EFFECTS OF USED MOTOR OIL CONTAMINATION ON SAND

Rakesh K R[1], Rani V[2]

[1]*M Tech student, Civil Engineering of Marian Engineering College, Trivandrum, Kerala*
[2] *Associate professor, Civil Engineering of Marian Engineering College, Trivandrum, Kerala*

Abstract - *A laboratory study was carried out on sandy soil contaminated with used motor oil. The testing program was carried out to establish the effect of used motor oil on the geotechnical properties of the material. The geotechnical properties altered due to contamination. The shear strength parameters and hydraulic conductivities of both clean and contaminated sand were studied. Contaminated samples were prepared by mixing sandy soil with 5, 10 and 15% by weight of used motor oil. The results obtained showed the shear strength and hydraulic conductivity of sand decreased with increase in contamination of used motor oil.*

***Key Words*: Used motor oil, Sand, Contamination, Shear strength parameters, Hydraulic conductivity**

1. INTRODUCTION

Petroleum and its products are major resources used for energy requirements in industrial and transportation sectors around the world. Motor oil is used for lubrication of various kinds of automotive and many other engines. When used for these purposes, motor oil picks up a number of additional components from engine wear. It include heavy metals such as lead, chromium, cadmium, and other compounds like naphthalene, chlorinated hydrocarbons, sulphur. After the passage of time, oil changes is necessary due to a change in the viscosity of the oil. Any such oil that becomes unsuitable after use due to contamination problem, making it unfit for its original purpose, is known as Used Motor Oil (U.M.O) and is required to be suitably disposed. Used oils can be recycled and re-refined if collected safely and properly, but in many cases it is poured into open drains or thrown into the trash thus it can contaminate the subsurface soil and ground water. One liter of oil can contaminate up to 1 million liters of water and can accumulate in the subsoil system, posing a risk to the environment. A single automotive oil change is estimated to produce 4– 5 L of used oil (S K Singh et al, 2009)

The contaminants reaching the soil matrix are held either by chemical adsorption or entrained within the pore space surrounding the soil grains. As the soil and used motor oil are relatively inert, they are held in soil pores either by capillary forces or as a small pool of liquid over clay and silt lenses as residual non aqueous phase liquids NAPL. Thus the properties, and behavior, of subsurface soils get modified due to change in the characteristics of their pore fluid and its interaction with soil particles. The reactivity of soil to the contaminants mostly depends not only on the surrounding environment, but also influenced by the mineral structure, , ion exchange capacity, particle size, bonding characteristics between particles etc. There is a greater chance for the smaller soil particle to interact with the contaminants in the surrounding.

2. MATERIALS AND METHODOLOGY

2.1 Soil

The sandy soil was collected from the nearby beach was used for the present study. The properties of sandy soil are listed in Table 1.

Table-1. Properties of poorly graded sand

Effective size, D_{10} (mm)	0.23
Uniformity coefficient, C_u	1.78
Coefficient of curvature, C_c	1.02
Bulk unit weight, γ (kN/m³)	16.05
Dry unit weight, γ_d (kN/m³)	15.61
Specific gravity, G_s	2.61
Angle of internal friction, ϕ (degree)	33

2.2 Contaminant

Used motor oil was chosen as the contaminant for the present study. It was obtained from a local automobile workshop. The grade of used oil was SAE 10W. Physical properties of the U.M.O are given in Table 2.

Table-2. Physical properties of U.M.O

Properties	Value
Weight density (kN/m^3)	8.70
Kinematic viscosity at 20°C (m^2/s)	1.19×10^{-4}
Surface tension at 20°C (N/m)	3.6×10^{-2}

2.3 Contamination

Contaminated soil samples were prepared with various degrees of contaminations such as 5, 10 and 15% of used motor oil by weight with sand. The used motor oil was sprayed on 5 kg of sand and the contaminated mixture was thoroughly mixed for 1 h in a tray. The mixture was placed in the container and covered for 1 week so that the U.M.O

would come to equilibrium with the sand. During this period, the sand was mixed periodically (ASTM 1993).

2.4 Evaluation of geotechnical properties

The geotechnical properties of the uncontaminated sand was determined as per relevant parts of SP36 (Bureau of Indian Standards (BIS; former Indian Standards Institute) 1987*a*). Similarly, geotechnical properties of the contaminated samples were determined.

