June. 2015. Vol. 7. No. 01 ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

EFFECT OF CRUDE OIL SPILLAGE ON GEOTECHNICAL PROPERTIES OF LATERITIC SOIL IN OKOROETE, EASTERN OBOLOLO

[1]UKPONG, E. C; AND [2]UMOH, I. C;

[1]Department of Civil Engineering, Faculty of Engineering University of Uyo Ibom State, Nigeria.
E-mail: cletoee@yahoo.com

ABSTRACT

This study was carried out to identify the effect of crude oil spill on the geotechnical properties of lateritic soil in Okorete town, Eastern Obolo Local Government Area with the view to evaluating possible challenges posed by crude oil spill on the geophysical properties of lateritic soil. Analysis was carried out by collecting soil samples from both the normal soil (no oil spillage sands) and contaminated area where there was oil spillage. The results show an increase in grain size distribution of soil after carryout sieve analysis of both samples. It was observed that there was 17% reduction optimum moisture content, 9% reduction in the maximum dry density (for compacted test); 45% and 39% reduction in the liquid limit and respectively for atterberge limit test. The reduction in the California Bearing Ratio due to crude oil contamination was 50%. These show that the presence of crude oil has remarkable effect on the geotechnical properties of lateritic soil.

Keywords: Crude oil, California Bearing Ratio, Soil, Optimum moisture content and geotechnical properties.

1.0 INTRODUCTION

Several definitions have been given in order to explain the meaning of oil spill to people of diverse professions. One of such definitions is that put forward by the online Dictionary.com. It defines oil spill as an accidental discharge of oil into a body of water as from tanker, offshore drilling rig, or under water pipeline, often presenting a hazard to marine life and the environment.

According to Anoliefo (1991) crude oil is a complex mixture of hydrocarbon and organic compounds of Sulphur, Nitrogen, Oxygen and a certain quantity of water which varies in composition from place to place. Oil spill is a manace and possess serious threat to the environment. These complications degrade the environment and destroy the ecosystem. The worse effect can be seen in engineering construction and the geotechnical properties of soil. The effect of these leaks and spills on the environment cannot therefore be overlooked or disregarded one of such effect is that it causes changes in the engineering properties and behavior of soils. Thus changes have a far reaching implication on existing and proposed structures to be supported by the contaminated soil. All this can result in changes in structural or functional failures of existing structures, especially when the contamination causes significant changes in the soil plasticity, loss of its bearing capacity, increases its settlement and prevent drainage of water or other liquid, Osinubi et al; (2007).

Oil spill can have a serious effect on the proposed structures located on oil spill site having the contaminated soil. This may result in a reduction on the scope of the project or may result on an increase in its project cost. The increase in the project cost may result from variation in the geotechnical properties and chemical changes of the soil due to it contamination with the soil spill (Gidigasu and Kuma, (1987).

Because of the devastating effect of oil spill, government in Nigeria has enacted laws to ensure that affected communities of a particular spill are being compensated. Also any oil company associated with oil spillage are forced by law to thoroughly clean up the spillage, but in spite of these laws, oil companies have not been able to stop the spillage due to various complication involved in crude oil drilling and activities of oil theft involved in exploding pipes with sophisticated equipment such as dynamite.

 ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

The problem in carrying out this study has to do with investigating the effect of crude oil spill and it numerous effects on the lateritic soil in Okoroete and oil producing area in Eastern Obolo. Generally, this study is limited only to Okoroete which is a riverine oil producing town where it land mass mainly consists of lateritic soil.

1.2 Aims of the Study

The aim of this study includes:

i) To evaluate the effect of crude oil on the geotechnical properties of lateritic soil in Okoroete which is a riverine oil producing community in Eastern Obolo?

ii) T o assess the effect of oil spill on the study area.

iii) To determine the kind of material that would be suitable for construction in Okoroette area.

iv) To determine the possible challenges posed by crude oil.

1.3 The Study Area

Okoroette is a town in Eastern Obolo Local Government Area created out of Ikot Abasi Local Government Area of Akwa Ibom State in 1996. It is bounded by Ikot Abasi and Mkpat Enin at its North, Onna and Ibeno at its north east and Atlantic Ocean at its south. The official language of the people in the area is Obolo Language which is also spoken in Andoni Local Government Area of River State. The people are mainly Fishermen. They fish in Atlantic Ocean, the numerous rivers and the Creeks of the area. Only few people are engage in crop production, timber production and white collar jobs. In recent time, many people are unemployed because of the effect of oil exploitation which renders the territorial ocean and the rivers polluted, resulting in low fish production. Other activities like timber production are equally affected due to oil spill.

The major significant features in the area are numerous rivers, Atlantic Ocean, estuaries, Creeks, hills, thick forest growing mangroves. Sharp sand from the ocean and the rivers of the area are salty. There are a lot of lateritic soil which are often used for construction work. Periwinkle shells and other strong shells of aquatic animals obtained from the area are used as bio-mineral aggregates for concrete production, foundation and stabilization of soil.

