STUDY OF VARIATION OF BEARING CAPACITY OF SOIL BY DIFFERENT PARAMETERS

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ABSTRACT

There are various layers of earth such as inner core, outer core, mantle and crust. Soil is a loose deposit of materials and organic particles occupying the top position of earth crust, it is a naturally available material produced by weathering of rocks. Soil being the product of nature its properties may vary from site to site. Bearing capacity of soil is most important parameter in the stability, durability and strength of foundation of any structure. The principal factors that influence safe bearing capacity are type of soil, width of foundation, surcharge water table shape of footing cohesion and angle of internal friction. Structure and rigidity and contact stress distribution does not affect bearing capacity greatly. In this paper, bearing capacity is calculated by IS Code, Terzaghi and Geo5 Software for soil samples collected from various parts of Amravati cities such as Parvati Nagar, Sai Nagar, Dastur Nagar, Navsari. Then, the variation of bearing capacity by all these three methods for strip footing, also the effect of various other parameter suggest soil type, degree of saturation, cohesion and angle of internal friction is studied.

KEYWORDS: - Bearing capacity, Soil parameters, Depth of footing, Geo5 software, Cohesion, Angle of Internal Friction, Degree of Saturation.

1. INTRODUCTION

Soil is a universally natural material derived mostly from rocks and rocky materials. As soil is a product of nature possess an inherently variable and complex character. The bearing capacity is the most important soil property which governs the design of foundation. Soft clay strata are often unable to bear

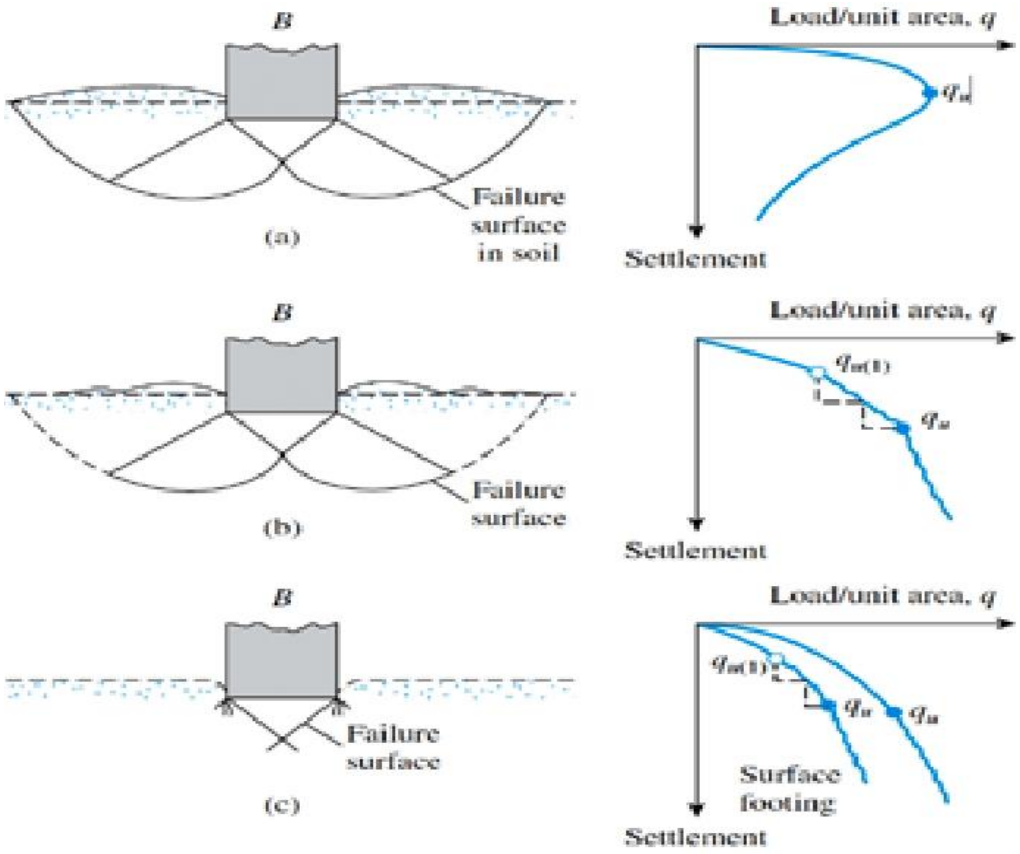
the load transferred from the super structure to the foundation. Bearing capacity and the settlement are the two important parameters in the field of Geotechnical Engineering. Civil engineering projects such as buildings, bridges, dams and roadways require detailed subsurface information as part of the design process. Bearing capacity is affected by the various factors like change in level of water table eccentric loads, inclined loads, dimensions of the footing, etc.

