EXPERIMENTAL ANALYSIS ON ANGULAR FOOTING TO DETERMINE DIFFERENT ANGLES FOR COMPRESSION AND FAILURE LOADS

Tasadduk Mohd Khan [1], Pankaj Dwivedi [2]
MTech.Scholar[1], Asst. Prof.[2]
Department of Civil Engineering[1,2]
Madhyanchal Professional University, Bhopal, India

Abstract — In our analysis, experimental investigation was performed and the model was developed by casting of trapezoidal footing. In order to verify the present experimental model, the compressive strength and failure load with different sieve sizes and folded angle of footing , thus it was observed that 0.75mm of sand sieve size with an angle of 30 degree gives higher value of compressive strength and higherstability in failure load at the constant load of 400KN the maximum load bearing capacity is observed on 30 degree folded angle of footing is 140KN, Natural frequency of this footing enhances higher compared to another configurations of footing, the experimental values are validated from mathematical formulation by regression analysis, Hence 0.1048 significance is observed with 10.91% of error with experimental and mathematical model.

Keywords— *Footing, Folded footing, compressive strength,failure load, regression analysis, natural frequency*

I INTRODUCTION

Structures supported on foundation are subjected to earthquakes relying on different seismic zones. Earthquakes produce seismic excitation and because of this a dynamic load is carried out on structural foundation. Basically foundations are designed for static load, however due to this phenomenon, foundations need to also face up to dynamic load. Dynamic load may additionally come due to various natural and manmade reasons. Therefore the design of foundation wishes unique attention for dynamic load in comparison to the static case. The Purpose of the inspiration is to safely transfer the load of superstructure directly to the underlying soil. In doing so the soil need to not fail in shear and at the identical time agreement as well as the lean if any should be inside the permissible restriction. The eccentricity in loading causes the foundation to settle by means of exceptional amount and therefore it enjoy tilt. When the eccentricity exceeds 1/sixth width of basis the lifting of the similarly stop is predicted to arise as soil is a no tension medium. Any basis is subjected to eccentric loading because of (i) second in addition to axial load transferred from the column, (ii) foundation being at the edge belongings line, (iii) basis subjected to eccentric load and (iv)foundation subjected to inclined loading or wind loading etc. A huge variety of experimental and analytical research at the Angle Shaped Footing beneath static loading display the uniform compression decreased normal settlement and growth in bearing capability. The utility of such footing has been determined even beneath eccentric willing loading when the projections also are provided at some inclination. To put it truly, the feature of a shape is to do not anything. The maximum a success structures stay nevertheless. That's the purpose of the exercising.

II FOOTING TYPES

Footings may be classified as deep or shallow. If depth of the footing is equal to or greater than its width, it is called deep footing; otherwise it is called shallow footing. Shallow footings comprise the following types.

- **Isolated Footings:** An remoted footing is used to aid the load on a unmarried column. It is commonly either square or square in plan. It represents the simplest, most comparatively cheap kind and most widely used footing. Whenever possible, rectangular footings are furnished so as to lessen the bending moments and shearing forces at their important sections. Isolated footings are used in case of light column loads, whilst columns are not intently spaced, and in case of true homogeneous soil. Under the impact of upward soil pressure, the footing bends in a dish formed form. An remoted footing have to, therefore, be furnished via sets of reinforcement bars located on top of the alternative close to the bottom of the footing. In case of belongings line restrictions, footings may be designed for eccentric loading or blended footing is used as an opportunity to isolated footing.

- **Wall Footings:** A wall footing is a strip of bolstered concrete, normally wider than the wall, used to assist the loads that the wall incorporates at the top floor degree of the footing. Under the motion of soil stress, it bends in the transverse path. Thus, predominant reinforcement is supplied inside the brief route close to the lowest of the footing. Secondary reinforcement is furnished within the longitudinal path to satisfy shrinkage and temperature requirements.