Figure 1, 2, 3 and 4 shows the numerous effects of crude oil spill in the area.

Figure 1: A Villager collects sample of crude oil polluting a farmland in Okoroete in Nigeria's Akwa Ibom State.

ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

Figure 2: Picture showing a crude oil spill in Okoroete

Figure 3: Fishermen of Eastern Obolo, Eket Senatorial District abandoning their fishing tools & livelihood due to oil spill devastation

International Journal of Engineering and Applied Sciences

www.eaas-journal.org

Figure 4: Oil Spill impact killing birds and aquatic animals

2.0 EFFECT OF OIL SPILL ON SOIL

Oil contaminated soil (OCS) has been defined by Colorado, Department of Health and Environment (2003), as any earthen material or artificial fill that has human or natural alteration of its physical, biological or radiological integrity resulting from the introduction of crude oil, any fraction or derivation there off (such as gasoline, diesel, or used motor oil) or any oil based product.

According to Evagin and Das (1992), crude oil pollution on land depends on a number of factors which include permeability of the soil and the partition coefficient. Aiban, (1997) said that the term laterization describes the process that produces lateritic soils. Euchun and Braja, (2001) proposed the following definition for laterillic soil which states that lateritic in all its form is a highly weathered natural material formed by the concentration of the hydrated oxides of iron and alumimium. This concentration may be by residual accumulation or by solution, movement and chemical precipitation. Also, Ikimdiya and Igboro (2010) stated that laterite is a highly weathered material rich in secondary oxide of any of iron aluminium/manganese or titanium. The extent of contamination depends on the chemical composition of the contamination and the properties of the soil, Alban (1997).

2.1 Compaction

Compaction is the process of applying energy in order to loose soil to consolidate it and remove the voids, thereby increasing the density and consequently its load bearing capacity. According to the studies carried out by Euchum (2001), the Maximum Dry Density (MDD) and the Optimum Moisture Content (OMC) of crude oil contamination soil decreases, and the decrease increases with the period of contamination. Also, Ijimdiya (2010) also reported that the load carrying capacity of oil particularly saturated sand decreased with the oil content. He also reported that an increase in unconfined compressive strength of soil when contaminated with crude oil also decreases. It is also reported that the bearing capacity of soil contaminated with used motor oil (made of crude oil) can drastically reduce and made the soil unsuitable for supporting engineering structures or plant growth by increasing the toxic content of the soil (Euchum and Braja (2001). Alban (1997) confirmed a decrease on some of the geotechnical properties such as compaction of soil, soil stiffness and permeability of the clay and he attributed it to a formation of an open structure occasioned by the crude oil. He also explained that there is variation in the hydrocarbon content of crude oil and the concentration of these hydrocarbon affect the extent to which crude, oil influence the geotechnical properties of lateritic soil. According to a study carried out by Iymidiya

International Journal of Engineering and Applied Sciences

www.eaas-journal.org

(2011) to investigate the effect of hydrocarbon on the engineering characteristics of oil contaminated soil, they observed that changes in the hydraulic conductivity of a particular soil (including lateritic) can be associated with the changes in the soil fabrics when moulding pore fluid and permeation pore fluid are water. He added that as a result of soil contamination, various liquids interact chemically with active soil of lateritic particles, altering their behaviours.

Figure 5a and 5b shows the effect of oil before and after crude oil pollution according to Eugin (1992).

2.2 Effect on Atterberge Limit

A lot of researches have been carried out on Atterberg limit of soil with respect to crude oil contamination. All the results showed that the liquid limit (LL) and plastic limit (PL) of soil reduces when contaminated with crude oil.

In 1993, Osinnubi and Kasai (2007) carried out Atterberg limit test on laterite to determine the influence of crude oil spillage on lateritic soil in the Niger Delta Area of Nigeria. The result shows a decrease in the values of (PL) and (LL). According to them, the decrease was due to alteration of the cohesive bonds and forces that exist between the articles of the lateritic soil. The decrease was due to reduction in the Cation Exchange Capacity (CEC) of the soil. They also investigated the effect of crude oil on the geotechnical properties of sandy soil, clay soil and lateritic soil. The result showed that the Atterberg limit decreased with increase in oil percentage.

2.3 The Particle Size Distribution

The particle size distribution of a soil refers to the granular particle of a soil as a list of values or mathematical function that defined the relative amount of soil by mass of particles present in the soil. Evgin (1992) said that the particles distribution is critical to the behavior of the soil under loads and in contact with water and that if the particles size distribution of a particular soil is known, it is possible to make good prediction of how it would behave as a foundation for buildings, dams and road. It was also observed that there was a great reduction in the percentage of fines with increase in the oil content.

3.0 MATERIALS AND METHODS

3.1 Sample Collection

Several samples where collected from Okoroete, in Easten Obolo Local Government Area. Samples were collected in two locations where oil spills occurs and where there was no spill. These were achieve by using hand auger for both location. The samples were labeled before drying in an oven in the Department of Civil Engineering Soil Laboratory at the University of Uyo, Uyo, Akwa Ibom State, Nigeria.