If the bearing capacity of soil at shallow depth is sufficient to safely take the load of the structure, a shallow foundation is provided. Isolated footing, combined footing or strip footing are the option for the shallow foundation. Deep foundations are provided when soil immediately below the structure does not have the adequate bearing capacity. Pile, piers or well are the options for deep foundations. Mat or raft foundations are useful for soil which is subjected to differential settlement or where there is a wide variation in loading between adjacent columns.

Permeability of sandy soils is higher than clay soils. Buildings are constructed gradually. First, the footing is constructed, then the columns and walls, then upper floors. Full load on footing does not materialize overnight. Depending upon the speed of contraction, full load on footing may take months or years. Hence, there is plenty of time for the sandy soils to drain excess pore pressure. Hence bearing capacity computations in sandy soils are done based on drained friction angle parameter.

There are three principle modes of shear failure under footing :

1. General Shear failure : It is seen in dense and stiff soil.
2. Local Shear Failure : It is seen in relatively loose and soft soil.
3. Punching Shear Failure : This type of failure is seen in loose and soft soil in deeper elevations.



There are various types of bearing capacity such as Ultimate Bearing Capacity, Net Ultimate Bearing capacity, Safe Bearing Capacity, Net Safe Bearing Capacity, Net Allowable Bearing Capacity. The various comparison n this paper is done by considering safe bearing capacity.

2. LITERATURE REVIEW

Soil is a universally available natural material mostly from rocks and rocky minerals. As soil is a product of nature process an inherently variable and complex character. The bearing capacity is most important soil property which governs the design of foundation. soft clay strata are often unable to bear the load transferred from the super structure to the foundation. The bearing capacity and settlement are two important parameters in the field of geotechnical engineering.

Civil engineering project such as building, bridges, dam and roadways required detailed subsurface information as part of the design process. Bearing capacity is affected by various factor like change in water table eccentric load inclined loads dimension of the footing etc.

K. Manjunath and A.S. Reddy studied 1997: the effect of depth and water table on bearing capacity of rectangular footing. They found that as depth of foundation increases, bearing capacity increases. They found that these is increased in dry density and decrease in optimum moisture content. They also studied the effect of depth of footing using geotextile reinforcement.

Javad Hajiani and Nader Hataf 2003: carried out experimental and numerical investigation of the bearing capacity of model circular footing on reinforced sand. They investigated the bearing capacity of circular and ring footings on reinforced sand by conducting laboratory model tests along with numerical analysis. The effects of the depth of the first layer of reinforcement, vertical spacing and number of reinforcement layers on bearing capacity of the footings were investigated.

G. Bhagyama, P. pradeep kumar 2021: This paper looks into the Ultimate Bearing Capacity of soils in Kadapa surrounding areas. Samples from Buggaletipalle, Puttampalle, TATA Motors, Jamal Palle, and K. Ramachandrapuram were collected and tested. Tests such as soil moisture content, particle size analysis, Atterberg limit test, free swell index test, CBR test, unconfined compression test, and field density test were carried out using the collected soil samples.

A.N. Mohammed and A.A. Khalil 2021: The current study aims to investigate the effects of swell pressure on the bearing capacity of swelling soil. A model and some laboratory tests have been created to investigate the swell pressure effect on the bearing capacity variation of soil swelling due to swelling pressure. The influence of varying water content w/c and dry unit weight (γd) on the shear strength and swelling pressure was studied.

M.S. Dixit & K.A. Patil 2019: The present paper deals with the study of effect of shape of footing on bearing capacity of soil. Similarly the effect of depth of footing on bearing capacity of soil is studied. In general, other factors remaining constant, bearing capacity of soil goes on increasing as depth or width of foundation increases. The comparison of bearing capacity of soil with methods of analysis given by Terzaghi and IS code method is carried out for different shapes i.e., strip, square, circular and rectangle. In case of local shear failure, amongst different shapes of footing the bearing capacity of strip footing is found to be lowest in comparison with square, circular and rectangular shaped footings.

3. METHODOLOGY

LABORATORY TESTS

The soil used in the study is collected from various parts of Amravati City. The aim of this work is to study the effect of different parameters on bearing capacity of soil. Experimental work was to study the properties of soil samples collected for determination of safe bearing capacity.

For the soil samples collected, basic properties such as specific gravity, sieve analysis was carried out to determine classification of soil. Standard proctor test and triaxial test were conducted to determine maximum dry density, optimum moisture content, cohesion, angle of internal friction. CBR Test is also done on this soil samples. The test results of soil sample tested for these properties are shown in table.

