An Experimental study on the behaviour of Shallow foundation by eccentric Loading

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Abstract: The bearing capacity of foundations has always been a subject of major interest in soil mechanics and foundation engineering. A shallow foundation should be structurally adequate to sustain all the applied loads and transmit them safely to the ground without undue settlement. It should generally be constructed of reinforced concrete, and rest on a rock or soil stratum with adequate bearing capacity at a shallow depth from ground level. A shallow foundation should neither overload the foundations or structures of adjacent buildings or the ground supporting such foundations or structures, nor render any instability to any hillside or slope, nor interfere with any drain, nullah, sewer or other services in its vicinity. There is extensive literature dealing with this topic, from both the theoretical and experimental standpoints. Few experimental studies have been made on the evaluation of bearing capacity of shallow foundations on geogrid-reinforced sand under eccentric load. These studies relate to strip and a square foundation is yet to be done. The purpose of this thesis is to conduct few model tests in the laboratory by using square surface foundation over the reinforced sand bed. The model footing used for the model tests in the laboratory is of size 10cm x 10cm. The average relative density of soil will ranges from 65-85.

Keywords: Shallow Foundation Bearing Capacity, Correlation, reduction Factor.

1.0 INTRODUCTION

The bearing capacity of foundations has always been one of the subjects of major interest in soil mechanics and foundation engineering. Load bearing Capacity of Foundations is to exchange the basic loads from a building securely into the ground. A terrace instrument shed may require just wooden slides to spread its heap over a region of ground surface, while a house would require more prominent soundness and thusly its establishment should achieve the fundamental soil that is free of natural issue and inaccessible by the winter's frost. A bigger and heavier working of brick work, steel, or cement would require its establishments to go further into earth with the end goal that the dirt or the stone on which it is established is skilled to convey its enormous burdens; on a few destinations, this implies going a hundred feet or more beneath the surface. In view of the assortment of soil, shake, and water conditions that are experienced beneath the outside of the ground and the one of a kind requests that numerous structures make upon the establishments, establishment configuration is an exceptionally particular field of geotechnical engineering.

1.1 BEARING CAPACITY OF FOUNDATION

The ultimate bearing capacity (*qu*) is defined as the pressure at which shear failure occurs in the supporting soil immediately below and adjacent to the foundation. Following are the various loading conditions in the bearing capacity of foundations:

1.1.1 Central Vertical Loading

The ultimate bearing capacity of a foundation subjected to a vertical central load over a homogenous soil can be expressed as

$$q_{u=} qNq\, s_q\, d_q + 1/2\, gBNg\, sg\, dg$$

Where

qu = ultimate bearing capacity;

q = surcharge pressure at footing level = g*Df;*

Df = depth of foundation;

g = unit weight of soil;

B = width of foundation;

*NC, Nq, N*g = bearing capacity factors;

sc, *sq*, *s*g = shape factors;

dc, *dq*, *d*g = depth factors.

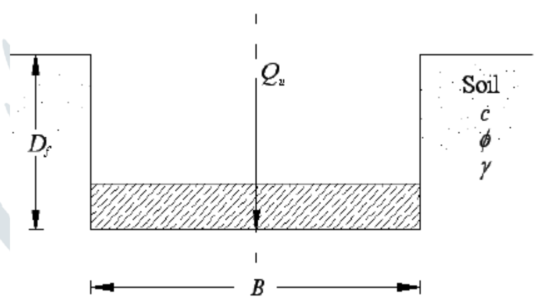

Figure 1.1: Central Vertical Loading

1.1.2 Eccentric Vertical Condition

Due to an eccentric load on the foundation, the foundation tilts towards the side of the eccentricity and the contact pressure below the foundation does not remain uniform. Thus for a shallow horizontal strip foundation of width *B* and depth *D* carrying a vertical load *Q* with an eccentricity *e* on the base

$$q = cN_{cq} + 1/2\ gB\ Ng_q$$

Where *Ncq*, *N*g*q* = resultant bearing capacity factors for a central load and depend on f and *D/B'; c* = unit cohesion; g = density of soil; *B′* = effective width = *B* – 2*e*