- **Combined Footings:** In some instances, a column is to be furnished near the threshold of belongings and it could no longer be permissible to extend the footing beyond a sure restrict. In this type of case, the burden at the footing may be eccentric and consequently this can end result in choppy distribution of load to the helping soil. Hence, an opportunity design might be to offer a commonplace footing to the brink column and to an indoors column close to it. Combined footings beneath or extra columns are used below closely spaced, closely loaded interior columns in which character footings, in the event that they were furnished, might be both very near each other, or overlap every different. This footing is called “mixed footing”. The form of mixed footing in plan will be such that the centroid of the inspiration plan coincides with the centroid of the masses in the columns. Combined footings are either square or trapezoidal. Rectangular footings are favored because of their simplicity in phrases of layout and creation. However, rectangular footings aren't constantly achievable due to the restrictions that may be imposed on its longitudinal projections past the two columns or the huge distinction that could exist among the magnitudes of the 2 column masses. Under these situations, the provision of a trapezoidal footing is greater comparatively cheap. Combined footings behave as inverted beams spanning among the columns and subjected to the upward soil stress. Reinforcement need to, therefore, be provided in the longitudinal direction and positioned close to the tension facets. In addition to this predominant reinforcement, secondary reinforcement is supplied in the quick route and concentrated under every column. When the spacing between the columns is fairly huge, a spine beam is furnished to lessen the thickness of the base slab.
- **Strap (Cantilever) Footings:** A strap footing is used wherever the belongings strains of the constructing web page do not permit an inexpensive or no extension of the footing beyond the face of an outdoors column. It is also used while the distance between this column and the nearest internal column is long that a blended footing might be too slim. It includes separate footings, one below every column, connected collectively by using a beam referred to as “strap beam”. The reason of the strap beam is to prevent overturning of the eccentrically loaded footing. It is usually subjected to a linearly various negative second and constant shear, as a result referred to as “cantilever footing”. Its most important

reinforcement should be furnished near its topside. This kind of footing is greater reasonable than blended footings wherein distance between the columns is long.

Raft (Mat) Footing: This is a footing that covers the whole area beneath the structure. This footing is used when very heavy masses of building are to be transmitted to the underlying soil having very low and differential bearing capacities. Due to its tension, it minimizes differential agreement. There are numerous styles of raft basis in use. The maximum not unusual kinds are; the flat slab and the slab-beam sorts, Where the floor water desk is excessive, rafts are often positioned over piles to control buoyancy.

.

III DISCRETE ELEMENT METHOD

A discrete element method (DEM), also called a distinct element method, Is any of a own family of numerical strategies for computing the movement and effect of a huge variety of small debris. Though DEM is very closely related to molecular dynamics, the approach is typically distinguished by way of its inclusion of rotational stages-of-freedom in addition to stateful contact and regularly complex geometries (together with polyhedra). With advances in computing electricity and numerical algorithms for nearest neighbor sorting, it has grow to be feasible to numerically simulate millions of particles on a single processor. Today DEM is becoming widely frequent as an powerful method of addressing engineering issues in granular and discontinuous materials, in particular in granular flows, powder mechanics, and rock mechanics. Recently, the method become improved into the Extended Discrete Element Method taking thermodynamics and coupling to CFD and FEM into consideration

V METHODOLOGY

a) MATERIAL USED

The basic ingredients of rubberized concrete which were used in this research work are OPC (ultra tech cement), Fine , Natural Coarse aggregate (sedimentary rock source), and Natural Fine aggregate (sand), Water (fresh drinkable water).

b) ORDINARY PORTLAND CEMENT

The ordinary Portland cement of 53grade manufactured by the ULTRATECH Cement Company was used in the study, which is in accordance with IS 12269:1987.Having design strength for 28 days being a minimum of 700MPa or 1000kg/sqcm.

c) COARSE AGGREGATES

Locally available coarse aggregates were used for the preparation of test samples using angular footing. Sieve sizes were used & is described by its nominal size i.e. 0.6, 0.75, 1.18, 2.36 mm)etc. The coarse aggregate having nominal size 20mm has been used in this study. Sieve analysis on the coarse aggregate samples was carried out in the laboratory and the results obtained are shown in the Table 3.2. The properties of the coarse aggregates used for the experiment are shown in Table 3.1.

