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CYCLIC LOADING ON FOUNDATION TO EVALUATE THECOEFFICIENT OF ELASTIC UNIFORM COMPRESSION FOR DIFFERENT RELATIVE DENSITY OF SAND

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Abstract—***The coefficient of elastic uniform compression of soil (Cu) is the most important parameter to be determined in designing a machine foundation. This paper presents the results of cyclic-footing-load tests from the Laboratory - model tests on square footings supported by a sand bed. The various intensity of cyclic load (loading, unloading and reloading) apply on the footing and then the elastic rebound of the footing corresponding to each intensity of loading obtains during the tests to determine the coefficient of elastic uniform compression of sand.***

The influence of sand relative densities of 37.5%, 48.3%,57.5%, 65.7%, and 78.56% on behavior of footing under cyclic loads case investigated. The results indicate that with increasing the relative density of soil the value of Cu increases.

Keywords— Laboratory test; Cyclic loads; Coefficient of elastic uniform compression; Machine foundation; Relative density

INTRODUCTION

Machine foundations require the special attention of a foundation engineer. In addition to static loads due to the weight of machine and the foundation loads acting on such foundations are dynamic in nature. In general, a foundation weighs several times as much as a machine. Also, a dynamic load associated with the moving parts of a machine is generally small as compared to its static load. In this type of foundation a dynamic load applies repetitively over a very large period of time but its magnitude is small, and it is therefore necessary that the soil behavior be elastic, or else deformation will increase with each cycle of loading until the soil becomes practically unacceptable. Shvets and Nazha (2000) investigated the influence exerted by anisotropy of the deformation properties of soil foundation beds on the elastic characteristics used in dynamic analyses of machine-bearing foundations. They suggested that correction factors dependent on the degree of anisotropy of the soil should be used in the analyses. DE Merchant et al. (2002) performed an experimental study to investigate the beneficial effect of geogrid on subgrade modulus of lightweight aggregate beds. Moghaddas Tafreshi & Khalaj (2008) performed an experimental study to investigate the beneficial effect of geogrid on settlement of soil surface, subjected to repeated loads to simulate the vehicle loading. They reported that settlement of soil surface can be reduced significantly by using geogrid reinforcement.

In designing a machine foundation, the coefficient of elastic uniform compression of soil (Cu) is the most important parameter to be determining which can calculate by a cyclic-foundation-load test. Nevertheless, this has not been comprehensively investigated. This paper attempts to study a point of this phenomenon.

In the current research, a series of different tests on square footing subjected to static and incremental cyclic loads (similar to cyclic-plate-load test) are performed. The testing program is planned to evaluate the role of sand relative density factor of 37.5%,48.3%,57.5%,65.7%,78.56% (Dr) on the coefficient of elastic uniform compression (Cu).

MATERIAL OF INVESTIGATION

The sand used in the present investigation is brought from Bahadarpur near Sankheda, situated in Gujarat (India). The tests were performed on dry sand. The various engineering properties of the sand are tabulated in Table I. Grain size distribution characteristics of Bahadarpur sand are shown in fig I.

TABLE I

ENGINEERING PROPERTIES OF SAND USED

Sr. No.	Properties of sand	Value
1	D_{10}, mm	0.32
2	D_{30}, mm	0.51
3	D_{60}, mm	0.71
4	Coefficient of Uniformity, C_u	2.22
5	Coefficient of Curvature, C_c	1.14
6	Fine Sand	19.00%
7	Medium Sand	74.10%
8	Coarse Sand	6.90%
9	I.S Soil Classification	SP
10	Specific Gravity	2.61
11	Maximum Density, $\gamma_{d\ max}$	1.9 g/cc
12	Minimum Density, $\gamma_{d\ min}$	1.47 g/cc

