Performance Analysis of Laterally Loaded Pile Groups Embedded in Oil-Contaminated Sand

Aakash[1], Mrs. Nitu Balhara[2]

[1]Department of Civil Engineering, Matu Ram Institute of Engineering and Management, Rohtak
[2]Assistant Professor, Department of Civil Engineering, Matu Ram Institute of Engineering and Management, Rohtak

ABSTRACT

Oil contamination brings adverse effect on basic geotechnical properties of foundation soil in addition to environmental concerns for ground water pollution. Thus main objective of the study is to find the impact of oil polluted sandy soil on the sidelong conduct of heap gatherings implanted in oil sullied sand by changing thickness of oil sullying layers, by replacing the oil substance for tainting and by changing the sort of oils (Mobil and Diesel). For coordinating the field conditions, contaminated sand layers was set up by blending the sand with oil content 0-5% as to dry soil. Little scale test model tests were performed on different - heap gatherings .Further for exploring point of inward rubbing different direct shear tests were done in research facility. It is obvious from test outcomes that parallel burden that on polluting not just rely on tainted thickness and substance of oil yet in addition rely on the sort of oil through which soil get contaminated.

Keywords: oil, contamination, sand, effect, layers.

HOW TO CITE THIS ARTICLE

Aakash1, Mrs. Nitu Balhara, "Performance Analysis of Laterally Loaded Pile Groups Embedded in Oil-Contaminated Sand", International Journal of Enhanced Research in Science, Technology & Engineering, ISSN: 2319-7463, Vol. 8 Issue 5, May -2019.

INTRODUCTION

The effective way of increasing discharge efficiency of a weir is by replacing linear weir with a non linear weir. In case of linear weirs width of weir is same as that of length of weir crest but in case of non linear weirs the length of crest exceeds the width of weir. Two types of non linear weirs having length more than width (L>W) are labyrinth weirs and piano key weirs. Labyrinth weirs are mix of grouping of straight weirs collapsed on display in a crisscross manner to give longer successful peak length than width. Labyrinth weirs were utilized for most recent 50 years. Labyrinth weirs have different states of rectangular, triangular and trapezoidal. Trapezoidal Labyrinth weirs offer huge amplification for accessible width of a methodology channel and broadly embraced to pass the flood [1]. Labyrinth weirs have wide application for the earth dams. Labyrinth weirs can expand weir release productivity three to multiple times with respect to a straight weir, however Labyrinth weirs have confinements identified with spillway impression. Labyrinth weirs utilized for low explicit streams and can't be utilized to pass high measure of release in the event of zones where impression length is less and width is constrained because of geology. So piano key weir changed from Labyrinth weir ought to be considered for impression limited nonlinear weir applications and can be effectively worked over existing gravity dams. Piano key weir is a financially savvy answer for both recovery of dams and new dam ventures. It was first created by Lempérière in year 2001 to improve the presentation of Labyrinth weir with constrained impression. Piano key weir has basic rectangular peak structure with upstream and downstream shade part and slanting floors are given along channel and outlet keys [2].

Piano key weirs can be effectively put over existing gravity dams because of lesser space necessity for spillway impression and peak length increments for constrained impression and more release departure limit than Labyrinth weirs over same confined impression spillway. The base territory required by Labyrinth weirs can't be found on normally gravity dam segments. Piano key weir is basically basic and affordable while Labyrinth weir requires huge fortification and vertical dividers of trapezoidal Labyrinth weirs are not using pressurized water great for enormous releases. At present four model piano key weir structures in France are in activity: Goulours dam (2006), Saint Marc dam (2006), Etroit dam (2009) and Gloriettes dam (2010) [3].

At the point when direct shear test was performed on sand with diesel sullying edge of inside erosion was observed [4] to be expanded for sand polluted with 2% diesel yet further on expanding rates of diesel in sand edge of interior grinding was observed to diminish as on tainting sandy sand with diesel at 0%, 2% and 4% concerning dry soil edge of inner contact in degree was observed to be 37,45,35 and when horizontal burden test were performed on different heap bunches either on expanding the thickness, parallel burden conveying limit was observed to diminish. While when horizontal burden test were performed on sand defile with diesel at 2% parallel burden limit was observed to be more than that of clean sand and on further increment in rates of diesel sidelong burden limit was observed to diminish [5].

