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Study on Geotechnical Properties of Diesel Oil Contaminated Soil

Dr.Solly George[1], Aswathy EA[2], Berlin Sabu[3], Krishnaprabha NP[4], Maria George[5]

[1]Professor , [2 3 4 5]Under Graduate students,
[1,2,3,4,5]Mar Athanasius College of Engineering, Kothamangalam, India

Abstract: **Soil contamination by engine oil causes huge damage to the environment. This basically takes place due to oil exploration, transportation, production and processing, leakage of diesel products from oil tankers, spills due to vehicular accidents, from buried pipelines etc. The hydrocarbons present in the oil influences the quality and physical properties of oil contaminated soil. These hydrocarbons infiltrate into the soil through pore spaces and collect at the top of the ground level. Some major tasks are needed to be performed for remediation and reclamation of contaminated area. For this knowledge of the geotechnical properties and behaviour of contaminated soils is required. This study aimed to investigate the geotechnical properties of engine oil-contaminated sandy soil. The amount of oil added to soil was varied at 0%, 4%, 8% and 12% of the dried weight of samples. Results showed that the oil contamination decreased the liquid limit, plastic limit. The MDD value was found to be decreasing whereas value of OMC was increasing as a result of increasing amount of oil added into the soil. This indicates that the addition of oil has adverse effects to the geotechnical properties of the studied soil. This affects the safety of civil engineering structures. The results from the study will be used for geotechnical purposes and will benefit engineers for the safe and economic construction of structures on contaminated land.**

Keywords: **Soil contamination, Remediation, Reclamation, Geotechnical Properties.**

I. INTRODUCTION

The Engine oil contamination of soil is very common in areas in the vicinity motor mechanic workshops. It has been reported that the engineering properties of such soil are drastically changed and made unsuitable for supporting engineering structures. At the sites with excessive oil contamination, vertical settlement of tanks, cracking of pipelines etc. are usually expected to occur. Not only highways, but garages, petrol stations, oil storage sites etc. are common sites contaminated with oil, especially engine oil. The extent of contamination has a lot to do with the chemical composition of contaminant and properties of the soil. For any application of these contaminated soil, knowledge of geotechnical properties and behaviour of contaminated soil.

II. PROCEDURE

A. Sample Collection:

The soil sample was collected from the premises of Mar Athanasius College of Engineering, Kothamangalam.

B. Sample preparation:

The diesel oil was used in this study. The degree of contamination is defined as percentage of volume of oil with respect to dry weight of soil. Each portion of soil for sampling was mixed thoroughly with diesel at different percentage of 0, 4, 8 and 12 to the dry weight of soil. The samples were kept in air tight container for one week to attain a stage of homogeneous mixture. These samples then were used to determine the engineering properties of soil. The tests were generally carried out on the soil samples in accordance with the procedure outlined by Indian standards.

C. Soil Characteristics:

Particle size analysis showed that the sample consisted of 60%sand, 32% silt and clay. It is clearly seen in Fig.1, in the soil sample. The proportions of gravel and sand in soil samples showed the high % of the sand, soil samples showed moderate amount of silt proportion.

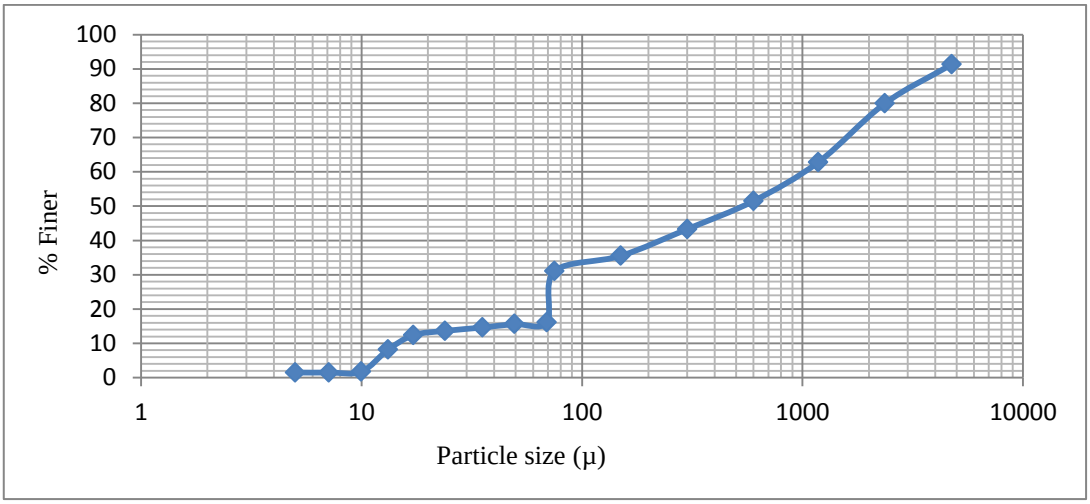

Fig.1.Particle size distribution curve for uncontaminated soil.

