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A LABORATORY STUDY OF LATERITE SOIL MIX WITH USABLE COOKING OIL UNDER UNSOAKED AND SOAKED CONDITION

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Abstract
Nowadays, peoples are more concern about the environment impact assessment towards sustainable development. For that reason, this research is focusing on the effect of the usable daily cooking oils which easily thrown into the soil in the backyard. Furthermore, the stabilization of a foundation in a building mainly depends on the shear strength of soil especially when it's been soaked into the water for a long period of time. Due to that, the mixing of oil with water in the soil may lead to reduction in shear strength and thus will lead to failure in a foundation of structures. A studied were carried out to investigate the effect of mixing samples with usable cooking oil with 3% and 5% into the laterite soil under the condition of unsoaked and soaked for 14 days using multistage triaxial consolidated drained test. From the results, it's show that there are significant reduction in shear strength for control samples and with the mixing of 3% and 5% oil for unsoaked and soaked condition in 14 days. For control sample under unsoaked condition compare to the sample that mix with 3% and 5% of usable cooking oil under the same condition, about 6° of effective friction angle were deduced. Meanwhile for control sample that been soaking compare to 3% mixing, the shear strength were deduced about 6° and for 5% mixing, the shear strength was 9°.In the end, results show that reduction in shear strength will continuously decreased with the increase of the quantities of usable cooking oil and thus will reflect towards the failure of a foundation.

Keywords: Usable Cooking Oil, Multistage, Shear Strength, Unsoaked, Soaked.

1. Introduction

Human population is growing parallel with world pollution. Pollution is the action of environmental contamination with man-made waste. Land, water and air are place that includes in the world pollution. Land pollution basically is about contaminating the land surface through dumping urban waste mater, industrial waste, minerals exploitation and misusing the soil by harmful agriculture practices. Oil spills in most cases are accidental; during transportation both on the land and sea; as leakage from storage tanks; or during oil drilling process (Khamehchiyan et. al., 2006). Cooking oil is one type of the oil that has been thrown out into land area. This daily usage for food ingredient has often been thrown away without a proper way and then it will infiltrates into the soil and cause to the decreasing of shear strength of that soil and also contaminated it. The contamination will be expended and that depends on the chemical composition of the contaminant and the properties of the soil affected (Fine et. al., 1997). People might not even think about how can the smalls amount of cooking oil that have been throw away can harm life. This is true that the effect maybe small and cannot been seen but the effect will grow larger if the cooking oil is continuously been thrown away everyday at the same spot. The old and new cooking oil will mixed together and thus it will increased the effect to take action by means of deduce in shear strength especially in the foundation systems of a buildings or housings.

Throwing this liquid substance without proper channels would give negative impact to the soil. For examples, when the cooking oil is infusing into the sink, the oil will become hardened and caused the sink to clog. The cooking oil that has been thrown into the drainage system may infiltrate into the crack of the drain and infiltrate more into the soil. These two examples would give same effect which is decreasing the shear strength of the soil. The effect to the sink may not give too much problem cause the pipe can be easily been replaced but the effect on the soil may lead to major disaster if the cooking oil with large quantity has been thrown away at the same spot every day. Therefore, some studied are needs to be done in order to determine the effect of usable cooking oil towards the shear strength of soil especially in the foundation systems. Besides that, studied also will revealed the effect of usable cooking oil due to soaking effects on the shear strength of laterite soil with different percentage of usable cooking oil. The soaking effects would replicate the rainfall intensity when it's infiltrate into the soil and thus mixed with the usable cooking oil that have been thrown to the ground. Furthermore, outcome of these findings would be able to gives the information and trigger the awareness to public about the effect of throwing away the cooking oil without proper way.

2. Literature Review

Previous study conducted by Aiban, 1998 revealed that the compressibility and permanent deformation of the oil contaminated sand increased as the temperature increase above the room temperature and the shear strength parameters were not sensitive to the testing temperature when samples were not compacted to their maximum dry densities. This study was conducted on the effect of temperature with respect to shear strength, permeability and compressibility of oil contaminated sand in eastern Saudi Arabia. Furthermore, a research was conducted by Evgin and Das, 1992 found that the motor oil can cause a significant reduction in friction angle of both loose and dense sand and a drastic increase of volume strains when it tested on clean and oil contaminated quartz sand in full saturation process in triaxial test. Due to that, by using finite element analysis, it found that the settlement of a footing will increase due to oil contamination.

