International Journal of Scientific Engineering and Research (IJSER)
www.ijser.in
ISSN (Online): 2347-3878, Impact Factor (2014): 3.05

Effect of Motor Oil Spillage on the Properties of Silty Clay

Geethu Raveendran[1], Emy Poulose[2]

[1]PG Student, Department of Civil Engineering, Toc H Institute of Science and Technology, Arakkunnam Ernakulam, Kerala, India
[2]Faculty, Department of Civil Engineering, Toc H Institute of Science and Technology, Arakkunnam Ernakulam, Kerala, India

Abstract: ***The increase in number of different automobiles and machinery has resulted in an increase in the use of lubricating oil. Motor oil are used for lubrication of internal combustion engines, and are derived from petroleum based and non-petroleum synthesized chemical compounds. The organic compounds in motor oil consisting of carbon and hydrogen. This has been shown to have harmful effect on the environmental and human being at large. The main objective of this project is to find out the effect of motor oil contamination on the properties of soil. In this study effect of motor oil contamination on plasticity, optimum moisture content, maximum dry density and compressive strength of soil is determined. The amount of motor oil contamination is varied at 2%, 4%, 8% and 16% of dry weight of soil sample. The results showed that the motor oil contamination affects the geotechnical properties of soil.***

Keywords: Motor oil contaminated soil, Plasticity, Optimum moisture content, Compressive strength

1. Introduction

The environment is polluted by human activities. Not only water and air but the soil also being polluted. It is difficult to construct structures on contaminated soil because the soil is unstable and the strength may probably reduce. One among the main source of soil contaminant is oil. The majority of oils are petroleum products contain hydrocarbons and the component of oil largely affects the geotechnical properties of soil, especially chemical and physical. The oil contaminated soil harmfully affects not only the soil but also the underground water and atmosphere. The oil contaminated soil affects human beings also. Oil contamination reduces the soil fertility and there by reduces the agricultural productivity. Oil spillage on soil may occur through various sources such as leakage from pipe lines, accidents during transportation and seepage from storage tanks. The settlement of oil storage tanks in refineries and petrol pumps may cause due to the strength reduction. For the decontamination and recycling, it is need to know about the geotechnical and behavior of contaminated soil.

The objective of this study is to find out the effect of motor oil contamination on the properties of soil. The laboratory tests are contacted on uncontaminated soil and soil with 2%, 4%, 8% and 16% motor oil contamination. The properties studied are Atterberg limits, dry density, optimum moisture content and unconfined compressive strength. The testing is contacted on silty clay, which is taken from Vaikkom, Kottayam district.

1.1. Literature Review

The effects of oil contamination are conducted on different soil samples and with different oils. The oil which are used for soil contaminations mostly petroleum products. The Atterberg limit is lower in contaminated soil than uncontaminated soil [1, 2, 3, 5]. A general trend is followed in the case of maximum dry density and optimum moisture content. Both maximum dry density and optimum moisture content decreases with increase in oil content [1, 2, 3, 5]. The strength of oil contaminated soil is lesser than uncontaminated soil [4]. From these studies the motor oil, crude oil and other petroleum product changes the geotechnical properties of soil.

2. Materials and Method of Study

Clay sample were collected from Vaikkom, Kottayam district, Kerala. The samples were obtained from a depth of 1.00 m from ground surface. In order to prepare contaminated soil, the motor oil is mixed in various percentage. The contaminated soil is then kept in an air tight container for one week. After one week the soil becomes mixed homogeneously. Hydrometer analysis is used in this study to determine the particle size distribution of soil collected. According to the hydrometer analysis the sample collected is silty clay. Table 1 shows the obtained results. The contaminant used in this study is servo heavy vehicle engine oil.

In order to study the effect of motor oil contamination on clayey soil laboratory tests programs to be designed. This laboratory tests include Atterberg limits, maximum dry density, optimum moisture content and unconfined compressive strength.

