International Journal of Constructive Research in Civil Engineering (IJCRCE)
Volume 2, Issue 1, 2016, PP 44-48
ISSN 2454-8693 (Online)
www.arcjournals.org

Effect of Amino Acid Based Effluent on Soil Characteristics

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Abstract: *The present investigation is an attempt to study the behavior of the soil which has been reported to be polluted by the disposal of amino acid based effluent on land. Studies have also been carried out on artificially polluted soil collected from the site of a multistoried building where deep foundation was carried out. The geotechnical properties of the above soil samples were determined (i.e. index properties and shear strength parameters), in the laboratory based on standard testing procedures. Laboratory tests were conducted on the above soil samples for determining the index and strength properties. From the results, it was observed that the effluent has no significant effect on the index properties of the soil collected at the discharge point (S_0) whereas, the index properties of the soil collected from the deep foundation site at a depth of about 13 m (S_0^1) are found to be slightly affected by the pollutant, which may attributed due to the presence of substantial quantities of fines and a higher quantity of clay in the above soil sample. However, soil S_0^1shows a higher sensitivity to the U.C.C. value than S_0.*

Keywords: *Effluent, Amino acid, Strength properties, Index properties, and pollution*

1. INTRODUCTION

In developing and in under-developed countries, industrial wastes are indiscriminately disposed-off over land in water bodies, either after partial treatment of their effluent or without treatment. The disposal of liquid and solid wastes without proper and adequate treatment onto the ground is becoming a routine affair, which is due to two reasons, is the absorbing capacity of the soil and the other a more favorable reason being, the negligible cost associated with the above form of disposal. Leachates from the wastes infiltrate into the ground and cause severe problems, such as groundwater contamination, degradation of soil fertility and alteration of soil characteristics relevant to civil engineering activities. In order to understand the engineering properties of soils for any kind of design of structures, the sub surface investigation is very much essential [9]. Studies on the failure of structure due to chemical influence on soil which might be due to accident or discharge from industry or spillage has been reported [6]. The characteristics of fine grained soils in particular showed a greater influence on the soil due to the presence of organic or inorganic chemicals present in the industrial effluents [1]. Hence it necessitates the study of influence of chemical effluents discharged into soil from industries [10]. The procedures of artificial contamination of soil under laboratory conditions resembling field conditions were studied to understand the geotechnical properties of soil [4]. The cations and zwilterions present in amino acid anables to undergo absorption or exchange of ions on soil and clay surfaces [7]. The discharge of effluent containing heavy metals into soil creates a hazard to our environment [5]. This lead to introduction of organic and inorganic contaminants into soil [2].

Amino acid are found to exist in soils as a result of the decomposition of proteins and other soil organic matters, by soil microorganisms and play a vital role in biochemical processes. The products such as indoles act as growth promoting substances, hormones or auxins in plants. Cystine, is an amino acid produced human hair as a raw material. The wastewater contains a high concentrations of acidity, volatile and suspended solids, BOD, COD and sodium chloride. Investigated the mechanisms involved in the mobilization process of certain amino acids through pesticide amended soils [3]. Sodium chloride is not attenuated during the percolation of effluent through the earth's mantle and directly leaches into the ground water table [8].

2. MATERIALS

The amino acid effluent was collected from the storage pond at the end of the process and before it was let out. About 10 liters' of the sample was collected for the present experimental investigations. The effluent was collected in polythene cans, immediately sealed and transferred to a refrigerator within a few hours of collection. The characteristic of effluent is shown in Table 1.

2.1 Characterization of Effluent

2.1.1 pH

The electromotive force is measure with a pH meter according to IS 3025 (Part 2) : 1983.

2.1.2 Total Dissolved Solids

The sample is filtered and the filtrate evaporated in a dish on stream bath. The residue after evaporation is dried to a constant mass and TDS is determined based on IS 3025 (Part 16) : 1984.

