Effect of length to diameter ratio (L/D) of pile on bearing capacity of piles buried in the silty sand under homogeneous hydrocarbon contamination conditions

Arashk Sabzipour Hafshejani, Alborz Hajiannia, Shahrouz Pousti, Ashkan Gholipoor Noroozi

Abstract— Nowaday, the oil pollution has great effect on the human environment, especially the soil environment. In fact, the pollution makes changes in the geotechnical parameters such as cohesion, friction angle, dry density and permeability. this study analyze buried piles in oil contamination soil by using strength parameters of oil contamination silty sand soil and models it by PLAXIS and the effect of length to diameter parameter of pile on bearing capacity of pile Is evaluated. The results of this study shows the reduction in the amount of the reduction factor bearing capacity of pile by increase in the length to diameter ratio.

Keyword— Cohesion, internal friction angle, silty sand, PLAXIS, length to diameter ratio, reduced bearing capacity.

1 Introduction

In recent years, numerous studies and experiments is applied on the effect of oil pollution on soil strength parameters. In fact, it can be said that the oil contamination had several impacts on the bearing capacity of the buried in addition to the geotechnical properties of soil. This combinations not only are effective on appearance but also on physical and chemical properties. Changes in soil strength parameters of soil due to oil pollution occurs as the change in physical properties in the granular soils and in cohesive soils, it occurs as changes in soil structure [1]. The research conducted about this subject, It can be noted to researches of Evgin and Das (1992)[2] on samples of infected and non-infected quartz oil, research Khamechian et al (2007) [3] on the three samples SM (silty sand), SP (bad sand grain size) and CL (thin clay), research Pandey and Bind (2014)[4] on alluvial soil soaked in oil, research Zulfahmi et al (2010) [5] research Adejumo (2012)[6] and the other similar researches. In the present study, has been discussed to introduce the silty sand soils and geotechnical parameters of the different levels of pollution. In the following, we present the software and modeling process are discussed. Finally, the analysis of the results of the modeling, the values of the parameters affecting the ultimate bearing capacity and the length to diameter ratio in the samples buried deep foundation pile bearing capacity reduction coefficient is evaluated.

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2 Sample Properties

In the present study samples of silty sand (SM) from research Khamechian et al in 2007 [3] were used to investigate the issue. After mixing the samples with values of 0, 4, 8, 12 and 16 percent of oil pollution have been examined. It is noteworthy that the strength and geotechnical parameters of experiments that the results based on them is presented in the Table 2. The values of the density and modules of elasticity of each sample are shown in Table 3.

TABLE 1
EXAMINED SOIL SAMPLES [4]

Examined soil sample	Precent of crude oil
SM0	0
SM4	4
SM8	8
SM12	12

TABLE 2
GEOTECHNICAL PARAMETERS OF OIL CONTAMINATED SILTY SAND SOIL [4]

Oil content	C (kg/cm^2)	φ (deg)	ψ (deg)	ω (%)
0	0.272	33	3.517	13.5
4	0.195	32.9	3.398	9.43
8	0.227	32	2.332	8.57
12	0.210	26.2	0	5.55
16	0.210	26.2	0	5.55

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TABLE 3
VALUES OF DENSITY AND MODULES OF ELASTICITY OF THE SAMPLE [4]

Oil content	γ_d (gr/cm^3)	γ_{sat} (gr/cm^3)	γ_{unsat} (gr/cm^3)	E (Kg/cm^2)
0	1.9	2.160	2.156	49.821
4	1.87	2.142	2.046	44.643
8	1.84	2.124	1.998	48.153
12	1.84	2.124	1.942	39.811
16	1.84	2.112	1.860	21.128

Results Tables 2 and 3 show reduction in values of geotechnical parameters of the soil due to oil contaminants.

3 SOFTWARE AND MODELING

3.1 Used Software

One of the most used software for civil engineering, especially in the fields of geotechnical is PLAXIS software, which are used in almost all geotechnical projects. In fact, this software is a package of engineering modeling using finite element method to analyze the deformation and stability of geotechnical engineering projects.

A program with simple graphical input, analysis complex models of finite element and outputs it provides accurate results and in great detail. In this software calculations based on numerical methods will be done in fully automatic. This software provide a suitable condition to analysis some parameters such as deformation caused by the manufacturing process or forces applied, considering the values of stresses and strains in different parts of the design, stability and safety factor, and also plot curves of them.

In this study, two-dimensional version of the software is used to analysis finite element for two-dimensional environment. One of the most important parameters that can be easily calculated from the output of this application is the maximum tolerable load by modeling structures, or in other words, to determine the ultimate bearing capacity of a buried foundation [7].

3.2 Details of Model

The present study determined the ultimate bearing capacity of cylindrical concrete piles with a diameter of 1 m and length of 10 meters under different oil contamination conditions as a primary base model. Note that in this study, half of the pile with the d/2 due to axial symmetry, it will be defined; and details of piles is considered according to software guidance for concrete type to provide a poison ratio equal to 0.15. Young module is equal to 21000000 kPa and pile density is equal to 25kN/m^3 [8].

so according to the above, pile foundation modeled in contaminated soil with 0, 4, 8, 12 and 16 volume percent of oil pollution and in the end the results of the analysis has been studied. In this study used *f* [9] as pile bearing capacity reduction factor to investigate the effect of length to diameter ratio on the bearing capacity of the pile. In fact, this parameter will obtained from rate of bearing capacity of pile under oil contaminated condition to non-contaminated one.

4 RESULTS AND SOFTWARE OUTPUTS

The results of this study shows the reduction in the amount of ultimate bearing capacity of piles buried in the soil by increasing the hydrocarbon mixture. This can be seen in Figure 1 that shows values of Terzaghi's method to obtain ultimate bearing capacity of foundations [10].