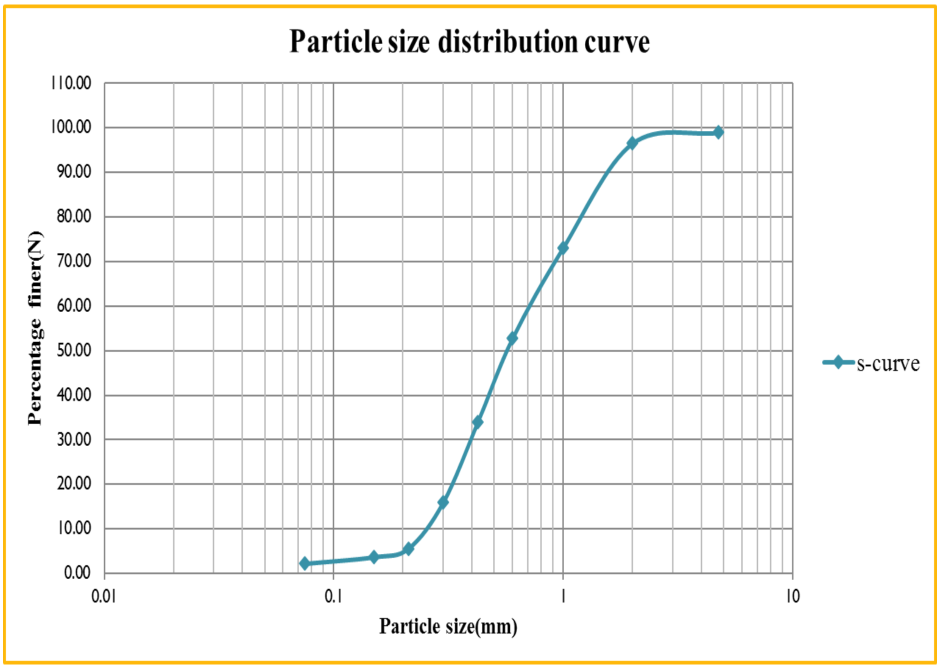

Fig. 1 Grain size characteristics of bahadarpur sand

EXPERIMENTAL STUDY

Preparation of model test

In present study the laboratory tests were conducted for different relative density. The size of the model tank was 122 cm x 122 cm x 108 cm. Mild steel solid plate having size of 240mmx240x25mm are placed on the sand. sand was filled in the tank according to the different relative density that is achieved by vibration. Figure 2 shows the model foundation experimental setup. The sand was filled in the tank in the three layer of 20 cm and compacted using small surface vibrator having standard vibrations, vibrated and achieve density 37.5%, 48.3%, 57.5%, 65.7%, 78.56% respectively.

Then plate was place on the sand bad then checked that mechanical screw jack and plate are aligned with plumb bob in vertical line. If it was not then plate model was removed and process was repeated. Horizontal level of the mild steel plate was checked by spirit level. Proving ring for measuring load was placed centrally between jack and mild steel plate along with solid steel ball to fill the gaps. Then vertical loading arrangement done on the plate. **Figure 3** shows the loading arrangement of cyclic plate load test. After each test, tank was emptied and refilled for the next test.

