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Effect of Acid and Base Contamination on Red Soil

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Abstract: Soil which is a major and primary element for the construction is gradually leading to the degradation of its properties. The cause of this is the industrial advancements which led to the release of variety of pollutants in the form of liquids in to the soil. These comprises of harmful acids and bases wastes effecting the soil properties and geotechnical properties of soil gets changed. This proposed study mainly aims to determine the depth of contamination with pollutants in the soil. To determine this the soil sample is tested by adding various contaminants and the study is carried by testing it for the various tests such as particle size analysis, swelling index, plasticity index, unconfined compression strength and the compaction are examined. For this the soil is contaminated by adding acids contaminants preferred are nitric acid, Sulphuric acid, hydrochloric acid and base contaminants preferred are sodium hydroxide, potassium hydroxide and calcium chloride. The geotechnical properties are examined by adding acids and bases at various percentages such as 5% 10% 15% 20% 25%. Further the effect of soil properties with the contaminants are studied.

Keywords: Atterberg's limits, acid contamination, base contamination, plasticity index, red soil

1. INTRODUCTION

Industrial advancements are necessary for the social development of the country but at the same place it is challenging the present soil mechanics concepts. The growth of population leads to the decline of the nature with increase of solid and liquid waste. The increasing technologies also lead to environmental degradation. A geotechnical is concerned mostly about the impacts of the soil which is the key element for the construction. The task of geotechnical engineer has increasing widely.

Soil waste interaction affects all the properties of soil .The unintended problems of soil changes lead to ground modification with the interaction of pollutants. The effect of this can cause various soil related problems and leads to engineering issues the type of soil and its pollutant depends on the nature and mineralogy of soil which needs to understand the properties of soil when contaminated with acids and bases.

2. MATERIALS

2.1 SOIL SAMPLE:

Soil sample is collected from the Parvathapur, Uppal Hyderabad. It is then tested for its various engineering and index properties. The results are shown in the following table1.

S.No	Properties	Result
1	Initial moisture content	12.1%
2	Specific gravity	2.64
3	Percentage of sand	38.1%
	Percentage of silt	27.9%
	Percentage of gravel	27.8%
	Percentage of clay	31.15%
4	Differential free swell	40.6%
5	Liquid limit	55.6%
	Plastic limit	17.0%
	Shrinkage limit	13.6%
	Plasticity index	39.9%

6	Classification of soil	CH
7	Optimum moisture content	25.55%
	Maximum dry density	1.68g/cc
8	Compression strength	0.216N/mm^2
	cohesion	0.121N/mm^2

2.2Acid contamination

Nitric acid(HNO_3), hydrochloric acid (HCL), sulphuric acid (H_2SO_4) were taken and prepared with Normality 1.these are oven dried with soil without gravel fraction. These contaminants were added at different percentages such as 5% 10% 15% 20% 25% weight and these samples stored in dessicator for four days.

2.3 Base contamination

Sodium hydroxide (NAOH), Calcium hydroxide (CAOH) and potassium hydroxide (KOH) were prepared with normality 1. These soils are oven-dried without gravel fraction. These contaminants were added at different percentages such ads 5% 10% 15% 20% 25% weight and these samples were stored in desiccator for seven days.

3. EXPERIMENTAL PROGRAM

This involves Atterberg's limits specific gravity test, and standard compaction test, unconfined compression test on natural and contaminated soil with various percentages.

3.1 Atterberg's limit

These test was performed as per IS :2720 (Part 5)- 1985 and IS: 2720 (Part 6)-1972 on the normal and contaminated clay sample with different amounts of acids and bases such as 5% 10% 15% 20% 25%.