3. RESULTS AND DISCUSSION

3.1 Shear Strength

The results obtained for shear strength parameters are shown in table-3. Frictional angle decreased by about 60% of that of clear soil with increasing degree of contamination. The reduction of friction angle occurred because the used motor oil acted as a lubricant that enabled the particles to slip and slide against each other. The reduction of the friction between the particles decreases the space between them, and also reduces the frictional angle. So there exists an inverse correlation between oil content and internal friction angle of poorly graded sand

Table-3. Values of friction angles of sand at different percent of oil content

Percentage of oil (%)	Angle of shearing resistance (°)
0	33
5	28
10	23.5
15	19.5

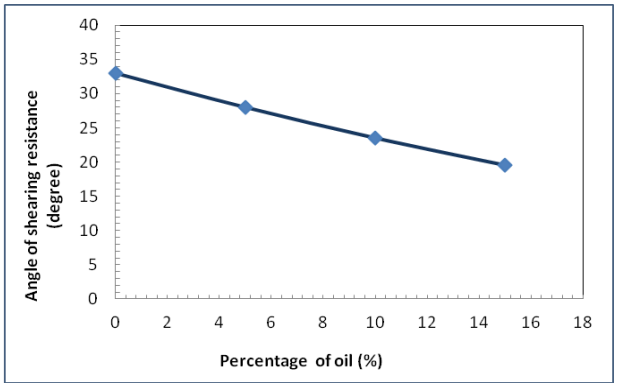

Chart-1. Variation of angle of shearing resistance with different percent of oil content.

3.2 Hydraulic Conductivity

The results of hydraulic conductivity of contaminated sandy soil are shown on table 4. The hydraulic conductivity has been found to be decrease in comparison with its virgin state. The permeability decreased almost 1/3 times of that of uncontaminated sand. The oil content presents in the voids of soil grains causes the reduction of permeability of soil mass. There occurred a reduction in the pore volume as the droplets of used motor oil are already occupying the pore spaces between and within the sand particles. The reduction in permeability may also be attributed to the blockage of some inter-particle space with oil.

Table-4. Hydraulic conductivity sand at different percent of oil content

Degrees of contaminations (%)	Hydraulic conductivity(*10^{-3} cm/s)
0	3.02
5	1.77
10	1.25
15	0.91

4. CONCLUSIONS

The performance of soil as a supporting medium is affected adversely by contamination with used motor oil due to changes in some of the soil properties. The effective angle of internal friction of sandy soil decreases sharply upon contamination with used motor oil. So the shear strength and allowable bearing pressure on granular soil decreases significantly upon contamination with used motor oil, thereby restricting its use as a supporting medium. A structure that is already constructed will experience distress, such as cracks, upon subsequent contamination of the supporting soil. The hydraulic conductivity of used motor oil contaminated sand is decreasing with corresponding increment in degree of contamination. The presence of oil in soil mass reduces the flow of water through it. So it is clear that, the shear strength parameters and hydraulic conductivity of sand are deeply influenced by the presence used motor oil.

REFERENCES

[1] Urum et al. (2006) "A comparison of the efficiency of different surfactants for removal of crude oil from contaminated soil", Chemosphere 62, 1403-1410.

[2] Feng et al. (2001) "Ex situ diesel contaminated soil washing with mechanical methods", Minerals Engineering, vol.14, no.9, 1093-1100.

[3] Urum and Pekdemir (2004) "Evaluation of bio-surfactants for crude oil contaminated soil washing", Chemosphere 57, 1139-1150.

[4] Khamehchiyan et al.(2007) "Effects of crude oil contamination on geotechnical properties of clayey and sandy soils.", Engineering Geology.89, 220–229.

[5] Conte et al. (2005) "Soil remediation: Humic acids as natural surfactants in the washing of highly

contaminated soils", Environmental pollution 135, 515-522.

[6] Rajab et al.(2014) "Effect of light hydrocarbons contamination on shear strength of fine sand", Geotechnique, Construction Materials and Environment,vol.10, 2186-2982

[7] Abumaizar and smith (1999) "Heavy metal contaminants removal by soil washing", Journal of Hazardous materials b70, 71-86.

[8] Srivastava et al. (2009) "Studies on soil contamination due to used motor oil and its remediation", Can. Geotech. J. 46, 1077-1083.