Table 1: Properties of uncontaminated soil

Property	*Value*
Specific gravity	2.66
Liquid limit (%)	71.11
Plastic limit (%)	33.33
Plasticity Index (%)	37.78
Optimum moisture content (%)	20
Maximum dry density (g/cm^3)	1.84
Percentage of clay size particles	43.9
Percentage of Silt size particles	55.08

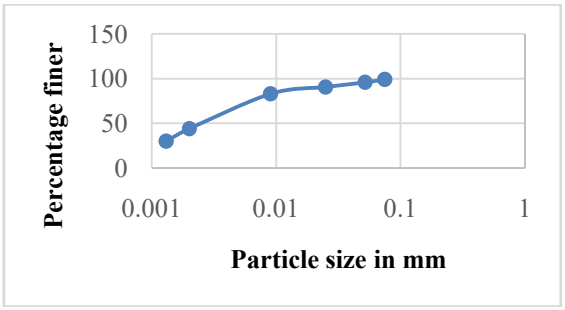

Figure 1: Grain size distribution curve of clayey soil

3. Results and Discussions

3.1. Atterberg limits

The Atterberg's tests conducted on uncontaminated and contaminated soil were used to determine the plastic limit (PL) and liquid limit (LL). The results are shown that both plastic and liquid limit decreases with increase in oil contamination. The liquid limit and plastic limit reduced from 7.11% to 54.35% and 33.33% to 23.50% respectively is figure 2 and 3.The values as shown in table 2.

The percentage of motor oil contamination on silty clay affects the index properties. The results show that the contents of hydrocarbons in motor oil, which cause reduction in thickness of water around the clay particles.

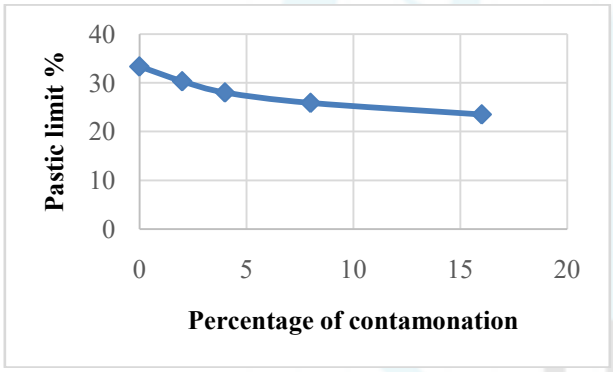

Figure 2: Percentage of contamination verses plastic limit

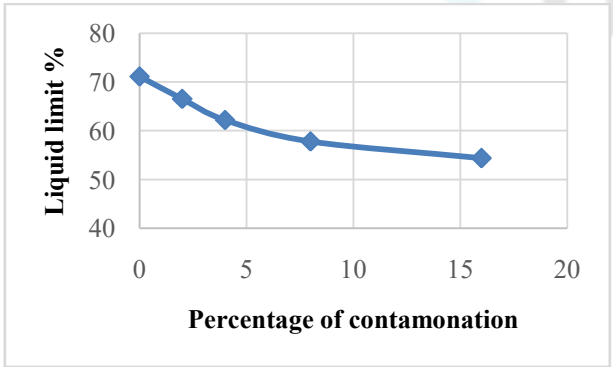

Figure 3: Percentage of contamination verses liquid limit

Table 2: Plastic limit and liquid limit vales of samples

Percentage of contamination	Plastic limit	Liquid limit
0	33.33	71.11
2	30.3	66.53
4	28	62.2
8	25.87	57.81
16	23.50	54.35

3.2. Optimum moisture content and maximum dry density

The moisture unit weight tests conducted on uncontaminated and contaminated soil by 2%, 4%, 8% and 16% were used to determine the compaction parameters namely optimum moisture content (OMC) and maximum dry density. The percentage of contamination should be on the dry side of optimum.

The maximum dry density and optimum moisture content a value at various percentage of motor oil contamination is shown in figure 4 and table 3.