3. 2 Determination of Attenerg Limit, Compaction, Particle Size Distribution and California Bearing Ratio (CBR)

This method involves conducting test to determine the effect of crude oil spills on liquid limit and plastic limit of the soil sample. Casagrades liquid limit device was used to determine the liquid limit of the soil sample. The method used for plastic limit was different. 20g of soil passing through sieve No.40. (ASTM) was thoroughly mixed with water and rolled with hand until the soil sample showed sign of crumbling. The water content at the crumbled state was the Plastic Limit (PL). The sample with contaminated oil was also carried out and the value also determined.

Similarly compaction test using the West African Standard method was used. The equipment used were: rammer weight of 4.5kg, 153.4mm mould diameter, 127mm mould height, 27 No. of blows with 27 No of layers and five compaction was carried out on both samples.

The particle size analysis was carried out in a set of standard sieve with various sieve mesh width, expressed in milimetres in accordance with BS 1377 (1990). Also, the CBR test was determined with a CBR machine. This machine reads both force and penetration on a soil in mould compacted at Optimum Moisture Content (OMC) and Maximum Dry Density (MDD).

4.0 RESULT AND DISCUSSION

After carrying out series of tests on the contaminated and uncontaminated soil samples the results show remarked changes on the geotechnical properties of the soil. Results of the compaction shows a higher value in the optimum moisture content (OMC) and Maximum Dry Content (MDD) of the uncontaminated soil sample, but reduction in OMC and MDD of the crude oil contaminated soil sample. For Atterberg limit and corresponding plasticity index of the oil contaminated soil were drastically reduced.

Similarly the particles size distribution in the presence of crude oil was slightly affected.

June. 2015. Vol. 7. No. 01 ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

The particle size was falsely increased, reducing the amount of clay in the particle distribution. Again the value of California Bearing Ratio (CBR) of the uncontaminated soil was higher than that of the contaminated soil. Details of these results are presented in the tables and graphs below.

4.1 Table 1: Physical Properties of the Natural Soil

Characteristic	Quantity
% passing No. 75µ is sieve	1.49
Liquid Limit (LL)%	29.00
Plastic Limit (PL)%	20.25
Plasticity Index (PI)%	8.75
AASHTO Classification	A-2-4 (0)
Natural Moisture Content %	14.11

4.2 Compaction (Comparison)

Table 2: Compaction of Uncontaminated Sample

University of Uyo			COMPACTION - TEST				University of Uyo					
TESTED BY;												
SAMPLE LOCATION: Okoroete					MV (cm3)		2316.97					
NO OF BLOWS:27												
WEIGHT OF RAMMER:4.5kg					MWT (g)		2750					
SAMPLE DESCRIPTION: UNCONTAMINATED												
DETERMINATION NO.		1		2		3		4		5		6
WT OF WET SOIL + MOULD(g)		7500		7750		7850		7850		7760		7650
WT OF WET SOIL (g)		4750		5000		5100		5100		5010		4900
WET DENSITY p (g/cm^3)		2.05		2.16		2.20		2.20		2.16		2.11
DRY DENSITY pd (g/cm^3)		1.89		1.98		1.98		1.95		1.89		1.93
MOISTURE CONTENT												
LID NO.	AI	Agk	Ad	900	C5	Bb	F1	110	Aq	oo2	Bg	08
WT OF LID (g)	41.45	41.50	41.35	41.55	41.55	41.20	41.40	41.40	41.60	41.75	41.40	41.35
WT OF WET SOIL+LID (g)	85.65	85.35	87.30	94.35	87.85	90.45	101.00	101.65	92.55	83.35	93.30	92.9
WT OF DRY SOIL+LID (g)	82.30	81.80	83.65	89.80	83.25	85.55	94.25	94.90	86.25	78.20	91.50	85.8
WT OF DRY SOIL (g)	40.85	40.30	42.30	48.25	41.70	44.35	52.85	53.50	44.65	36.45	50.10	44.45
WET OF WATER (g)	3.35	3.55	3.65	4.55	4.60	4.90	6.75	6.75	6.30	5.15	1.80	7.10
MOISTURE CONTENT %	8.20	8.81	8.63	9.43	11.03	11.05	12.77	12.62	14.11	14.13	3.59	15.97
AVERAGE MC %	8.50		9.03		11.04		12.69		14.12		9.78	

Table 3: Compaction of Contaminated Sample

	COMPACTION - TEST			
TESTED BY;		DATE	23/12/2014	
SAMPLE LOCATION: Okoroete	MOULD VOL. (cm3)	2316.97		

June. 2015. Vol. 7. No. 01 ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

NO OF BLOWS:27			NO. OF LAYERS:5			
WEIGHT OF RAMMER:4.5kg			MOULD WT (g)	2750		
SAMPLE DESCRIPTION: UNCONTAMINATED						
DETERMINATION NO.	1	2	3	4	5	6
WT OF WET SOIL + MOULD(g)	6700	6850	7100	7250	7350	7250
WT OF WET SOIL (g)	3950	4100	4350	4500	4600	4500
WET DENSITY p (g/cm^3)	1.70	1.77	1.88	1.94	1.99	1.94
DRY DENSITY pd (g/cm^3)	1.62	1.67	1.74	1.79	1.80	1.76