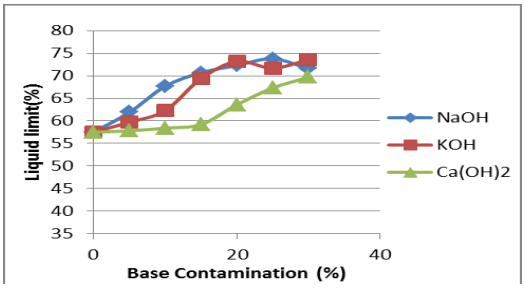


Fig.1 liquid limit results for base contamination

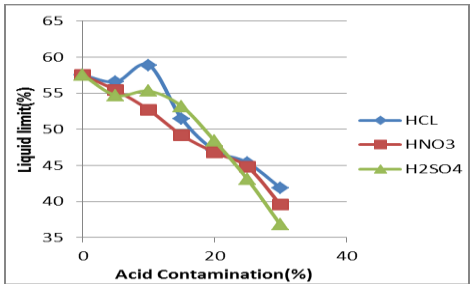


Fig.2 liquid limit results for acid contamination

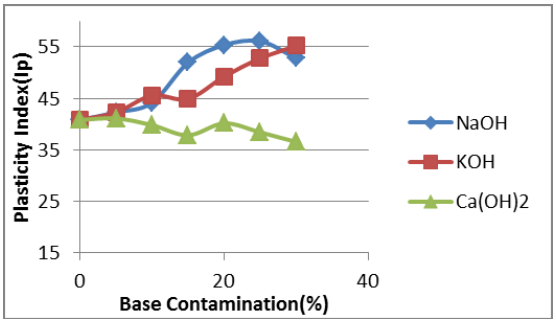


Fig.3 plasticity index results for base contamination

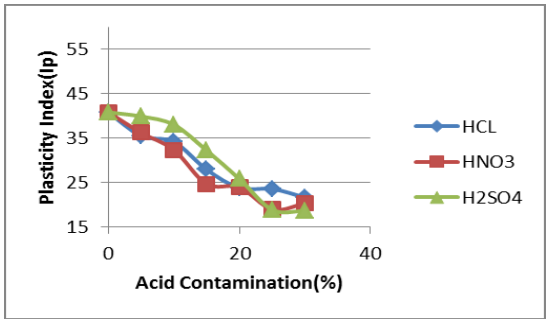


Fig.4 plasticity index results for acid contamination

3.2 Freeswell test

Free swell test was conducted on the acid and base contaminated soil sample with different percentages such as 5% 10% 15% 20% 25%. The results are charted below

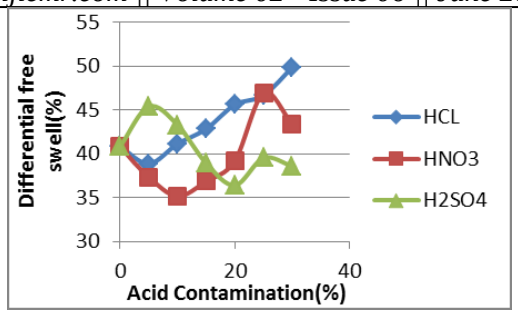


Fig.5 Freeswell results for acid contamination

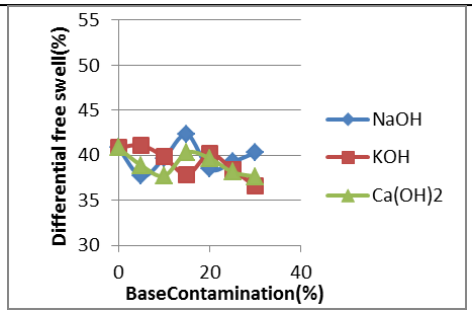


Fig.6 Freeswell results for base contamination

3.3 Specific gravity test

These test was performed as per IS :2720 (Part 5)- 1985 and IS: 2720 (Part 6)-1972 on the normal and contaminated clay sample with different amounts of acids and bases such as 5% 10% 15% 20% 25%. The results are noted and charted.

3.4 Standard proctors compaction test

Standard proctors compaction test was conducted on the acid and base contaminated soil sample with different percentages such as 5% 10% 15% 20% 25%.

From these samples the compaction characteristics OMC and MDD are determined respectively. The results are charted below.