2.1.3 Total Suspended Solids

Non filterable residue is calculated from the increase in mass of the filter and TSS determined based on IS 3025 (Part 17) : 1984.

2.1.4 Hardness

Di-sodium salts to form stable complexes with calcium and magnesium ions are determined based on IS 3025 (Part 21) : 1983.

2.1.5 Alkalinity

It is determined based on IS 3025 (Part 23) : 1986. It may be defined as quantitative capacity of an aqueous medium to react with hydrogen ion.

2.1.6 Sulphate

It is determined based on IS 3025 (Part 24) : 1986. Sulphate is precipitated in hydrochloric acid medium as barium sulphate by the addition of barium chloride solution.

2.1.7 Chlorides

Silver chloride is precipitated before red silver chromate is formed. Chlorides are determined based on IS 3025 (Part 22): 1988.

Table1. *Characteristics of Amino Acids Based Effluent*

PARAMETER	CONCENTRATION
pH	6.53
Conductivity	4670
Chlorides	1752.7
Sodium	1134.1
Bicarbonate Alkalinity	283.5
Total Solids	0.7
Total Dissolved Solids	3.0
Total hardness	137.5
BOD	36.8
COD	54.0
Sulphate	80.0

2.2 Determination of soil properties

The color of the native soil changed due to the effluent (i.e. presence of white pitches on the superficial surface). The soil collected from the amino acid effluent discharge site and the soil taken from deep foundation along with artificially polluted soil was tested for its index and Strength properties as listed below:

2.2.1 Hydrometer analysis

The coarse particles (gravel and sand) are separated by sieving, while a sedimentation procedure is used for the analysis fine-grained soils as specified in IS 2720 (Part 4): 1975.

2.2.2 Atterberg's limit

According to IS 2720 (Part 4): 1985, the soil samples passing through IS 425μ sieves are to be used for determination the liquid limit and plastic limit. The shrinkage limit was determined as per IS 2720 (Part 6): 1985.

2.2.3 Proctor Compaction

To obtain the moisture density relationship of soil samples, the standard proctor compaction tests were conducted as IS 2720 (Part 7): 1980.

2.2.4 Specific gravity

Specific gravity test was conducted using specific gravity bottle as per IS 2720 (Part 3 /Sec 1): 1980 for all the soil samples.

2.2.5 Unconfined Compressive Strength

In order to understand the strength characteristics of samples, unconfined compressive test was conducted as per IS 2720(Part 10): 1972.

2.2.6 Direct Shear

In order to determine the shear strength of the soil, direct shear test is performed as per IS 2720 (Part 13):1972.

2.2.7 Water Content

For determination of water content of the soil, the procedure as given in the IS 2720 (Part 2): 1973.

3. METHODOLOGY

The soil sample used for the present study was collected from a place where it was polluted by the effluent from a chemical industry wherein amino acids are present when deriving a substance of commercial value. Soil samples were collected from the above site at shallow depth from two locations namely (1) at the discharging site (S0) and (2) at a distance of 100 m (S100) form the discharging site. The index properties and Strength properties of S0 and S100 is shown in table 2 and 3 respectively. In order to study the effect of the pollutant on various types of soils, soil samples are also collected wherein a deep foundation work for a proposed multi-storied building is in progress. The soil sample (S01) collected from the above site from a depth of about 13 m when the deep foundation work was in progress. Artificially polluted soil samples were prepared in the laboratory, by mixing the effluent from the source with the soil. 5 kg of soil sample were weighed and with that 20% of the effluent by weight of soil was mixed by adding the effluent slowly and finally a thoroughly mixed sample was prepared. The artificially polluted sample thus prepared was allowed to remain polluted for 5-days in open air. At the end of 5-days, the soil sample is tested to ascertain Geotechnical properties. The index properties and Strength properties of soil collected from deep foundation of soil S01 and the soil from deep foundation which was artificially polluted by amino acid effluent (S2) is shown in Table 4 and 5 respectively.