TABLE I: Geotechnical properties of soil.

Sl no.	Soil properties	Results
1	Gravel (%)	8
2	Coarse sand (%)	16
3	Medium sand (%)	28
4	Fine sand (%)	16
5	Clay + Silt(%)	32
6	Moisture content (%)	40.57%
7	Specific gravity	2.67
8	Liquid limit (%)	33.2
9	Plastic limit (%)	30.57
10	Shrinkage limit (%)	21.24
11	Flow index (%)	7.28
12	Plasticity index (%)	2.63
13	Max. dry density	1.73g/cc
14	OMC(%)	17.5

On the basis of Indian standard classification, the soil can be classified as SM type (silty sand).

III. RESULTS AND DISCUSSIONS

A. Atterberg limits:

The results from the liquid limit, plastic limit and shrinkage limit tests for the soil samples at various percentage of oil content have been shown in Fig 2, 3 and 4.

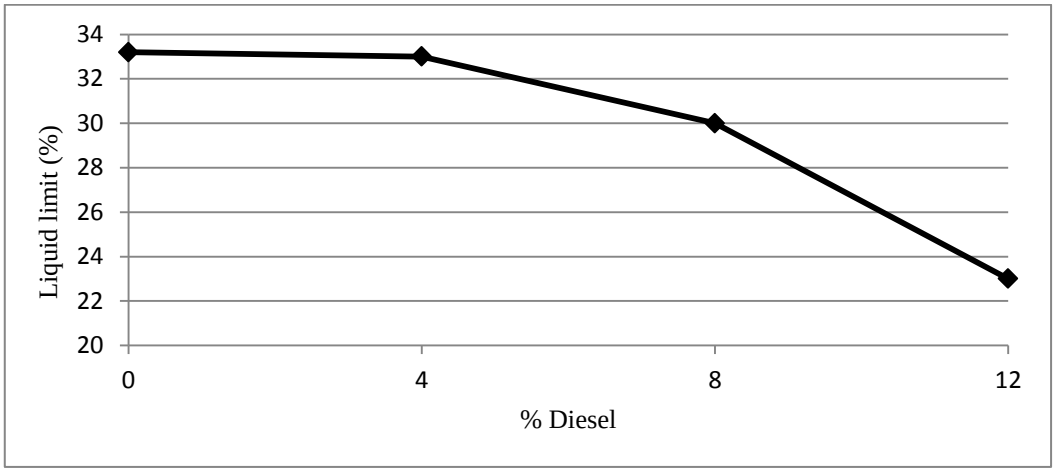

Fig.2. Liquid limit variations for contaminated soil.

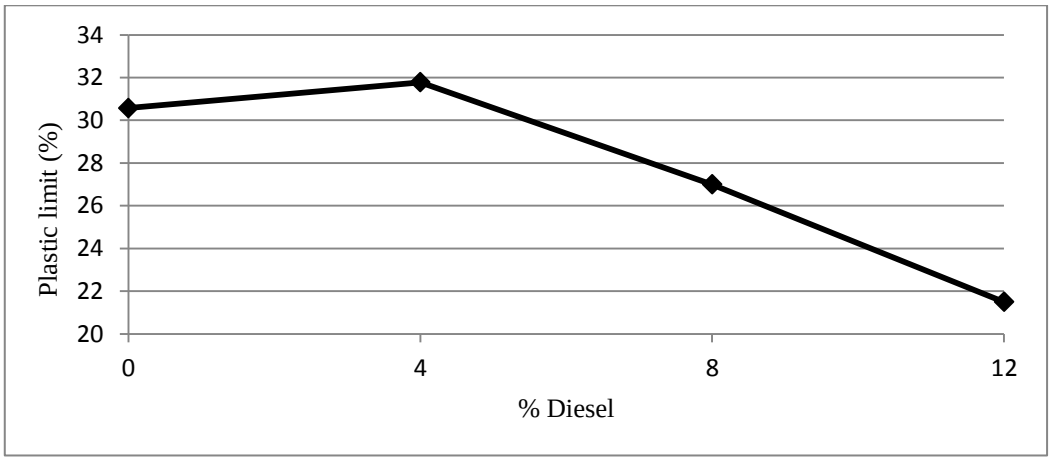

Fig.3. Plastic limit variations for contaminated soil.