On the other hand, research study by Ahmed, 2009 by using experimental model tests and theoretical analysis, reveal that the presence of an oil contaminated sand layer under the footing resulted in a significant decrease in the bearing capacity and an increase in the settlement of footings compare to on clean sand. This study was conducted to determine the effect of depth and length of the contaminated sand layer under the footing, the percentage of oil content and the type of oil contamination on the ultimate bearing capacity and on the settlement characteristics of footings. It also revealed that the type of oil is significant parameters on the behaviour of a footing on oil contaminated sand. In this case, heavy motor oil affects the bearing capacity of the footing more than light gas oil with other variables kept constant as shown in Figure 1.

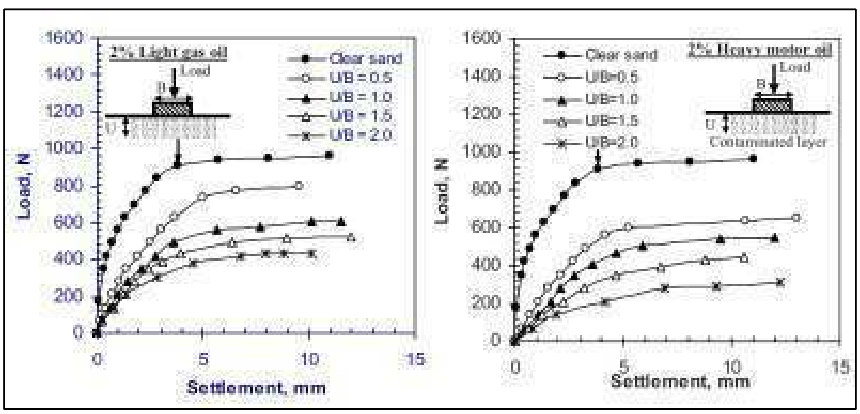

Figure 1 : Summary of load-settlement curves at different U/B ratios at 2% contamination (Ahmed, 2009)

A studied by Hasan, et. al., (1995) found that there are significant decrease in term of permeability and shear strength of Kuwaiti sand and also there is an increasing in compressibility with oil contamination. Based on result of triaxial test, the reduction in the angle of friction was at 2° for specimens prepared at a relative density of 60% and mixed with 6% of heavy crude oil as shown in Figure 2 and Figure 3. The study was conducted to determine the geotechnical properties of oil-contaminated Kuwaiti sand.

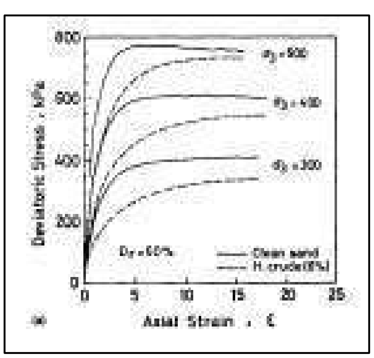

Figure 2 : Stress versus Axial Strain from Consolidated Undrained Triaxial Tests (Hasan, et. al., (1995)

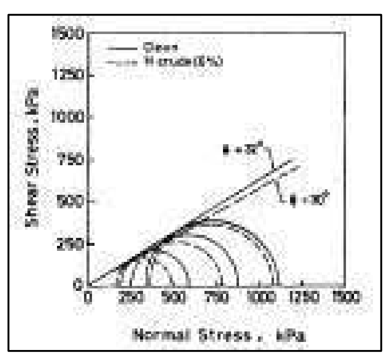

Figure 3: Failure Envelopes for Clean and Contaminated Specimens (Hasan, et. al., (1995)

In addition, Shin et al. (1999) discover that the variation of shear strength and ultimate bearing capacity of shallow foundations above the sand contaminated by the crude oil. Based on the results, the appearance of oil contamination can caused a deduction in bearing capacity of a shallow foundation. Puri, (2000) carried out the effect of oil contamination on the compressibility, shear strength, consolidation and hydraulic conductivity of a sandy soil and found that that angle of friction of the sand tended to decrease with the existence of a contamination oil in the pore spaces.