- *Weighing and Batching of materials*

The first step in the preparation of the cube sample is the weighing and batching of materials. The materials are batched according to the requirements and then a fixed amount from this batched lot of materials is taken for the preparation of sample. The figure 3.1 shows the simple batching done in the laboratory;

- *Sand Test*

V RESULT AND DISCUSSION

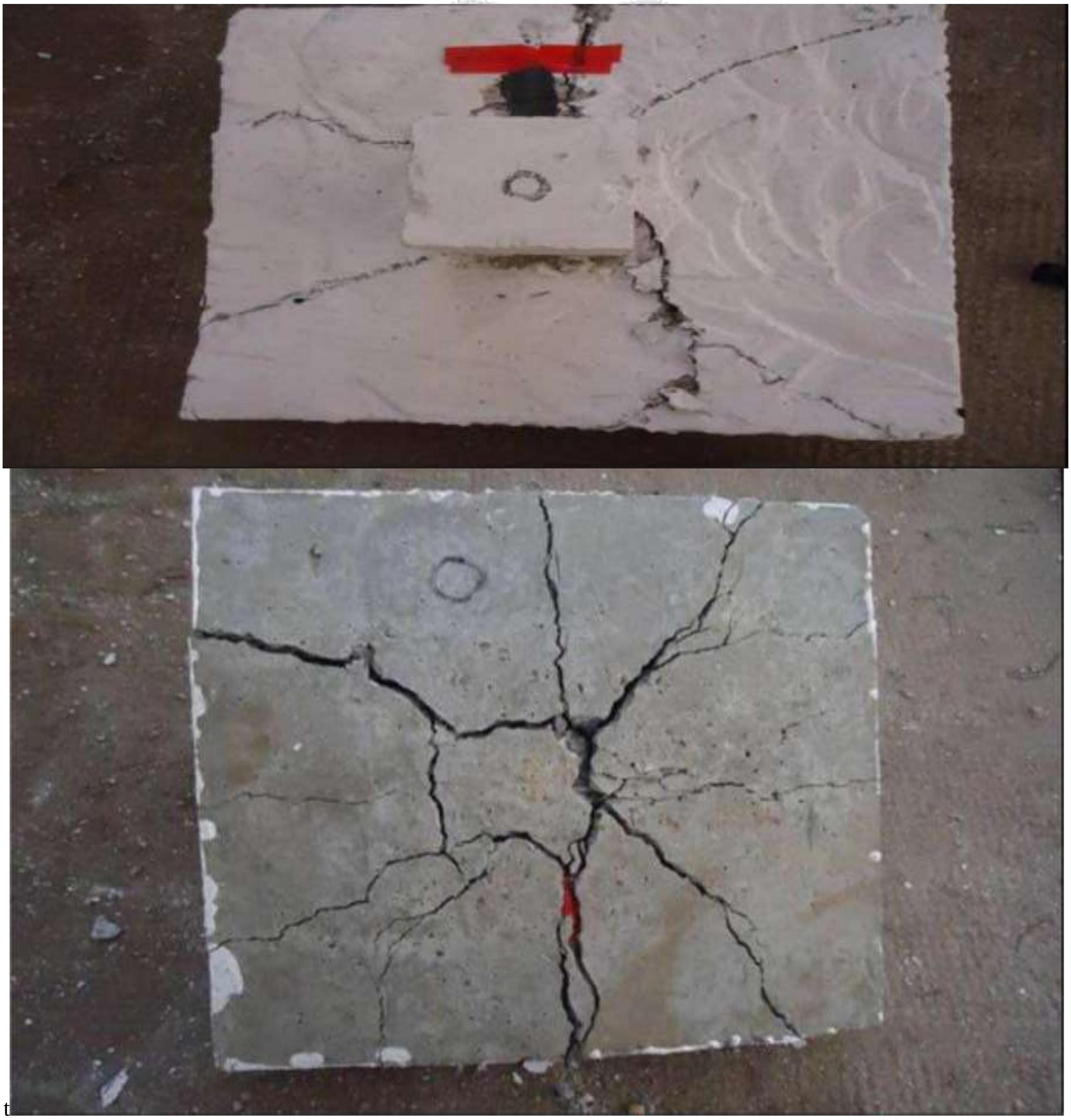
Experimental Investigation on Different Folded Footing Angle

Fig Calibrated loading in 0 degree footing

2) 4.2 Compressive strengthof different folded footing with different sieve sizes of sand.

