

# Reviewing on the effect of hydrocarbon contamination on the angle of internal friction of soil

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**Abstract**—In recent years, Hydrocarbon contaminations have been made more effects on its surroundings environments specifically on soil environment. Among of these contaminations due to the crude oil have been performed a respective share in this range. In fact, oil contaminations have been affected not only on the chemical properties of soils, but also on the strength & geotechnical features of soils such as, on cohesion, maximum dry density, optimum moisture, permeability and other relative parameters especially on the angle of internal friction of soils. So far numerous researches have been done regarding the influencing the strength properties of soils specifically on the angle of internal friction. (Due to oil contamination) In this research is to consider & review several last researches and experiments regarding the changes of the angle of internal friction of soils. (With the presence of oil contaminations & its behavior during different percentages of hydrocarbon contamination) In general, the results of the accomplished studies in this field have been showed the reduction of the angle of internal friction contents (under the condition of oil contamination), but with regard to the type of porous environment & the study soil and as well as the chemical properties of hydrocarbon contaminations, the behavior was been different and often in some cases has been caused the addition of the angle of internal friction.

**Keywords**—Hydrocarbon contaminations, Crude oil, Strength & geotechnical features of soils, Angle of internal friction.

## I. INTRODUCTION

These days, due to the human activities have been irreparably changed and contaminated not only the air & water, but also the soil & its surrounding environment .Meanwhile, hydrocarbon compounds have been performed a significant share in contaminating the soils. Hydrocarbon contamination (especially by crude oil) can be occurred through various sources such as, leakage from oil transfer pipes, natural oil leakage, oil discharge

from internal sea or land establishments, the dusts from oil associated Gas burning and oil transportation & storage which have been performed an effective role in expanding & spreading of hydrocarbon contaminators in its soil medium& surrounding underground water sources[1]. In fact, hydrocarbon compounds have been considerably affected not only the physical & apparent ,but also the chemical properties of soils[2]. In geotechnical engineering science the strength & geotechnical parameters of soils are seriously taken into account. Actually the changes in granular soils are in the physical properties while in cohesive ones the texture & structure are affected[3, 4]. And changes (due to spreading in hydrocarbon contamination)in geotechnical properties of soils such as cohesion, percent optimum moisture, maximum dry density, permeability and especially angle internal friction of soils are much more considered by various researches. Certainly from among of these researches can be mentioned some of them & other similar studies, for examples Kermani & Ebadi's researches [5], Khomehchiyan & colleagues' researches [6], Sabzipour & colleagues' numerical researches & studies (under the condition of spreading single dimension oil contamination)[1], Sedghiani & Jiriai's researches[7], Rahman& co-workers [8], Khosravi, Ghasemzadeh & colleagues [9], Mohammadi, Yasrebi & Khoshneshin's researches[3]. In fact in present research has been reconsidered several last researches & studies on the basis of the applications of the researches' results by other scholars on the angle of internal friction of soils sample.(Due to different percentages of oil contamination in environment).

## II. REVIEWING ON SEVERAL ACCOMPLISHED RESEARCHES REGARDING TO THE INFLUENCING THE VALUES OF THE ANGLE OF INTERNAL FRICTION OF SOILS SAMPLE BY REASON OF SPREADING HYDROCARBON CONTAMINATION

Among the last researches results, regarding the spreading of hydrocarbon contaminations in soil medium, the strength & geotechnical properties of soils specifically the angle of internal friction actually is played an important role in measuring the strength & geotechnical conditions of soils. In this section, it has been considered some of the researches' results (Regarding this matter during different percentages of oil contamination). Certainly, it must be pointed that the most of the results have been approximately had a definite procedure. While some of the observed differences in results can be occurred by different factors for example, the sort of the observed soil, different chemical properties of oil contamination, different environment conditions, & as well as, other effective factors. And it be studied some of these relative researches regarding this matter.

