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EFFECT OF FOOTINGS SIZE ON ULTIMATE BEARING CAPACITY OF COHESIONLESS SOIL

تأثير مقاسات القواعد على قدرة تحمل التربة الغير متماسكة

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ملخص :-

هذا البحث يقدم دراسة عملية لدراسة تأثير مقاس الأساسات علي قدرة تحمل التربة الرملية. و تم إجراء تجارب تحميل الألواح الجاسئة علي الرمل المتدرج لقياس الهبوط علي السطح و على أعماق مختلفة تحت إجهادات مختلفة وكذلك كثافات نسبية مختلفة للرمل المتدرج . وتم حساب الهبوط بالطرق الحسابية المعتمدة علي تجارب تحميل الألواح في الموقع عند نفس الأحمال والكثافات النسبية . وقد اظهرت نتائج البحث أن مقاس الأساسات يؤثر علي قدرة تحمل التربة الرملية أسفل الأساسات فالأساسات ذات المقاس الصغير اعطت قدرة تحمل التربة اقل من الأساسات ذات المقاس الكبير كما أن الأساسات الدائرية اعطت قدرة تحمل للتربة أقل من الأساسات المربعة .

ABSTRACT: Settlement of the soil is usually the most important consideration in assessing the allowable bearing pressure. The ultimate bearing capacity of footings resting on cohesionless soil depends on the properties of the soil as well as the size, the shape and the embedment depth of the footings.

In the present study, the ultimate bearing capacity of footings on cohesionless soil at surface with and without surcharge has been determined in field for graded sand samples. The tests have been conducted in field by using the plate load test. In the present study six steel rigid plates were used in testing. The plates have a finished thickness of 32 mm. Three rigid circular plates have been used with diameter B = 305 mm, 455 mm and 610 mm. Three other rigid square plates have equivalent areas to the above mention plates. The settlement has been measured under different stress levels at the surface along the center line of the plate as well as the edge of the plate. Also, the settlement has been measured under different applied stresses. The effect of plate size on the ultimate bearing capacity of cohesionless soil has been determined for different relative densities of the tested soil.

1- INTRODUCTION:-

The estimation of ultimate bearing capacity in cohessionless soil still remains a serious geotechnical problem, both from a practical and a theoretical point of view. The effect of the foundation size or width of footings on the settlement and bearing capacity of cohessionless soils has been investigated by many researchers in order to test the reliability of the calculation methods or to indirectly estimate settlements by extrapolating the results of

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plate load-bearing tests. Terzaghi and Peck (1948) used the modulus of sub grade reaction as defined by settlement to pressure ratio. In that approach, the modulus of sub grade reaction is determined from field plate test. Terzaghi tested his equation against plate load test on a 0.305 m x 0.305 m wide plate. Abdrabbo and Mahmoud (1989) performed series of experimental tests to study the bearing capacity and settlement of circular footing on stratified soil using a brass drum 210 mm and 250 mm internal diameter. Kenny and Andrawes (1997) made recommendations regarding the use in practice of some available solution of two layered soil as Terzaghi and Peck (1948), based on the data obtained from laboratory model bearing capacity testing. A strip footing 0.12 m wide was used in all tests. The test tank had inner dimensions of 2.0 m length, 1.4 m height, and 0.3 m width and parallel glass sides and contained a soft clay sub grade overlain by sand. Funyu. Z, Jacki. C and Ryan.PH (2001) presented the results of a research program of strip and circular footings resting on dry dense sand. The scale effect on the bearing capacity and the shape factor of the footings is investigated numerically and experimentally. The footings are analyzed using the method of characteristics. The numerical results indicate that the bearing capacity increases exponentially with footing size. With increasing footing size, the bearing capacity factor is reduced, while the shape factors is increased.

In the present study, the settlement of foundation has been determined in field by using the plate load test. Plate load test presents a direct measure of compressibility. For that, the objective of this study is to determine the effect of footings size on ultimate bearing capacity of cohesionless soil.

2- EXPERIMENTAL STUDY:-

The plate load test includes applying a load to a given area and measuring the settlement. The plate load tests were carried out and the settlement of sand was measured under different stress levels at surface of plate. The plates are manufactured from steel machined on both faces. The plates have concentric markings on one face and are plated against corrosion.

2-1 FIELD SAMPLES:-

In the present study for determining the effect of footings size on ultimate bearing capacity of cohesionless soil, graded sand sample has been used. Each sample has been compacted in layers and the relative density for each layer has been determined.