An experimental investigation was performed on different angle folded footing with different sieve sizes of sand to determine compressive strength and failure under constant load of 800 to 950 KN the footing with different folded angle and sieve size to determine the natural frequency along the longitudinal of the folded footings. Compressive stress distributioninsieve size 0.75 mm with 30 degree folded angle have higher compressive strength and low failure effect are represented in this experimental study.

3) 4.3 Compressive Strength-



t

Fig. 4.3 Bottom Failure of 0 degree folded footing during a constant load

Fig. 4.4 Failure of 30 degree folded footing during a constant load

Fig. 4.5 Bottom Failure of 30 degree folded footing during a constant load

Result of top failure and bottom failure during compression testing are obtained by experimental approach is compared with the different folded angle and sieve sizes of sand calculated by the strain gauge, Data logger and LVDT. The result shows the accuracy of the experimental analysis.

Table-(4.1) Experimental Result for Compressive Test with 0.6 mm Sand Sieve size

Compressive Test with 0.6 mm Sand Sieve size				
0 Degree	**10 Degree**	**20 Degree**	**30 Degree**	**40 Degree**
40	52	57	61	59

able 4.2-Experimental Result for Compressive Test with 0.75 mm Sand Sieve size

Compressive Test with 0.75 mm Sand Sieve size				
0 Degree	**10 Degree**	**20 Degree**	**30 Degree**	**40 Degree**
60	64	69	73	70

Table-(4.3) Experimental Result for Compressive Test with 1.18 mm Sand Sieve size

Compressive Test with 1.18 mm Sand Sieve size				
0 Degree	**10 Degree**	**20 Degree**	**30 Degree**	**40 Degree**
43	49	54	58	52

Table 4.4-Experimental Result for Compressive Test with 2.36 mm Sand Sieve size

Compressive Test with 2.36 mm Sand Sieve size				
0 Degree	**10 Degree**	**20 Degree**	**30 Degree**	**40 Degree**
51	55	59	65	60

Compressive Test with different Sand Sieve size					
Sand Sieve Size	**0 Degree**	**10 Degree**	**20 Degree**	**30 Degree**	**40 Degree**
0.6	40	52	57	61	59
0.75	60	64	69	73	70
1	43	49	54	58	52
2.36	51	55	59	65	60

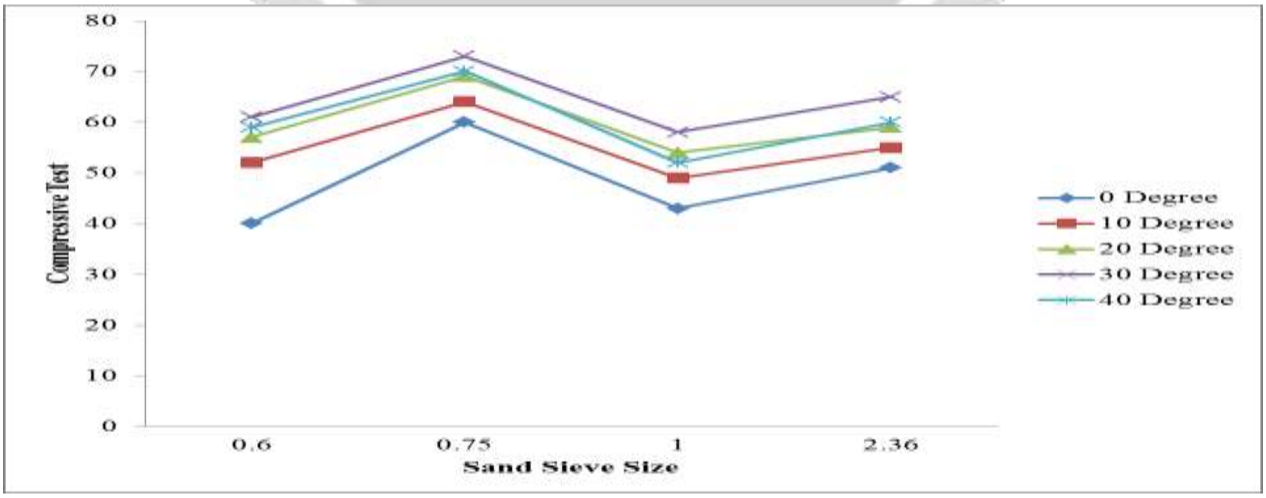


Figure – 4.10Comparison for Different Folded Angle with Different Sand Sieve Sizes