3. Methodology

This study was conducted using laterite soil. The samples were taken at the nearby construction site at Shah Alam, Selangor. The samples were divided into two types which namely disturbed and undisturbed which will used to determine the physical and engineering properties respectively. The soil samples were tested in the laboratory of Faculty of Civil Engineering, UiTM Shah Alam. Firstly, the soil was dried in the oven for 24 hours. For physical tests, samples were tested to determine the percentage of size distribution, Atterberg limits and specific gravity. For undisturbed samples, about 6 samples were used where 2 samples were used as a control samples of unsoaked and soaked for 14 days, 2 samples were used with mixing of 3% of usable cooking oil for unsoaked and soaked for 14 days while 2 samples were used with mixing of 5% usable cooking oil for unsoaked and soaked for 14 days. For engineering test, the samples were tested using triaxial consolidated drained test. In addition, multistage was decided to use in order to avoid the problem of variability between samples. Thus it will ease the interpretation of the shear strength envelope. Another reason why multistage were used is to avoid the complexity in the interpretation of the shear strength envelope when the soaking effect being incorporates.

Soaking effects can be accomplish by allowing back pressure and cell pressure flowing through in a value of 50kPa applied in cell pressure while 45kPa will be applied in back pressure. Therefore, the different of 5kPa will be the soaking value of the samples allowing through for the desired time which in this case is for 14 days. Samples will be under soaking process for the desired time where all the microstructures of the samples being saturated.

4. Result and Analysis

Table 1 shows the effective friction angle, ϕ' incorporates curvi-linear shear strength envelope for control , mix with 3% and 5% usable cooking oil samples with unsoaked and soaking effect for 14 days duration. From the data, it shows that the effective friction angle, ϕ' significantly decrease when the samples being mix with 3% and 5% usable cooking oil. For control sample under unsoaked condition, it found that the value of effective friction angle, ϕ' is 37° while for both samples mix with 3% and 5% under unsoaked condition, the values is the same which is 31°. It means that there are drastically reduction in terms of effective friction angle, ϕ' about 6° between control and sample that mix with 3 and 5% usable cooking oil for unsoaked condition. Meanwhile, for control sample under soaked condition for 14 days, the effective friction angle, ϕ' is 33° while for sample that mix with 3% usable cooking oil was 27° and 5% usable cooking oil was 24°. It means that for control sample soaked for 14 days compare to 3% mix with usable cooking oil have a different of 6° of effective friction angle, ϕ' while if the same condition been compare from control with 5% mix with usable cooking oil give a value of 9° effective friction angle, ϕ'. It clearly shows that there is drastically reduction of effective friction angle, ϕ' between control and sample that mix with 5% usable cooking oil under soaked for 14 days.

Table 1: Effective friction angles, ϕ' incorporates curvi-linear shear strength envelope for control, mix with 3% and 5% usable cooking oil samples under influence of unsoaked and soaked for 14 days condition

Samples	Condition	Effective Stress, kPa	Condition of Failure			Shear Strength Parameters		
			DS (kPa)	PWP (kPa)	CP (kPa)	ϕ'	τ_t kPa	$(\sigma-U_w)_t$ kPa
Control	Unsoaked	50	126	404	450	37°	65	50
		100	292	402	500			
		200	605	392	600			

		300	836	400	700			
	Soaked for 14 days	50	106	396	450	33°	86	53
		100	203	395	500			
		200	461	394	600			
		300	733	396	700			
Mix with 3% usable cooking oil	Unsoaked	50	143	393	450	31°	88	62
		100	260	393	500			
		200	455	395	600			
		300	668	394	700			
	Soaked for 14 days	50	196	389	450	27°	100	83
		100	257	403	500			
		200	377	434	600			
		300	559	430	700			
Mix with 5% usable cooking oil	Unsoaked	50	109	397	450	31°	90	59
		200	214	382	600			
		300	613	419	700			
	Soaked for 14 days	50	188	381	450	24°	110	81
		100	190	371	500			
		200	353	407	600			
		300	418	436	700			

In order to determine the effective internal friction angle of the samples, stress-strain plain needs to be plotted using data in the multistage triaxial testing. Maximum value of deviator stress when failure will be recorded in each stage of effective stress as shown in Figure 4.