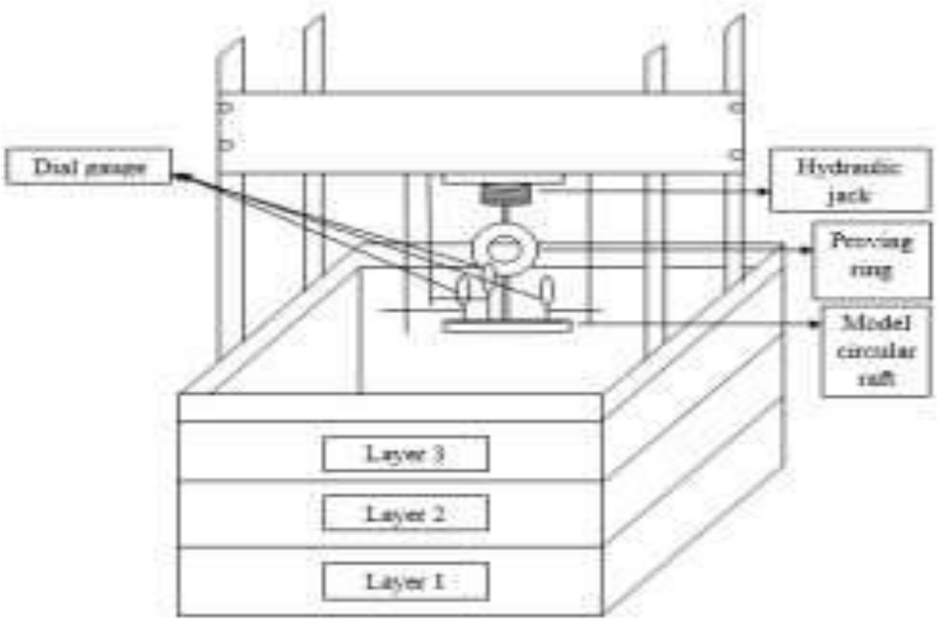

Fig. 2 Model foundation set-up

Fig.3 Arrangement of vertical loading of cyclic plate and dial gauges

Testing procedure

The equipment for the test shall be assembled according to the details given in IS 1888: 1982. After the set-up has been arranged the initial readings of the dial gauges should be noted and the first increment of static load should be applied to the plate. This load shall be maintained constant throughout for a period till no further settlement occurs or the rate of settlement becomes negligible. The final readings of the dial gauges should then be recorded. The entire load is then removed quickly but gradually and the plate allowed to rebound.

When no further rebound occurs or the rate of rebound becomes negligible, the readings of the dial gauges should be again noted. The load shall be increased gradually till its magnitude acquires a value equal to the proposed next higher stage of loading, which shall be maintained constant and the final dial gauge readings should be noted as mentioned earlier. The entire, load should then be reduced to zero and final dial gauge readings recorded when the rate of rebound becomes negligible. The cycles of loading, unloading and reloading are continued till the estimated ultimate load has been reached, the final values of dial gauge readings being noted each time.

Result and analysis

Load vs plate settlement for size 240mm X 240mm and thickness 25mm.It can be observed that as the load on plate increase the displacement of plate also increase. In initially this increase in the displacement is at very slow rate with progress of loading and unloading on plate rebound sand and some permanently some deformation are there. graph is plotted load vs plate settlement.

Fig.4 Settlement vs loading intensity graph plot at 37.5% relative density. Using a graph slope finding coefficient of uniform compression value is 165000KN/m3.

