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A Study on The Effect of Oil Contamination on Sandy Soil and Clay: A Review

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***Abstract*—In today's world there is an increasing chance of soil being contaminated. Oil, gas and petroleum are considered to be the major source of pollution. Contamination has the ability to alter the geotechnical properties of soil. This paper evaluates the comparative study on the effect of oil contamination on geotechnical properties of fine-grained soil and sandy soil. This paper also includes the study on bearing capacity of isolated square footing resting on contaminated sandy soil with crude oil.**

Keywords—Fine-grained soil,oil contaminated,bearing capacity

I. INTRODUCTION

For the short-term benefits of industrial, petro-chemical, construction and sanitary activities air, water and land are being contaminated. Geotechnical experts must consider the effect of soil contamination on geotechnical properties of the soil. Oil spillages in most of the situations are accidental and it occurs during the transportation of oil by both on land and sea. Automobile garages, petrol stations and oil storage sites are some of the common places for soils contaminated with used engine oils. Oil leakage in soil can takes place both by natural seepage and artificial spillage. The extent of oil contamination in soil mainly depends on the chemical composition of the contaminant and it also depends on the properties of soils. An excessive oil contamination in the ground may leads to vertical settlement of oil storage tanks or cracking of pipelines laid in the oil contaminated ground. When an oil product get spilled over the ground surface, it will infiltrate through the soil pores. Crude oil is one of the most common soil contaminant. The soil-bearing capacity, foundation settlement, shear resistance, compressibility, and plasticity these are the factors that must be taken into consideration. Scientists and professional engineers have suggested several remedial measures for the oil-contaminated lands. These included the conversion of oil contaminated soil to road base material or topping layers for car parks and roads after mixing with aggregate or consolidation agents. Other methods include the containment in large burial sites, incineration, biological methods, absorption methods, soil washing methods etc. In contrast to treatment methods that are costly, the contaminated soil can also be used in construction as a road base, surfacing material, back fill or other engineering applications, such as landfill caps etc.

II. LITERATURE REVIEW

The properties of clay soil contaminated with varying percentage of oil with respect to aging was studied by S. Karthigeyan et.al (2020). It was found that Liquid limit, plastic limit and free swell index values of oil contaminated clay were decreased with increase in the oil content, however, the rate of decrease is mainly depended on the aging period. The percentage reduction in liquid limit was observed by a maximum of 19 % in case of immediate effect and 13 % for 28 days. Similarly, the percentage reduction in plastic limit is by a maximum of 31 % in the case of immediate effect and for the aging period of 28 days it was 24%.The percentage reduction in free swell index of the oil contaminated clay soil was found by a maximum of 40 % in the case of immediate effect and 35 % for the aging period of 28 days. As the oil content increased the shrinkage limit also get increased. The percentage increase in shrinkage limit of oil contaminated clay soil is by a maximum of 14 % in the case of immediate effect and for the aging period of 28 days it was 9%.It was observed that the shear strength of the oil contaminated clay is decreased with increase in the aging period. The percentage reduction in the shear strength of oil contaminated clay is by a maximum of 27 % to 46 % in the case of immediate effect and for the aging period of 28 days it was 17% to 30%.

A series of loading tests were carried on model of isolated square footing resting on clean and oil-contaminated sand by Ahmed Ibrahim Fadhil Al-Adly et.al (2019). The contaminated sand layers were being prepared by mixing the sand with crude oil at percent 10 and 20 % by weight of dry sand to simulate the field conditions. The depth of contaminated sand layer (d) under the footing was chosen depending on the footing width (B) and it is expressed as (d/B) ratio and it varied as 0.5, 1, 1.5 and 2 to simulate the field conditions.

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Fig.1 Sand bed preparation

Fig.2 Load test on model footing

From the result it is analyzed that the bearing capacity of footing decreases when the sand is contaminated with crude oil. As the percentage of oil content and depth of contaminated sand layer increases the bearing capacity of footing decreases. For d/b ratios 0.5 and 2 the ultimate bearing capacity reduced by 16.3% and 69.4%.It was also found that the presence of oil changes the mode of shear failure in sand under the footing from local shear failure to punching shear failure.

A set of laboratory tests has been conducted on both uncontaminated and contaminated fine-grained soils containing different amounts of crude oil by Mohammad Kermani et.al (2012). From the findings it was observed that the plastic limit increases as the oil content increases, liquid limit increases with a very light slope and plasticity index decreases. The maximum dry density increases and the optimum moisture content decreases as the oil contamination decreases. It was found that by increasing the oil content cohesion reduces and by increasing the moisture there is an increase in cohesion. The effect of moisture on cohesion decreases as the contamination increases. Due to the lubrication effect of oil compressibility increases as the oil content increases.

III. CONCLUSION

The following conclusions were obtained from the literature study

- In case of fine-grained soil(clay) the liquid limit, plastic limit and free swell index values of oil contaminated clay decreases with the increasing oil content.
- From the shrinkage limit and FSI the swelling potential for oil contaminated clay is decreased with the increase in oil content.
- As the sand is oil contaminated the bearing capacity of footing reduces. For d/b ratios 0.5 and 2 the ultimate bearing capacity reduced by 16.3% and 69.4% for 10% oil content and for 20% oil content the ultimate bearing capacity reduced by 38.8% and 71.42%.
- Bearing capacity reduces as the depth of contaminated sand layer increases.
- As the oil content increases there is an increase in the internal friction angle.
- Compressibility increases as oil content increases.

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