Table2. *Index Properties of Soil at Discharging Site*

S.No	Description	S_0	S_{100}
1.	Clay, %	10	12
2.	Silt, %	78	73
3.	Sand, %	12	15
4.	Gravel, %	0	0
5.	Liquid Limit, %	35	38.5
6.	Plastic Limit, %	22.5	29.8
7.	Plasticity index, %	12.5	8.7
8.	Toughness index, %	0.5	0.2
9.	Flow index, %	26.1	44.3
10.	Shrinkage index, %	10.4	8.5
11.	OMC, %	12.9	18.8
12.	Dry density,kN/m^3	17.8	17.8
13.	Specific gravity	2.4	2.4

Table3. *Strength Properties of Soil at Discharging Site*

S.No	Description	S_0	S_{100}
1.	U.C.C. (q_u)	60.5	68.8
2.	C_u	28.0	32.0
3.	Φ value	26°	23°

Table4. *Index Properties of Soil from deep excavation*

S.No	Description	S_0^1	S_2
1.	Clay, %	19	14
2.	Silt, %	66	66.5
3.	Sand, %	15	19.5
4.	Gravel, %	0	0
5.	Liquid Limit, %	66	73
6.	Plastic Limit, %	30.9	33.3
7.	Plasticity index, %	35.1	39.7
8.	Toughness index, %	0.9	4.6
9.	Flow index, %	41.6	8.7
10.	Shrinkage index, %	8.7	7.8
11.	OMC, %	23.2	27.1
12.	Dry density, kN/m^3	14.9	14.4
13.	Specific gravity	2.3	2.4

Table5. *Strength Properties of Soil from deep excavation*

S.No	Description	S_0^1	S_2
1.	U.C.C. (q_u)	130.7	88.4
2.	C_u	46	40.0
3.	Φ value	16°	20°

4. RESULT AND DISCUSSION

Comparing the various index properties of the soil samples S_0, S_{100} and S01 and S2 following observations are drawn:

- The liquid and plastic limit values no appreciable change as seen from the Table 2 for the soil S_0 and S_{100} at the amino acid effluent discharge site. The mechanism controlling the liquid and plastic limits have been bought out as due to Physical and physico-chemical forces which depend on the type of mineral.
- There was an increase in flow index of soil which depicts that the effluent has no impact on soil at a distance of 100 m from the discharge of the effluent resulting in a less shrinkage index value at S100.
- The optimum moisture content value increases for S_{100} when compared to S_0 as the effluent did not have any impact on soil characteristics at a distance of 100 m from discharge point.
- When the strength parameters were examined it showed the same trend of the index properties wherein there was an increase in strength at a distance of 100m from discharge point as shown in Table -3.
- When the soil collected from a deep foundation was artificially polluted with amino acid effluent there was no appreciable change in index properties as shown in table -4.
- Soil collected from deep foundation which was artificially polluted with amino acid showed a greater impact on the strength parameters as shown in Table-5. There was about 32.36% decrease in strength when the soil (S_0^1) is exposed to amino acid effluent.This is may be attributed due to finer particles of soil at greater depth from where the sample was taken.

5. CONCLUSIONS

Following are the salient conclusions drawn from the present study:

- The index properties that is liquid and plastic limit values do not show appreciable change, for the soil S_0 due to pollution of the effluent, considered in this study. However, there is a slight increase in the various index properties, which may be attributed to the presence of larger clay content in S_0^1 than in S_0.

- The U.C.C values decreases for both soils S_0^1 and S_0, when they are polluted with amino acid based effluent which may be attributed to the slight acidic nature if the effluent and other predomination present in the effluent like chlorides and sodium.
- The soil S_0 show medium plasticity, where are the soil S_0^1 shows highly plasticity, when they are polluted by the amino acid based effluent.

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