MOISTURE CONTENT												
LID NO.	Ab	Ah	5a	Soq	AF	Al	AC	Aq	Ba	Bb	lb	B2
WT OF LID (g)	41.75	41.80	41.45	41.75	41.65	41.80	41.60	41.70	41.40	41.35	41.70	41.4
WT OF WET SOIL+LID (g)	89.50	98.80	73.10	76.00	75.25	80.20	86.50	78.65	82.00	87.30	94.10	102
WT OF DRY SOIL+LID (g)	87.15	96.10	71.35	74.00	72.85	77.50	82.90	75.75	78.25	83.10	89.00	96.5
WT OF DRY SOIL (g)	45.40	54.30	29.90	32.25	31.20	35.70	41.30	34.05	36.85	41.75	47.30	55.10
WET OF WATER (g)	2.35	2.70	1.75	2.00	2.40	2.70	3.60	2.90	3.75	4.20	5.10	5.80
MOISTURE CONTENT %	5.18	4.97	5.85	6.20	7.69	7.56	8.72	8.52	10.18	10.06	10.78	10.53
AVERAGE MC %	5.07		6.03		7.63		8.62		10.12		10.65	

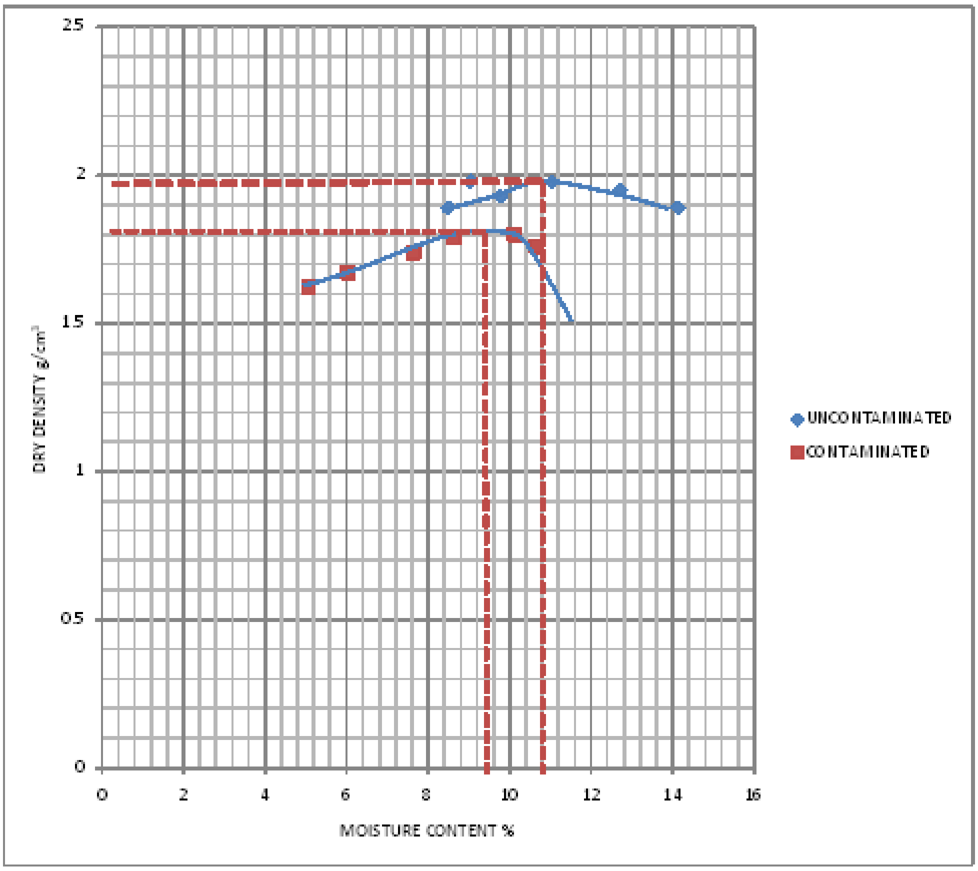

Figure 5: Graph Showing Result of Compaction for Uncontaminated and Contaminated Soil Samples.

International Journal of Engineering and Applied Sciences

www.eaas-journal.org

Figure showing result of compaction for Uncontaminated and Contaminated oil Samples.