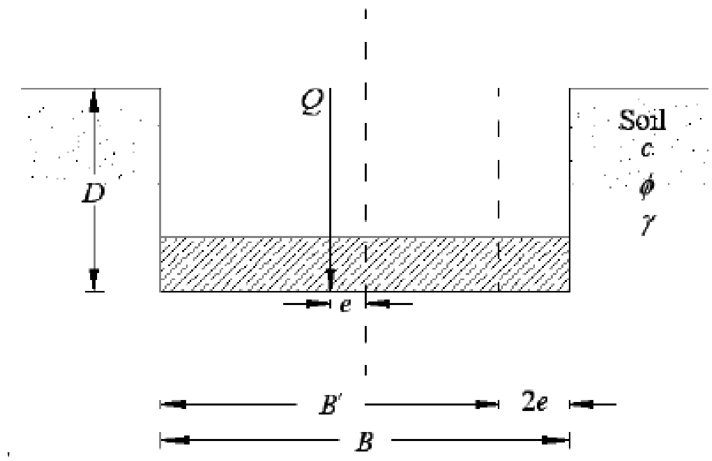

Figure 1.2: Eccentric Vertical Condition

1.1.3 Central Inclined Condition

The ultimate bearing capacity of shallow strip footings under central load inclined in the direction of footing length is shown in figure 1.3.

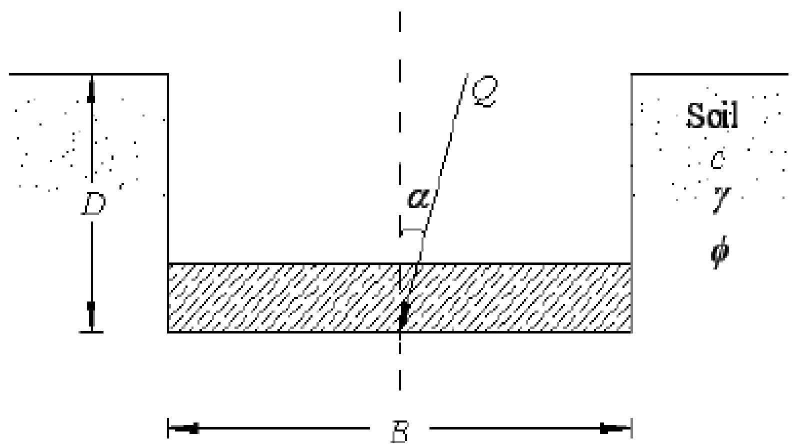

Figure 1.3: Central Inclined Condition

1.1.4 Eccentric Inclined Condition

The ultimate bearing capacity of shallow strip footings under Eccentric load inclined in the direction of footing length is shown in figure 1.6.

