes decrease in double layer thickness. (Rao et al.,2012). The scanning electron microscopic image of soil mixed with 100% textile effluent is shown in fig 3.

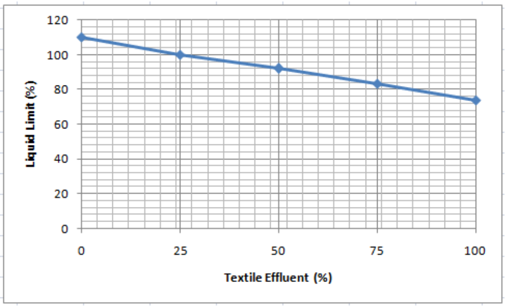

Fig-2: Variation in Liquid limit with varying percentages of textile effluent

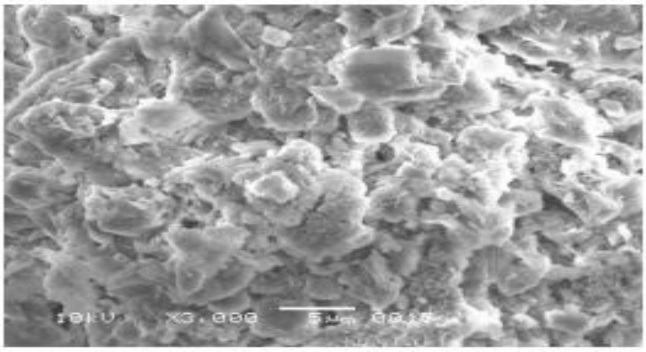

Fig-3: SEM image of soil mixed with 100% textile effluent

3.2 Compaction Characteristics

The effect of textile effluent on the compaction characteristics such as optimum moisture content (OMC) and maximum dry density (MDD) were studied and is discussed here.

i) Effect on OMC

The change in OMC due to varying percentages of textile effluent is discussed here.

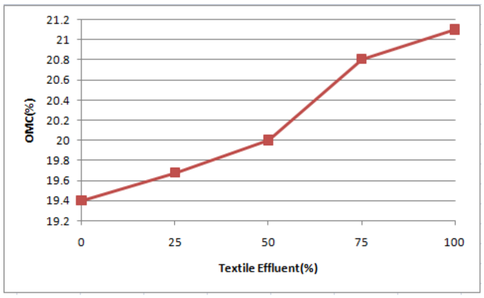

Fig-4: Variation in OMC with varying percentages of textile effluent

OMC slightly increases with increase in concentration of textile effluent. Since there is a decrease in diffused double layer thickness, the net attractive forces increase and flocculation will occur. Due to the water holding capacity within the voids of flocculated structure, water holding capacity of soil increases and hence OMC increases.

ii) Effect on MDD

The change in MDD due to varying percentages is shown in fig 5.

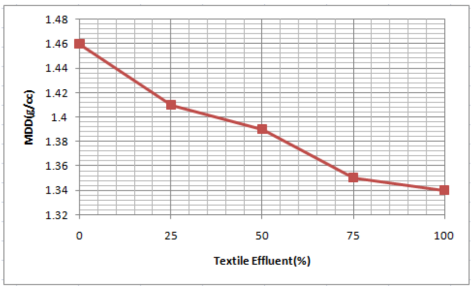

Fig-5: Variation in MDD with varying percentages of textile effluent

It can be seen that MDD decreases with increase in concentration of textile effluent. It is because of the decrease in specific gravity of the soil caused by textile effluent. Also, due to flocculation, net attractive forces increases and thereby dry density decreases.

3.3 Compressive Strength

The variation of unconfined compressive strength with varying percentages of textile effluent is shown in fig 6.

