Performance of Petrol and Diesel Contaminated Black Cotton Soil

Dr. S. S. Pusadkar
Associate Professor, Department of Civil Engineering,
Government College of Engineering, Amravati,
Maharashtra.

P. S. Bharambe
M. Tech Scholar, Department of Civil Engineering,
Government College of Engineering, Amravati,
Maharashtra

***Abstract*— The leakage of petroleum product through vehicles plying on the road, from storage tank or through pipe line leads to the contamination of soil. The contamination of these product leads to alter the geotechnical properties of different soils. This paper aims to study the geotechnical properties of petrol and diesel contaminant black cotton soil. Black cotton soil contributes to 70 % of central India. The study shows that increase in contamination leads to decrease in specific gravity, swelling pressure and CBR .The liquid limit, plastic limit and shrinkage limit found to be increase with increase of contaminants. The increase in shrinkage limit and decrease in swelling pressure may improve swelling characteristic of black cotton soil. But decrease in CBR value shows concerned about the pavement stability**

***Keywords*— Black Cotton Soil, Petrol, Diesel, MDD, OMC, CBR, Swelling Pressure, Specific Gravity, Atterberg Limit**

I. INTRODUCTION

The exposure of hydrocarbon into soil and aquatic environments is probably due to human errors such as underground storage leakage, accidental collides and spill. The degree of hydrocarbon contamination is controlled by many factors such as distance from source, types of hydrocarbon components, initial concentration and types of medium of pathway.

Oil waste dumping, production, pollution, and spills wreak havoc on the surrounding wildlife and habitat. It is in this vein that geotechnical engineers are faced with increasing challenges as a result of petroleum product pollution and hence the need for laboratory studies in order to understand engineering behaviour, for such soils. This paper focuses on geotechnical properties of petrol and diesel contaminant black cotton soil.

II. LITERATURE REVIEW

As the world demand for oil products is increasing, the possibility of leakage of oil would also increase. This leakage associated with many problems to both environment and soil properties. There is not much work on the effect of crude oil products on the geotechnical properties of soil. Recently, some researchers studied the effect of crude oil contamination on clayey and sandy soil.

Shaheen (2011) studied effect of crude oil products (kerosene and diesel) on geotechnical properties of sandy soil. Three different types of sandy soils were selected based on their grain size distribution. Their optimum moisture content, maximum dry density, and shear strength, angle of internal friction, grain size distribution, and permeability were determined. A slightly greater decrease in the friction angle was noticed for the addition of kerosene than that with the addition of diesel. The percentage of crude oil products added to the soil is increased, the shear strength increases up to a certain percent. The addition of diesel and kerosene has caused a reduction in the permeability of the sand.

Ling *et. al* (2012) investigated the geotechnical properties on palm biodiesel contaminated weathered granite soil and mining sand. The laboratory experiment has been carried out by using a direct simple shear device on clean and contaminated soil samples. The overall results indicated decrease of shear strength with increasing palm biodiesel contents

Sahibin *et. al* (2013) studied the restored oil contaminated soil. Surfactants are often used as a cleaning agent for restoration of oil-contaminated soil. The shear strength of soil with added surfactant was examined using the undrained unconsolidated triaxial tests. The presence of surfactant in soil can modify the mechanical behaviour of the soil. The effects of surfactant on silty soil were investigated for consistency index, compaction, permeability and shear strength. Maximum dry densities increased and optimum moisture contents decreased as contents of added surfactant were increased. The undrained shear strength was significantly decreased. Surfactant in treated soil reduced liquid and plastic limits, permeability and shear strength. The presence of surfactant assists soil to achieve maximum density at lower water content

Sim *et. al* (2013) studied the soil samples prepared by mixing the mining sand with 10% by weight of B20 palm biodiesel. The effect of aging period for one, four, and six months in natural environmental conditions were investigated in this study. The soil shear strength and stiffness of soil increases due to the evaporation of palm biodiesel content in the aging period. The maximum shear stress of contaminated samples increases when the aging period increases. The contaminated aged samples strength increases with aging period increases

Alhassan *et. al* (2013) studied effects of crude oil, low point pour fuel oil and vacuum gas oil contamination on the geotechnical properties sand, clay and laterite soils.

The testing program was carried out to establish the effect of the contaminants on the engineering properties of the materials. Testing included Atterberg properties, compaction, consolidation, California bearing ratio (CBR), triaxial compression. The results obtained showed that the shear strength of sand and laterite increased with used engine oil contamination. The shear strength of clay soil increased with used engine oil contaminations. The CBR values of the contaminated sand and laterite recorded higher values at 2% oil contaminations. CBR values for the clay decreased with oil contaminations. The consolidation settlement of the contaminated clay soil generally decreases with all the contaminants.

Walia *et. al* (2013) studied geotechnical parameters of soil by using diesel pollutant. Diesel decreases the specific gravity of soil. The contaminated soils were found to increase the liquid limit and plastic limit of contaminated soil. The MDD and OMC of contaminated soil decreased. Free swell index increased when diesel oil was added.

From the literature review it was observed that many studies have been carried out on contaminated sand and clay. The effect of petrol and diesel on geotechnical properties of black cotton soil is not studied and hence this work intends to study the same.

