INFLUENCE OF INDUSTRIAL EFFLUENTS ON PROPERTIES OF SOIL

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ABSTRACT

Industrialization and urbanization play a key role in economy of a country. Industrialization and urbanisation of the country though lead to a rapid growth of industries is prone to produce certain spillovers like contamination of land and water streams through improper treatment practices. Contamination of land is a serious issue as it modifies index and engineering properties of soils. Modification of soil properties from industrial wastes results in foundation failures, structural damage in light industrial buildings .Safe disposal of wastes is one of the important factors that has become the present paramount. On the other hand in many situations, soils in its natural state do not present adequate geotechnical properties to be used as foundation layers and road service layers. An emphasis is laid on soil stabilization of expansive soils so that geotechnical properties are in confirm with technical specifications of construction industry. Present work is to find out the properties of the expansive soil mixed with effluents at varying percentages and to govern the behavior of soil when mixed with different percentage of effluent.

Key words: Index and Engineering properties of soil, Industrial effluents, Stabilization of soil

I INTRODUCTION

Soil is one of the vital resources which is obtained by weathering of rock. The nature of soil in a place is largely influenced by such factors as climate, natural vegetation and rocks. Various types of soil found in India include alluvial soil, laterite soil, red soil, black soil, desert soil, and mountain soil. Determination of soil conditions is the most important work for every type of civil construction. Out of the listed down types of soils, black soil also called as regur soil is the vulnerable type as it has expansive and shrinkage property which is due to the presence of montmorillonite. The formation of swelling soil is generally attributed to sedimentation and environmental conditions in geological past[1]. They are prone to have low shear strength. Because of this alternate swelling and shrinkage, structures erected on them are severally damaged. Expansive soils pose serious problems to civil engineers in general and to geotechnical engineers in particular. They result in detrimental cracking of lightly loaded civil engineering structures such as foundations, retaining walls, pavements, airports, sidewalks, canal beds and linings etc[3]. The primary problem that arises with regard to expansive soils is that, the swelling induced deformations are significantly greater than elastic deformations and classical elastic and plastic theories cannot predict them. [13].

Once an expansive soil has been characterized, guidelines for systematic and logical selection of treatment, alternatives, or combinations of treatments that effectively minimize volume change and associated damage to structures should be thought of. One of the best said remedial measure is stabilization of soil with the help of external agents[4][5]. Soil stabilization is the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction beyond their original classification. Inherent soil physicochemical properties influence the behavior of soil and hence, knowledge of soil property is important. Cropping and leaching of soil nutrients, in turn adversely affects physicochemical properties of the soil.

An effluent is an inevitable production of industrial process. It is defined as the "wastewater (treated or untreated) that flows out of a treatment plant, sewer or industrial outfall[7]. Increased number of industries has enlarged the disposal of effluent to open land or to natural water resources. Effluent of different industries may vary in composition depending upon the source of production. Effluent may contain essential nutrients and some toxic substances. Disposal of untreated industrial and domestic wastes into the environment affects both soil and ground water quality[8]. The available macronutrients and micronutrients of effluents can increase soil fertility. Physiochemical analysis of the effluents is necessary in order to decide the time period of application of effluents so that engineering properties of soil are not affected adversely

II MATERIALS

The primary material used in the present study is black cotton soil which is obtained from GPREC campus, Kurnool. These types of soils are very sensitive to changes in environment such as change in applied stress, pore fluid chemistry and its surrounding environmental conditions. The soil is air dried, pulverized and sieved through 4.75mm and 425μ, 300μ IS sieve depending on the type of test. The physical properties of the soil were determined as per IS specifications. Effluents are collected from dairy and alkalies industry.

III METHODOLOGY

The methodology formulated for the present study is shown in fig 1.The soil from the site is dried and hand sorted to remove the pebbles and vegetative matter if any. It is further dried and pulverized and sieved through a sieve of 4.75mm to eliminate gravel fraction if any. The soil sample so prepared is then mixed with water and different concentrations of dairy and alkalies effluent in 30:70, 70:30 and 0:100 proportions. The ratio of concentration of alkali and dairy effluents taken for the present study is 1:2 as the pH of effluent from alkalies was found to be more than the dairy effluent. In order to avoid formation of complex hydro silicates a reduction in concentration of alkali effluent is assumed in present study. Various laboratory tests were carried out for determining the index properties of the soil and the physical and chemical properties of industrial effluents. Index properties

