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Chemical and Mineralogical Characterization of Dispersive Soils

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ABSTRACT
Many earth dams, hydraulic structures and other structures like road way embankments have suffered serious erosion problems and have failed due to the presence of the dispersive soils. The tendency for dispersive erosion in a given soil depends on variables such as mineralogy and chemistry of the clay, as well as dissolved salts in the water in soil pores and in the eroding water. When dispersive clay soil is immersed in water, the clay fraction behaves like single-grained particles; that is, the clay particles have a minimum of electrochemical attraction and fail to closely adhere to, or bond with, other soil particles. Soil dispersivity is mainly due to the presence of exchangeable sodium present in the structure. This article presents the characterization and identification of dispersive soils using chemical method and X-ray diffraction analysis.
Keywords - About five key words in alphabetical order, separated by comma

I. INTRODUCTION

Some natural clay soils dispersing in the presence of relatively pure water and are, therefore ,highly susceptible to erosion and piping. Dispersion property of soil is a physical-chemical phenomenon and influenced by chemical properties of the fine grained soils minerals. The amount and type of minerals in the soil, is one of the important issues that should always be considered in selecting borrow resources of fine-grained soils. Past experiences have shown that insufficient attention to this issue has created lots of problems for hydraulic structures and even their destruction.

1.1. Cause of Dispersivity and Mechanism

The clay fraction in dispersive soil that comes in contact with water behaves like a single grained particle with less electrochemical attraction and does not adhere with other soil particle.The electrical surface force (inter particle repulsive force) exceeds the Van der walls attraction and the detached clay particles are carried away causing piping in earth dams. The principal difference between dispersive clays and ordinary erosion resistant clays appears to be the nature of the cations in the pore water of the clay mass.

Dispersive clays have a preponderance of sodium cations, whereas ordinary clays have a preponderance of calcium, potassium, and magnesium cations in the pore water .The sodium increases the thickness of the diffused double water layer surrounding the individual clay particles. This causes the repulsive forces to exceed the attractive forces so that the particles readily go into suspension in the presence of water The sodium ions are adsorbed onto the surface of the clay. It is a large ion with a weak charge. The positive ions bind the negatively charged clay particles together(Fig.1)

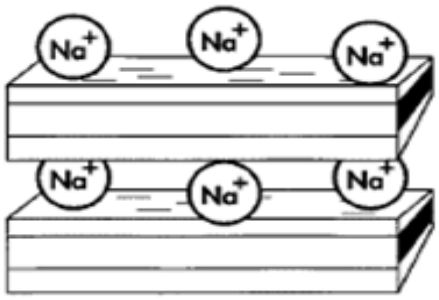

Fig.1 Showing negatively charged clay particle with adsorbed sodium counter ions.

The tendency for dispersive erosion in a given soil also depends on variables such as mineralogy and chemistry of the clay, as well as dissolved salts in the water in soil pores and in the eroding water. Mineralogy thus plays an important role in the study of clay dispersive characteristics of fine grained soils. These in turn are related to the type of minerals present and structure they possess, Sodium montmorillonite even at low sodium ion concentrations exhibits dispersion. Kaolinite another principal clay mineral, though structurally different from montmorillonite does not show dispersive characteristics.

1.2 Motivation and Objective

There is no single confirmatory test to determine dispersivity of soil. All the available tests rather some time contradict each other in their findings. Therefore mineral characterization along

with chemical analysis of pore water extract are taken in to consideration for further investigation.

