PERFORMANCE OF CYCLIC LOADING ON CIRCULAR FOOTING ON GEOGRID REINFORCED SANDBED

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Abstract

Foundation is a part of structure which transmits weight of structure to the ground. In addition to static loads the foundations are subjected to dynamic loads like machine loads, seismic loads and moving wheel loads. This paper presents laboratory test results of cyclic loading on circular footing on geogrid reinforced sandbed for different densities. In this paper, works are carried out on circular footing with different densities i.e. 1.642gm/cc, 1.722gm/cc, 1.763gm/cc and with number of layers as 0, 1, 2, 3. Dynamic soil properties as coefficient of elastic uniform compression Cu, coefficient of elastic uniform shear Cτ, coefficient of elastic non-uniform shear Cψ and the coefficient of elastic non uniform compression Cφ were also determined. It has been concluded that as density of sand bed and as number of layers increases, settlement of footing decreases.

Keywords *: Cyclic loading, geogrid, coefficient of elastic uniform compression , coefficient of elastic uniform shear, coefficient of elastic non-uniform shear and the coefficient of elastic non uniform compression.*

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1. INTRODUCTION

Foundations are widely used in transmitting loads from the superstructure to the supporting soils. In addition to static loads the foundations are subjected to dynamic loads like machine loads, seismic loads and moving wheel loads. In most constructions such as residential buildings, the live loads are much less than the gravity loads (own wt. of structure). And in some structures, the live loads are greater than the dead loads of the structure itself and change with time, such as the loads of petroleum tanks and ship repair tracks. In the ship repair tracks, the ship loads are transferred to the footings during the ship repair and the load is removed totally by moving the ship to the sea. Several studies have been carried out to understand the behavior of model footings on sand deposits and subjected to cyclic loads.

In the present study, performance of cyclic loading on circular footing is investigated by varying number of geogrid reinforcement layers as N= 0, 1, 2, 3 at different densities. The dynamic soil properties of soil such as coefficient of elastic uniform compression (C_u), coefficient of elastic uniform shear (C_τ), coefficient of elastic non-uniform shear (C_ψ) and the coefficient of elastic non uniform compression (C_φ) were determined.

2. MATERIALS AND EXPERIMENTAL STUDY

In the present study river sand with symbolic representation SP is filled in the testing tank of size 60cm X 60cm using raining technique for densities 1.642gm/cc, 1.722gm/cc, 1.763gm/cc with geogrid as reinforcement. Number of layers varied as N = 0, 1, 2, 3. A steel plate of 11.3cm in diameter and 1cm of thickness is used as model footing. Base of footing is made rough by using epoxy glue. All tests were conducted using wooden set up as shown in below fig.1. The vertical load was applied through scew jack, load is transferred via metallic ball to footing. Proving ring and two LVDT (Linear variable displacement transducer) placed diagonally on the footing were used to measure applied load and settlement of footing respectively. The loading, unloading and reloading was done at five stages.

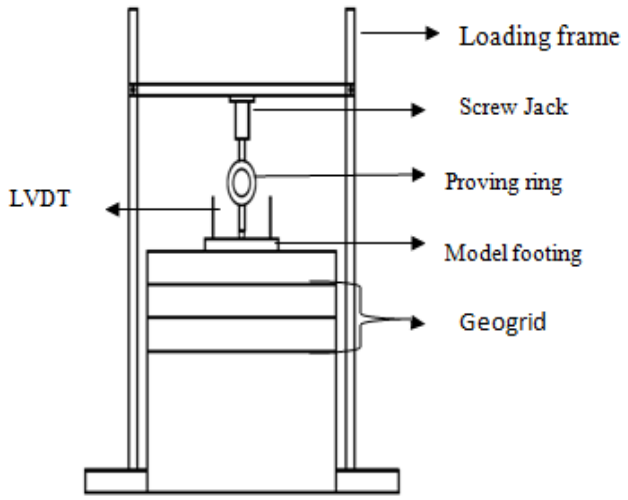

Fig 1 Schematic representation of Experimental setup

3. RESULTS AND DISCUSSIONS

3.1 Cyclic Tests on Unreinforced Sand

The cyclic tests for the unreinforced foundation bed were plotted, pressure versus settlement curves are plotted for 1.642gm/cc, 1.722gm/cc, 1.763gm/cc in fig.2.

From fig. it is observed that as the density of foundation bed increases, settlement of the footing decreases.

3.2 Cyclic Tests on Reinforced Sand

The pressure – settlement curves were plotted for reinforcement layer as N =1, 2, 3 for various densities such as 1.642gm/cc, 1.722gm/cc, 1.736gm/cc. From the below figures from Fig.3 to fig.5, it can be concluded as
(i) As the density increases, settlement of the foundation bed decreses.
(ii) As Number of layers increases, Settlement of decreases.