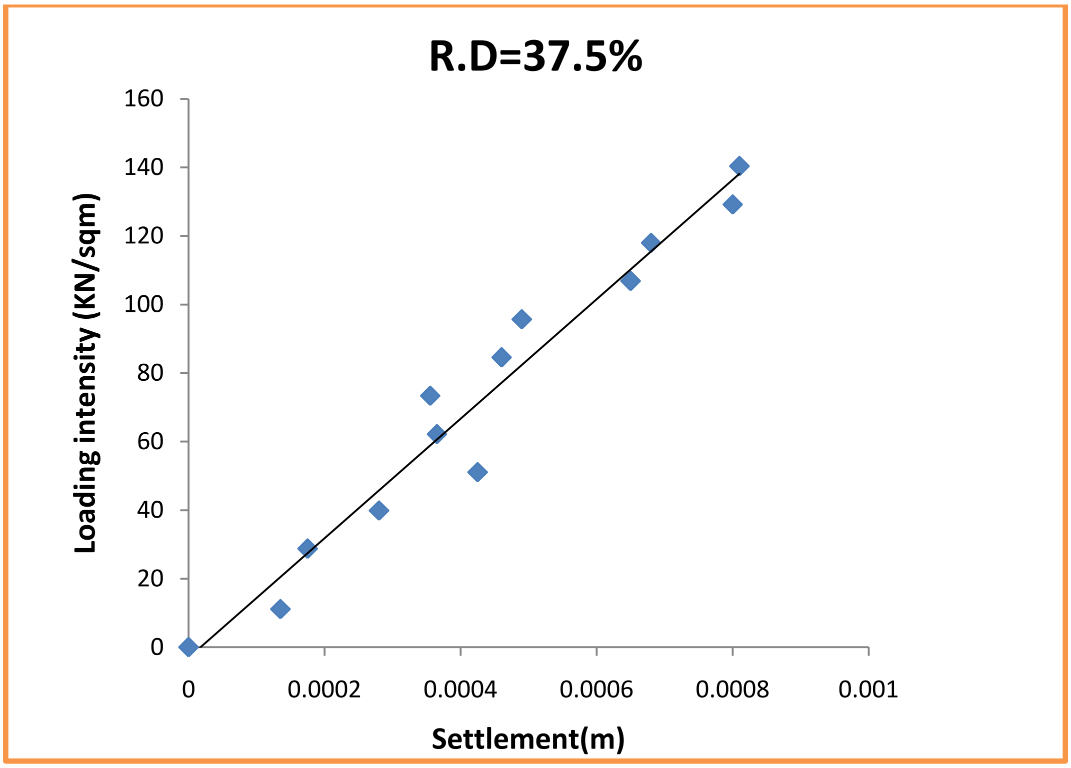

Fig.4 loading intensity vs elastic settlement

Fig.5 Settlement vs loading intensity graph plot at 48.3% relative density. Using a graph slope finding coefficient of uniform compression value is 174000KN/m3.

