Influence of Oil Contamination on Geotechnical Properties of Sand

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Abstract- *Oil spills and oil leakage from the storage tanks is one of the main problems facing the oil producing countries of the world. The effect of these leaks and spills create problems to the environment. It pollutes subsurface water, changes the behavior of soil and also its engineering properties and loss in strength of soil, which leads to differential settlement and cracks in existing foundation of structures. An extensive laboratory testing program was carried out to determine the geotechnical characteristics of this material. Testing included basic properties, permeability tests and CBR on clean and contaminated sand at the same relative density. Contaminated specimens were prepared by mixing the sand with oil in the amount of 6% by weight or less to match field conditions. The influence of the type of oil also investigated by direct shear tests. The results indicated a small reduction in strength and permeability. The preferred method of disposal of this material is to use it as a stabilizing material for other projects such as road construction.*

Keywords- Oil contamination, Direct shear test, permeability, CBR

I. INTRODUCTION

Soil contamination or soil pollution as part of land degradation is caused by the presence of human- made chemicals or other alteration in the natural soil environment. It is typically caused by industrial activity, agricultural chemicals, or improper disposal of waste. The most common chemicals involved are petroleum hydrocarbons, polynuclear aromatic hydrocarbons, solvents, pesticides, lead and other heavy metals. Contamination is correlated with degree of industrialization and intensity of chemical usage.

Soil pollution can be caused by the following,

- Oil drilling
- Oil and fuel dumping
- Mining and activities by other heavy industries
- Accidental spills as may happen during deforestation activities,etc.
- Corrosion of underground storage tanks
- Acid rain (in turn caused by air pollution)
- Intensive farming
- Agrochemicals, such as pesticides, herbicides and fertilizers
- Industrial accidents
- Road debris
- Drainage of contaminated surface water into the soil
- Waste disposal
- Nuclear wastes
- Direct discharge of industrial wastes to the soil
- Electronic waste

Contaminated or polluted soil directly affects human health through direct contact with soil or via inhalation of soil contaminants which have vaporized and greater threats are posed by the infiltration of soil contamination to ground water aquifers used for human consumption. Health consequences from exposure to soil contamination vary greatly depending on pollutant type, pathway of attack and vulnerability of the exposed pollution. Petroleum solvents and many pesticides and herbicide formulations can be carcinogenic; can cause congenital disorders chronic exposure to benzene cause leukemia. Mercury and cyclodienes are known to induce higher incidences of kidney damage and some irreversible disease. Many chlorinated solvents damage liver and kidney and also cause depression of the central nervous system. There is an entire spectrum of further health effects such as headache, nausea, fatigue, eye irritation and skin rash caused by other chemicals. At sufficient dosage a large number of soil contaminants can cause death by exposure via direct contact, inhalation or ingestion of contaminants in groundwater contaminated through soil.

II. OBJECTIVES

- To investigate the physical properties of clean sand
- To investigate the shear strength characteristics of both clean and oil contaminated sand
- To investigate the hydraulic characteristics of both clean and oil contaminated sand
- To investigate the CBR value of both clean and oil contaminated sand

III. MATERIALS AND METHODOLOGY

The sand was collected from Bharathappuzha. The sand used in the particular study shown in figure 3.1

Fig 3.1 :Sand

Oil used in this study is diesel is purchased from Bharath petroleum dealer. Diesel oil used has light yellow colour, specific gravity at 40 drgree centrifuge to be <0.835 and kinematic viscosity at 50degree centigrade to be 73.5

All geotechnical properties were done in accordance with Indian Standard procedures. Grain size analysis was conducted to determine the particle size distribution of soil as a percentage of the total dry weight. Gradation is determined by passing the material through a series of sieves ranging from 4075mm to 75micrometer stacked with progressively smaller openings from top to bottom and weigh the material retained on each sieve. Tests were done according to IS 2720(Part-4) – 1985. The specific gravity of sand was determined by using pycnometer as per IS 2386 part 3. The specific gravity of sand was found by the average of three test trials.

The rate of flow under laminar flow conditions through a unit cross sectional area of porous medium under unit hydraulic gradient is defined as coefficient of permeability. It was determined by using constant head permeability test as per IS 2720 part 17- 1986. The test conducted by using IS 2720-part 14 procedure. The maximum and minimum dry density were found as per the standars. The dry density of sand determined using 50% relative density.

Sand were collected and transported to the laboratory. It is the dried and various laboratory tests like sieve analysis, specific gravity, coefficient of permeability, relative density and CBR test were conducted. The contaminated sample were prepared by adding diesel oil, was calculated as a percent by weight of the dry sand. Contaminated-sand layers were prepared by mixing the sand with an oil content of 2, 4 and 6% to match the field conditions. The mixed sand layers were put into closed containers for 2 days for aging and equilibrium, allowing possible reactions between soil and oil. After the preparation of sample direct shear test, permeability test and CBR tests were conducted.