Pressure versus settlement of reinforced bed is better than unreinforced bed. This is due to interlocking property of geogrid and sand, as it offers increase in internal frictional resistance.

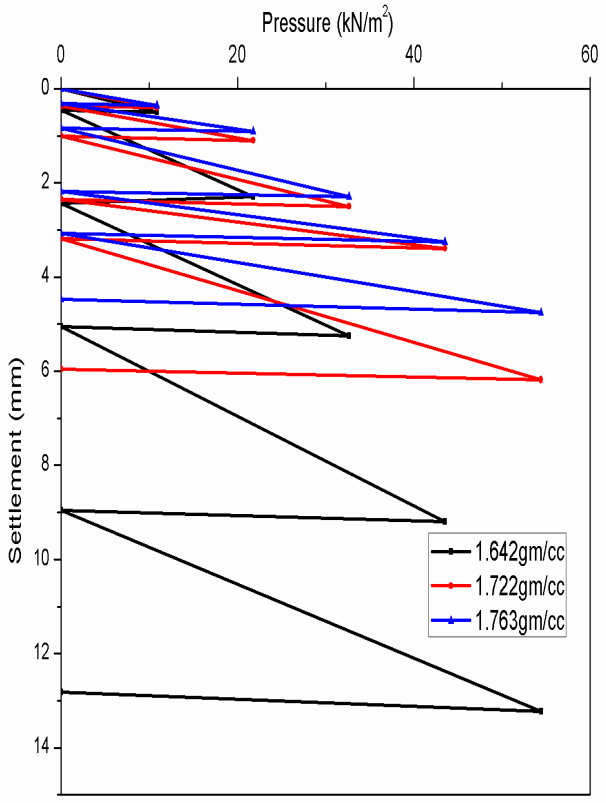

Fig.2. Pressure settlement curve for unreinforced sand with varying densities (N= 0)

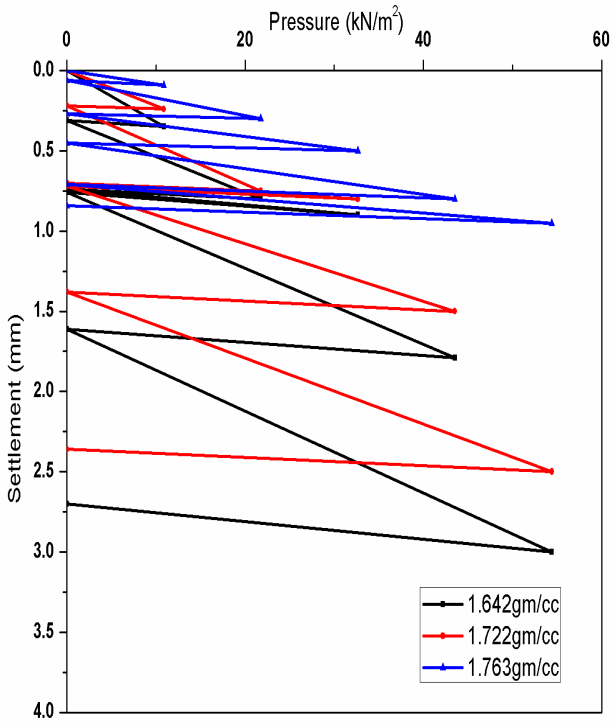

Fig.3. Pressure settlement curve for reinforced sand with varying densities (N= 1)

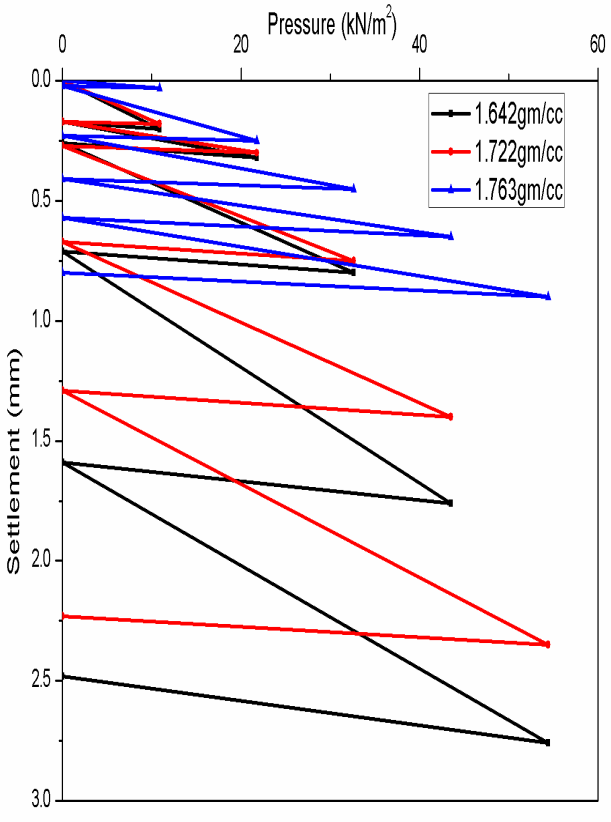

Fig 4. Pressure settlement curve for reinforced sand with varying densities (N= 2)