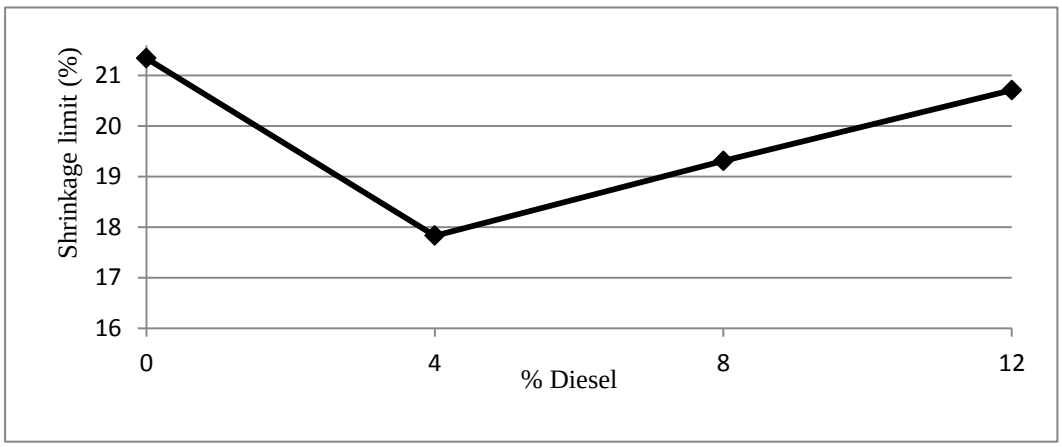

Fig.4.Shrinkage limit variations for contaminated soil.

The result of the addition of engine oil into the sandy soil has clearly affected the index properties of the contaminated soils. The increase in oil content in soils caused the reduction of water content in the liquid and plastic limit. The presence of hydrocarbons in engine oil, which is non-polarizing liquid has caused reduction in thickness of water film around the soil particles.

B. Compaction characteristics:

Standard proctor compaction test (ASTM-D698, method) was performed on uncontaminated and artificially contaminated samples. Dry density variations for soil samples with different percentages of oil content is shown in Fig.5.

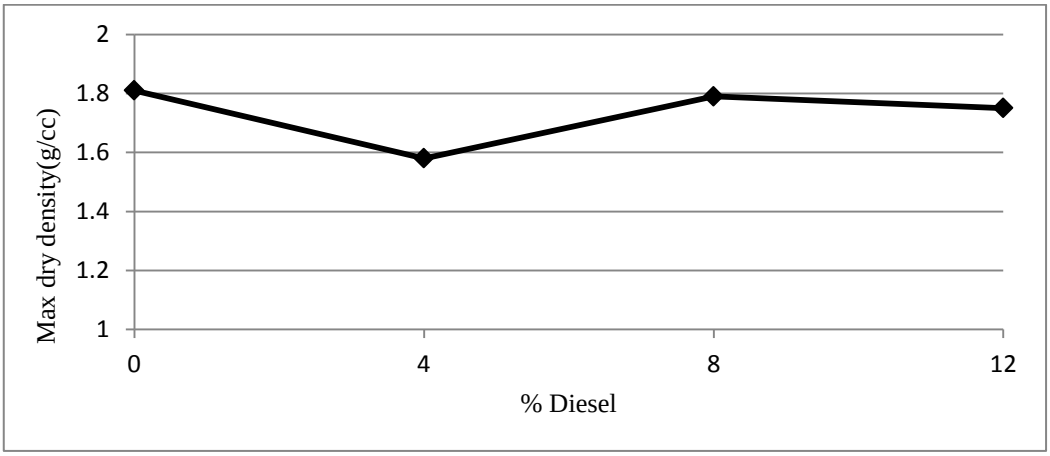

Fig.5. Maximum dry density variations for contaminated soil.

It can be clearly seen in curve that there is reduction in maximum dry density with increasing oil contents. This reflects the effect of lubrication imparted by the soil due to the presence of engine oil in it, which facilitates compaction due to slippage of soil particles in empty voids.

C. Unconfined compressive strength:

Unconfined compressive strength test (confirming IS: 2720 (PART X) results show that the UCS is increased when diesel engine oil is added. Figure 6 shows the variation of UCS with uncontaminated and contaminated soil with 4%, 8% and 12% diesel.