2-2 USED PLATES:-

In the present study six plates were used in testing the specifications of which are shown in table (1). The plates have a finished thickness of 32 mm and are according to ASTM D1194 and D1196. The used six rigid plates.

2-3 LOADING:-

The loads were applied by using steel frame fixed in the ground and loaded. The applied load has been measured by using pressure gauge connected to a hydraulic jack which gives the applied load.

2-4 MEASURING OF SETTLEMENT:-

a- The soil has been placed in a square open box.

b- The box was filled with different soil layers compacted to different densities which has been determined by sand cone test.

c- The settlement has been measured by using dial gauges of sensitivity 0.01mm placed on the edge of the steel plates.

d- The settlement has been measured at the surface of the plate.

2-5 TEST PROCEDURE:-

The test procedure was as follows:-

a- The square box was filled in compacted sand layers.

b- The sand cone method has been carried out in field for each layer after compaction to determine the field density.

c- The surface of the tested soil was prepared for plate test using fine sand at the surface.

d- The steel plate was placed on the prepared surface.

e- The hydraulic jack was placed on the steel plate.

f- Four dial gauges has been placed on the plate surface.

g- The readings were recorded of all dial gauges before applying loads (initial readings).

h- The load was applied in increment by using steel frame and loaded. Each load increment was maintained constant until the settlement rate reaches 0.02 mm/min but not less than one hour in any case.

3- EXPERIMENTAL RESULTS:-

The settlement in field were recorded for cohesionless soil for different sizes and shapes of plates along center line of plates as well as the edge of plates under different stresses ranging between 58.9 kN/m^2 and 530.1 kN/m^2. However, from the test results the followings have been obtained:-

a- The ultimate bearing capacity of cohessionless soil has been determined from the relationships between the stresses and the measured settlement for (circular and square plates) plotted under different relative densities experimentally by using tangent-tangent method (1977) and Chin method (1970) as shown in Figs. (1) to (4).

b- The relationship between the ultimate bearing capacity and angle of internal friction of cohessionless soil for (circular and square plates) under different applied stresses are shown in Fig. (5) and (6).

c- The relationship between the ultimate bearing capacity and footing size of cohessionless soil for all six plates under different stresses are shown in Figs. (7) and (8).

From these results the values of ultimate bearing capacity obtained from Chin method are higher than the values from the tangent-tangent method.

From the above, it can be noticed that the ultimate bearing capacity for small size circular plates is less than the measured settlement of the square plate.

Also, it can be noticed that the ultimate bearing capacity of cohessionless soil increases with increasing the footing size.

4- CONCLUSIONS:-

a- The ultimate bearing capacity for (circular and square) plates increases with increasing angle of internal friction.

b- The ultimate bearing capacity of cohessionless soil increases with increasing the footing size.

c- The ultimate bearing capacity of cohessionless soil at the same applied stress under square footings is higher than that under circular footings of the same equivalent area.

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TABLE NO. (1) THE USED PLATES

Circular Plate (diameter) B (mm)	Square plate (B=L) (mm)	Equivalent area mm^2	Thickness (mm)	Weight (kg)
305 mm	270.2 mm	73061.66mm^2	32 mm	14.5 kg
455 mm	403.2 mm	1625970.05mm^2	32 mm	33 kg
610 mm	540.6 mm	292246.66mm^2	32 mm	56 kg

