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BEHAVIOUR OF LATERALLY LOADED PILE GROUPS EMBEDDED IN OIL-CONTAMINATED SAND

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ABSTRACT

Onshore and offshore spills contaminate soil. This basically takes place due to oil exploration, transportation, production and processing leakage of diesel products from oil tankers, spills due to vehicular accidents, from buried pipelines. In addition to environmental concerns for ground water pollution, oil contamination brings adverse effect on basic geotechnical properties of foundation soil. Thus main aim of the study was to discover the influence of oil contaminated sandy soil on the lateral behavior of pile groups. Small scale test model tests were performed on a single pile and pile groups. The investigation was carried out by varying the percentage of oil content, the thickness of the contaminated layer and the type of oil (Mobil oil) and pile group configuration .For matching the field conditions, contaminated sand layers was prepared by mixing the sand with oil content 0-5% with regard to dry soil. The results from the study can be used for the geotechnical purpose and can benefit engineers for safe and economic construction of a structure on the contaminated sand.

Keywords: Contamination, Mobil oil, Model tests, Piles, Sand.

I. INTRODUCTION

Past few years witness rapid growth of industrialization and due to which oil pollution become the one among the major threat to not only environment but also for associated buildings .As it has been seen that engineering properties of oil contaminated soils are drastically changed .Thus oil contamination is not only threat for environment consideration but is also threat for geotechnical engineer .Soil contamination can take place due to oil transportation ,production ,leakage from storage tanks of gas stations ,stranded oil spills, from buried pipelines etc. At the sites with excessive oil contamination, vertical settlement of tanks, cracking of pipelines etc are usually occurring. During the last decade a number of studies related to the physical properties and behavior of oil contaminated sand have been published. AL-Sanad et al.(1995)made lab testing to find out influence of oil contamination and geotechnical properties on Kuwait sand by contaminating soil by adding oil ranging from 3 to 6% by weight of dry soil and angle of internal friction decreases from 32 to 30 degree. E. C. Shin,J. B. Lee and B. M. Das (1998)evaluate the shear strength by varying the crude oil % from 0 to 4.2.They find out that with decrease in soil friction angle with oil contamination the ultimate bearing capacity also decreased. When the oil content increases from 0 to 1.3%the ultimate bearing capacity reduced by 75%. Dr. Solly George , Aswathy EA .Berlin Sabu , Krishnaprabha NP , Maria George (2014)investigate the geotechnical properties of engine oil-contaminated sandy soil by varying the percentage of oil from 0%,4%,8%and 12% of dried weight of samples. They state that oil contamination decreases the liquid limit and plastic limit but unconfined compressive strength increases and the MDD value is found to be decreasing and whereas value of OMC was increasing .They indicate that CBR value for 4% diesel was higher than that of un contaminated soil while for 8% and 12% it got reduced. Mahdi Karkush (2016) performed the experiment on clay by contaminating with synthetically with industrial waste water of 10%.20%,40%,and 100%and find out that vertical displacement of pile cam increases from 5.5% to26.6% as contamination increases and lateral resistance of pile group decreases by 5.5% to 26.6%.

II. EXPERIMENTAL SET-UP AND TESTING PROGRAMME

2.1 SOIL TANK

The testing tank used was rectangular with pulley arrangement for applying lateral load and had a length 120cm, width 90cm, height 90cm.These dimensions of tank ensure that failure wedge around the model is not exceeding walls .The soil was filled up to 80 cm height from bottom of testing tank.

2.2 OIL PROPERTIES

Motor oil available in market was used in this test .laboratory test were performed for finding out properties of mobil oil .And through this test it was find its specific gravity comes out to be 0.88 and viscosity measured by redwood viscometer is 23 RW sec.

2.3 MODEL PILES AND PILE CAPS

Iron piles of diameter (d) 1.5 cm and length of 40 cm was used in laboratory and iron pile cap of centre to centre spacing of (3d) 4.5 cm is used.

2.4 DIAL GAUGES

Lateral deflections were measured by dial gauges having least count of 0.01mm.

2.5 PROPERTIES OF CLEAN SAND

Table 1. Properties of clean sand

S.NO.	Property	Value
1	Soil Type	SP
2	Effective Size in mm	0.175
3	Uniformity Coefficient(Cu)	2.00
4	Coefficient of Curvature(Cc)	3.84
5	Specific Gravity(G)	2.63
6	Minimum Dry Density	14.3
7	Maximum Dry Density	17.3
8	Maximum Void Ratio	.84

9	Minimum Void Ratio	.52
10	Friction Angle	38

2.6 PREPARATION AND PROPERTIES OF OIL-CONTAMINATED SANDS

Here oil contaminated sand was prepared artificially by mixing dried sand with motor oil at different percentages of 2,4&6(by weight of dry sand).As compared to other study in this study here test is performed within 4 hours after mixing of oil with sand. Firstly sand of definite amount was laid in layers of definite thickness than definite amount of oil for respective percentage by dry weight of soil was added after that oil was mixed in sand.

