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

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ABSTRACT

This basically takes place due Onshore and offshore spills, oil exploration, transportation, production and processing leakage of diesel products from oil tankers, spills due to vehicular accidents, from pipelines beneath ground. 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 pile groups and on a single pile. 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, Diesel) to find out suitable 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.

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

I. INTRODUCTION

Last few years we have seen rapid growth of industrialization and due to which oil pollution is becoming the one among the major threat to not only surrounding environment but also for buildings which are near- by it. As it has been seen that engineering properties of oil contaminated soils are drastically changed by oil contamination .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 ,its production ,its leakage from storage tanks of gas stations ,stranded oil spills, from pipelines etc. At the sites with 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 seconds.

Diesel used has been taken from petrol pump and it is having specific gravity 0.82 and viscocity of diesel measured by redwood viscometer is 7 RW seconds

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 center to center spacing of (3d) 4.5 cm is used.

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 a similar way 2 piles cap combination of series when two piles in a row and parallel when 2 piles in a column taken And a single pile was also used.

2.4 Dial Gauges

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

2.5 Properties of Clean Sand

Properties of clean sand was find out by various tests in soil laboratory are mentioned in table 1 .

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.

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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 .The lateral deflections were measured using dial gauge having least count of 0.01mm.

III. FIGURES AND TABLES

Table1. 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(KN/m3)	14.3
7	Maximum Dry Density(KN/m3)	17.3
8	Maximum Void Ratio	0.84
9	Minimum Void Ratio	0.52
10	Friction Angle	38

Table1. Value of angle of Shearing Resistance of sand at Different Percentages of Oil Content

Percent Of Mobil oil	Friction Angles (φ)	Percent Of Diesel	Friction Angles (φ)
0%	38	0%	38
2%	35.2	2%	45
4%	33.6	4%	35

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3.1 For 1 Pile

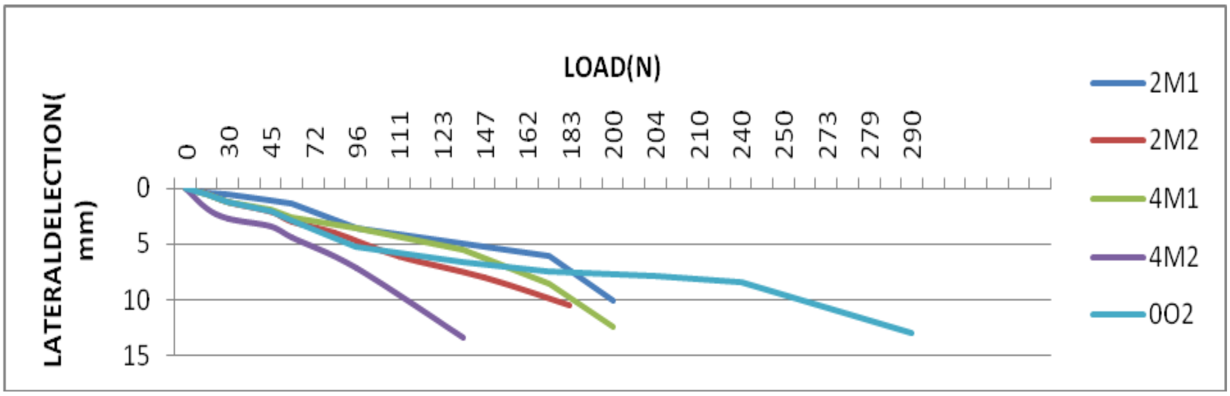

Fig.1 Variations of Lateral Load H With Lateral Load Deflection Y For Single Pile on Varying % of mobil oil and Thickness of oil Contamination Layers.