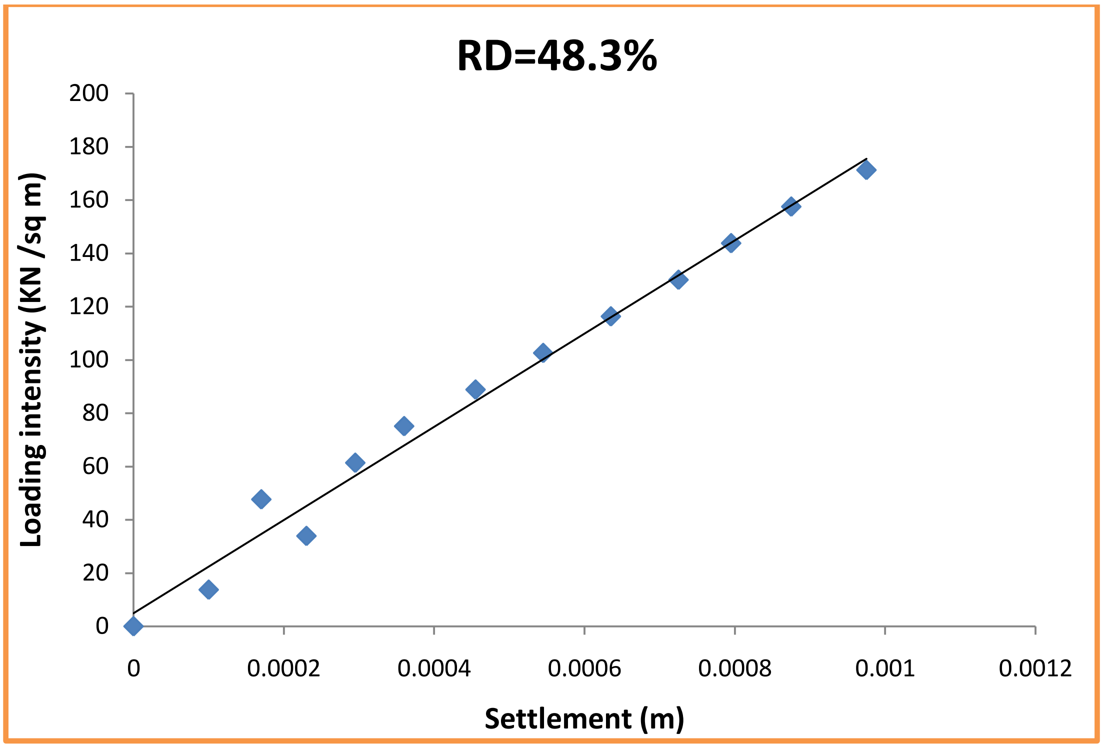

Fig.5loading intensity vs elastic settlement

Fig.6 Settlement vs loading intensity graph plot at 57.5% relative density. Using a graph slope finding coefficient of elastic uniform compression value is 188592.02KN/m3.

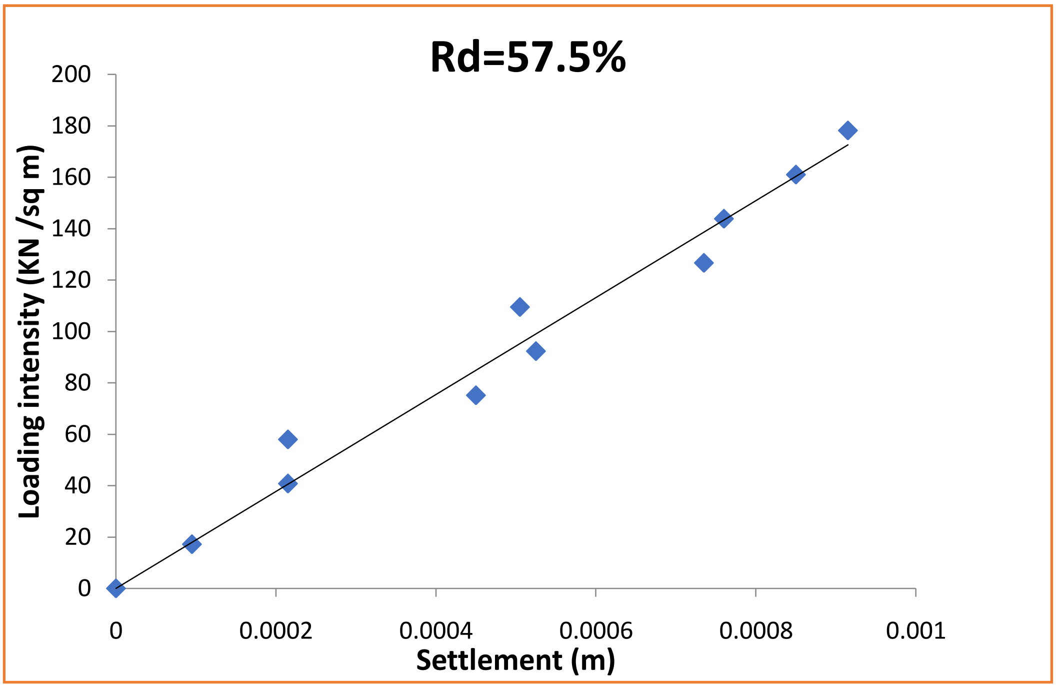

Fig.6 Loading intensity vs settlement

Fig.7 Settlement vs loading intensity graph plot at 65.7% relative density. Using a graph slope finding coefficient of elastic uniform compression value is 206485.73KN/m3.