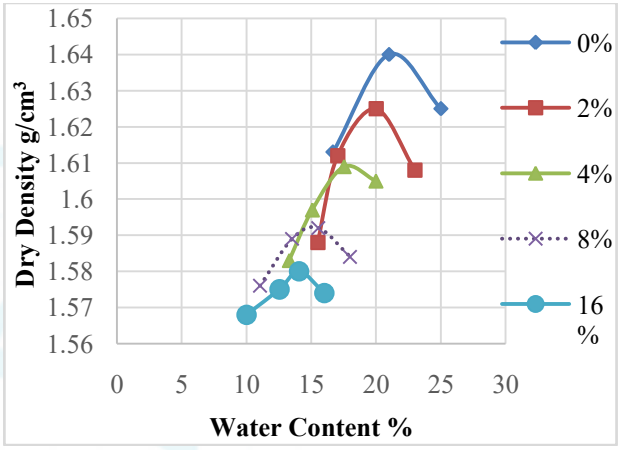

Figure 4: Compaction curve for 0%, 2%, 4%, 8% and 16% contaminated soil

Table 3: Optimum moisture content and maximum dry density

Sl No	*Percentage of motor oil*	*Optimum Moisture Content (%)*	*Maximum Dry Density g/cm³*
1	0	21	1.64
2	2	20	1.63
3	4	17.54	1.61
4	8	15.55	1.59
5	16	14.05	1.58

From the results it shown that there is a reduction in maximum dry density and optimum moisture content with increase in motor oil contamination.

Motor oil which fills the empty space between the soil particles hence reduces the amount of water content required to attain maximum dry density.

3.3. Unconfined compressive strength

In this test, a cylindrical soil specimen usually 3.8 cm in diameter is subject to an axial compression without any lateral confining pressure. The unconfined compressive strength q_u is defined as the compressive load per unit area at the time of failure of soil sample.

The stress strain curve for uncontaminated sample and soil with 2%, 4%, 8% and 16% contamination is shown in figure 5.

The value of unconfined compressive strength and cohesion is shown in table 4.

Table 4: Unconfined compressive strength

Percentage of contamination	*Unconfined compressive strength Kpa*	*Cohesion Kpa*
0	104.05	52.025
2	103.45	51.725
4	101	50.5
8	99.8	49.9
16	90.8	45.4

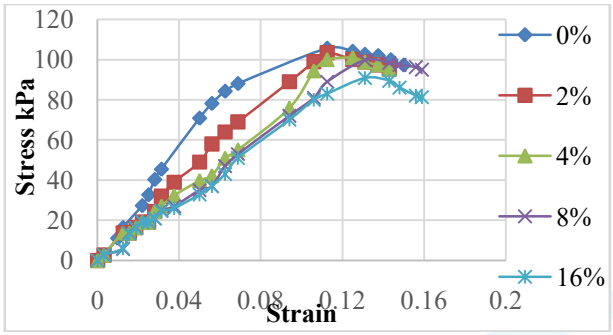

Figure 5: Stress strain curve for 0%, 2%, 4%, 8% and 16% contaminated soil

4. Conclusion

The laboratory tests were conducted on silty clay to determine the effect of motor oil contamination. The amount of 0%, 2%, 4%, 8% and16% motor oil by dry weight of sample was selected for oil contamination. The tests results show that;

- By the addition of motor oil there is a decrease in liquid limit and plastic limit.
- The maximum dry density decreased by addition of each percentage of motor oil.
- Compared to the uncontaminated soil the optimum moisture content value found to be decreased in contaminated soil by the addition of motor oil.
- There is a decrease in compressive strength with an increase in motor oil contamination.

References

Journal Articles

[1] P. Annu and Y.K. Bind, "Effects of Oil Contamination on Geotechnical Properties of Alluvial Soil Naini, Allahabad", International Journal of Innovative Technology and Exploring Engineering. Volume No. 3, Issue No. 8, PP. 2278-3075, 2014.

[2] K.N.Ashraf, "Effect of motor oil contamination on geotechnical properties of over consolidated clay", Alexandria Engineering Journal, Volume No. 50, PP. 331–335, 2011.

[3] K. Mashalah, H.C. Amir and T. Majid, "Effects of crude oil contamination on geotechnical properties of clayey and sandy soils", Engineering Geology. Volume No. 89, PP. 220–229, 2006.

[4] A. Hasan, AI-Sanad, K.E. Walid and F.I. Nabil, "Geotechnical properties of oil-contaminated Kuwaiti sand", Journal of Geotechnical Engineering Geotech. Engrg. Volume NO. 121, PP. 407-412, 1995.

Conference Proceedings

[5] V.P. Arpita (2011), "Study of geotechnical properties of black cotton soil contaminated by castor oil and stabilization of contaminated soil by sawdust", National Conference on Recent Trends in Engineering & Technology, 2011