The Experimental values obtained for failure load

Table 4.5-Experimental Result for Failure Load Test with Different Folded Angle

Failure Load Test with Different Folded Angle				
0 Degree	**10 Degree**	**20 Degree**	**30 Degree**	**40 Degree**
63	70	115	140	129

a) 4.5 The Experimental values obtained for Natural Frequency

Table 4.6-Natural Frequency for 0.75 Sieve sizes of Sand with different Folded Angle

Natural Frequency for 0.75 Sieve sizes of Sand with different Folded Angle					
Modes	0 Degree	10 Degree	20 Degree	30 Degree	40 Degree
1	147.2	150.3	163.1	183.6	170.5
2	159.1	168.2	182.9	199.5	190.3
3	172.7	184.6	197.3	210.7	203.5
4	189.5	192.8	208.5	223.4	215.6
5	200.3	210.5	220.6	240.6	227.8

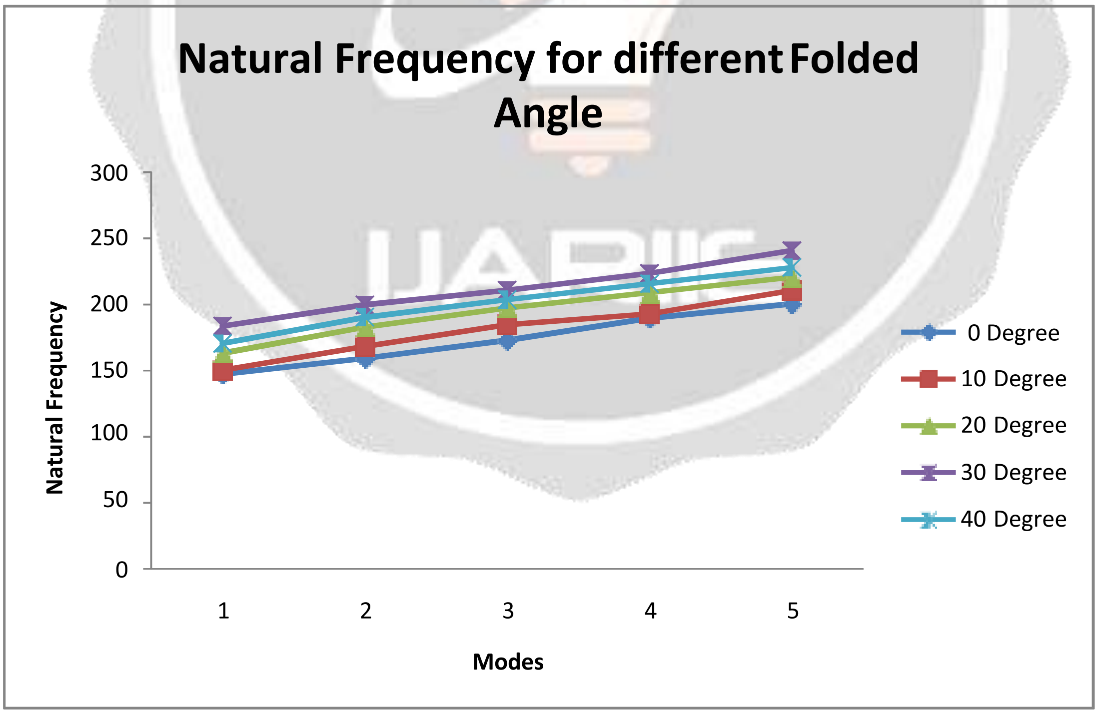


Figure – 4.12Natural Frequency for different Folded Angle

4) 4.6 Validation of experimental result by mathematical formulation by using regression analysis