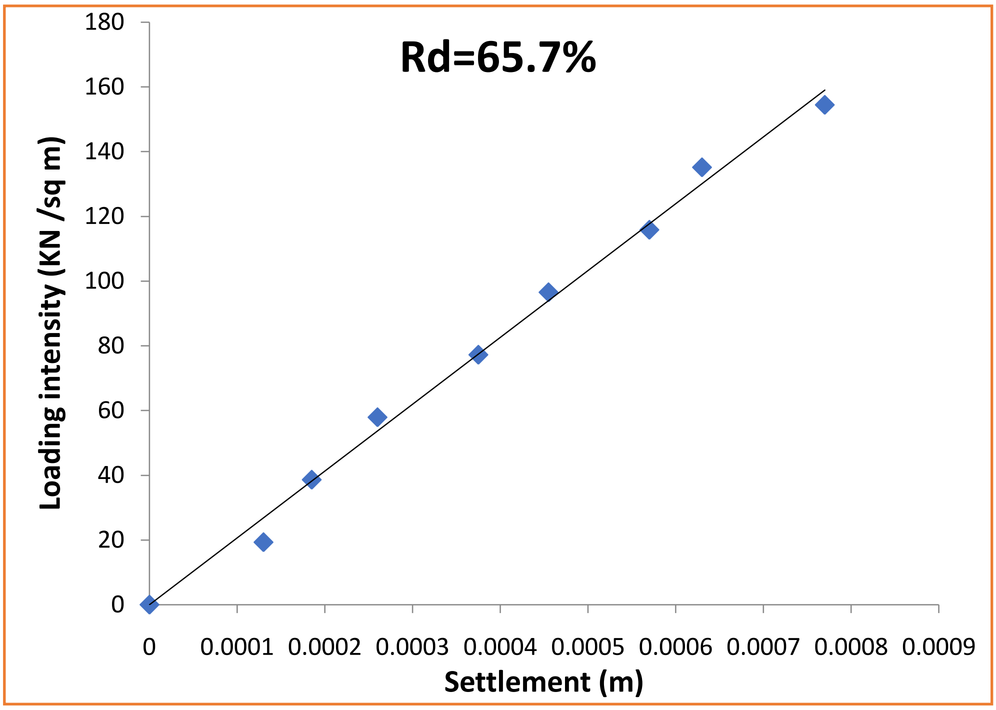

Fig.7 Loading intensity vs Settlement

Fig.8 Settlement vs loading intensity graph plot at 78.56% relative density. Using a graph slope finding coefficient of elastic uniform compression value is 214574.89KN/m3.