Based on the laboratory test results and as per bureau of Indian standards two soil samples classified as SW (Well Graded Sand) and other two soil sample classified as SP (Poorly Graded Sand)

Fig 3.1 : CBR Test

Fig. 3.3 : Specific Gravity

Fig. 3.2 : Compaction Test

Fig. 3.4 : Triaxial Test

Table 1. Properties of soil samples from various site locations

	Parvati Nagar	Sai Nagar	Navsari	Dastur Nagar
IS Classification	SW	SP	SP	SW
Specific Gravity	2.30	2.40	2.49	2.41
Unit Weight of soil	17.77 kN/m^3	17.75 kN/m^3	17.75 kN/m^3	17.80 kN/m^3
Moisture content	20.4%	22.75%	23.25%	19.95%
Dry Density	1.61 gm/cc	1.65 gm/cc	1.70 gm/cc	1.59 gm/cc
Cohesion	47.07 kN/m^2	34.32 kN/m^2	58.84 kN/m^2	41.18 kN/m^2
Angle of internal friction	5.85^o	7.58^o	4.57^o	5.19^o

4. EXPERIMENTAL ANALYSIS

The inputs required for determination of ultimate bearing capacity of soil are cohesion, unit weight of soil, depth of proposed foundation, width of foundation and bearing capacity factors. By IS Code method, bearing capacity is calculated for various shapes of footing at 1.2m depth. By Terzaghi method, bearing capacity is calculated for various shapes and at 1.2m, 1.5m and 1.8m depth respectively. By Geo5 Software, bearing capacity is calculated for strip footing and at 1.2m, 1.5m and 1.8m depth. Variations in bearing capacity by these methods and soil parameters are discussed below

4.1 : Variation in CBR values for soil samples by analytical and graphical method

Table 4.1. Results of California Bearing Ratio test for all samples

Sample No.	CBR Values in %	
	From Analytical Method	From Graphical Method
Sample 1	2.35	3.21
Sample 2	2.44	2.77
Sample 3	1.72	2.09
Sample 4	1.43	1.75

4.2 : Variations of safe bearing capacity values by all three methods

Table 4.2.a) Variation in the values of Safe Bearing Capacity by analytical methods for Strip footing @ 1.2 m depth

Sample No.	IS CODE METHOD (qs)	TERZAGHI METHOD (qs)
Sample 1	115.27	105.15
Sample 2	101.08	90.46
Sample 3	127.25	118.02
Sample 4	93.46	92.71

There is approximately 1-15kN/m² difference between IS Code and Terzaghi method

Table 4.2.b) Variation in the values of Safe Bearing Capacity by analytical and software methods for Strip footing @ 1.2 m depth

Sample No.	IS CODE METHOD (qs)	GEO5 SOFTWARE (qs)
Sample 1	115.27	167.44
Sample 2	101.08	148.32
Sample 3	127.25	186.74
Sample 4	93.46	149.49

There is approximately 40-60 kN/m² difference between IS Code values and values given by GEO5 Software.

4.3 : Effect of degree of saturation in bearing capacity

Table 4.3. Variation in the values of Safe Bearing capacities with respect to degree of saturation (S)

Sample No.	S (%) (ascending order)	q_s (kN/m²)
Sample 3	24.58	157.83
Sample1	26.05	141.91
Sample 4	28.15	123.07
Sample 2	29.01	122.96

Table shows the values of Degree of saturation calculated for each sample at their OMC i.e., Optimum Moisture Content and MDD i.e., Maximum Dry Density and their respective values of safe bearing capacities calculated for square footing by IS CODE method at 1.2m depth.

4.4 : Effect of cohesion and angle of internal friction on bearing capacity

Table 4.4. Variation in the values of Safe Bearing Capacity with respect to Cohesion and angle of internal friction

Sample No.	C (kN/m³)	q_s (kN/m²)	Ø	q_s (kN/m²)
Sample 1	47.07	141.91	5.85	141.91
Sample 2	34.32	122.96	7.58	122.96
Sample 3	58.84	157.88	4.57	157.83
Sample 4	41.18	123.07	5.91	123.07

Table shows the values of cohesion and angle of internal friction and their respective values of Safe bearing capacity calculated for square footing by IS Code method at 1.2 m depth.