### 2.1. KERMANI & EBADI'S RESEARCH

Kermani & Ebadi [5] have started their researches with considering the changes in contents of granular soils parameters due to oil contamination. They have done their experiments on the sample of obtained soils in a large zone from Tehran oil refinery's surrounding lands (in the depth of 30 to 50 centimeters in earth). And in this study some specimens are taken into account (With these oil percentages 0, 4, 8, 12% during 7, 30 & 90 days). The grading curve of soil sample is shown according to figure 1.

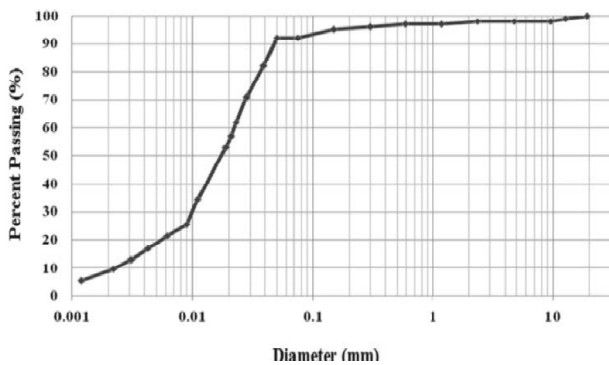


Fig. 1: Diagram of grading soil sample in Kermani & Ebadi's research [5]

In figures 2, 3 & 4 have been orderly shown the results due to the effect of the percentage of oil & moisture on the angle of internal friction (during 7, 30 & 90 days).

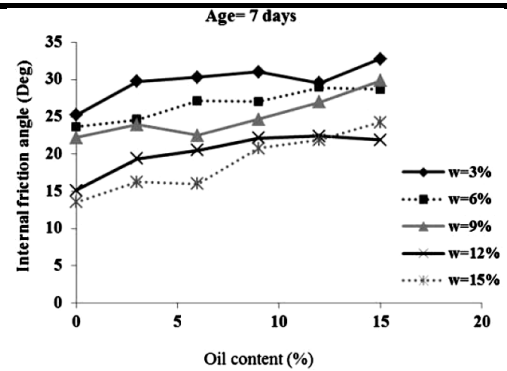


Fig. 2: The effect of the percentage of oil & moisture on the angle of internal friction on 7 days specimens in Kermani & Ebadi's research [5]

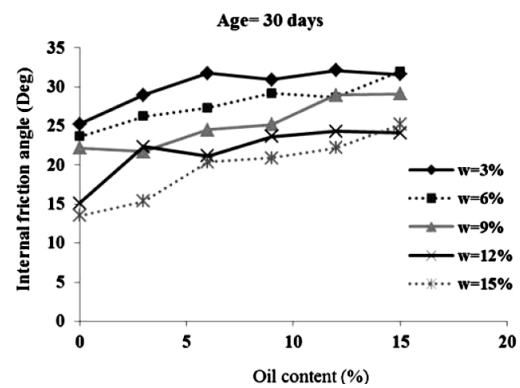


Fig. 3: The effect of the percentage of oil & moisture on the angle of internal friction on 30 days specimens in Kermani & Ebadi's research [5]

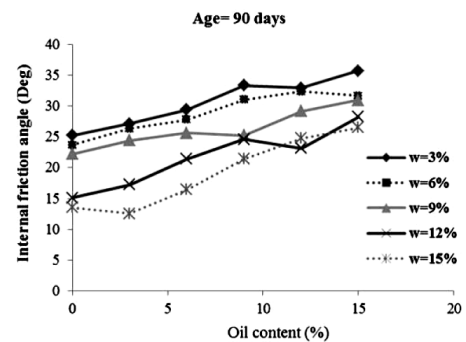


Fig. 4: The effect of the percentage of oil & moisture on the angle of internal friction on 90 days specimens in Kermani & Ebadi's research [5]

As it is pointed in above figures, with increasing the percentage of oil contamination the extent of the angle of internal friction specimens actually has experienced an increasing procedure. Certainly the age of the sample was been more considered on the angle of internal friction. According to above diagrams the most & least extent of the angle of internal friction are equal to 35.69 & 12.52.