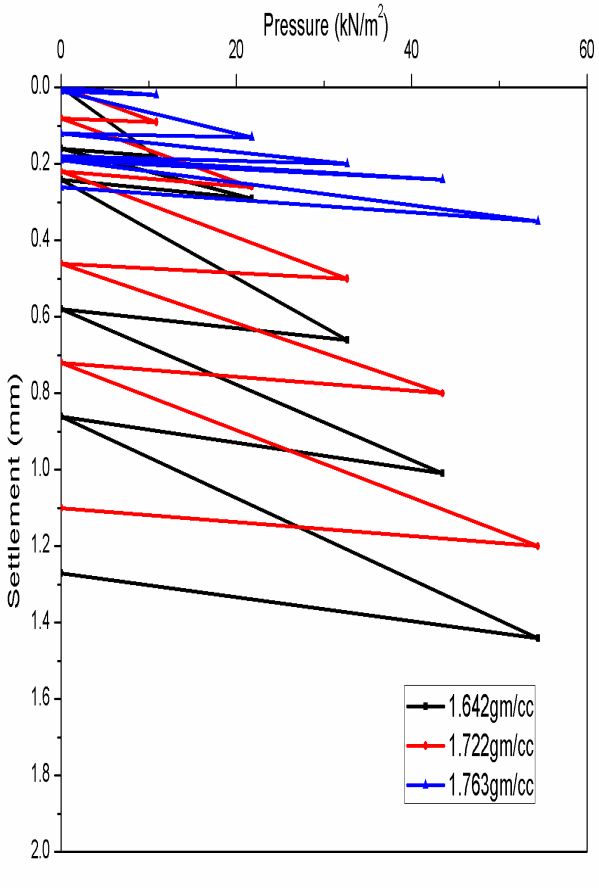

Fig.5. Pressure settlement curve for reinforced sand with varying densities (N= 3)

3.3 Dynamic Properties of Soil

From the data obtained during cyclic plate load test, the elastic rebound of the plate corresponding to each intensity of loading shall be obtained..

The value of Cu, shall be calculated from the equation given below:

$$Cu = P/Se$$

Where
P = Corresponding load intensity kN/m^2 and
Se = Elastic rebound corresponding to P in m.
The Coefficient of elastic uniform compression (C_u), Coefficient of elastic uniform shear (C_τ), Coefficient of elastic non uniform compression (C_φ), Coefficient of elastic non uniform shear (C_ψ) are related to each other as given below.

$C_\tau = C_u/1.75$
$C_u = 1.5$ to $2\ C_\tau$
$C_\varphi = 3.46\ C_\tau$
$C_\psi = 1.5\ C_\tau$

The following tables shows elastic rebound of each cycle with different number of layers for densities 1.642gm/cc, 1.722gm/cc, 1.763gm/cc. From these results we calculated coefficient of elastic uniform compression C_u.

Fig. 6 to fig.8 Pressure Vs Elastic rebound were plotted for varying number of reinforcement layers for different densities. From these graphs coefficient of elastic uniform compression (C_u) is obtaind.

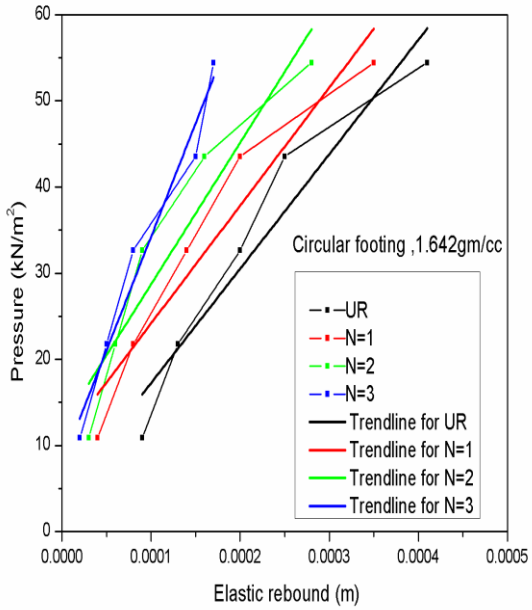

Fig.6. Elastic rebound Vs Pressure for different layers of geogrid at density 1.642gm/cc