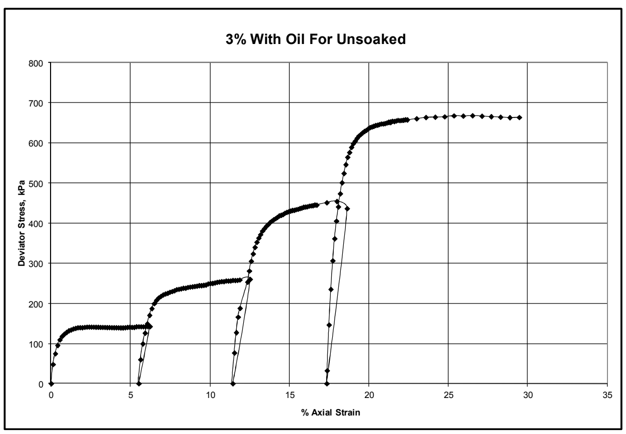

Figure 4: Multistage stress-strain plain for sample mix with 3% usable cooking oil under unsoaked condition

Meanwhile, Figure 5 shows the comparison of failure envelope between control samples for unsoaked and soaked for 14 days condition incorporates curvi-linear shear strength envelope. It found that there are significant changes with respect to effective friction angle, ϕ’ by 4° between these samples.

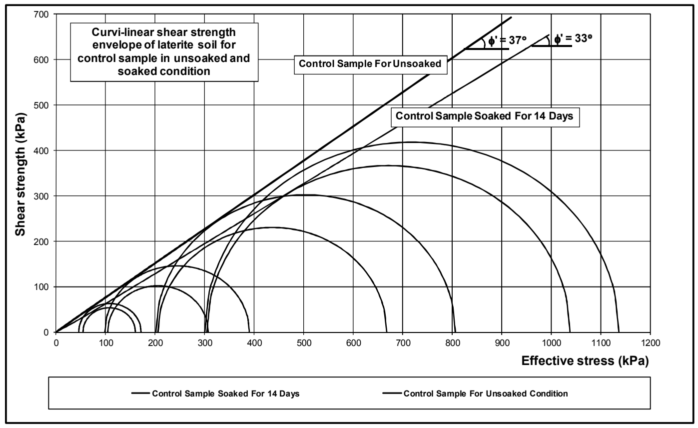

Figure 5: Combination of failure envelope between control samples under unsoaked and soaked condition for 14 days incorporates curvi-linear shear strength envelope

On the other hand, findings also revealed that there is a significant reduction in term of effective friction angle, ϕ’ by 4° between samples that mix with 3% usable cooking oil under unsoaked and soaked for 14 days condition as shown in Figure 6 meanwhile from this study also found that there are a steep reduction in effective friction angle, ϕ’ by 7° between samples that mix with 5% usable cooking oil under unsoaked and soaked condition as shown in Figure 7.

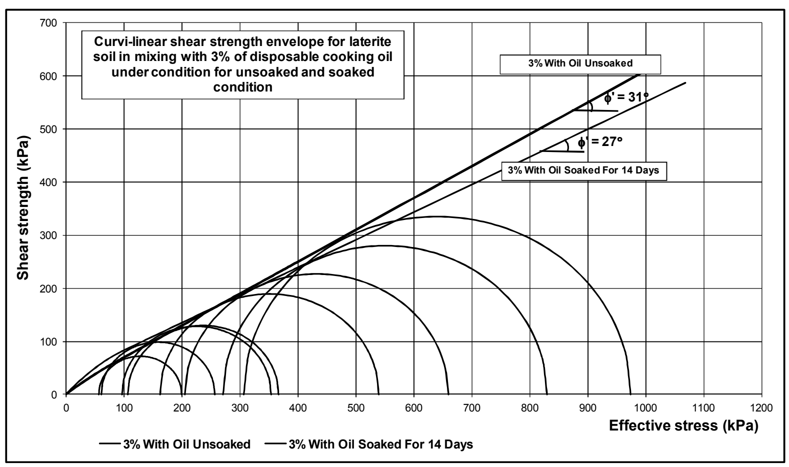

Figure 6 : Combination of failure envelope between samples that mix with 3% usable cooking oil under unsoaked and soaked condition for 14 days incorporates curvi-linear shear strength envelope