IV. RESULT AND DISCUSSION

The tests for index properties and engineering properties of sand were carried out to classify the sand. The tests were conducted as per IS specification. The particle size distribution analysis was conducted using dry sieve analysis. From the sieve analysis it is found out that sand is uniformly graded sand. The uniformity coefficient of sand is 1.78 and coefficient of curvature is 1. The test for specific gravity as conducted as per IS specification by using pycnometer. The specific gravity of sand was obtained as 2.51.The coefficient of permeability determined using constant head permeability test. From the test the coefficient of permeability is determined as 1.81*10^-3 cm\sec. from these sand is clean fine sand with medium permeability.

4.1 Variation on shear stress

Figure given below shows the variation shear stress for various percentage of oil contaminated soil.

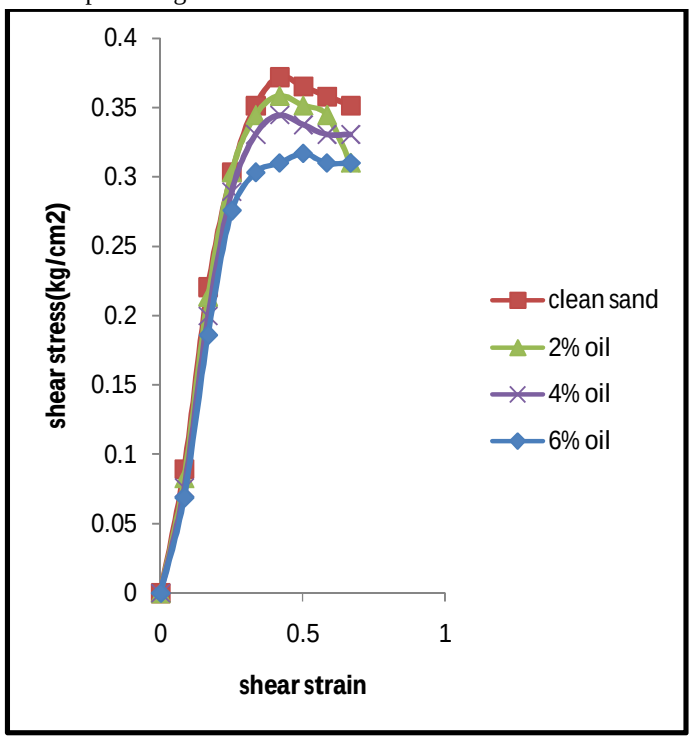

Fig.1 Variation on shear stress with shear strain for normal stress 51 kN/m2

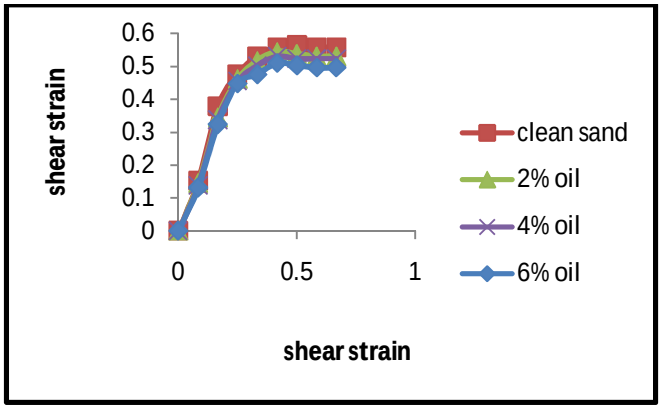

Fig.2 Variation on shear stress with shear strain for normal stress 78 kN/m2

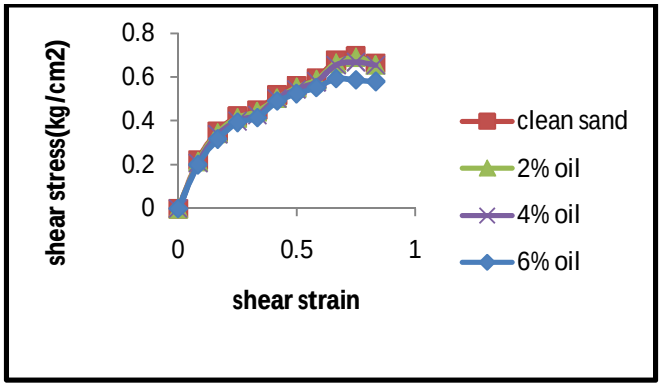

Fig.3 Variation on shear stress with shear strain for normal stress 101 kN/m2

V CONCLUSIONS

Effect of oil contamination on shear strength parameters is not uniform and it depends on the soil type but it leads to decreased peak shear strength in all studied samples

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