### 2.2. KHAMHCHIYAN & COLLEAGUES' RESEARCH

Khamehchiyan & colleagues [6] have done their experiments on 3 kinds of SM soils (silty sand), SP (bad

grading sand)& CL(thin clay) which are taken from Bushehr beaches zone (0,4,8,12&16 percentages of oil contamination in laboratory)with the purpose of affecting geotechnical properties of specimens( Due to oil ). The results which are obtained by the changes of the contents of the angle of internal friction in all 3 samples are actually stated the existence of oil contamination(according to figure 5).

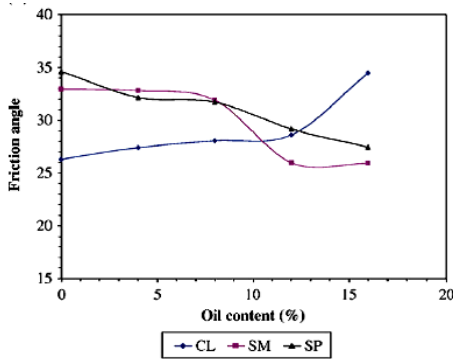


Fig. 5: The percentage Changes of crude oil to the angle of internal friction in Khamehchiyan & colleagues' research[6]

As it is been noted in above figure, with adding the percentage of contamination the extents of the angle of internal friction in specimens have been reduced excluding in CL sample. In fact, the addition of the percentage of hydrocarbon contamination by reason of psychoanalysis property of oil products among the soil particles has decreased the extents of the angle of internal friction. This subject in CL sample in exchange for more extents (from 16%) has been performed a reverse effect.

**2.3. SEDGHIANI & JIRIAI'S RESEARCH**

Sedghiani & Jiriai[7] by using the triaxial strength tests, compression test & consolidation test on the mixed sand specimens (with 0, 2, 4&8% of crude oil) have been investigated parameters changes such as strength parameters, settlement & compressibility. In this research the grading curve of the study cases has been shown according to figure 6.

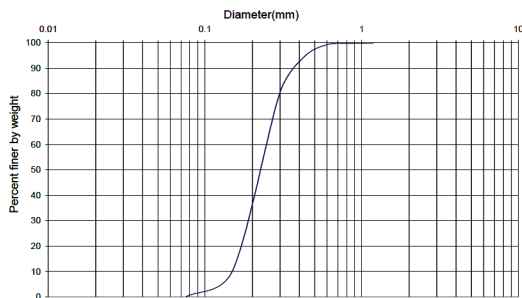


Fig. 6: Diagram of grading sand of study case in Sedghiani & Jiriai's research[7]

Also in below figures have been orderly shown the results due to the changes of the angle of internal friction contents against the percentage & the extent of their oil contamination and proportional compression.

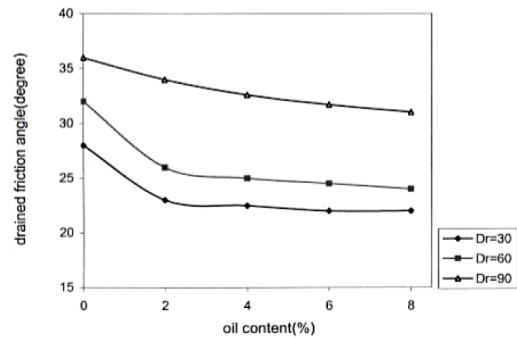


Fig. 7: Diagram of the changes of the angle of internal friction against the percentage of contamination by using CD triaxial test in Sedghiani & Jiriai's study[7]