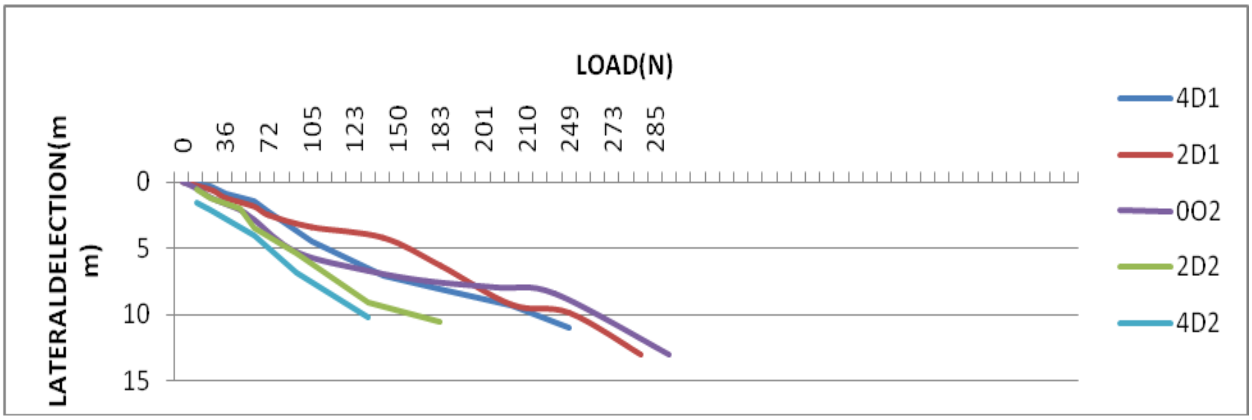

Fig.2 Variations of Lateral Load H With Lateral Load Deflection Y For Single Pile on Varying % of diesel and Thickness of oil Contamination Layers.

3.2 For 2 Piles

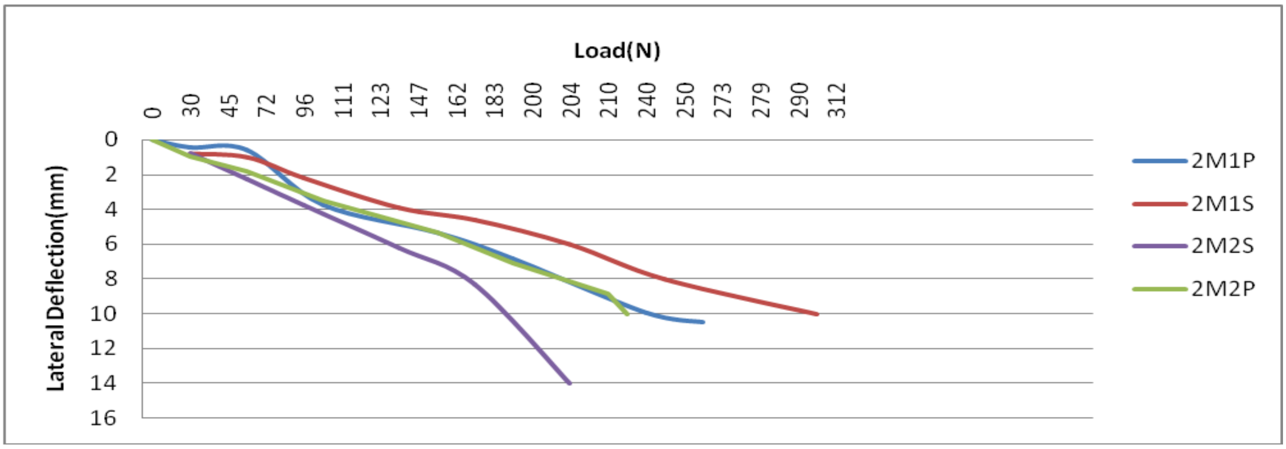

Fig.3 Variations of lateral load H with lateral load deflection y for 2 piles for 2% of mobil oil contamination on varying configuration and thickness of oil contamination layers.

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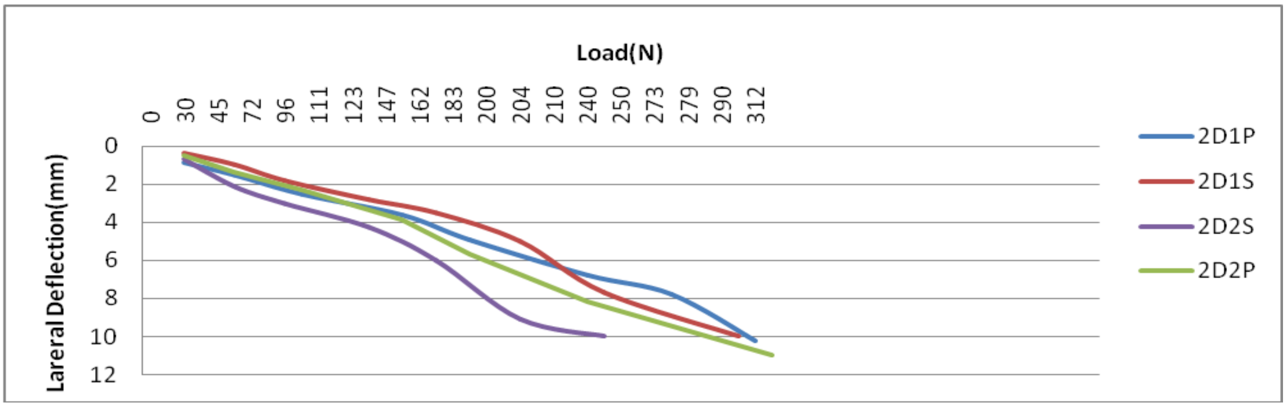