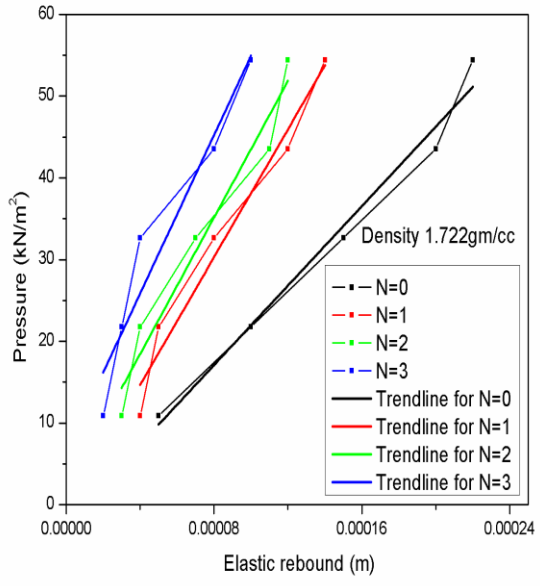

Fig.7. Elastic rebound Vs Pressure for different layers of geogrid at density 1.722gm/cc

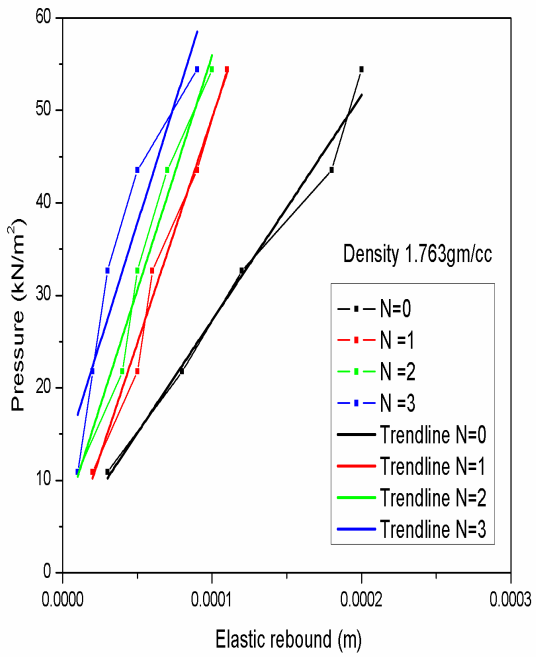

Fig.8. Elastic rebound Vs Pressure for different layers of geogrid at density 1.763gm/cc

Dynamic properties of soil are tabulated from table1 to table 4. From these results it can be concluded as , as the density of foundation bed increases and as number of reinforcement layers increases, dynamic properties also increase.

Table 1 - Coefficient of elastic uniform compression (C_u) for N = 0, 1, 2,3 for various densities.

Density (gm/cc)	Coefficient of elastic uniform compression (C_u) (X 10^4) (kN/m^3)			
	N = 0	N = 1	N = 2	N = 3
1.642	13.27	13.67	16.44	26.35
1.722	24.28	39.08	41.73	48.72
1.763	24.33	48.67	50.57	51.70

Table 2 - Coefficient of elastic uniform shear (C_τ) for N = 0, 1, 2,3 for various densities

Density (gm/cc)	Coefficient of elastic uniform shear (C_τ) (X 10^4) (kN/m^3)			
	N = 0	N = 1	N = 2	N = 3
1.642	7.58	7.81	9.39	15.05
1.722	13.87	22.33	23.84	27.66
1.763	13.90	27.81	28.89	29.54

Table 3 - Coefficient of elastic non-uniform compression (C_φ) for N = 0, 1, 2,3 for various densities.

Density (gm/cc)	Coefficient of elastic non- uniform compression (C_φ) (X 10^4) (kN/m^3)			
	N = 0	N = 1	N = 2	N = 3
1.642	26.22	27.02	32.48	52.07
1.722	47.99	77.26	82.48	95.70
1.763	48.09	96.22	99.95	102.20

Table 4 - Coefficient of elastic non-uniform shear (C_ψ) for N = 0, 1, 2,3 for various densities.

Density (gm/cc)	Coefficient of elastic non- uniform shear ($C\psi$) (X 10^4) (kN/m^3)			
	N = 0	N = 1	N = 2	N = 3
1.642	11.37	11.71	14.08	22.57
1.722	20.80	33.49	35.76	41.49
1.763	20.85	41.71	43.33	44.31

4. CONCLUSION

Pressure versus settlement of reinforced bed is better than unreinforced bed. This is due to interlocking property of geogrid and sand, as it offers increase in internal frictional resistance.

As density of foundation bed increases, Settlement of footing decreases. And as number of layers of geogrid reinforcement increases, it leads to decrease in settlement of footing. As density of foundation bed increases, coefficient of uniform elastic compression also increases and all dynamic soil properties also increase. Minimum settlement occurred at geogrid reinforced sandbed with number of layer3, for the density 1.763gm/cc.

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