2. Experimental

2.1. Material and Methodology

The four different types of soil samples are selected for this study based on engineering tests conducted on these soil samples**.**

2.2 Chemical Tests

The chemical analysis of soils pore water extract was seems to the most reliable methods for characterizing soil dispersivity. The phenomenon of dispersivity is due to the presence of dissolved sodium content in pore water and therefore its percentage was calculated by estimating total dissolved cations (Na, K. Ca & Mg) present in soils pore water extract. To obtain saturation extract, soil is mixed with distilled water until a saturated soil paste with water content near the liquid limit is obtained. The paste is allowed to set for a number of hours until equilibrium is attained between the salts in the pore water and those on the cation exchange complex. Subsequently, a small quantity of pore water is filtered from the soil paste using a vacuum. This extracted pore water is tested using EDTA titration method (For Ca & Mg) and using flame photometer(For Na & K).(Fig.2)

Fig.2. Determination of Sodium and Potassium using Flame Photometer.

The percent sodium and TDS (sum of the four metallic cations) are determined .The further interpretation were evaluated using graph presented in Fig.3.

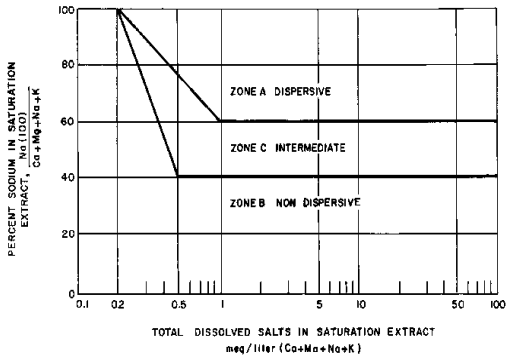

Fig.3. The Plot of Percent Sodium Verses Total Dissolved Cations.

After plotting the above graph for each samples the results were categorized as follows:-

Zone A: Dispersive

Zone B: Non Dispersive

Zone C: Intermediate

2.3. Mineralogy study using X-ray Diffraction. (XRD tests)

XRD is a technique used extensively in the geological sciences, materials, environmental science, chemistry, physics, metallurgy and other subjects. The instrumental setup is presented in fig.4.

Fig.4 Mineralogy study with XRD.

II. RESULTS AND DISCUSSION

The results of chemical analysis of pore water extracts of all the four samples are presented in table-1.

Table-1. Chemical Analysis Results

Sl. No.	Milliequi./Lit				Total Cations	Sodium %	Remarks Grade
	Na	K	Ca	Mg			
1	2.39	0.51	0.8	0.2	3.90	61.28	A
2	2.27	0.32	0.6	0.4	3.59	63.23	A
3	0.99	0.61	0.6	0.2	2.40	41.25	C
4	2.70	0.63	6.4	1.4	11.13	24.25	B

The first two samples were fall in category (A), which indicated their dispersive natur ,However sample number 3,was fall in intermediate category(C) and last sample number 4 was reported to be non dispersive (B) in nature.

The results of XRD pattern of these soil samples are presented in fig.5 .

The XRD pattern of soil samples shows that soil with dispersive and intermediate nature are rich in

montmorillonite and illite clay minerals. Both of these clay minerals are having high colloidal activity and responsible for soil dispersion.

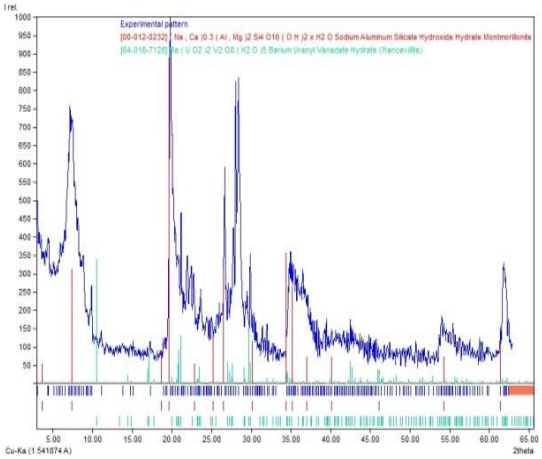

Fig. 5 XRD pattern of Dispersive soil.

V. CONCLUSIONS

The results of chemical analysis of pore water extract of soils clearly shows that soils with high sodium content and contains Montmorillonite minerals such as Smectite and illite are dispersive and intermediate in nature .

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