4.1 The Effect of Pile Length to Diameter Ratio on the Bearing Capacity of the Pile

In the present study, by considering the ratio of length to pile diameter of 10, 15, 20 and 25 for diameters 0.5, 0.7, 1 and 1.20 m in the amount of 4, 8, 12 and 16% homogeneous oil pollution changes in the reduction parameter values pile bearing capacity (*f*) of the L/D in Fig. 2 through 5 are provided separately.

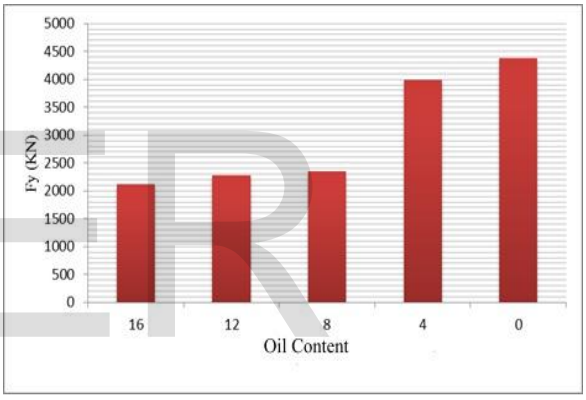

Fig. 1. Comparison of the obtained ultimate bearing capacity of foundations buried in contaminated samples by Terzaghi's

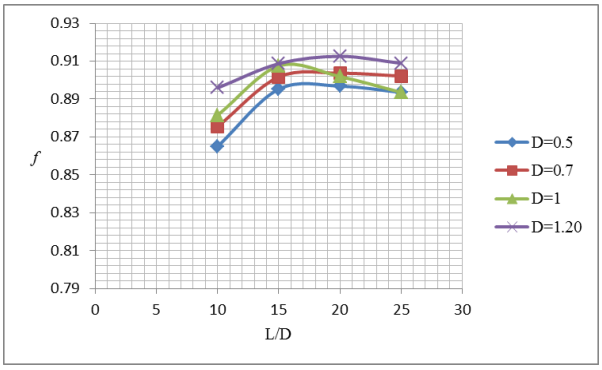

Fig. 2. The effect of length to diameter ratio on the reduction factor of bearing capacity of the pile at 4 percent pollution.

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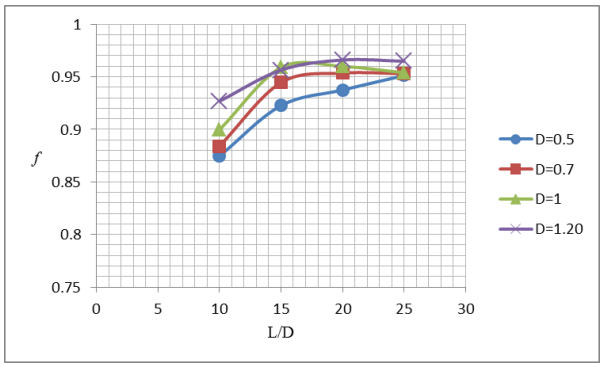

Fig. 3. The effect of length to diameter ratio on the reduction factor of bearing capacity of the pile at 8 percent pollution.

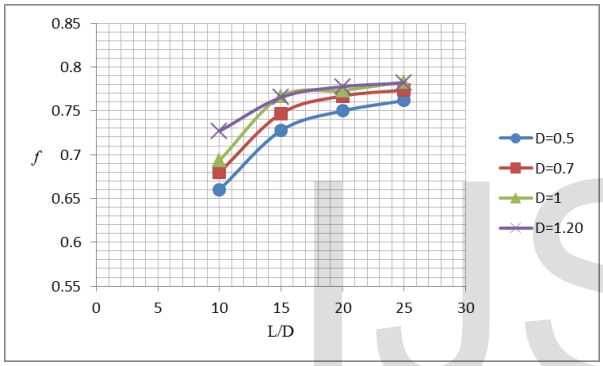

Fig. 4. The effect of length to diameter ratio on the reduction factor of bearing capacity of the pile at 12 percent pollution.

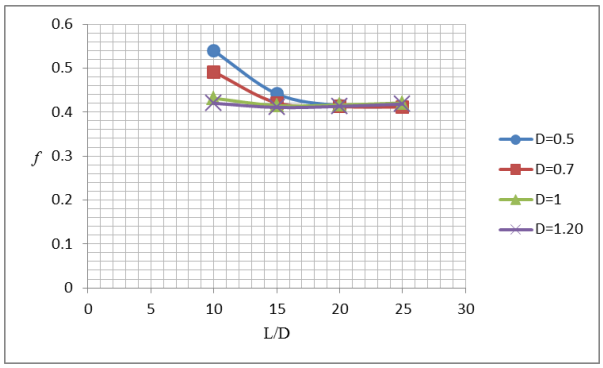

Fig. 5. The effect of length to diameter ratio on the reduction factor of bearing capacity of the pile at 16 percent pollution.

The figures above show a decrease in the amount of the reduction factor of foundation strength by increasing in ratio of length to diameter. In other words, both increase in length and reduction in diameter of the pile has been an increase in the value of the *f* parameter. It can be explained by investigating the effect of increasing the diameter or decreasing the length of the pile one by one on reduction capacity of pile.

5 Conclusions

In this study, the results indicated a reduction in amount of ultimate bearing capacity of buried pile in oil contaminated soil due to the reduction in the geotechnical properties of soil. The presence of contaminants within the soil particles due to increased lubricating among them, make reduce in the bearing capacity of buried pile. Increasing the L/ D parameter in the buried foundations in the soil make increase in reduction of strength values. The results of this study may help in the design of oil platforms near the coast and in the oil region.

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