III. MATERIALS AND METHODS

1. Materials

A. Black Cotton Soil

The soil was procured from Government College of Engineering Amravati, campus at a depth of one meter from ground surface.

B. Diesel and Petrol

The petroleum product Petrol and Diesel were used as contaminant. The soil was contaminated in the laboratory with varying percentage of Diesel and Petrol. The contaminated soil was then packed in polythene bag for specified condition period.

2. Methods

A. *Sampling*

The soil samples were collected from one meter depth with Government College of Engineering, Amravati, campus. The soil was kept in the oven for 24 hours for drying. The sample for contamination and testing was collected from oven dried sample by quarter sampling method. Petrol and Diesel were mixed separately with the samples in different content. The amount of contamination calculated as a % by weight of the dry uncontaminated soils and then mixed with the predetermined weight of the dry soil samples

B. Procedure of Sample Preparation

The soil collected from field was oven dried and hand sorted to remove the pebbles and vegetable matter, if any. The soil was then be contaminated by Diesel and Petrol in varying percentage by weights of black cotton soil and allowed to cure for 24 hour period before testing and then tested to determine their geotechnical properties.

IV. TEST PROGRAM

The Tests conducted for different condition is shown in Table I

Table I. Testing Program

Soil	Black Cotton Soil
% Diesel and Petrol	0,3,6,9
Curing Period	24 Hrs
Tests	Specific Gravity Standard Proctor Atterberg Limit CBR Swelling Pressure

V. RESULT

The Atterberg Limit, specific gravity, standard Proctor tests, California bearing ratio (CBR) test and swelling pressure tests were conducted on uncontaminated and contaminated black cotton soil with varying % of Diesel and petrol. The tests were conducted as per IS 2720. Fig. 1 and Fig. 2 shows the results of standard Proctor test for different % of Diesel and petrol contamination. The results of different tests conducted on contaminated soil are shown in Table II and Table III for petrol and Diesel contamination respectively.

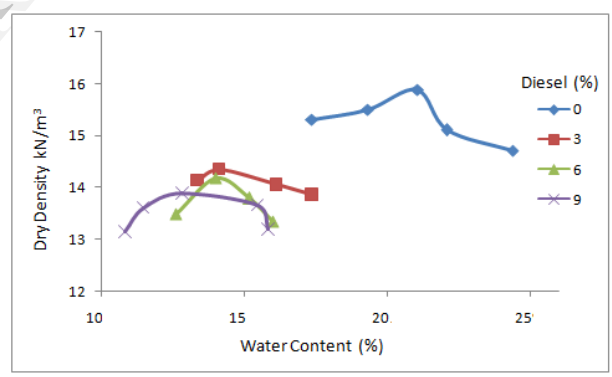

Fig 1: Effect of Diesel on Compaction Characteristics

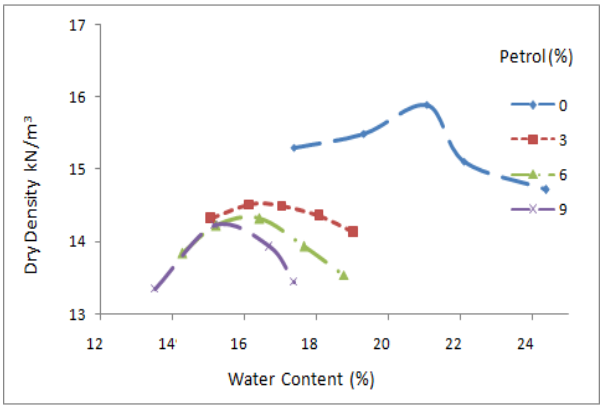

Fig 2: Effect of Petrol on Compaction Characteristics

Table II: Various Geotechnical Properties of contaminated Black Cotton Soil with Petrol

Sr. No	Property of Soil	Petrol			
		0 %	3 %	6 %	9 %
1	Specific Gravity	2.63	2.59	2.42	2.34
2	Liquid Limit (%)	53.10	58.50	62.96	64.20
3	Plastic Limit (%)	31.14	39.53	45.45	47.05
4	Shrinkage Limit	9.20	13.21	17.22	18.57
5	(%)	21.06	16.20	15.50	14.82
6	OMC (%)	15.89	14.52	14.32	14.22
7	MDD (kN/m^3)	12.91	11.31	10.07	8.75
8	CBR(Unsoaked)	118.83	77.56	49.02	32.58
	Swelling Pressure (kN/m^3)				

Table III: Various Geotechnical Properties of contaminated Black Cotton Soil with Diesel

Sr. No	Property of Soil	Diesel			
		0 %	3 %	6 %	9 %
1	Specific Gravity	2.63	2.58	2.44	2.35
2	Liquid Limit (%)	53.10	56.10	59.69	66.66
3	Plastic Limit (%)	31.14	36.98	39.53	48.14
4	Shrinkage Limit	9.20	12.85	16.54	17.56
5	(%)	21.06	14.15	13.45	13.01
6	OMC (%)	15.89	14.32	14.12	13.93
7	MDD (kN/m^3)	12.91	12.11	10.51	9.70
8	CBR(Unsoaked)	118.83	85.29	56.23	34.39
	Swelling Pressure (kN/m^3)				

Fig. 3 to Fig. 6 shows the variation of specific gravity, shrinkage limit, swelling pressure and CBR (unsoaked) with uncontaminated and contaminated soil. The shrinkage limit of soil increases with the increase percentage of petrol and Diesel in the soil. The MDD, OMC, specific gravity California bearing ratio and swelling pressure of contaminated soil decreases. This may be due to contaminants with polar organic liquids along with lubricants effect which may lead to disperse the soil structure.