Fig.4 Variations of lateral load H with lateral load deflection y for 2 piles for 2% of diesel contamination on varying configuration and thickness of diesel contamination layers.

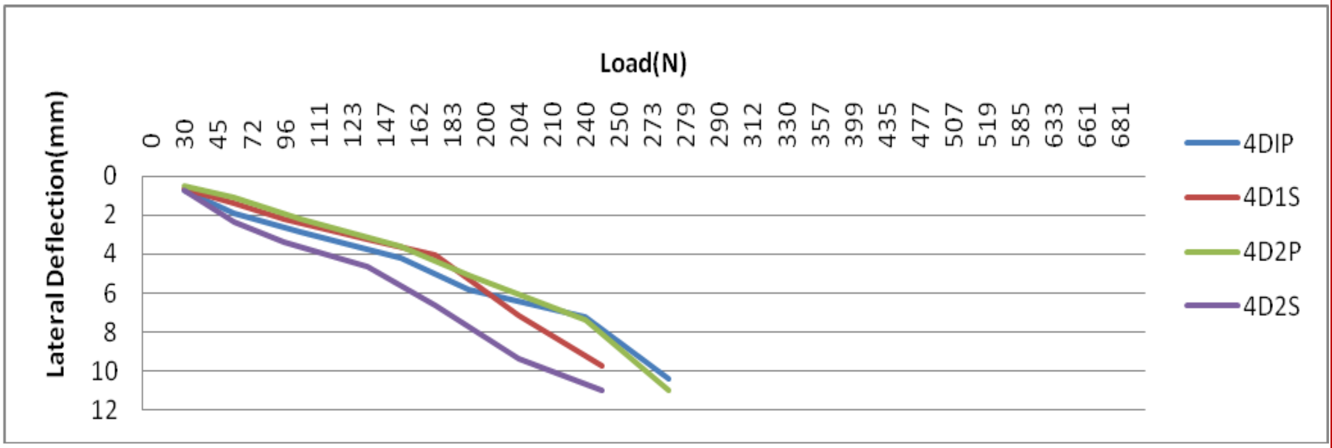

Fig.5 Variations of Lateral Load H With Lateral Load Deflection Y for 2 Piles for 4% diesel Contamination on Varying Configuration and Thickness of Diesel Contamination Layers.

3.3 For 2x3 Piles

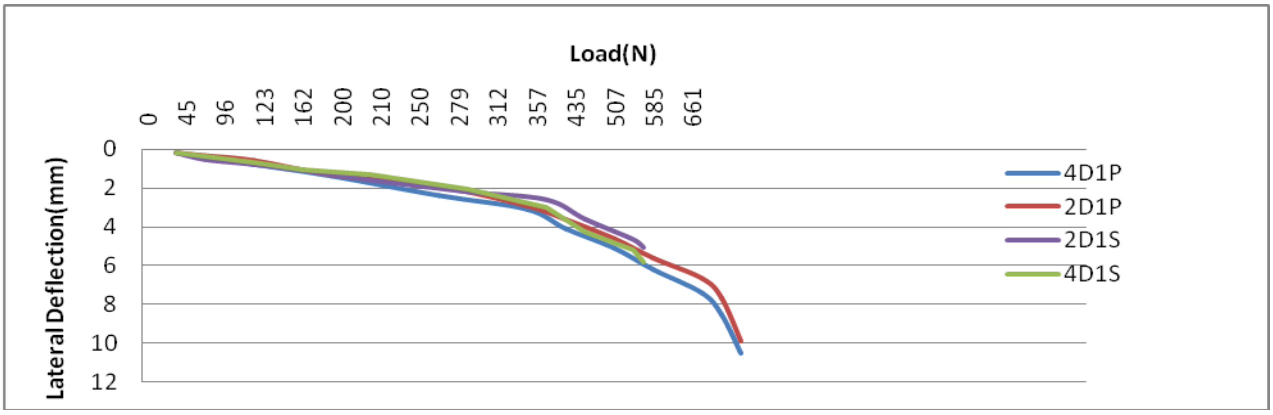

Fig.6 Variations of lateral load H with lateral load deflection y for 6 piles on varying % of diesel configurations of pile in a group for one layer contaminated with

diesel.