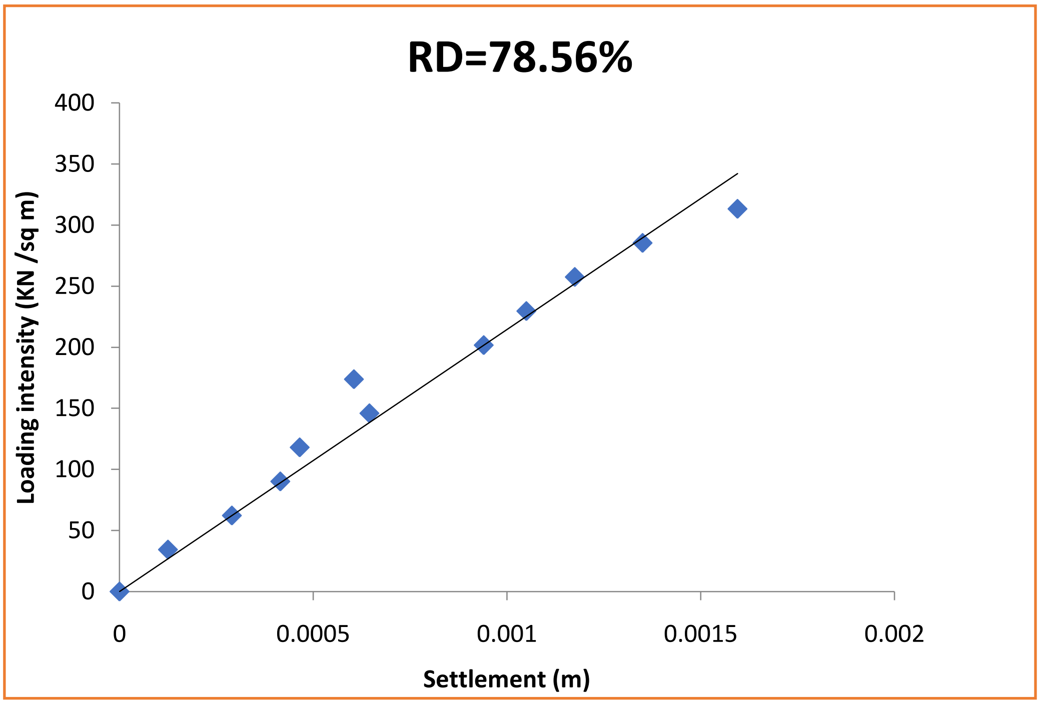

Fig.8 Loading intensity vs Settlement

Fig.9 Coefficient of elastic uniform compression vs Relative density graph at different relative density by cyclic plate load test. Using this graph clearly see that coefficient of elastic uniform compression value increase with increase in relative density in cyclic plate load test.

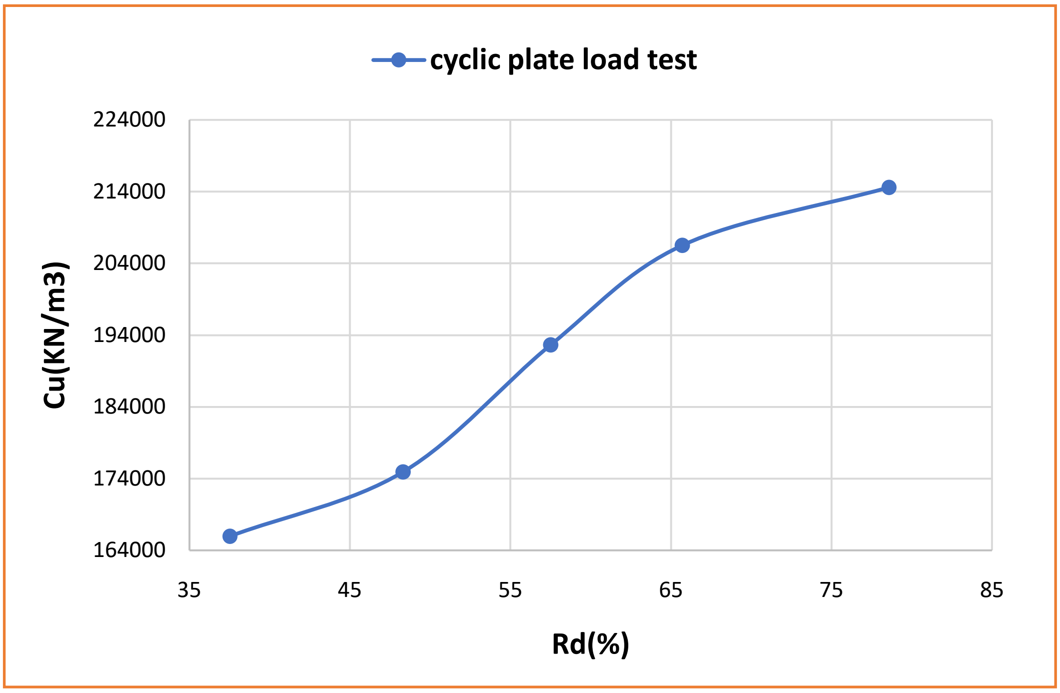

Fig.9 Coefficient of elasicuniform vs Relative density

CONCLUSIONS

- Laboratory tests were performed to investigate the behaviour of square footing constructed on the surface of homogeneous sand under cyclic loads. The laboratory tests that the behavior of footing is affected by the sand relative density significantly. Relative density vs Co-efficient of elastic uniformity of compression curve characteristics are typical non-linear in nature. The variation of coefficient of elastic uniform Cu of footing for variation of relative density between 63% and 78% is substantially greater than those for relative densities between 45% and 63%. In cyclic plate load test relative density of soil increase value of Cu is also increase

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