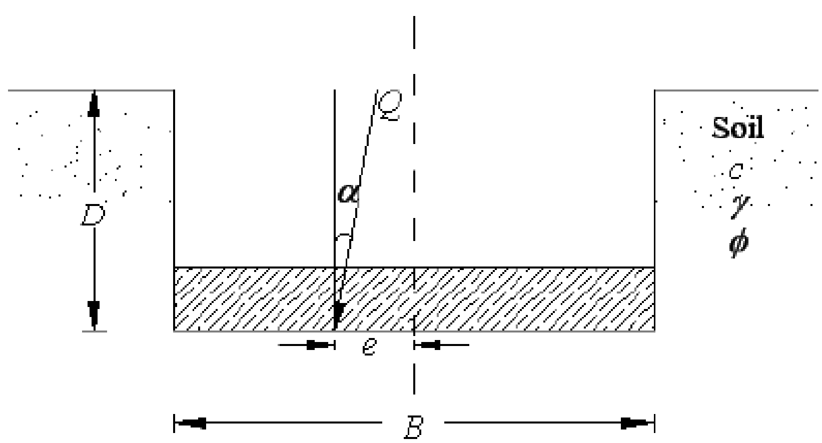

Figure 1.4: Eccentric Inclined Condition

1.2 LITERATURE REVIEW ON SHALLOW FOUNDATION

G. G. Meyerhof et al studied on the Bearing Capacity of Foundations under Eccentric and Inclined Loads. In this study, an analysis is given for eccentric vertical loads on a horizontal foundation and is compared with the results of laboratory tests on model footings on clay and sand. In the second section the theory is extended to central inclined loads on horizontal and inclined foundations and compared with the results o f some model tests on clay and sand and The previous bearing capacity theory of foundations under a central vertical load has been extended to eccentric and inclined loads. The theory, which indicates that the bearing capacity decreases rapidly with greater eccentricity and inclination of the load, is supported by the results of loading test with model footings on clay and sand.

H. A. TAIEBAT et al studied on the Bearing capacity of strip and circular foundations on undrained clay subjected to eccentric loads. The objective of the current studies is to determine the shape of the failure locus in (V, M) space using the results of a finite element study of this problem. Both strip and circular footings are considered. The (V, M) load case is significant, as it also corresponds to footing problems in which the vertical load is eccentrically applied. The failure envelopes for strip and circular footings subjected to vertical load and moment were obtained from finite element analyses and from the simple lower-bound solutions based on the effective width method. Derivation of the upper-bound solution for the problem of bearing capacity of foundations subjected to combined vertical load and moment is complex. However, comparison of the failure envelopes obtained in this study shows that the effective width method, commonly used in the analysis of foundations subjected to eccentric loading, provides good approximations to the collapse loads for these problems.

Gunay OZMEN contemplated on the Determination of Base Stresses in Rectangular Footings under Biaxial Bending. The reason for this paper is to build up a general strategy for ascertaining the base weights of rectangular footings under biaxial twisting. First the footings which are presented to extensive whimsy are characterized by the state of the weight area. At that point the definition given by Loser for the structure of rectangular sections exposed to biaxial bowing are summed up and connected to the count of base anxieties. Since the situation of the impartial hub isn't known at first, a procedure of progressive approximations is created and the technique which is produced for the instance of extensive unpredictability is autonomous of the state of the pressure zone. To be specific, it is legitimate for a wide range of pressure zones including triangular, trapezoidal and pentagonal shapes.

1.3 FOOTING TEST

A test tank of inside dimension 1.0m (length) 0.504m (width) 0.655m (height) is used. The two length sides of the tank were made of 12mm thick high strength fiberglass. The two width sides of tank are made up of mild steel of 8mm thickness. Scales are fitted on the middle of the four internal walls of the box so that it will be easier in maintaining the required density accurately. All four sides of the tank are braced to avoid bulging during testing. The following considerations are taken into account while deciding the dimension of the tank. As per provision of IS 1888-1962 the width of the test pit should not be less than 5 times the width of the test plate, so that the failure zones are freely developed without any interference from sides. By adopting the above tank size for the model footing (10cm x 10cm), it is ensured that the failure zones are fully and freely developed without any interference from the sides and bottom of the tank.

The Following test series is performed with different types of loading conditions in this study:

Table 1.1: Model Test series

Test Series	D_f/B	B/L	E/B
1-25	0	1	0.05B, 0.075B, 0.1 B, 0.15B
26-50	0.25	1	0.05B, 0.075B, 0.1 B, 0.15B
51-75	0.5	1	0.05B, 0.075B, 0.1 B, 0.15B
76-100	0.75	1	0.05B, 0.075B, 0.1 B, 0.15B
101-125	1.00	1	0.05B, 0.075B, 0.1 B, 0.15B

1.4 Bearing Capacity under Central Vertical Loading

The comparison values of bearing capacity versus e/B and df /B with respect to angle of inclination and correlation between Reduction Factor are given in Figure 4.1 to 4.10.