2.7 EXPERIMENTAL PROCEDURE AND TEST PROGRAMME

For sand we normally preferred a raining technique for soil placement in test tank but for filling of oil contaminated sand raining technique for soil placement was not suitable and did not provide uniform compaction .Hence ,sand unit weight was controlled by pouring pre calculated weight of sand in definite thickness of layer and sand was leveled by using a straight ply wood bar. And compaction effort needed was provided by four blows using a flat-bottom hammer (0.1x0.1.weighting 20N), to get the required sand unit weight. The sand unit weight which we required as checked by collecting samples in small cans having weight 55gm and having volume 240ml.After the testing, the weight of each can was measured to compare with required sand unit weight. The average unit weight achieved in this study was (15.15kN/m3+_0.3).Some tests were repeated to check whether test results were influencing by presence of cans.

After finishing the sand preparation,the pile or pile group was embedded into soil using a slightly light weight hammer to the required level. Finally the lateral loads were applied to pile cap a(s shown in Fig.1)The lateral deflections were measured using dial gauge having least count of 0.01mm.

III. FIGURES AND TABLES

TABLE 2. Value of angle of shearing resistance of sand at different percentages of oil content

Percent Of Oil	**Friction Angles(φ)**	**Reduction Percent (%)**
0	38	-
2	35.2	7.3
4	33.6	11.57
6	32.8	13.68

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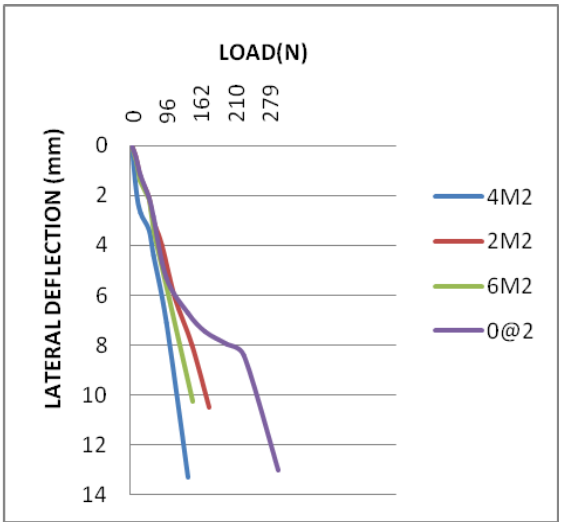
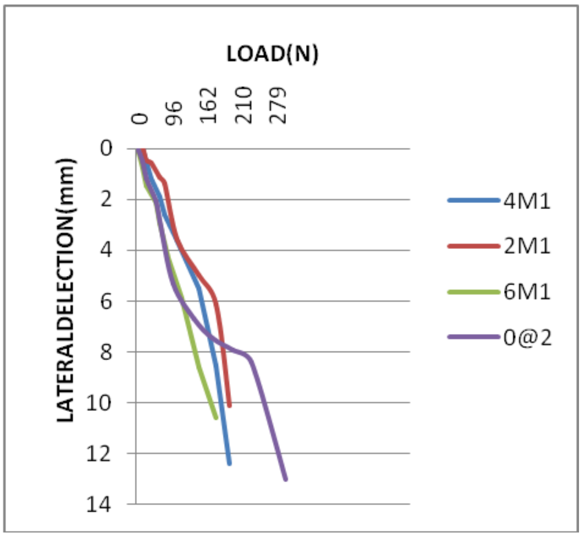


Fig.1



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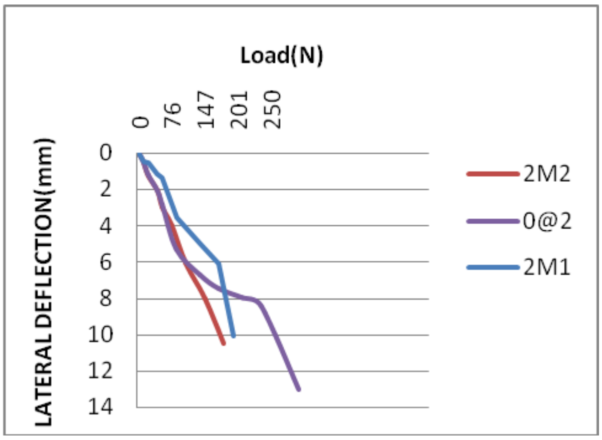