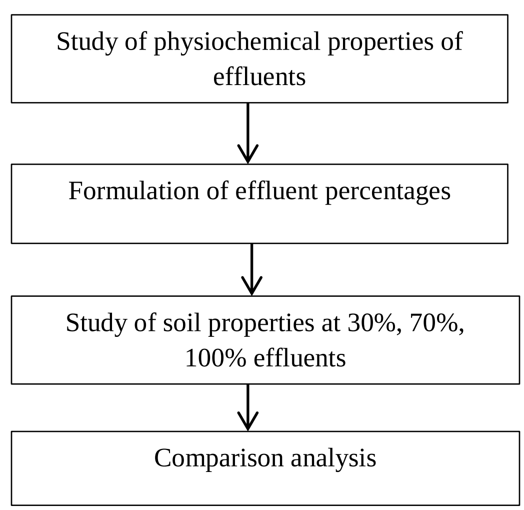

Fig 1: Methodology Involved

of soil include determination of consistency limits, proctor's test, unconfined compression test. The purpose of determination of consistency limits is to identify plastic nature of soil. Liquid limit is defined as the minimum water content at which the soil is in liquid state but has small shear strength against flow. The test is conducted on soil passing 425 micron I.S. sieve using Casagrande's apparatus. Plastic limit is defined as the water content at which the soil rolled into a thread of 3mm diameter begins to crumble. The test is conducted on soil passing 425 micron I.S. sieve. The liquid limit and plastic limits are both dependent on the amount and type of clay in a soil and form the basis for soil classification system for cohesive soils based on plasticity tests. They are also used directly in specifications for controlling soil for use in fill.

All types of constructions, such as dams, embankments, highways and airports require soil fill which is placed in layers and compacted. The compacted soil will have high compressive strength and high resistance to deformation. For the determination of compactness of soil at minimum water content formulation of results from Standard Proctor's test are essential. The purpose of a laboratory test is to determine the proper amount of mixing water to use when compacting the soil in the field and the resulting degree of denseness which can be expected from compaction at this water content.

In order to know the resistance of soil to compression, unconfined compressive strength is performed, which is then used to calculate the unconsolidated undrained shear strength of the clay under unconfined conditions. According to the ASTM standard, the unconfined compressive strength (q_u) is defined as the compressive stress at which an unconfined cylindrical specimen of soil will fail in a simple compression test. For any water associated structure the most critical condition for the soil usually occurs immediately after construction, which represents undrained conditions, when the undrained shear strength is basically equal to the cohesion (c).This is expressed as:

$$C = \frac{q_u}{2}$$

As the structure gets filled with water the pore water in the soil slowly dissipates, and the intergranular stress increases, so that the drained shear strength (s), given by

$$s = c + s' \tan \emptyset$$

where s' = intergranular pressure acting perpendicular to the shear plane,

s = total pressure,

c' and φ' are drained shear strength parameters.

In order to determine chemical properties of effluents, laboratory tests on pH, sulpahtes and chlorides content were conducted. The basic purpose of chemical analysis is to identify the percentage of dairy and industrial effluents to avoid formation of complex molecules.

IV RESULTS AND DISCUSSIONS

The consistency limits of the soil under study are tabulated as below.

Table 1: Consistency limits

Atterberg limits	Percentage
Liquid limit	76.85
Plastic limit	46.10

From the table it can be said that plasticity index which is the difference of liquid limit and plastic limit is around 30.75%. With reference to the plasticity chart, soil with liquid limit of 76.85% and plasticity index of 30.75% is classified as CH i.e inorganic clays of high compressibility. The characteristic of inorganic clays of high compressibility is that they exhibit high dry strength and toughness when compacted at appropriate moisture content.

The results of chemical analysis on effluents are shown in table 2. From the results it can be said that acidic content in alkalies industry effluent is more when compared to dairy industry. According to code SP-36, Sulphates content in water used for soil testing is to be less than 500mg/l and the result on effluents from dairy and alkalies is found satisfactory. Similarly chloride content in water should be less than 1000mg/l and the result on effluent from alkalies industry only is found to be satisfactory.

Table 2: Chemical analysis of effluents.

Parameter	Dairy Industry	Alkalies Industry
pH	7.07	1.82
Sulphates(mg/l)	204	259.2
Chlorides(mg/l)	1344.44	367.79

Based on the results obtained four different ratios of alkalies were adopted for conducting proctor's test and unconfined compression test. The ratios of effluents to water in percentages are 0:100, 30:70, 70:30 and 100:0.

The results of standard proctor test are tabulated in table 3. From table 3 it is evident that there is an increase of 6.8% in maximum dry density at 30:70 ratio accompanied by 3.8% decrease for 70:30 ratio which was found to be steady for other ratios even. The optimum moisture content corresponding to 30:70 ratio is found to have a decrease of about 12.46% when compared to 0:100 ratio which is again accompanied by a small increase. On the offset the ratio of effluent to water which amounts to 30:70 is found to give fruitful results. The results of proctor test for each ratio id shown in graphs for better understanding.