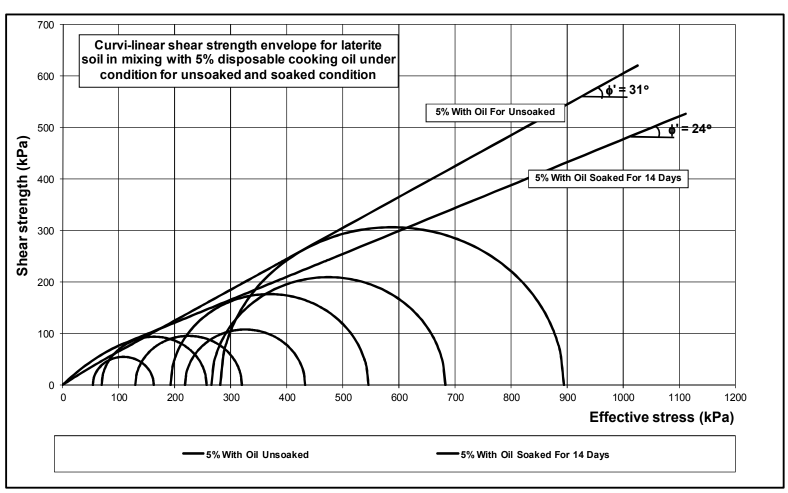

Figure 7 : Combination of failure envelope between samples that mix with 5% usable cooking oil under unsoaked and soaked condition for 14 days incorporates curvi-linear shear strength envelope

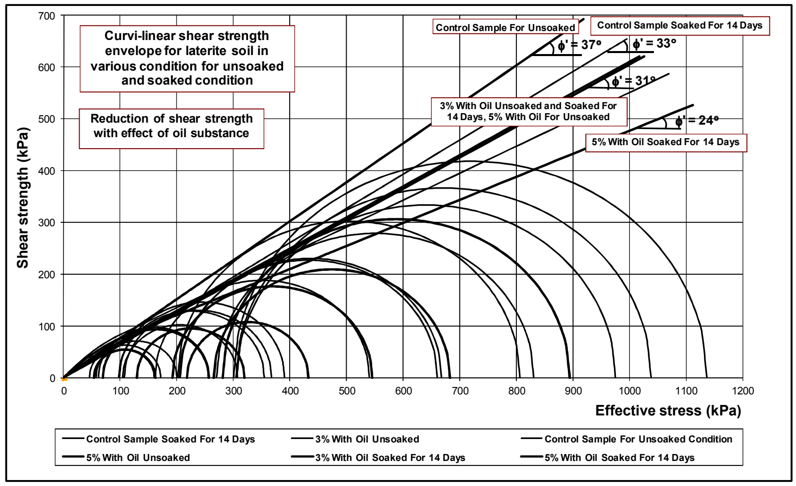

Figure 8: Combination of failure envelope between all samples incorporates curvi-linear shear strength envelope

From this study, it found that the higher effective friction angle, ϕ' above all is about 37° which is for control sample under unsoaked condition while the lowest effective friction angle, ϕ' is about 24° which for sample that mix with 5% usable cooking oil and soaked into water for 14 days duration as shown in Figure 8.

5. Conclusion

An extensive laboratory testing was carried out to determine the effect of usable cooking oil on the properties of laterite soil. Finding shows that there is a significant reduction in effective friction angle, ϕ' for all the samples. It clearly shown that sample under soaking condition with water for 14 days and mix with 5% usable cooking oil would result the lowest values of effective friction angle, ϕ' by 9° compared to control sample under the same condition of being soaked for 14 days. This would represent the best case scenario where when water infiltrated into the soil then it will become wetter for sometimes and thus it would further decrease the shear strength of the soil with time. Furthermore, with the existence of usable cooking oil that easily thrown away in the backyard will act as substance that will further decrease on the shear strength of the soil.

As a recommendation, in order to obtain more precise results and the interpretation of shear strength due to soaking effect and quantity of mixing usable cooking oil, a longer soaking effect might be the best option. Nevertheless, the percentage of usable cooking oil also play an important role on decreasing the shear strength. Due to that, the percentage of usable cooking oil also needs to be study through in order to determine the optimum value that may affect the shear strength of the particular soil.

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