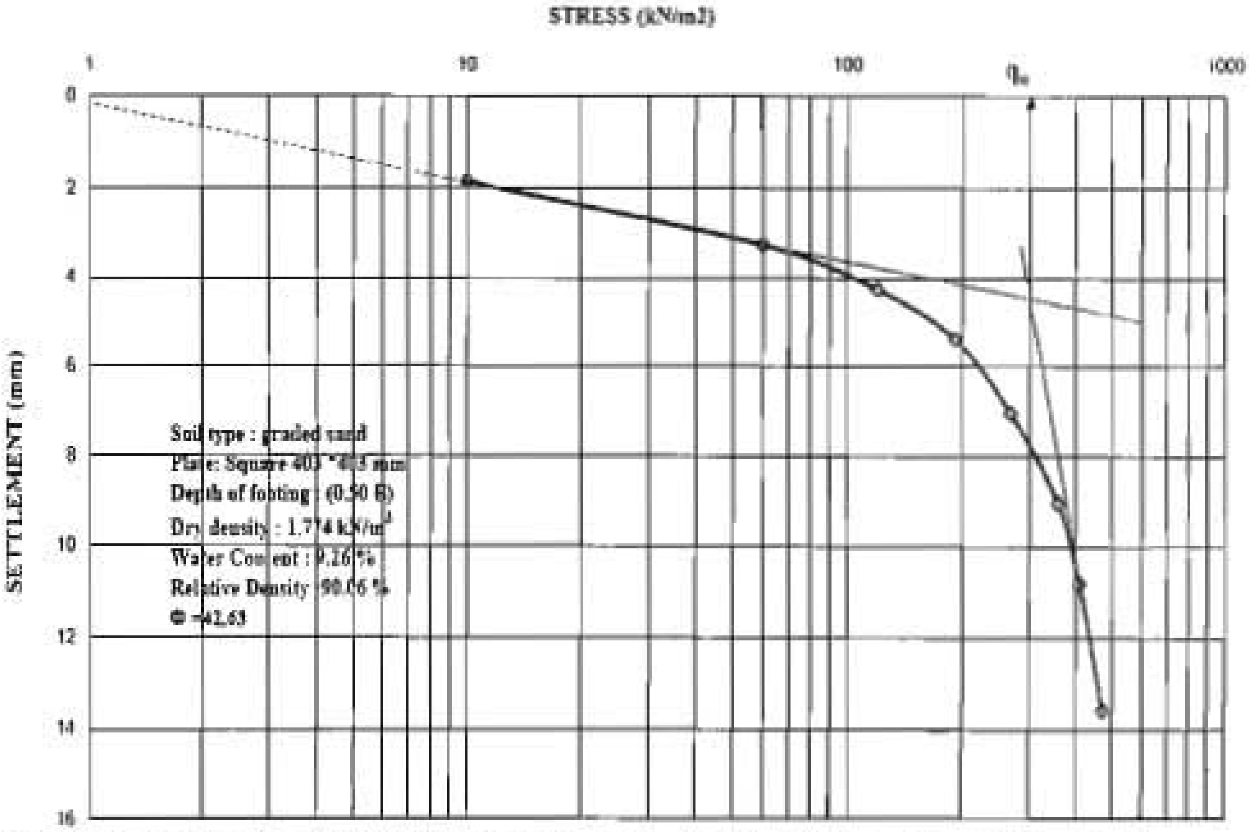

FIG.(1).RELATIONSHIP BETWEEN STRESS AND SETTLEMENT OF PLATE FOR DETERMINATION OF ULTIMATE BEARING CAPACITY FOR SQUARE PLATE 403 *403 MM