Table 3: OMC and MDD for different ratios

S.No	Effluent:Water	Property	Value
1	0:100	OMC	26.16%
		MDD	1.45 kN/m³
2	30:70	OMC	22.90%
		MDD	1.55 kN/m³
3	70:30	OMC	23.90%
		MDD	1.49 kN/m³
4	100:0	OMC	23.60%
		MDD	1.49 kN/m³

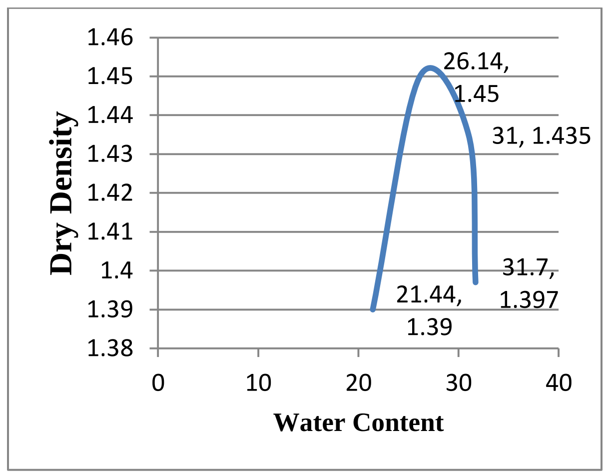

Fig 2: OMC vs MDD at 0:100 ratio

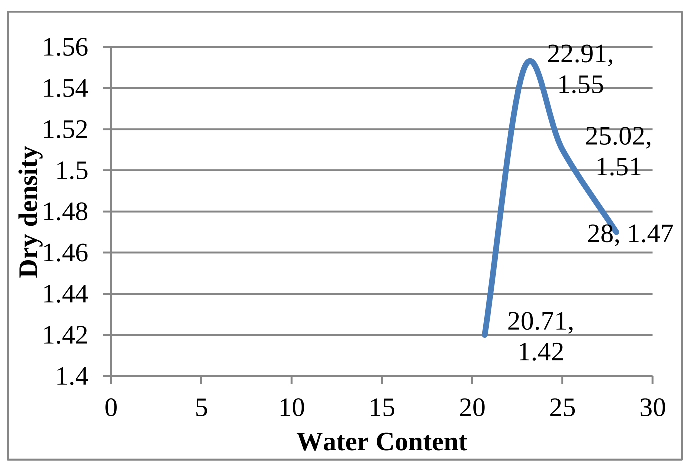

Fig 3: OMC vs MDD at 30:70 ratio

The soil treated with 30% of effluents is found to have more shear strength than the untreated sample as shown in table 4. An abrupt increase of shear strength is witnessed at 30:70 ratio followed by mild decrease of about 33.57% at 70:30 ratio accompanied by still 33% more decrease for 100:0 ratio. Thus in terms of shear strength, OMC and MDD 30:70 ratio of effluent and water which is used to treat soil is found satisfactory.

Table 4: Shear strength at different effluent: water ratios

S.NO	Effluent: Water	Shearstrength(Kg/cm^2)
1	0:100	0.66
2	30:70	1.76
3	70:30	1.17
4	100:0	0.78

In the case of Expansive soils the Engineering behavior of the soil is governed by thickness of diffused double layer. The thickness of double layer in turn affected by pore fluid chemistry such as Dielectric Constant, Electrolyte Concentration, Ion valency, and hydrated ion radius etc., When Soil interacts with Industrial effluents; the interaction changes the pore fluid chemistry and subsequently the thickness of diffused double layer. These changes are likely to be reflected by variation in compaction characteristics and also engineering properties of soil.

V CONCLUSIONS

Industrial activity is necessary for socio-economic progress of a country but at the same time it generates large amounts of solid and liquid wastes. Soil waste interaction causes improvement in soil properties and hence the industrial wastes can be used as soil stabilizers. The following conclusions can be obtained from the work:

- OMC and MDD were calculated for different proportion of effluents by performing Proctor Compaction Test.
- An increase of the order of 6.8% was observed in MDD when soil was treated with effluent: water proportion of 30:70 followed by a increase of the order of 2.7% at 70:30 proportion which remained to be constant for latter proportions.
- A decrease of the order of 12% was observed when soil was treated with 30:70 proportion followed by a decrease of 8% when soil was treated with 70:30 proportions which remained to be constant for further proportions.
- In the nutshell, the moisture content corresponding to higher MDD was observed to be low.
- The shear strength of the soil sample mixed with 30% effluent is found to be more compared to the untreated sample.
- The shear strength of the samples mixed with 70% and 100% effluent is little less than that of the sample mixed with 30% effluent but is higher than the untreated sample.

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