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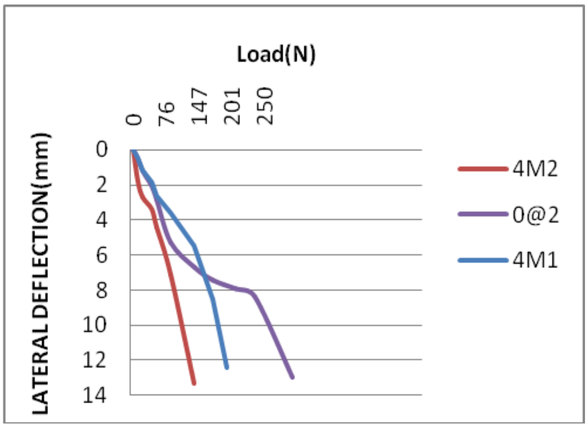

Fig.4

Single Layer Contamination

NOTATION

2M1 Here number before M represents percentage of mobil oil and number after M represents number of

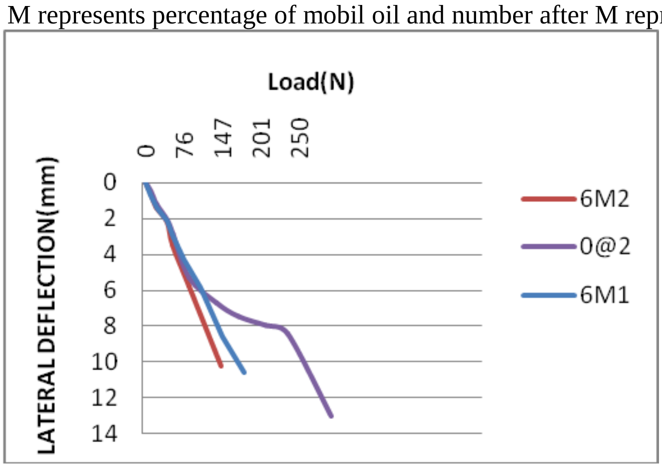

Fig.5

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NOTATIONS

2M1 - Number preceding M represents % of oil added for contamination (here 2%).And number succeeding M represents Number of layer contaminated (Each contaminated layer was having thickness of 15 cm for 2M1 one layer was contaminated, M used for representing mobil oil.

0@2 - represents soil without contamination i.e. tank was filled with clean sand only.

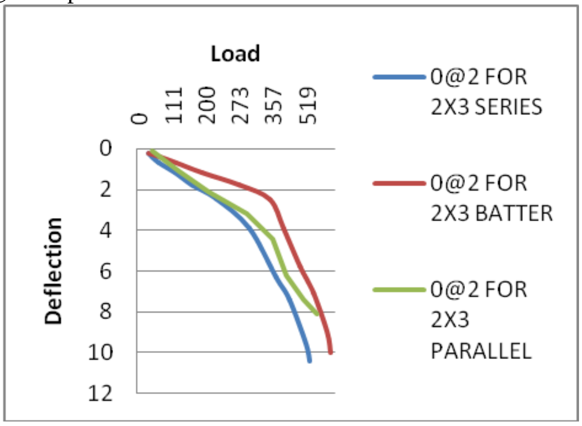

Fig.6

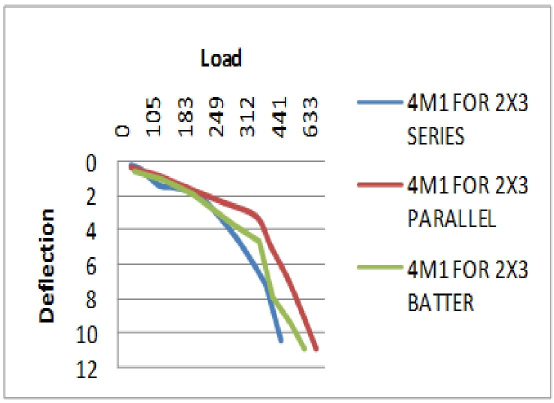

Fig.7

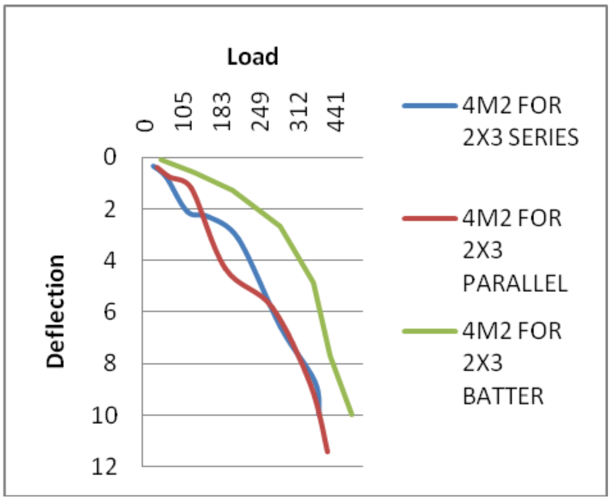

Fig.8

Fig.1 Variations of lateral load H with lateral load deflection y for single pile on single layer contamination.