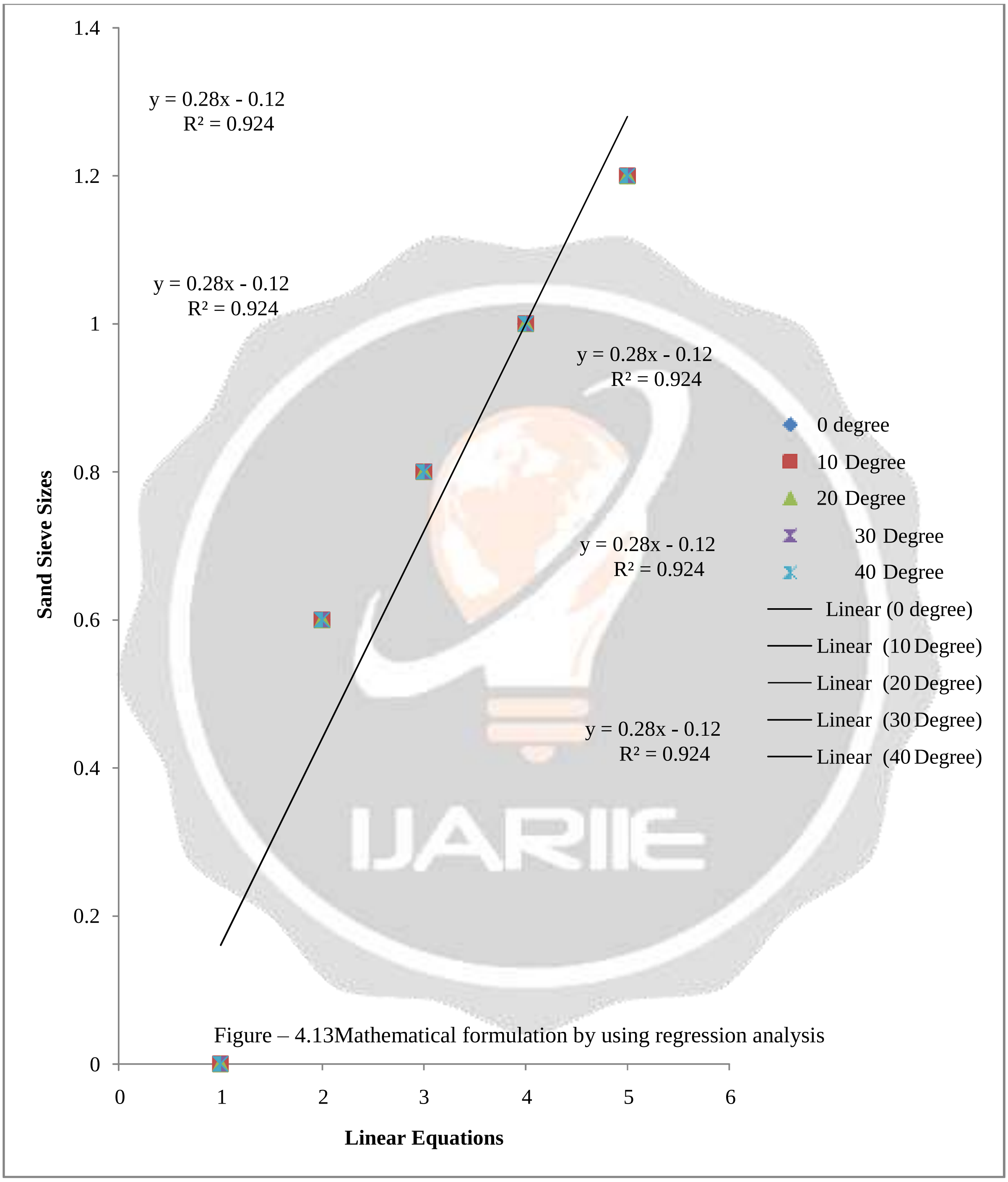


Figure – 4.13Mathematical formulation by using regression analysis

VII CONCLUSION

- The compressive strength along the different folded angle footing profile is found to be maximum of the 30 degree folded angle with 0.75 mm sieve size of sand.
- The failure load is maximum of 30 degree folded angle footing with 0.75 mm sieve size of sand, and reduces the failure condition of constant load.
- In a comparison with the different folded angle (0, 10, 20, 30, 40 degree) and sieve sizes (0.6, 0.75, 1.18, 2.36 mm) of sand in our analysis we found that 30degree folded angle gives the better results is compare to other folded angle.
- Analyze of natural frequency in our analysis, we found the 30 degree folded angle footing gives higher value of five modes.
- Experimenta validation which is perform in regression analysis with analysis of variance to the l compressive strength the overall 10.91% of improvement is observed thus the overall significance of 0.1048 is obtained in independent variable, thus this system could be implemented in the structural application for optimization of overall structural stability for enhancement in stable and effective structure with 95% of convergence.

References

1. PrimožJelusic, BojanZlender, Optimal design of pad footing based on MINLP optimization, Soils and FoundationsVolume 58, Issue 2, April 2018, Pages 277-289.

2. Jia-QuanWang, Liang-LiangZhang, Jian-FengXueYiTang, “Load-settlement response of shallow square footings on geogrid-reinforced sand under cyclic loading”, Geotextiles and GeomembranesVolume 46, Issue 5, October 2018, Pages 586-596.

3. Ran Yuan, Hai-SuiYu, NianHuYiHe., Non-coaxial soil model with an anisotropic yield criterion and its application to the analysis of strip footing problems, Computers and Geotechnics Volume 99, July 2018, Pages 80-92.

4. OmidSargaziEhsanSeyediHosseininia, Bearing capacity of ring footings on cohesionless soil under eccentric load,Computers and GeotechnicsVolume 92, December 2017, Pages 169-178.