From the above graphs and illustrations the optimum moisture content of the contaminated soil and the Maximum Dry Density reduce from 11.40%, 1.98g/cm3 to 9.50%, 81g/cm3 respectively. The reason for the reduction was due to the presence of crude oil as pollutant which inhibited the retention of the density value of the uncontaminated soil. The absorption of higher molecular weight components crude oil onto the lateritic soil surfaces caused wetability to change from water- wet to oil- wet. The absorption of these components created an adsorbed layer around the particles. This adsorbed layer is not water soluble and is not displaced by water. The organic content coats and agglomerates the lateritic soil particles thereby reducing the specific surface area. This in turn leads to the reduction in the bonding strength of the lateritic soil.

4.3 Atterberge Limit (Comparison)

Table 4: Atterberg Test (Uncontaminated Sample)

DETERMINATION OF ATTERBERG LIMITS						
PROJECT						
CLIENT						
JOB DESCRIPTION	UNCONTAMINATED					
SAMPLE Ref;						
		LIQUID LIMIT			PLASTIC LIMIT	
CONTAINER No	AA	C5	AQ	BB	900	AZ
NUMBER OF BLOWS	11	18	25	33		
MASS OF WET SOIL + TIN (g)	55.25	53.25	56.55	56.45	45.95	45.94
MASS OF DRY SOIL + TIN (g)	51.15	50.85	53.15	53.05	45.20	45.21
MASS OF TIN (g)	41.35	41.46	41.60	41.25	41.55	41.55
MASS OF MOISTURE g	4.10	3.05	3.40	3.40	0.75	0.73
MASS OF DRY SOIL g	9.80	9.20	11.55	11.80	3.65	3.66
MOISTURE CONTENT (%)	41.84	33.15	29.44	28.81	20.55	19.95
						20.25

Table 5: Atterberg Test (Contaminated Sample)

DETERMINATION OF ATTERBERG LIMITS						
PROJECT						
CLIENT						
JOB DESCRIPTION	UNCONTAMINATED					
SAMPLE Ref;						
		LIQUID LIMIT			PLASTIC LIMIT	
CONTAINER No	BF	AC	3A	AZ	PZ	AK
NUMBER OF BLOWS	12	15	23	27		
MASS OF WET SOIL + TIN (g)	57.36	53.95	54.75	55.55	63.60	59.75
MASS OF DRY SOIL + TIN (g)	55.05	52.10	52.90	53.65	61.20	57.75
MASS OF TIN (g)	41.50	41.04	41.50	41.70	41.50	41.65
MASS OF MOISTURE g	2.31	1.85	1.85	3.40	0.75	0.73
MASS OF DRY SOIL g	9.80	9.20	11.55	11.80	3.65	3.66
MOISTURE CONTENT (%)	41.84	33.15	29.44	28.81	20.55	19.95
						20.25

Results of the Atterberg limits mainly Liquid Limits (LL), Plastic Limit (PL) and Plastic Index (PI) are shown in table 4 and 5 and Figure 6.

June. 2015. Vol. 7. No. 01 ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

The Liquid Limits (LL) of the uncontaminated soil is 29.00 which is very high compared to 16.04, LL value of the crude oil contaminated soil. The decrease in the value of PL and LL of the contaminated soil was due to the alteration of the cohesive bonds and forces that exist between the particles of the lateritic soil. The decrease was also due to reduction in the Cation Exchange Capacity (CEC) of the soil.

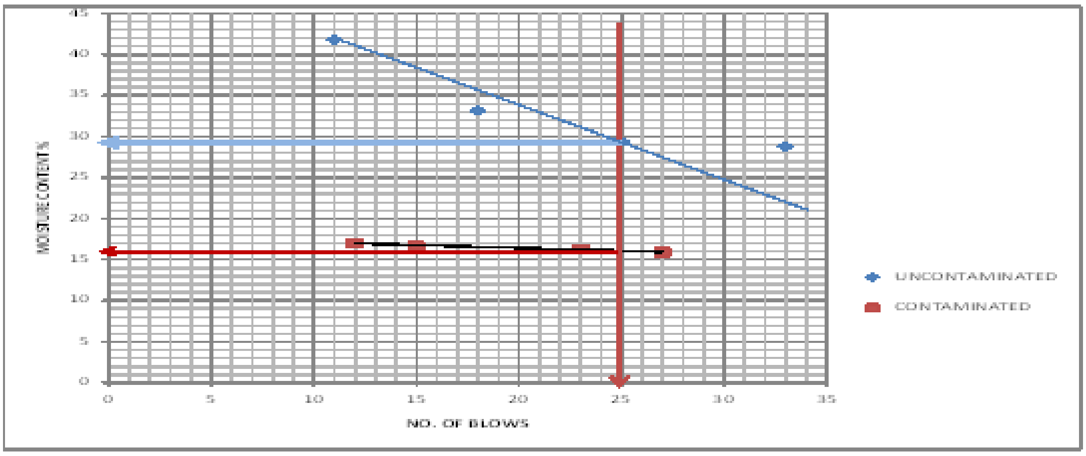

Figure 6: Graph of Atterberg Test for both Uncontaminated and Contaminated Soil Samples.