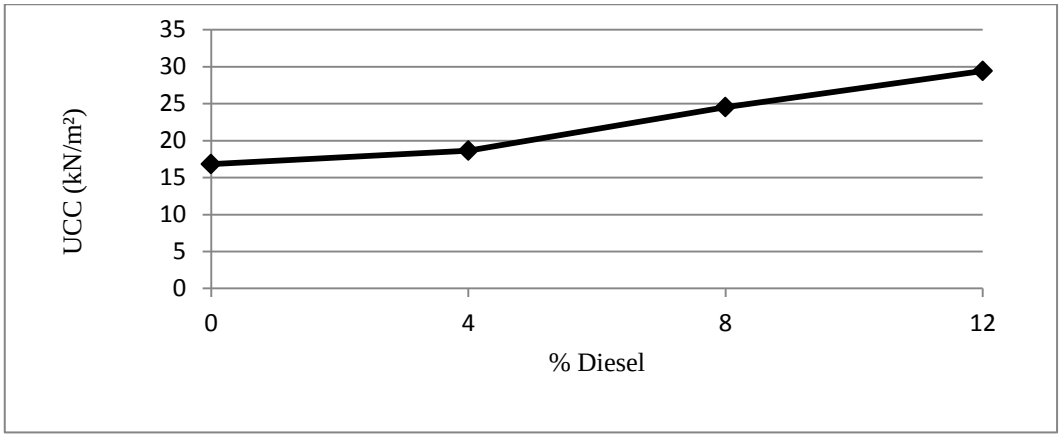

Fig.6.Strength variations for contaminated soil.

D. California Bearing Ratio test results:

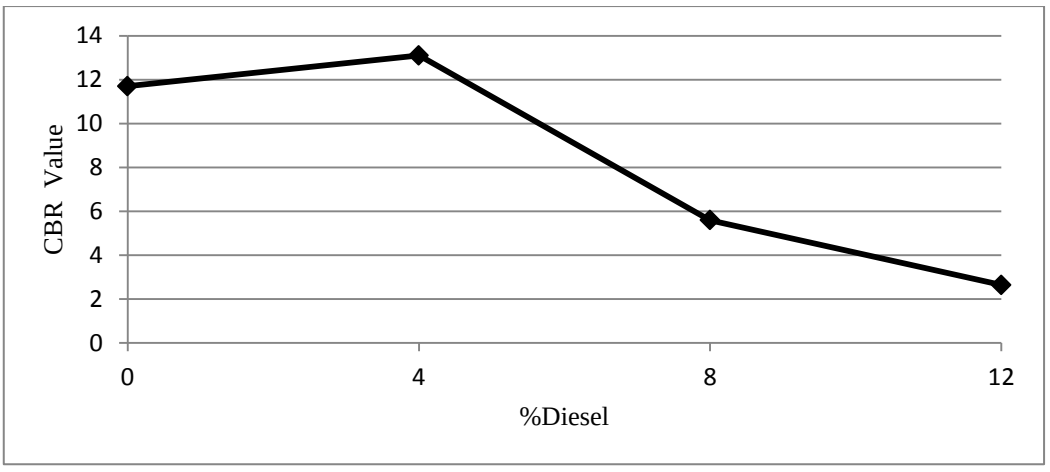

Fig.N. CBR value variations for contaminated soil.

Fig.N. shows the variation of unsoaked California bearing ratio with percentage of diesel in the soil composite. The un-soaked CBR value of the soil composite increases from 10.7% to 13.1% as the percentage of diesel increases from 0 to 4% and then decreases to 2.63% as %diesel increases further to 12%.

IV. CONCLUSIONS

The study demonstrates the contamination of local soil by diesel and its influence on geotechnical characteristics.

- Results indicated that CBR value for 4% diesel was higher than that of uncontaminated soil while for 8% and 12% it got reduced.
- The liquid limit and plastic limit of the contaminated soil showed a decreasing trend while for unconfined compressive strength it showed a rising trend.

The atterberg limits of contaminated soils were lower than that of uncontaminated soils. The role of oil is quite similar to water, it increases the chance of inter-particle slippage, thus reduce the shear strength of the contaminated soils. The maximum dry density dropped due to the increased content of engine oil. The increased inter-slippage of soil particles reduces the shear strength of soil. The results clearly showed that the oil contamination on soil system has negatively influenced the geotechnical properties of the soil.

Soil contamination by engine oil causes huge damage to the environment. The addition of oil adversely affects the geotechnical properties of the studied soil. This affects the safety of civil engineering structures. The results from the study will be used for geotechnical purposes and will benefit engineers for the safe and economic construction of structures on contaminated land.

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