Geometrical dimensions of piano key weir

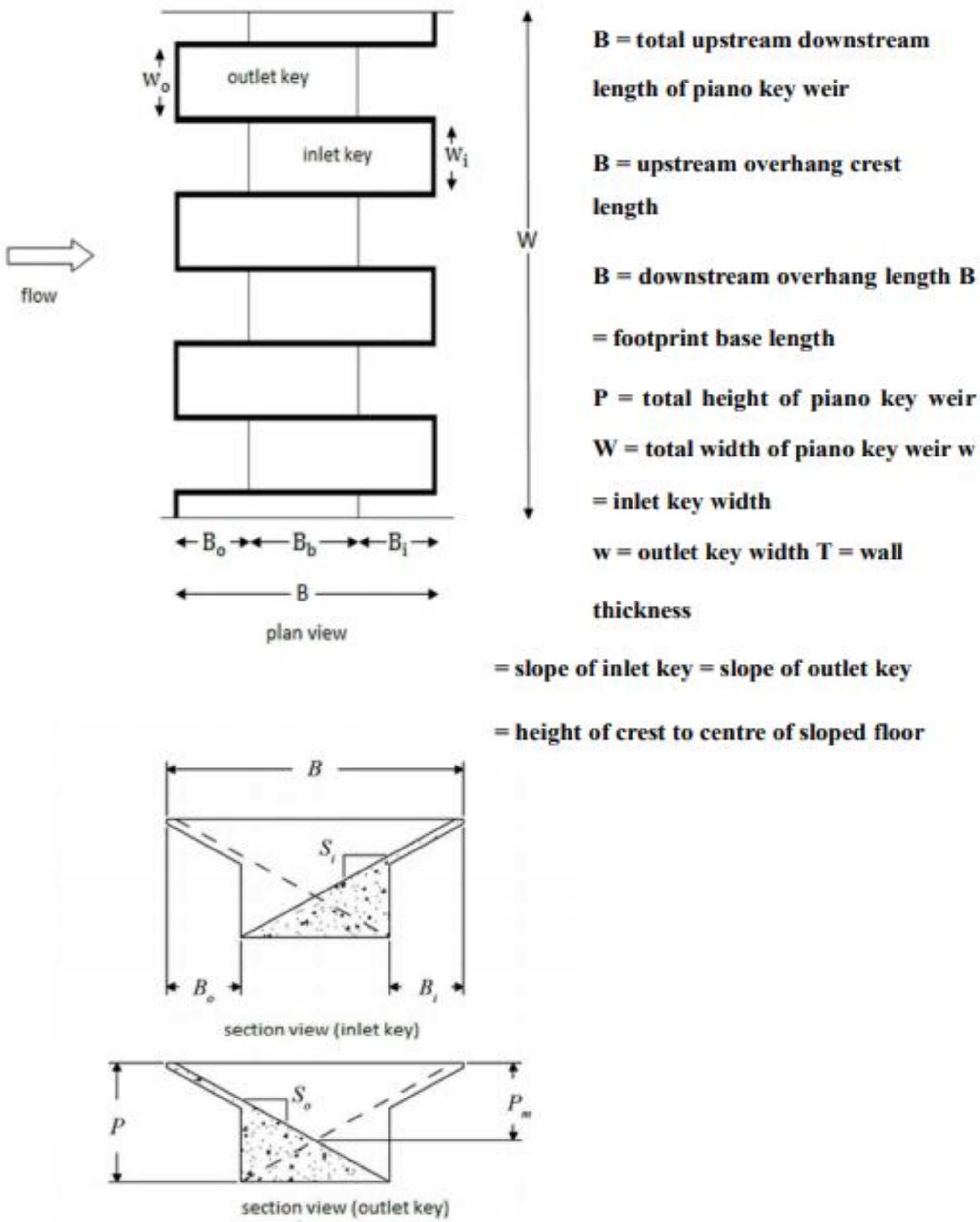

Figure 1: Geometrical dimensions of piano key weir [6]

MODELS AND METHODLOGY

The model was set up to conduct basic research tests but was not related to a prototype case study. Different arrangements of rectangular and trapezoidal piano key weir with similar upstream and downstream overhangs were tested including an upstream triangular nose. 13 model tests were conducted including with and without nose arrangements of rectangular and trapezoidal piano key weir. All piano key weirs were made from plywood having a uniform wall thickness of 0.5 cm. All piano key weirs have been placed over a supported platform of height 30 cm [7].