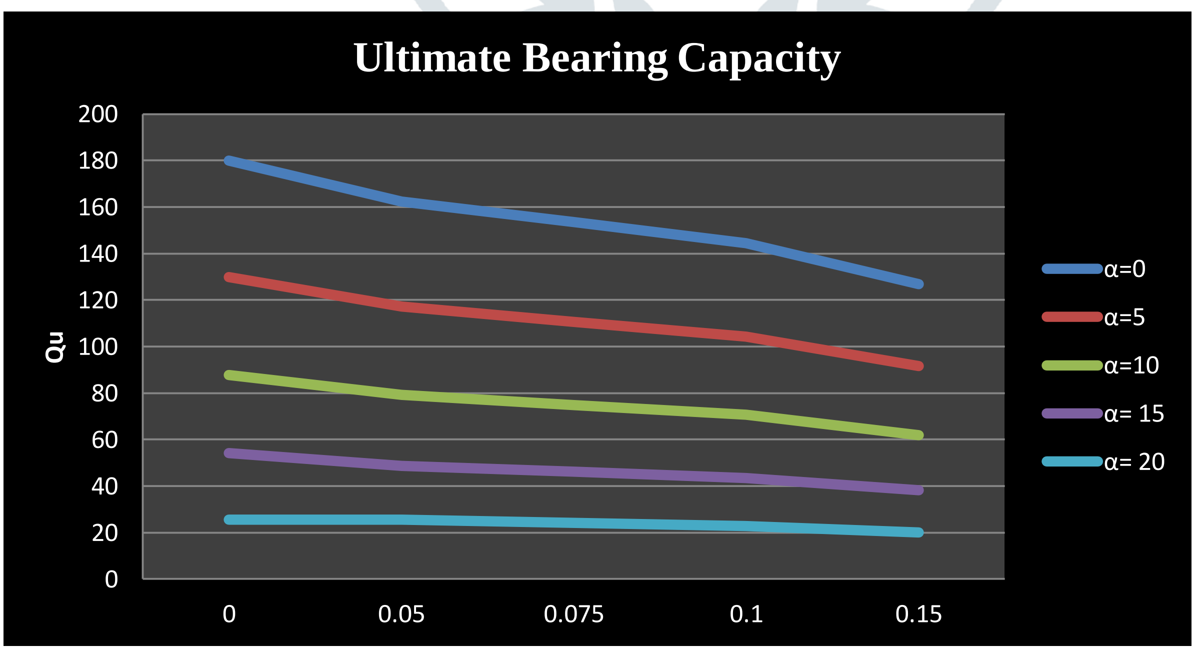

Figure 4.1: Variation of quR (e) versus e/B and df /B at Df / B=0

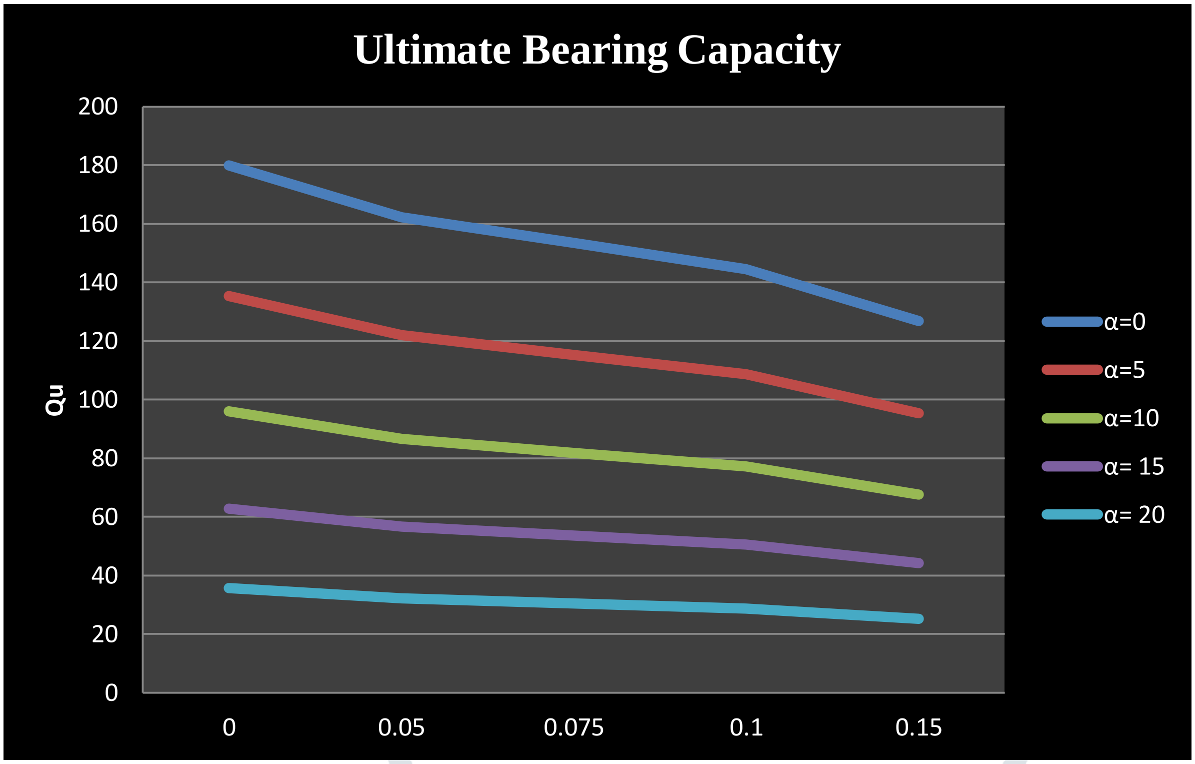

Figure 4.2: Variation of quR (e) versus e/B and df /B at Df / B=0.25

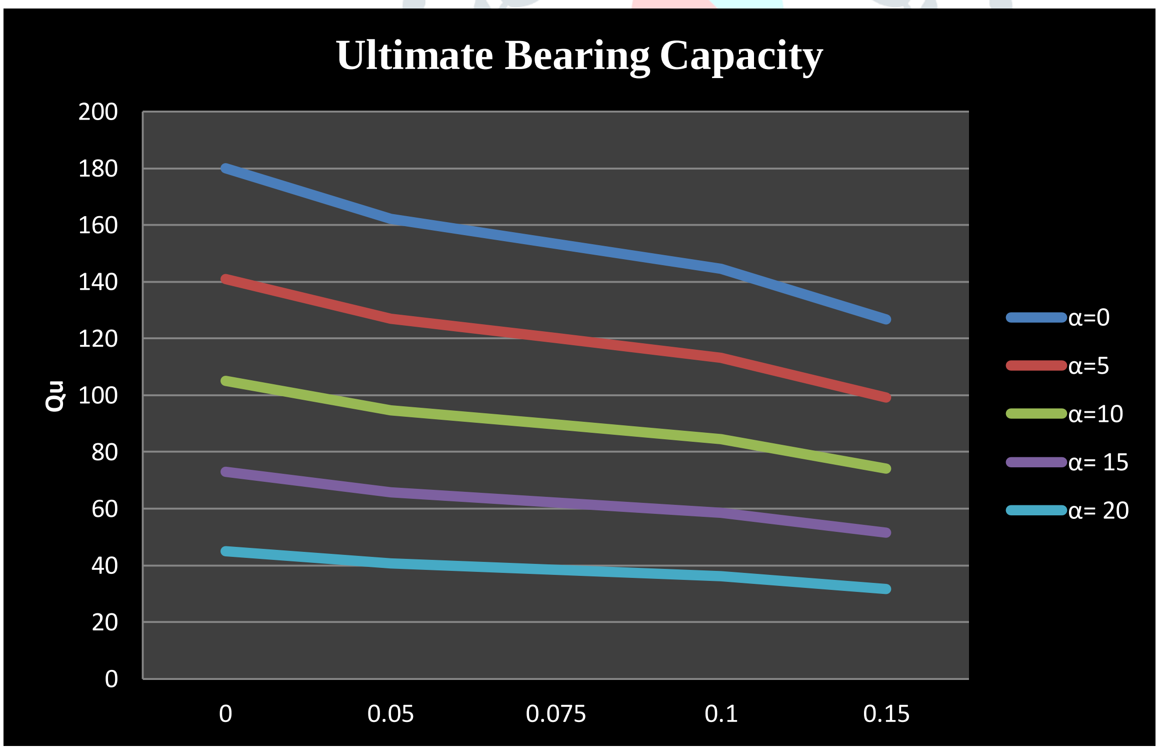

Figure 4.3: Variation of quR (e) versus e/B and df /B at Df / B=0.50

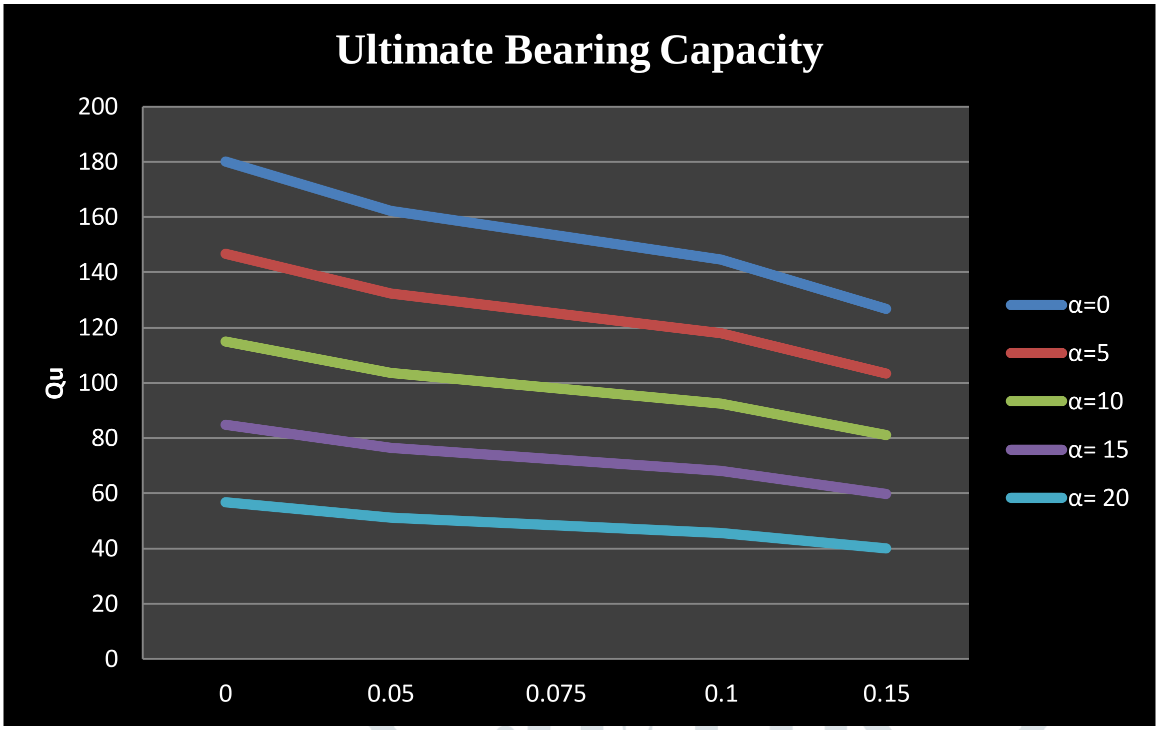

