Effect of Acid Rain on Geotechnical Properties of Different Soils: A Review

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***Abstract*: Acid rain or acid deposition is a broad term that includes any form of precipitation with acidic components, such as sulphuric or nitric acid that fall to the ground from the atmosphere in wet or dry forms. This can include snow, fog, rain or even dust that is acidic. The low pH and high fluxes of acid rain led to a reduction in soil strength and maximum dry density as well as an increase in the coefficient of permeability, liquid limit and optimum moisture content of the soil. The changes in the properties of soil affected by acid rain can be found out by comparing the geotechnical properties with that of the normal soil.**

Keywords: Acid rain, pH, soil strength

1. INTRODUCTION

Rapid industrialization and development in transport sector have polluted the atmospheric environment with noxious gases like oxides of sulphur, nitrogen, carbon that extent the acidic atmospheric precipitation which is being experienced in many parts of the world. The pH of such precipitation may be as low as 3 to 4.

Acidic fog, rain and water accumulate on the surface affecting the pH of the soil and is responsible for altering the physical and engineering properties of soil. The frequent, persistent and growing intensity of acid rain will certainly exceed buffering cation exchange capacity of soil which will enhance the rate of leaching of cations from the soil to a great extent. Absorption of H^+, $SO4^{2-}$, $NO3^-$ and $CO3^{2-}$ by the soil particles will alter the physico-chemical and engineering properties of soil which cannot be ignored. Therefore it is imperative to examine the properties of soils eroded due to acid rain in order to augment understanding of its influence on geotechnical engineering.

Acid rain results in changes in physico- chemical characteristics of soil due to cation exchange. pH of soil decreases, grain size distribution of the soil will shift towards silt fractions, the angularity of individual particles will increase, the consistency properties of soil are altered, overall strength of the soil reduce due to leaching of cations which reduce the attractive forces between the soil particles. Magnitude of deterioration depends on persistence and strength of acid rain.

2. LITERATURE REVIEW

Grytan Sarkar et al. (2012): The effect of acid rain on geotechnical properties of composite fine-grained soil is studied in order to increase our understanding and taking proper consideration during construction of substructure. The results showed that the physico-chemical behaviors, free swell index and consistency of soil were strongly affected by acid rain. Also, UCS and shear strength parameters decreased with the addition of acid rain.

N.Kusuma et al. (2020): In this report, the effect of sulphuric ($H2SO4$), Nitric ($HNO3$) and Boric ($H3BO3$) acids on the strength characteristics of black cotton soil at varying percentages were studied. The strength characteristics of soil get altered when an acid compound get mixed with the soil. Atterberg limits, compaction characteristics, UCC and CBR test have been carried out. The results indicated that the above properties altered due to the presence of acid rain in it.

P.Sharma et al. (2011): Objective of this study was to find the degree of variation in the texture, physico-chemical and the engineering properties of soil of different plasticity when exposed to acid rains having different pH. The consistency, strength and chemical characteristics of the samples were determined for the soil fraction passing 425µm sieve. The acidification causes de- flocculation of soil particles which directly affects the consistency as well as strength properties of the soil.

Sojil Jain et al. (2015): This research is done to understand the variation in engineering properties of virgin soil and the acid contaminated soil. For this purpose, high plastic black cotton soil passing from 4.75mm sieve is mixed with different acids of 0-15% concentration and observations were made on compaction characteristics, hydraulic conductivity, UCC, shear parameter, CBR value. The results indicated that the acid contamination of black cotton soil adversely affects its engineering properties.

T.S.Umesha et al. (2012): This paper reports the effect of hydrochloric, phosphoric and sulphuric acids on the compaction characteristics of black cotton soil at varying percentages. Atterberg limits, compaction characteristics and UCC tests have been carried out. There was a drastic change in the above properties due to the addition of acid rain.

Zeinab Bakhshipour et al. (2016): In this study, the effect of acid rain on the pysico- chemical properties of two different residual soils was investigated. The results showed that low pH and high fluxes of acid rain led to a reduction in soil strength and maximum dry density as well as an increase in the coefficient of permeability, liquid limit and optimum moisture content of soil. Also, SEM, EDX and AAS analysis of the soils proved the reduction in the concentration and the loose structure of elements for both soils due to effects of acid rain.

3. CONCLUSIONS

- OMC increases with increasing concentration of acid while MDD of soil decreases withincreasing amount of acid.
- Permeability of soil reduces with the addition of acids of increasing concentration.
- The UCS and shear strength parameters reduce with increase in acid concentration.
- As the concentration of acid increases, the pH of the soil decreases.
- As the acid concentration increases, Liquid limit decreases whereas plastic limit increases up to 5 percent of acid concentration then it decreases up to 15 percent of acid concentration.

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