Figure 2: Piano key weir setup with 2.5 key units

After fabrication of each weir, the as-built weir dimensions were measured to ensure they agreed well with the design drawings. The weirs were then introduced in the flume and a break test was performed to guarantee all joints were water-tight. Utilizing the point check introduced on a moving carriage over the flume, the rise of the peak was estimated. The flume was loaded up with water to a height just beneath the weir peak rise and the water surface rise, adjoining the weir, was estimated utilizing the moving carriage point measure. The rise distinction between the water surface and the weir peak, are estimated by the moving carriage point check. Head (h) was resolved for each stream condition utilizing the point check after the water level had been permitted to balance out for at least 2 minutes. At least 2 point measure readings were taken sequentially per stream rate to guarantee that steady, unfaltering state stream conditions upstream of the weir were accomplished; if the two readings were not in indistinguishable, the stream was permitted to balance out for a more drawn out timeframe [8].

Piano Key Weir Models

The present investigation incorporates the examination and correlation of rectangular and trapezoidal piano key weirs. All the lab scale models were created utilizing 5cm thick wooden sheet. In absolute, 13 diverse piano key weirs including 7 rectangular and 6 trapezoidal designs with nose and with level rectangular projections.

Rectangular piano key weirs with 3.5 key units (18, 15 and 12 cm stature).

The water stream over a piano key weir is described by two releasing stream including a typical fly stream over upstream and downstream zeniths and a spatially shifted stream over the side dividers of the keys. Two planes collaborates one another and make a muddled stream structure amid flood. There is a division zone over the side dividers of the PK weir. The area of the detachment zone depends on stream release and weir setup. By expanding the stream release, the partition zone extends and pushes toward the downstream end of the PK weir [9].

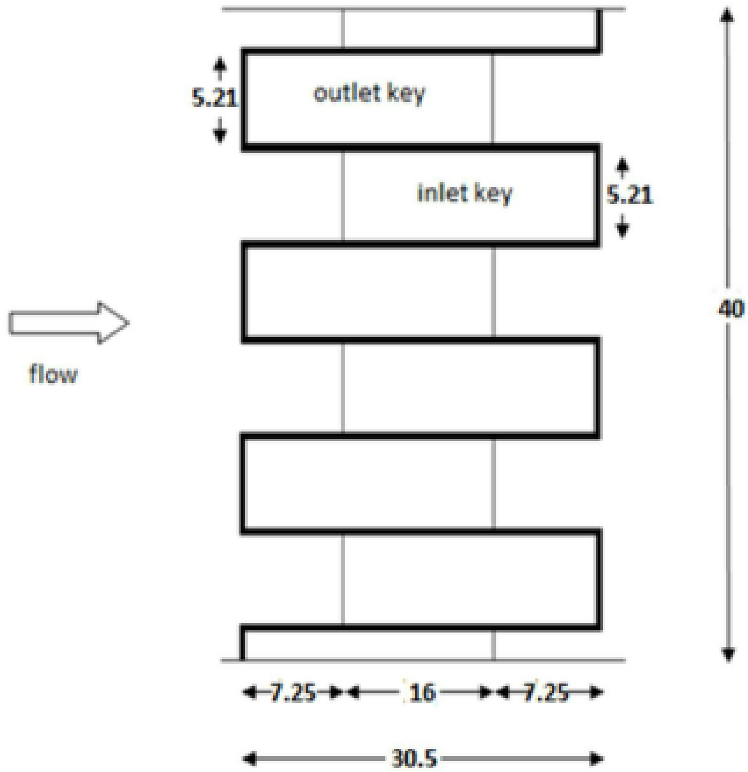

Figure 3: Plan of Rectangular PKW with 3.5 key units

Figure 4: Flow over Rectangular Piano Key Weir

Figure 5: Flow over Trapezoidal Piano Key Weir

EXPERIMENTAL SET-UP AND TESTING PROGRAMME

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.

Oil Properties: Motor oil available in market was used in this test .laboratory test were performed for finding out properties of mobil oil. Also, through this test it was locate its particular gravity turns out to be 0.88 and thickness estimated by redwood viscometer is 23 RW seconds. Diesel utilized has been taken from petroleum siphon and it is having explicit gravity 0.82 and viscosity of diesel estimated by redwood viscometer is 7 RW seconds [10].