4.4 Particle Size Distribution (Comparison)

As illustrated in table 6, 7 and in figure 7 below, the distribution of same soil sample in the same sieve sizes have varying proportions, depending on the percentages of crude oil in the soil. Though the variation was not really much, it was due to the oil which clod to different particles and prevents them from successfully passing through each stack of sieve. It is therefore necessary to properly analyze soils of this kind to avoid false value being used.

Table 6: Particle Size Distribution (Uncontaminated Sample)

PARTICLE SIZE DISTRIBUTION				
UNCONTAMINATED SAMPLE				
INITIAL WT	758.22			
SIEVE SIZE (MM)	WT RETAIN	% RETAN	CUM %	% FINNER
				100
2.36	0.35	0.05	0.05	99.95
1.7	0.2	0.03	0.08	99.92
1.18	0.2	0.03	0.11	99.89
0.6	0.6	0.08	0.19	99.81
0.5	0.35	0.05	0.24	99.76
0.4	1	0.13	0.37	99.63
0.25	205.15	27.06	27.43	72.57
0.15	441.35	58.21	85.64	14.36
0.75	89	11.74	97.38	2.62
PAN	8.6	1.13	98.51	1.49
	746.8			

International Journal of Engineering and Applied Sciences

www.eaas-journal.org

Table 7: Particle Size Distribution (Contaminated Sample)

PARTICLE SIZE DISTRIBUTION				
SAMPLE DISCRIPTION	8% CONTAMINATION			
INITIAL WT	840.2			
SIEVE SIZE (MM)	WT RETAIN	% RETAN	CUM %	% FINNER
3.35	0	0	0	100
2.36	10.6	1.2	1.2	98.8
1.7	6.05	0.72	1.92	98.08
1.18	5.7	0.68	2.6	97.4
0.6	8.55	1.02	3.62	96.38
0.5	1.7	0.2	3.82	96.18
0.4	4.65	0.55	4.37	95.63
0.25	38.6	4.59	8.96	91.04
0.15	445.4	53.01	61.97	38.03
0.75	300.7	25.79	97.76	2.24
PAN	10.55	1.26	99.02	0.98
	831.96			

Grain Size Distribution Graph for Uncontaminated and Contaminated Soil Sample

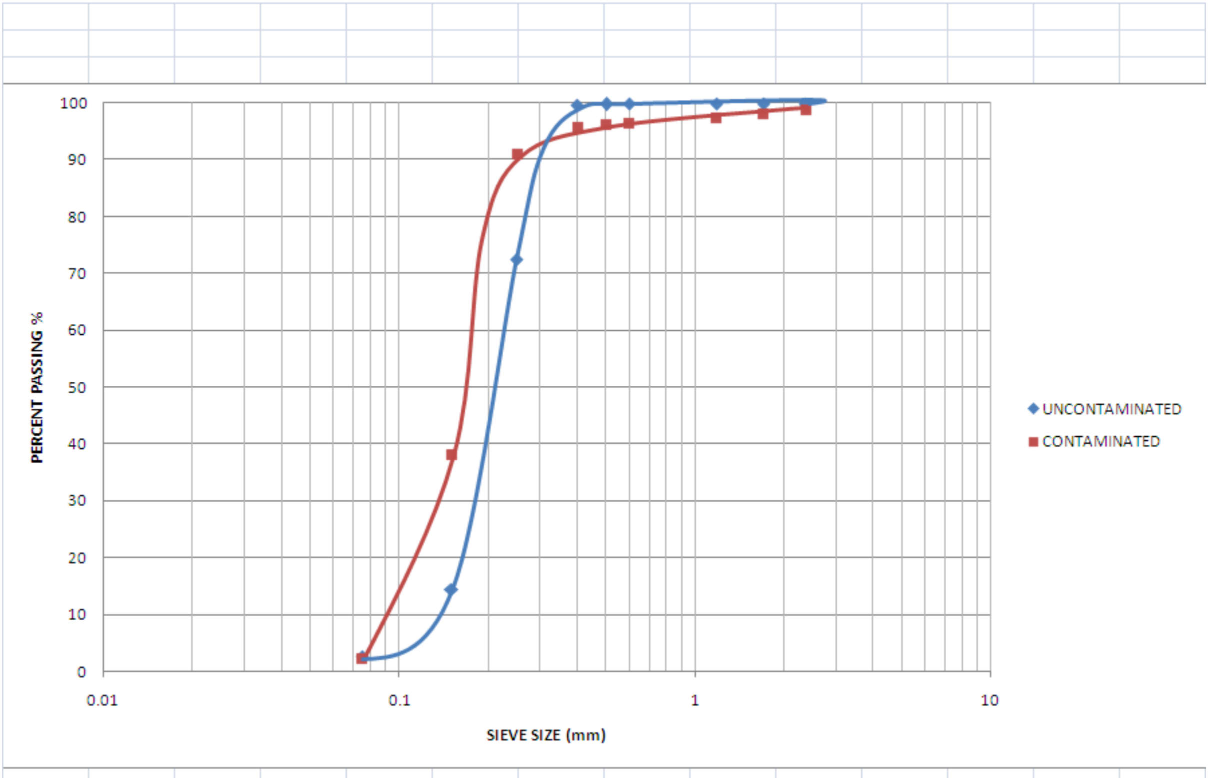

Figure 7: Grain Size Distribution Graph for Uncontaminated and Contaminated Soil Samples.