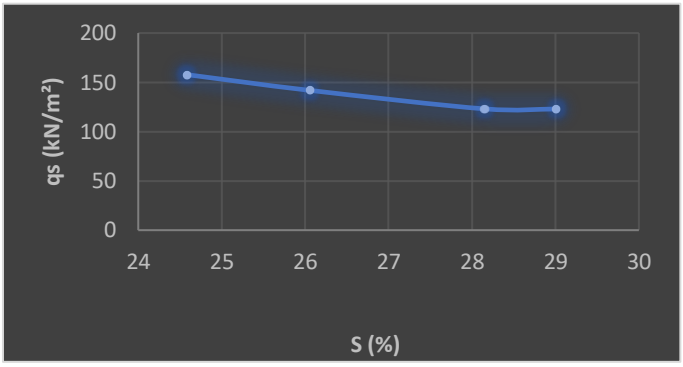


fig. 4.1 Degree of saturation vs Safe bearing capacity

Degree of saturation is inversely proportional to the safe bearing capacity.

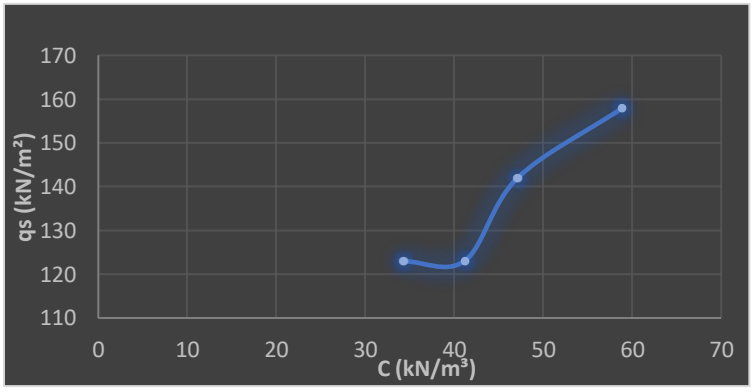


fig. 4.2 Cohesion vs Safe bearing capacity

It is observed that bearing capacity increases with increase in the value of cohesion

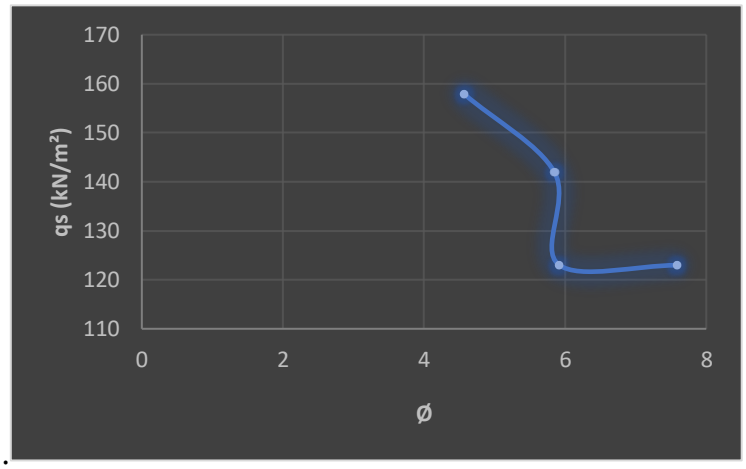


fig. 4.3 Angle of internal friction vs Safe bearing capacity

It is noticed that there will be decrease in the value of safe bearing capacity for increase in angle of internal friction.

5. CONCLUSION

The following conclusions were drawn based on the results on this research work. In this study, we have considered both analytical and software approaches and compare them along with comparison of other parameter with safe bearing capacity.

1. As the value of cohesion increases, the value of bearing capacity increases in the range of 9 to 16%.
2. Also, as the value of internal friction increases, the value of bearing capacity increases in the range of 9 to 16%.
3. The degree of saturation consider at OMC for all samples is inversely proportional to the safe bearing capacity.
4. CBR value for sample from graphical method is 15 to 25% greater than analytical method.
5. GEO5 Software shows 55% to 65% higher values than the Terzaghi method which shows lowest values among all these methods i.e., IS code method, Terzaghi method and software method.

6. FUTURE SCOPE

- As we have taken four samples of soil in Amravati city, for the detail study of bearing capacity. More than four samples can be taken from various locations for wide and effective work.

- In this work, the analysis for bearing capacity in Geo5 Software only for strip footing. Further, it can be analyzed for various types of footings in other software.
- Different methods can also be adopted to determine the bearing capacity such as Meyerhof and vesic theory etc. for finding variation in bearing capacity.
- Effect of depth of the footing and water table should be checked as it is very important parameter to check which type of failure may occur.

These are the points which can be considered for the extension of this work.

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