Model Piles and Pile Caps: Iron heaps of distance across (d) 1.5 cm and length of 40 cm was utilized in research facility and iron heap top of focus to focus separating of (3d) 4.5 cm is utilized. For correlation purposes three 2x3 heap bunch arrangements were taken. One was 2X3 parallel gathering in which heaps were taken in 2 lines and 3 segments, in second heap bunch 2x3 arrangement in which heaps were taken in 3 lines and 2 sections and along these lines 2 heaps top blend of arrangement when two heaps in succession and parallel when 2 heaps in a segment taken And a solitary heap was additionally utilized.

Preparation and Properties of Oil-Contaminated Sands: Here oil debased sand was arranged falsely by blending dried sand with engine oil at various rates of 2,4&6(by load of dry sand).As contrasted with other examination in this investigation here test is performed inside 4 hours in the wake of blending of oil with sand. Initially sand of clear sum was laid in layers of positive thickness than unmistakable measure of oil for separate rate by dry load of soil was included after that oil was blended in sand [11].

Experimental Procedure and Program: For sand we ordinarily favored a down-pouring strategy for soil situation in test tank yet for filling of oil sullied sand down-pouring system for soil arrangement was not appropriate and did not give uniform compaction .Hence, sand unit weight was constrained by pouring pre determined load of sand in unequivocal thickness of layer and sand was leveled by utilizing a straight handle wood bar. What's more, compaction exertion required was given by four blows utilizing a level base mallet (0.1x0.1.weighting 20N), to get the required sand unit weight.

The sand unit weight which we required as checked by gathering tests in little jars having weight 55gm and having volume 240ml.After the testing, the heaviness of each can was estimated to contrast and required sand unit weight. The normal unit weight accomplished in this investigation was (15.15kN/m3+_0.3).Some tests were rehashed to check whether test outcomes were impacting by nearness of jars. Subsequent to completing the sand readiness, the heap or heap gathering was installed into soil utilizing a marginally light weight sledge to the required dimension. At last the horizontal burdens were connected to heap top .The sidelong redirections were estimated utilizing dial check having least tally of 0.01mm [12].

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(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

Table 2: Value of angle of Shearing Resistance of sand at Different Percentages of Oil Content [13]

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

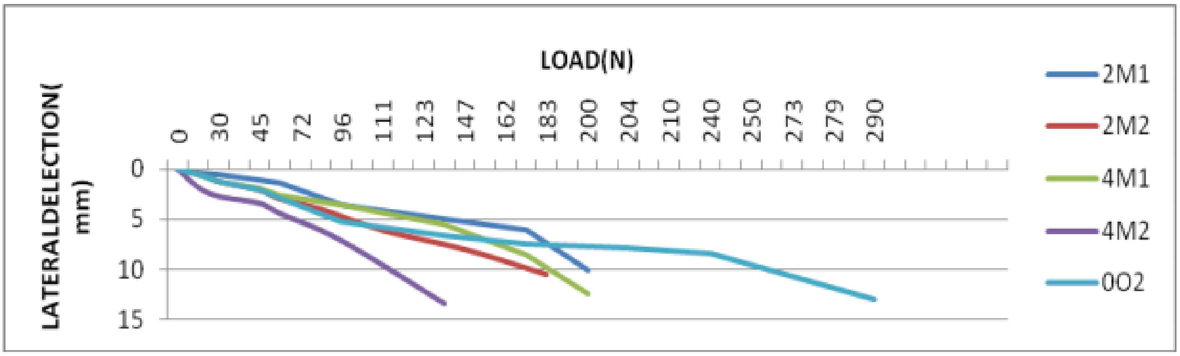

Fig. 6: Variations of Lateral Load H with Lateral Load Deflection Y for Single Pile on varying % of mobil oil and Thickness of oil Contamination Layers.