 ISSN2305-8269

International Journal of Engineering and Applied Sciences

www.eaas-journal.org

4.5 California Bearing Ratio (Comparison)

The California Bearing Ratio (CBR) of the contaminated soil shows a sharp decline, but that of the uncontaminated sample has a higher value.

Table 8: CBR Test (Uncontaminated Sample)

	CALIFORNIA BEARING RATIO			
UNCONTAMINATED SAMPLE				
SAMPLE NO:				
SAMPLE DISCRIPTION	UN SOAKED			
LABORATORY:				
WATER ADDITIVE(ml)	684			
MOISTURE CONTENT TIN NO:		PNETRATION (MM)	DIAGUAGE READINGS	
WT OF TIN+WET SOIL (g)			TOP	BOTTOM
WT OF TIN+DRY SOIL (g)		0.05	18	40
WT OF TIN ALONE (g)		1.00	67	64
WT OF WATER(g)		1.50	195	84
WT OF DRY SOIL(g)		2.00	255	106
MOISTURE CONTENT (%)		2.50	315	132
TARGET MOISTURE CONTENT %		3.00	356	157
WT OF MOULD+SOIL (g)		3.50	370	178
WT OF MOULD(g)		4.00	376	200
WT OF SOIL IN MOULD(g)		5.00	382	254
SOIL WET DENSITY(g/CM^3		6.00	405	324
WT OF SOIL IN MOULD(g)		7.00	432	366
		8.00	486	415
DRY DENSITY OF SOILIN MOULD		$CBR_{25\%=}$	f/13.44kN=	
MAX. DRY DENSITY OF SOIL	1.98	$CBR_{5\%=}$	f/20.16kN	
OMC(%)	11.4			
		$CBR_{=}$	1.59%	

Load at 2.5_{Top}= 23.86364
Load at 2.5BTTM= 10
AVgCBR2.5% = 16.93182

Load at 5_{Top} = 19.1
Load at 5BTTM = 12.7
AVgCBR5% = 15.9

Table 9: CBR Test (Contaminated Sample)

CONTAMINATED SAMPLE				
SAMPLE DISCRIPTION	UNSOAKED			
LABORATORY:				
WATER ADDITIVE(ml)	570			
MOISTURE CONTENT TIN NO:		PENETRATION(MM)	DIAGUAGE READING	
WT OF TIN+WET SOIL (g)			TOP	BOTTOM
WT OF TIN+DRY SOIL (g)		0.50	3	26
WT OF TIN ALONE (g)		1.00	7	38
WT OF WATER(g)		1.50	11	47
WT OF DRY SOIL(g)		2.00	15	54
MOISTURE CONTENT (%)		2.50	22	60
TARGET MOISTURE CONTENT %		3.00	27	69
WT OF MOULD+SOIL (g)		3.50	35	80

Load at 2.5_{Top}= 1.666667
Load at 2.5BTTM= 4.545455
AVgCBR2.5% = 3.106061

Load at 5_{Top} = 2.55
Load at 5BTTM = 4.7
AVgCBR5% = 3.625

June. 2015. Vol. 7. No. 01 ISSN2305-8269
International Journal of Engineering and Applied Sciences

www.eaas-journal.org

WT OF MOULD(g)		4.00	41	86
WT OF SOIL IN MOULD(g)		5.00	51	94
SOIL WET DENSITY(g/CM^3		6.00	68	105
WT OF SOIL IN MOULD(g)		7.00	85	120
MAX DRY DENSITY	1.81G/CM^3	8.00	98	131
OMC	9.50%			