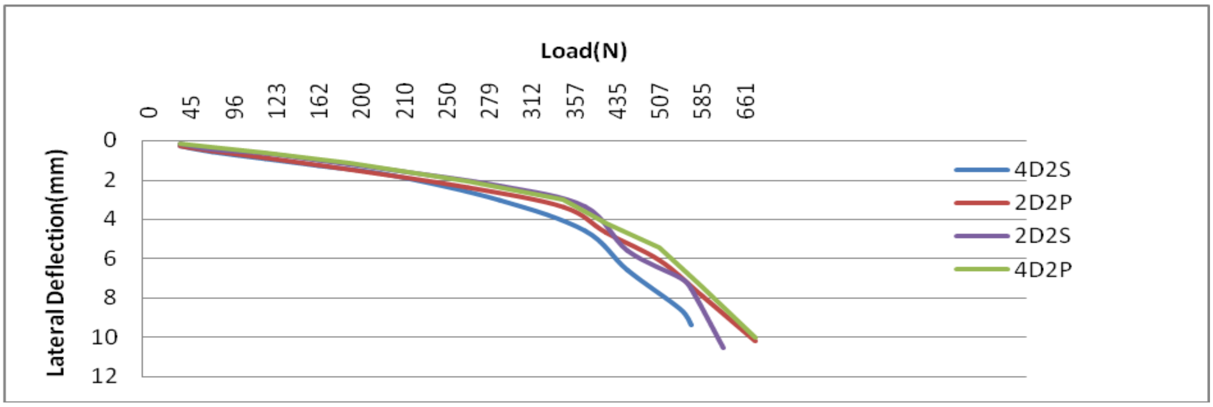

Fig.7 Variations of lateral load H with lateral load deflection y for 6 piles on varying % of diesel and configurations of pile in a group for 2 layer contaminated with diesel. .

NOTATIONS

nMnP - Number preceding M represents % of oil added for contamination .And number succeeding M represents Number of layer contaminated (Each contaminated layer was having thickness of 15 cm) , M used for representing mobil oil, At last P is used for parallel, S is used For series in a similar manner B is used for Batter pile group configuration for eg 4M2S represent 4% mobil oil in two layers by weight of dry soil and pile configuration was taken in series.

nDnP - Number preceding D represents % of diesel added for contamination .And number succeeding D represents number of layer contaminated (Each contaminated layer was having thickness of 15 cm), D used for representing diesel, At last P is used for parallel, S is used for series in a similar manner B is used for Batter pile group configuration , for e.g. 4D2S represent 4% Diesel in two layers by weight of dry soil and pile configuration was taken in series

0O2 – O preceding O represents 0% oil and number 2 succeeding O represents number of two layers. Here represent Oil it means 0% oil i.e. no oil was added in both layers i.e. whole tank was filled with clean sand only.

IV. DISCUSSION OF TEST RESULTS

4.1 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 in case of mobil oil but in case of diesel firstly it increases than started decreasing if conecentration of diesel in contamination increases.These results agree with AL- Sanad et al.(1995).

4.2 Lateral Load Tests on Single Pile

Fig.1 refers variations of lateral load H with lateral load deflection y for single pile on varying % of mobil oil and thickness of oil contamination layers and it was found out that whether we increases the thickness of mobil oil contaminated layers from 15 to 30 cm or increasing oil content from 2% to 4% lateral load carrying capacity decreases.

Fig.2 refers variations of lateral load H with lateral load deflection y for single pile on varying % of diesel and thickness of oil contamination layers and and it was found out that whether we increases the thickness of diesel contaminated layers from 15 to 30 cm or increasing diesel content from 2% to 4% lateral load carrying capacity decreases.

4.3 Lateral Load Tests on Single Pile

Fig.3 refers variations of lateral load H with lateral load deflection y for 2 piles for 2% of mobil oil contamination on varying configuration and thickness of oil contamination layers and it was find out for thickness of 15 cm series combination of two pile was more resistant to lateral load but as thickness increases to 30cm it become less resistant than parallel combination of piles. And for increasing thickness and oil content similar result as obtained on single piles were obtained.