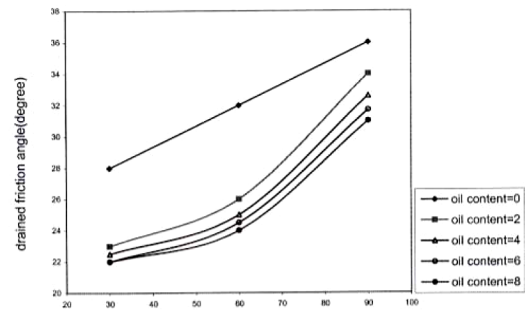


Fig. 8: Diagram of the changes of the angle of internal friction against proportional compression by using CD triaxial test in Sedghiani & Jiriai's study[7]

As it is obvious in above figures, the angle of internal friction of sand as the result of contaminating by crude oil is being reduced(The extent of 3% of oil contamination). The addition of contamination more than 3% has no respective effect on the angle of internal friction.

**2.4. KHOSRAVI, GHASEMZADEH & COLLEAGUES'RESEARCH**

Khosravi & colleagues[9]have done their researches on the sample of uncontaminated and contaminated Kaolinite soil (gas-oil) as a clay soil with Classed & a little plastic property (CL). Generally the results have been showed that adding the percentage of oil-gas the angle of internal friction of specimens gradually decreased. In fact this conclusion has been shown in figure 9.

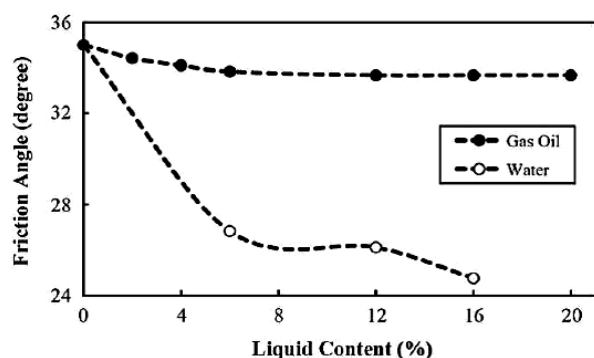


Fig. 9: The effect of the percentage of gas- oil & water on the angle of internal friction of sample of Kaolinite test in Khosravi & co-workers' study[9]

### 2.5. MOHAMMADI, YASREBI & KHOSHNEESHIN'S RESEARCH

In the study which is done by Mohammadi & co-workers[3] on the sample of clayey sand soil both hydrocarbon contamination (0,2,4&6%) and the results due to the reduced changes of the angle of internal friction contents have been given as the result of adding of the percentage of oil contamination according to table 1.

Table 1: The obtained results of the angle of internal friction by direct cutting test in Mohammadi & colleagues' research [3]

Oil Content (%)	the angle of internal friction (degree)
0	26.22
2	25.47
4	23.56
6	22.70

According to the values of above table, reduction in the values of the angle of internal friction is occurred due to the crude oil is gradually covered the surface of the soil particles and actually as a slider supplier decreased the cohesion of the soil particles. In this research the extent of the effect of contamination on the angle of internal friction with approximately 13% reduction has been reported.

### III. CONCLUSION

In current research the consideration of the effect of hydrocarbon contaminations on the angle of internal friction of soils have been known as one of the significant & strength indicators. And it has been performed on the basis of accomplished studies & researches in this field. In fact most of the accomplished researches have been shown the reduction in the values of the angle of internal friction by reason of adding the percentage of oil contamination in specimens. The reasons of difference in

some of the results & samples regarding to other researches are various, such as the type & property of different chemical and physical samples of study soils, different hydrocarbon contaminations properties as compared with each other, the condition of laboratory & strength tests and other effective factors. As a basic result by reason of studying the accomplished researches by scholars can be remarked that with bringing oil contaminators in soil porous environments both with adding the effect of oiling among soil particles and as well as reducing the involvement & internal friction between particles on special chemical properties of oil and its influencing on internal relation among particles actually the parameter extent of the angle of internal friction of particles which is shown the strength indicator of soils and can be measured a reduction procedures.

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