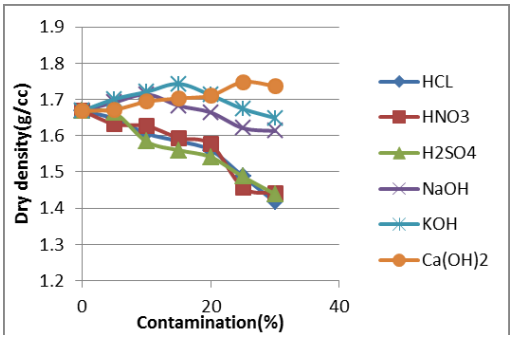


Fig.7 MDD results for acid and base contamination

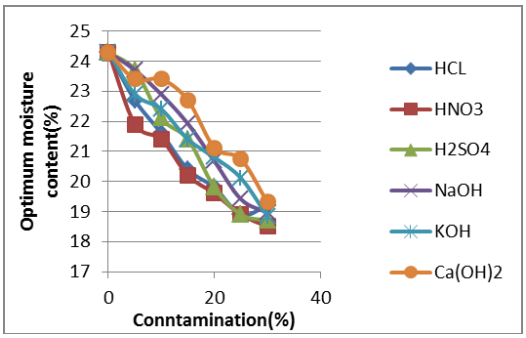
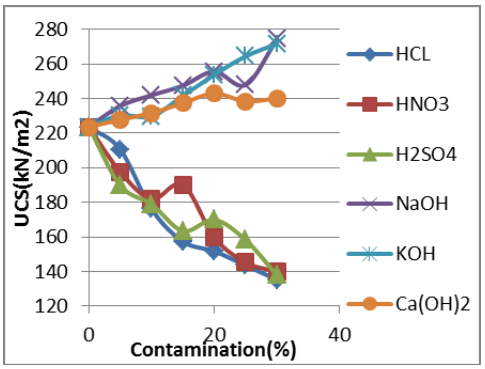


Fig.8 OMC test results for Acid and base contamination

3.5 Unconfined compression test

These test was performed as per IS :2720 (Part 5)- 1985 and IS: 2720 (Part 6)-1972 on the normal and contaminated clay sample with different amounts of acids and bases such as 5% 10% 15% 20% 25%. The results are noted and charted.

From this the unconfined compression strength and undrained cohesion were examined as per IS 2720 (Part 10) -1991. The obtained results are charted below.



Fig,9 UCS results for acid and base contamination

4. RESULTS AND DISCUSSION

4.1Acid contamination

From the obtained results it is seen that the liquid limit of the acid contaminated sample is decreased with the increase of acid content. The plastic limit of the sample is increasing and decreasing gradually. There is no variation with the plastic limit.

The plasticity index decreases with the increase in the acid content which resembles the problematic sign of the soil.

4.2 Base contamination

From the obtained results it is seen that the liquid limit of the base contaminated sample is increases with the increase of base content. The plastic limit and shrinkage limit has no variation.

The plasticity index increases with the increase in the base content which resembles the problematic sign of the soil.

5. CONCLUSIONS

The laboratory testing was performed to study the effects of acid and base contaminated soil sample by adding it with a increment of 5% by weight to contaminate artificially. The following are the conclusions from the experiments.

5.1Acid contamination

1. The liquid limit decreases with increase in acid content.
2. The plasticity index decreases in which soil changes from high plastic to normal plastic state.
3 .Free swell values have gradually increased with increase in acid content.
4 .The specific gravity decreases with the acid contamination.
5 .The optimum moisture content and maximum dry density decreases with the increase in the contamination.
6 .The values of shear strength have decrease with the increase in the acid contamination.

5.2Base contamination

1. The liquid limit decreases with increase in base content.
2. The plasticity index increases with increase in the base content.
3. Free swell values have shown gradual decrease with increase in acid contamination.
4. The specific gravity increases with the base content.
5. The optimum moisture content decreases with increase in case content and maximum dry density decreases with the increase in the contamination.
6. The values of shear strength have increase with the increase in the contamination.

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