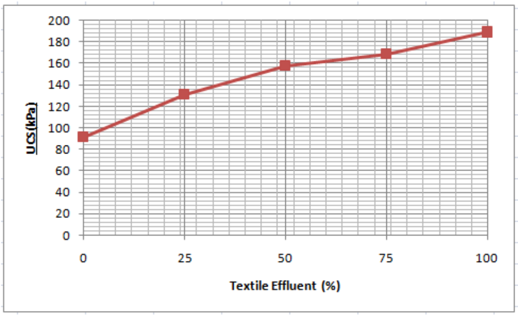

Fig-6: Variation in UCS with varying percentages of textile effluent

The unconfined compressive strength increases with increase in concentration of textile effluent. The strength of the soil mixed with 100% textile effluent is approximately 200% more than the strength of the original soil sample. The bonding of the effluent with the soil is the reason for the higher strength of soil. Textile effluent contains Cl^- or $O\text{-}SO_3$ as the leaving group enabling dyes to form covalent bonds with clay minerals. Also, flocculated structure has higher shear strength compared to dispersed structure.

3.4 Curing Strength

The curing strength of the soil sample with varying percentages of textile effluent is shown in fig 7. Four different curing periods are considered for the study namely 1,7,14 and 28 days.

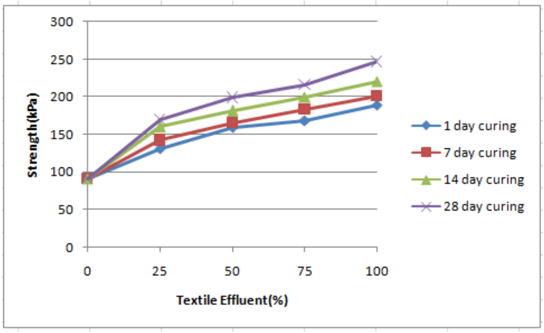

Fig-7: Variation of strength with varying percentages of textile effluent for different curing period

The strength of the soil increases not only with increase in concentration of textile effluent but also with increase in curing periods. The maximum strength is obtained for soil sample mixed with 100% textile effluent which is cured for 28 days. From this, it is clear that textile effluent do not cause decay in soil properties with ageing.

4. CONCLUSIONS

In this study, an attempt has been made to study the effect of textile effluent on the geotechnical properties of high plastic clay. From the results presented in this paper, following conclusions are drawn.

- Textile effluent has a positive effect on high plastic clay. The liquid limit decreases with increase in concentration of textile effluent. This due to the decrease in diffused double layer thickness.
- The OMC increases with increase in concentration of textile effluent. This is due to the higher water holding capacity within the voids of flocculated structure.
- MDD decreases slightly with increase in concentration of textile effluent. This is due to the lower specific gravity and also due to flocculation.
- Unconfined compressive strength increases with increase in concentration of textile effluent. This is due to the strong bonding of the textile effluent with the soil.
- The strength of the soil mixed with textile effluent increases with both increase in concentration of textile effluent and with increase in curing period.

Hence it is evident that textile effluent adds benefits to high plastic clay and can be safely disposed even without treatment on the land with high plastic clay.

REFERENCES

[1] IS: 2720 (Part 7) - 1980 Determination of water content-dry density relation using light compaction.

[2] IS: 2720 (Part 5)-1985 Determination of Liquid and Plastic Limit.

[3] IS: 2720 (Part 10) - 1991 Determination of Unconfined Compressive Strength.

[4] Mallikarjuna, Rao. K., Tirumala, Rao, K.,& Reddy, Babu, G.,(2008).“On interaction of clayey soil with textile dye waste”, EJGE ,Vol 13.

[5] Narasimha, Rao, A. V.,& Indiramma, P.,(2009) “Effect of textile effluent on geotechnical properties of black cotton soil”, IGC,308-311

[6] K. Muthukkumaran.,(2010). “Effect of liquid waste on index and engineering behavior of cohesive soils”, Indian Technical Journal, Vol 40, Issue 3, 195-200

[7] Oriola, O., & Saminu, A.,(2012). “Influence of textile effluent waste water on compacted lateritic soil”, EJGE,Vol17

[8] Narasimha, Rao, A.V., & Chittaranjan, M.,(2012). “Effect of certain industrial effluents on compaction characteristics of an expansive soil”, International Journal of Engineering Inventions, Volume1, Issue 7, 22-28.

[9] Narasimha, Rao, A.V., & Chittaranjan, M.,(2012). “Influence of soil industrial effluent interactions on subgrade strength of an expansive soil.” IJAET, Vol 5, Issue1, 326-335.