5. Vaibhav Sharma, Arvind Kumar, Behavior of ring footing resting on reinforced sand subjected toeccentric-inclined loading, Journal of Rock Mechanics and Geotechnical Engineering 10 (2018) 347-357.

6. G.CampioneF.CannellaC.Cucchiara, “Simplified model for compressive response of RC column footing with square cross-section,Engineering StructuresVolume 148, 1 October 2017, Pages 936-948.

7. FathiAbdrabbo, Zaki I. Mahmoud, Mariana Ebrahim, “Structural design of isolated column footings,Structural design of isolated column footings

8. FathiAbdrabboZaki I.MahmoudMarianaEbrahim, Structural design of isolated column footings, Alexandria Engineering JournalVolume 55, Issue 3, September 2016, Pages 2665-2678

9. A.Shadmand, M.Ghazavi, N.Ganjian “Load-settlement characteristics of large-scale square footing on sand reinforced with opening geocell reinforcement,” Geotextiles and Geomembranes Volume 46, Issue 3, June 2018, Pages 319-326

10. Md. JahidIftekharAlamC.T.GnanendranS.RLo, “Experimental and numerical investigations of the behaviour of footing on geosynthetic reinforced fill slope under cyclic loading”Geotextiles and GeomembranesVolume 46, Issue 6, December 2018, Pages 848-859.

11. GiaToaiTruongKyoung-KyuChoiHee-SeungKim "Punching-shear behaviors of RC-column footings with various reinforcement and strengthening details,Engineering StructuresVolume 151, 15 Oct.ember 2017, Pages 282-296

12. JianyeChing, Yu-GangHu, Kok-KwangPhoon, "Effective Young's modulus of a spatially variable soil mass under a footing"Structural SafetyVolume 73, July 2018, Pages 99-113.

13. Haizuo Zhou, GangZheng, XinYin, RuiJia, XinyuYang, "The bearing capacity and failure mechanism of a vertically loaded strip footing placed on the top of slopes," Computers and GeotechnicsVolume 94, February 2018, Pages 12-21.

14. JunLiu, N. Demirel, "Bearing capacity of rectangular footings in uniform clay with deep embedment," Computers and GeotechnicsVolume 86, June 2017, Pages 209-218.

15NingLuo, Richard J.Bathurst, "Reliability bearing capacity analysis of footings on cohesive soil slopes using RFEM" Computers and GeotechnicsVolume 89, September 2017, Pages 203- 212.