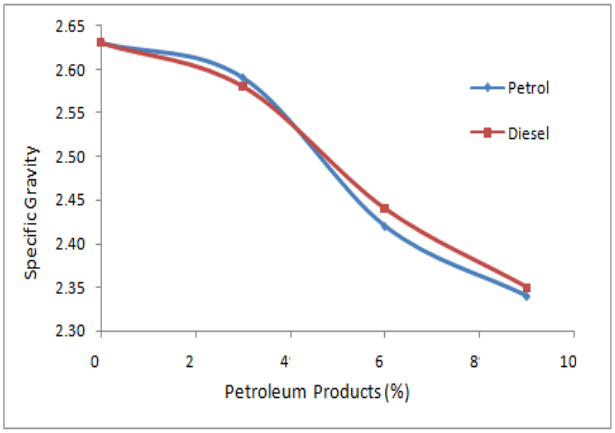

Fig 3 : Effect of Petroleum Products on Specific Gravity

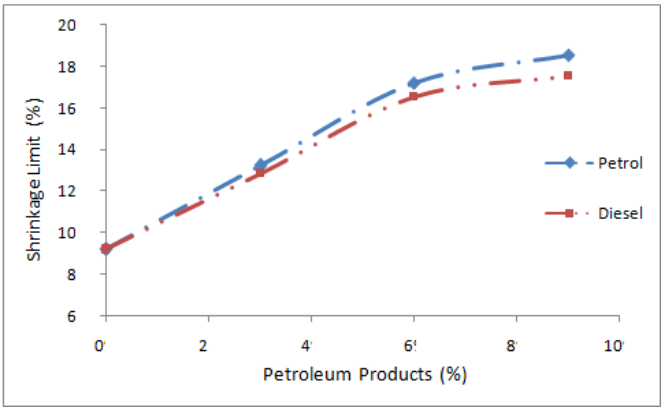

Fig 4 : Effect of Petroleum Products on Shrinkage Limit

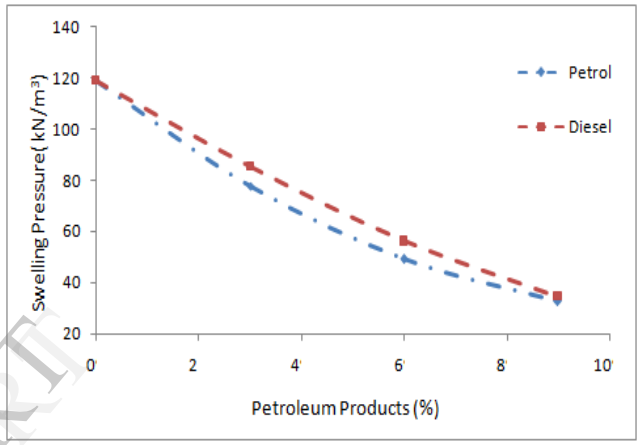

Fig 5: Effect of Petroleum Products on Swelling Pressure

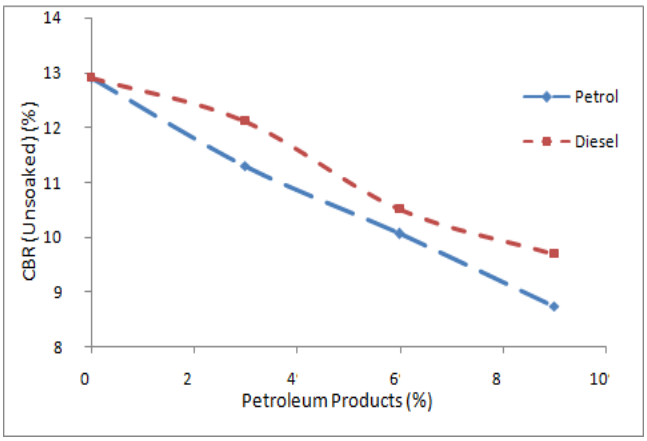

Fig 6: Effect of Petroleum Products on CBR

VI. CONCLUSION

Petrol and Diesel contamination on geotechnical properties of black cotton soil has been studied. It was observed that the Atterberg limits of contaminated soils were increases than that of uncontaminated soils. The maximum dry density, optimum moisture content, specific gravity California bearing ratio and swelling pressure reduces due to increase in content in contaminant soil. The role of contamination is quite similar to water, it increases a chance to inter-particle slippage, thus reduce the MDD and OMC. The decrease in CBR value shows concern for petrol and Diesel contaminated black cotton soil.

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