Figure 4.4: Variation of quR (e) versus e/B and df /B at Df / B=0.75

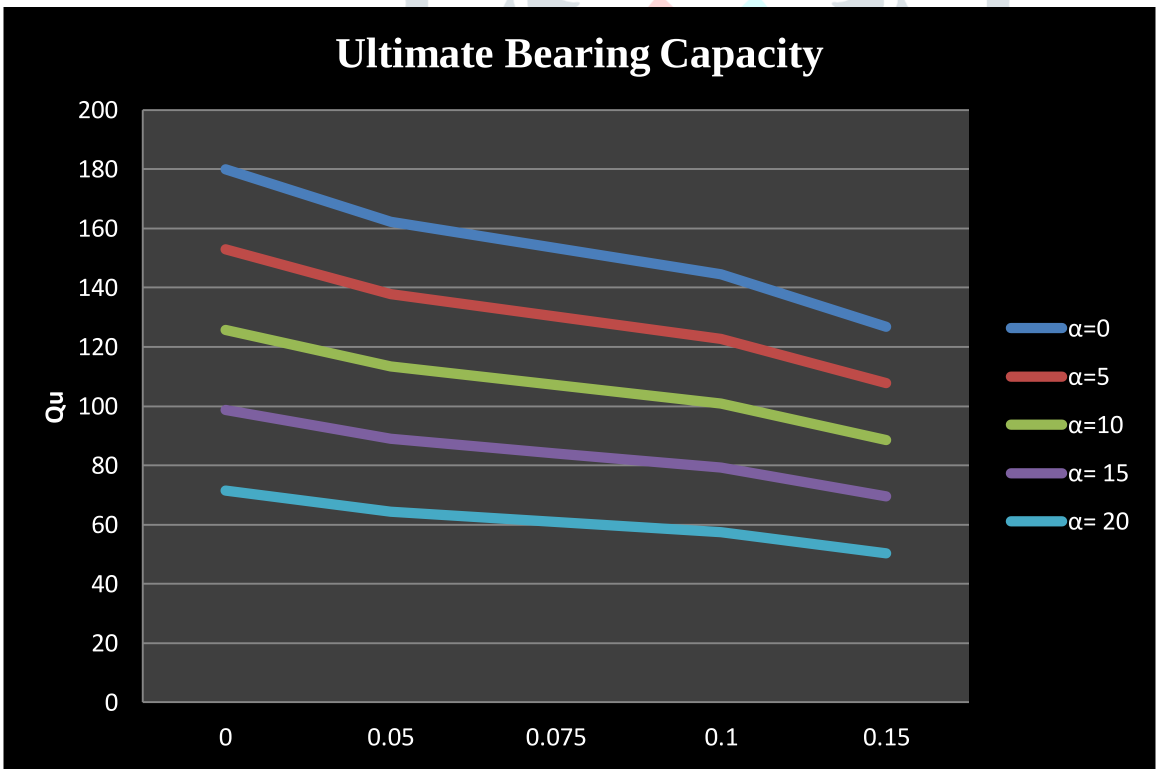

Figure 4.5: Variation of quR (e) versus e/B and df /B at Df / B=1.00

CONCLUSION

1. Based on the test results and within the range of parameters tested, an empirical relationship for a reduction factor *RF* has been proposed. A comparison between the reduction factors obtained from the empirical relationships and those obtained experimentally shows, in general, a variation of 15% or less.
2. good qualitative and quantitative agreement between experimental data and calculated results can be found for limited values of the foundation movement.
3. The load reduction factor is found to be a function of e/B and Df/B.
4. The ultimate bearing capacity by reduction factor developed from present experiments is in well agreement with existing theory by Meyerhof.
5. For the eccentric loaded square footing the Bearing Capacity increases with increase in embedment.
6. The reduction factors from the present simplified method compare reasonably well with those computed by different traditional methods.

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