Fig.4 refers variations of lateral load H with lateral load deflection y for 2 piles for 2% of diesel contamination on varying configuration and thickness of diesel contamination layers and it has been observed that whether the thickness of contaminated layer 15cm or 30cm parallel combinations of two piles was more resistant to lateral load than series combination .

Fig.5 refers variations of lateral load H with lateral load deflection y for 2 piles for 4% diesel contamination on varying configuration and thickness of diesel contamination layers and it was find out that for both thickness adopted in the experiment parallel combinations of piles was more effective in resisting the lateral load for 4% of diesel contamination.

4.3 LATERAL LOAD TEST ON 2x3 PILE GROUP CONFIGURATIONS

Fig.6 refers the variations of lateral load H with lateral load deflection y for 6 piles on varying % of diesel configurations of pile in a group for one layer contaminated with diesel and it was found out that for 15cm contaminated layer series combination of 2x3 is found to be more resistant to lateral load than parallel combination .On increasing thickness of contaminated layer or diesel content lateral load capacity found to be decreasing.

Fig.7 refers the variations of lateral load H with lateral load deflection y for 6 piles on varying % of diesel and configurations of pile in a group for 2 layer contaminated with diesel . it was found out that for 30 cm contaminated layer also series combination of 2x3 is found to be more resistant to lateral load than parallel combination.

If we compare it with results of M. A. Nasr and S. V. Krishna Rao , S.V they told for mobile oil parallel configuration is found to be more resistants than series but for diesel viceversa or contrary results obtained.

Thus, It has been seen that pile configuration not only affected by thickness and oil contents but also type of oil by which soil get contaminated.

V. 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 pile configuration and changing the contamination oil following conclusion can be drawn.

1.Variations of lateral load H with lateral load deflection y for 2 piles on varying thickness and configurations of pile in a group for single layer contaminated with 2% mobil oil and it was found out that for 15cm contaminated layers order of increasing lateral load resistance in increasing order for contamination is as
2x3 parallel < 2x3 series

2. Variations of lateral load H with lateral load deflection y for 2 piles on varying thickness and configurations of pile in a group for single layer contaminated with 2% mobil oil and it was found out that for 30cm contaminated layers order of increasing lateral load resistance in increasing order for contamination is
as 2x3 series < 2x3 parallel

3. Variations of lateral load H with lateral load deflection y for 2 piles on varying thickness and configurations of pile in a group for either contaminated with 2% diesel or 4% diesel and it was found out that either for 15 cm or 30 cm contaminated layers order of increasing lateral load resistance in increasing order for contamination is as 2x3 series < 2x3 parallel

4. Variations of lateral load H with lateral load deflection y for 6 piles on varying thickness and configurations of pile in a group for either contamination with 2% diesel or 4% diesel and it was found out that either for 15cm or 30 cm contaminated layers order of increasing lateral load resistance in increasing order for contamination is as 2x3 parallel < 2x3 series

REFERENCES

[1.] Al- Sanad ,H.A. Eid , W. K.& Ismael, N.F. Geotechnical properties of oil-contaminated Kuwait sand .J.Geotech. Engng 121, (1995) ,No.407-412.

[2.] Dan A. Brown, Clark Morrison, Lateral load Behaviour of Pile Group In Sand,(1988).

[3.] Dr Solly George, Aswathy EA .Berlin Sabu, Krishnaprabha NP ,Maria George ,Study on Geotechnical Properties of Diesel Oil Contaminated Soil,(2015).

[4.] E. C. Shin, J. B. Lee and B. M . Das,Bearing Capacity of a model scale footing on crude oil-contaminated sand,(1999).

[5.] M. A. Nasr and S. V. Krishna Rao , S.V. Behaviour of laterally loaded pile groups embedded in oil-contaminated sand , Geotechnique 66, (2016), N0.1,58-70.

[6.] Mahdi Karkush, Behavior of Piles Groups Subjected to Axial Static and Lateral Cyclic Loads in Contaminated soils,(2016).

[7.] Ramakrishna D, Stabilization of fuel oil contaminated soil, Geotechnical and Geological Engineering 21:415-427,2003.

[8.] Sanjay J.Shah ,A.V.Shroff, Jignesh V.Patel, Stabilisation of fuel oil contaminated soil-A case study, Geotechnical and Geological Engineering,(2013),21:415-427