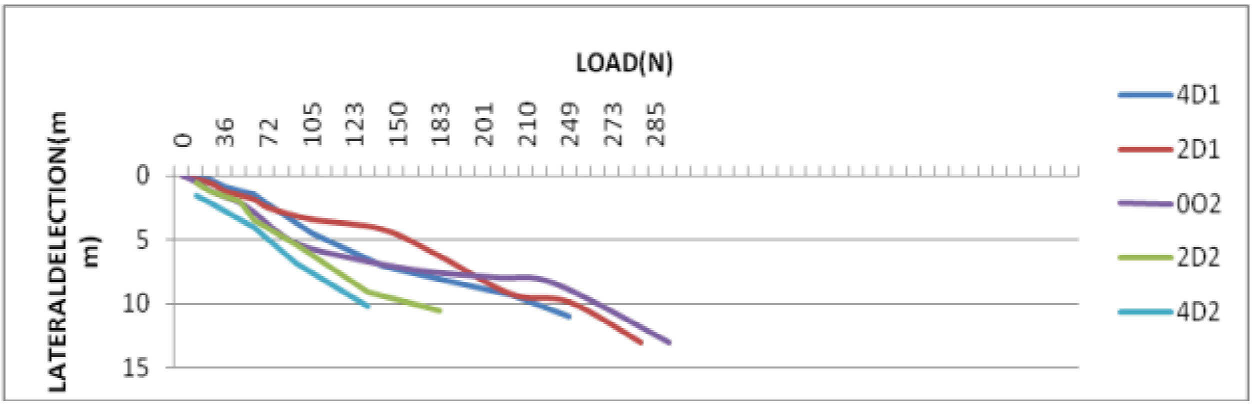

Fig. 7: Variations of Lateral Load H with Lateral Load Deflection Y for Single Pile on Varying % of diesel and Thickness of oil Contamination Layers.

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.

- 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.
- 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.
- 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.
- 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] A.J. Schleiss "From Labyrinth to Piano Key Weirs – A historical review".

[2] Khamehchiyan M., Charkhabi A. H., and Tajik M. (2006). "The effects of crude oil contamination on geotechnical properties of Bushehr coastal soils in Iran", The Geological Society of London, IAEG Paper No. 214, 1-6.

[3] Javaheri, A. R. Kabiri-Samani (2012) "Threshold Submergence of Flow over PK Weirs" World Academy of Science, Engineering and Technology 61.

[4] Nasr A. and Rao S. V. (2015). "Behaviour of laterally loaded pile groups embedded in oil-contaminated sand", ICE Publishing, Geotechnique, 66(1), 58-70.

[5] Indian Standards Institution, Design and Construction of Pile Foundation, Load Test on Piles, CED 43: Soil and Foundation Engineering, IS: 2911 (Part-4):1985.

[6] G. D. Singhal, N. Sharma, C. S. P. Ojha (2011) "Experimental Study of Hydraulically Efficient Piano Key Weir Configuration." ISH Journal of Hydraulic Engineering, Vol 17, No. 1

[7] J. Pralong, J. Vermeulen, B. Blancher, F. Laugier, S. Erpicum, O. Machiels, M. Pirotton, J- L. Boillat, M. Leite Ribeiro & A. Schleiss "A naming convention for the Piano Key Weirs geometrical parameters".

[8] Ouamane, A., and Lempérière, F. (2006). "Design of a new economic shape of weir." Proc., Int. Symp. on Dams in the Societies of the 21st Century, International Committee on Large Dams, Paris, 463–470.

[9] A.R. Kabiri Samani and A. Javaheri (2012) "Discharge coefficient for free and submerged flow over Piano Key weirs" Journal of Hydraulic Research Vol. 50, No. 6 (2014), pageno.. 642–645.

[10] O. Machiels, S. Erpicum, P. Archambeau, B. J. Dewals. and Archambeau P. " Experimental Analysis of PKW Hydraulic Performance And Geometric Parameters Optimum, 2015"

[11] M. Leite Ribeiro1; M. Bieri; J.-L. Boillat; A. J. Schleiss; G. Singhal; and N. Sharma (2016) "Discharge Capacity of Piano Key Weirs" Journal Of Hydraulic Engineering © ASCE 199-203.

[12] Marcelo Leite Ribeiro, Michael Pfister, Anton J. Schleiss & Jean-Louis Boillat (2017) "Hydraulic design of A-type Piano Key Weirs" Journal of Hydraulic Research Vol. 50, No. 4 (2018), pp. 400–408.

[13] Michael Pfister ,Anton J. Schleiss (2013) "Comparison of hydraulic design equations for A-type Piano Key weirs" Intl. Conf. Water Storage and Hydropower Development for Africa (AFRICA 2018).