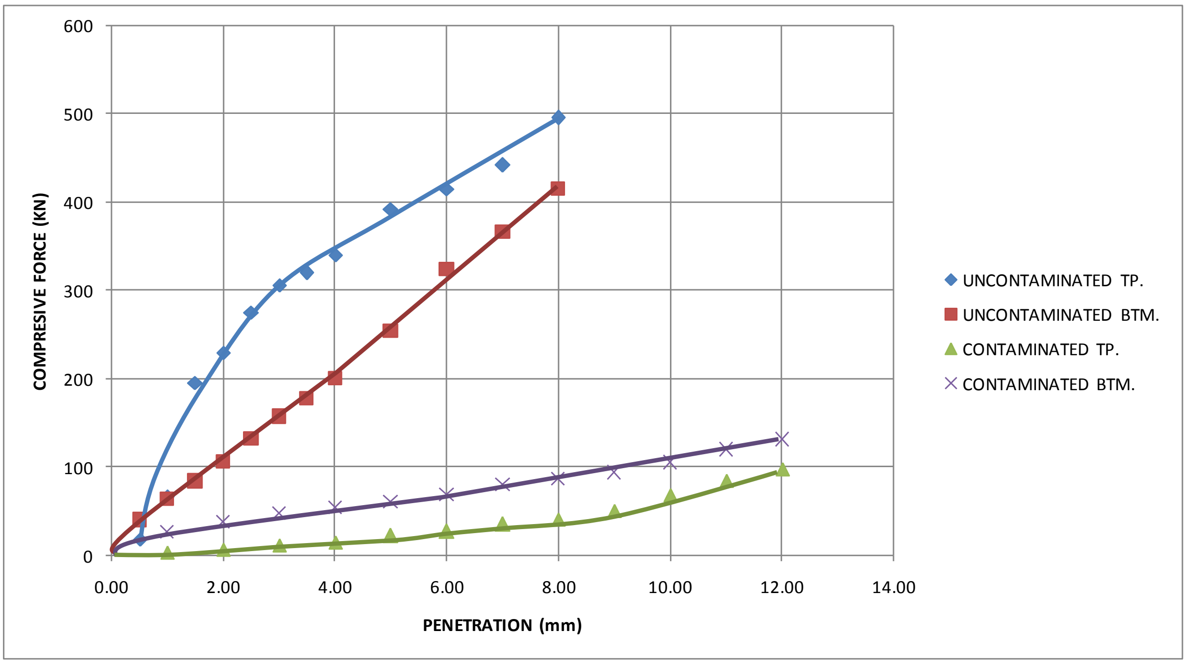

Figure 8: Graph Showing CBR Test Result for Uncontaminated and Contaminated Soil Samples.

International Journal of Engineering and Applied Sciences

www.eaas-journal.org

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The presence of crude oil in lateritic soil has remarkable effect on its geotechnical properties. It reduces the Optimum Moisture Content (OMC), Maximum Dry Density (MDD). Similarly the particle size distribution of the soil is altered as the crude oil clod to the soil particles reducing the bonding strength of the particles. Crude oil also lowers the atterberg limit of soil. The CBR of soil contaminated with oil is also reduced. Because of the series of changes accompanying the presence of crude oil in laterite, proper analysis of lateritic soil in areas prone to crude oil spills would enable effective selection of construction materials to be made which would not ensure durability and proper functioning of those structures.

5.2 RECOMMENDATION

Since the outcome of this study revealed that crude oil spills degrade lateritic soil, public enlightenment on the dangers of crude oil spills should be conducted regularly for the residents of areas prone to crude oil spill. Oil companies should also endeavour to improve on their exploration and exploitation process to minimize spillages. Besides, government should enact and implement laws to force oil companies to thoroughly clean up crude oil after each spill. This would help reduce its frequency of occurrence and minimize its effect on soil.

REFERENCES

1. Aiban, A. Saad (1997). "The Effect of Temperature on the Engineering Properties of Oil Contaminated Sand. *Environment International*, Vol. 24, No. 172, pp. 153-161, 1998.

2. Anoliefo, A. M. (1991). The Effect of Hydrocarbon on the Engineering Properties of Lateritic Soil.*International Journals of Engineering* (IJE) Vol. 5, No. 4, pp. 328 – 332.

3. BS (1377), (1990). Methods of Testing Soils for Civil Engineering Purposes, British Standard Institute, London.

4. Colorado Department of Public Health and Environment (2003). Monitoring and Removal or Treatment of Contaminated Soil. Colorado State. USA.

5. Evgin, E. and Das, B. M. (1992). "Mechanical Behaviour of an oil Contaminated Sand", Envir Geotech, Proc, Mediterranean Conf. Usmen and Acar, eds, Balkema Publishers, Rotterdam. The Netherlands pp. 101-108.

6. Euchun, C. S. and Braja M. D., (2001). Bearing Capacity of Unsaturated Oil-Contaminated Sand International of Offshore and Polar Engineering, Vol 11, No. 3, P.1

7. Gidigasu, M. D. and Kuma, D. O. K (1987). Geotechnical Characterization of Laterized Decomposed rocks for Pavement Construction in dry Sub-Humid Environment. Proc. 6th South East Asia Cont. on soil engineering, Taipei, Vol.1, pp. 493-506.

8. Ijimdiya, T. S. (2010) "The Effect of Compactive Effort on the Compaction Characteristics of oil Contaminated Lateritic Soils. *International Journals for Engineering* (IJE). Vol. 4, No. 4. Pp. 549-554.

9. Ijimdiya, T. S. (2010) "the effect of oil Contamination on Particle Size Distribution and Plasticity Characteristics of Lateritic Soils". Advance Material Research, vol. 367, pp. 19. http://www.scientific.net Trans Tech Publications. Switzerland.

i. .

10. Osinubi, K. J., Ijimdiya, T. S. and Kasai, K. J. (2007). "Evaluation of Strength of Reconstituted Laterite for Use as Liners and Covers" Book of Proc. Bi-monthly Material Society of Nigeria Conference, Zaria. Pp. 1-8