Fig.2. Variations of lateral load H with lateral load deflection y for single pile on double layer contamination.

Fig.3. Variations of lateral load H with lateral load deflection y for single pile at 2% oil content by varying the thickness of oil contaminated layer.

Fig.4. Variations of lateral load H with lateral load deflection y for single pile at 4% oil content by varying the thickness of oil contaminated layer.

Fig.5. Variations of lateral load H with lateral load deflection y for single pile at 6% oil content by varying the thickness of oil contaminated layer.

Fig.6 Variations of lateral load H with lateral load deflection y for 2x3 piles configurations on sand without contamination.

Fig.7 Variations of lateral load H with lateral load deflection y for 2x3 piles configurations on sand with single layer contamination with 4% mobil oil.

Fig.8 Variations of lateral load H with lateral load deflection y for 2x3 piles configurations on sand with 2 layers contamination with 4% mobil oil.

III. DISCUSSION OF TEST RESULTS

3.1 DIRECT SHEAR TEST

Direct shear tests were performed on clean sand and oil contaminated sands to find out friction angles .It has been observed that as percentage of oil contamination in sand increases friction angles started decreasing .These results agree with AL- Sanad et al.(1995).

3.2 LATERAL LOAD TESTS ON SINGLE PILE

Fig. 1 shows the variation of lateral load H with lateral deflection y for single pile on single layer contamination. And it was observed that as we increases the percentage of mobil oil content in soil lateral load carrying capacity decreases. As sufficient time for soil and oil reactions was not given to find out initial effect as it happen in field we observed that as load was increases lateral deflections were observed found to be increase but increase of deflection were found to be more as percentage of oil contamination increased for single layer.

Fig.2 Here also as sufficient time was not given for reactions between soil and oil clear graphs as obtained in earlier study was not obtained .But from above graph we can find out similar conclusion whether it is single layer or double layer of oil contamination as percentage of oil were increased lateral deflections were also increased as we can see from above graph if we take 10 mm deflection for sand it was observed on load of 290 N but for 2M2 it was found to be on 183 N and for 4M2 it was observed on 147N and for 6M2, 10 mm deflection was obtained on loading of 111N.Conclusion is that on increasing % of oil contamination at smaller lateral loading we were getting deflection which we were getting at higher load for clean sand .In other word with increasing percentage of oil lateral load carrying capacity is decreasing. From above showed Figure3, Figure 4 and Figure 5, it was observed that on increasing the thickness of contaminated layer irrespective of oil content lateral load capacity of pile was found to be decreasing.

3.3 LATERAL LOAD TEST ON 2x3 PILE GROUP CONFIGURATIONS

For comparison purposes three 2x3 pile group configurations were taken.One was 2X3 parallel group in which piles were taken in 2 rows and 3 columns, in second pile group 2x3 series in which piles were taken in 3 rows and 2 columns and in third group piles were taken in a similar fashion as 2X3 parallel but three piles of first rows were negatively battered at 30 degree.

From Fig.6, Fig.7 and Fig.8 it was observed that for clean sand lateral load capacity for piles group having 2x3 batter pile group was found to be largest as comparative to 2x3 batter and 2x3 parallel group combination. But when one layer of soil get contaminated lateral load capacity for 2x3 parallel group were found to be largest .Whereas when thickness of oil contaminated layer when get doubles 2x3 batter pile group is found to be effective.

IV. CONCLUSIONS

Available information regarding behavior of oil contaminated sand is very limited. That’s why, the lateral load tests for pile embedded in oil contaminated sand were performed by varying the thickness of oil contaminated layer, by varying the percentage of oil contents and following conclusion can be drawn.

1. The results shows that due to oil contamination friction angle(angle of internal friction) decreases .On addition of 2% mobil oil it got decrease by 7.3% and on addition of 4% mobil oil it got decrease by 11.57%.And in a similar manner on addition of 6% mobil oil it got decrease by 13.68%.
2. As we increases the mobil oil concentration lateral load carrying capacity decreases.
3. As we increases the thickness of oil contaminated layer lateral load carrying capacity is decreasing.
4. For clean sand among pile of configuration 2x3, 2x3 batter pile was more resistant to lateral load. But for single layer of oil contaminated layer 2x3 parallel group configuration was found to have more resistant to lateral load as compared to other pile configuration. But if we increases the thickness of oil contaminated layer 2x3 batter pile group is found to have more resistant than others for lateral load.

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