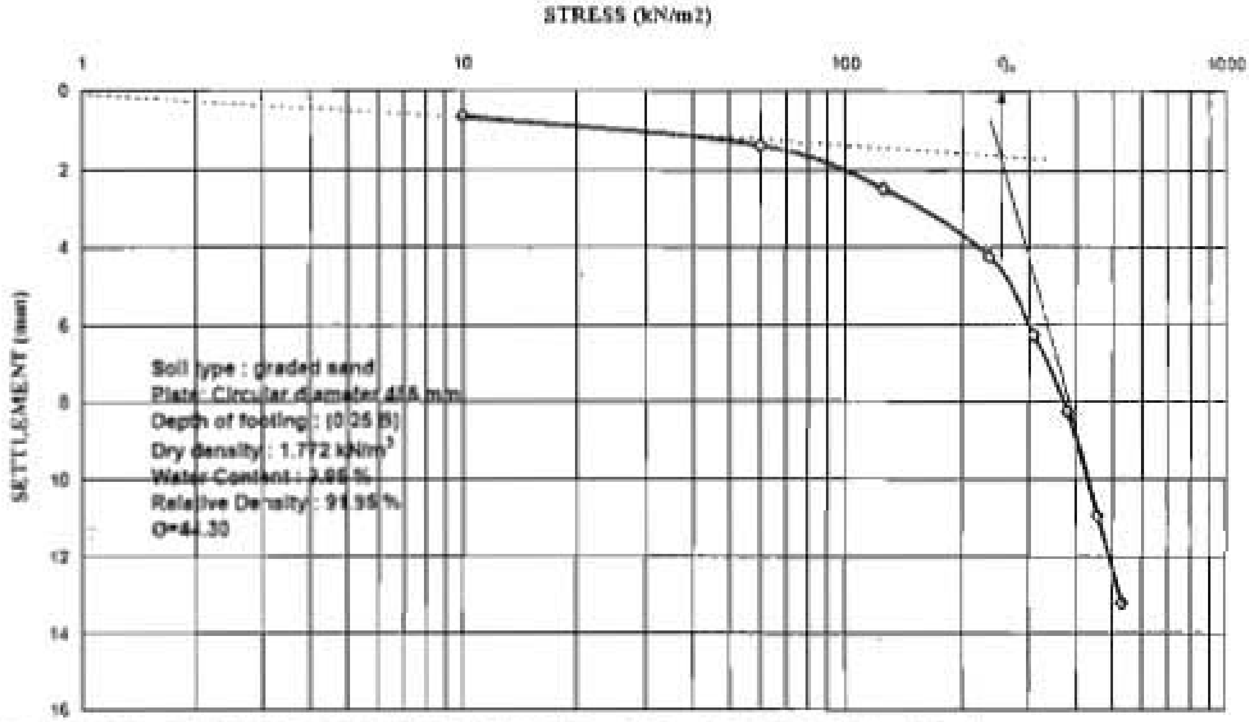

FIG.(2). RELATIONSHIP BETWEEN STRESS AND SETTLEMENT OF PLATE FOR DETERMINATION OF ULTIMATE BEARING CAPACITY FOR CIRCULAR PLATE DIAMETER 455 MM

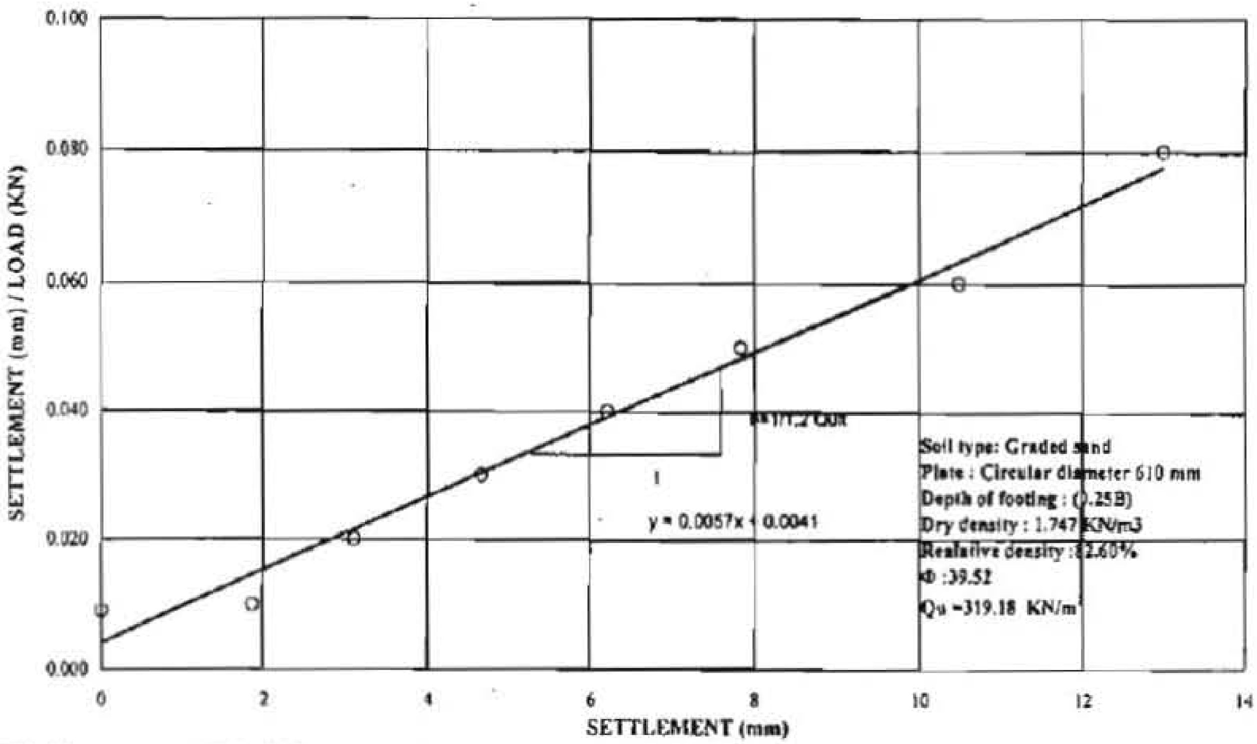

FIG.(3). DETERMINATION OF THE ULTIMATE BEARING CAPACITY FOR CIRCULAR PLATE DIAMETER 610 MM BY MODIFIED CHIN METHOD.

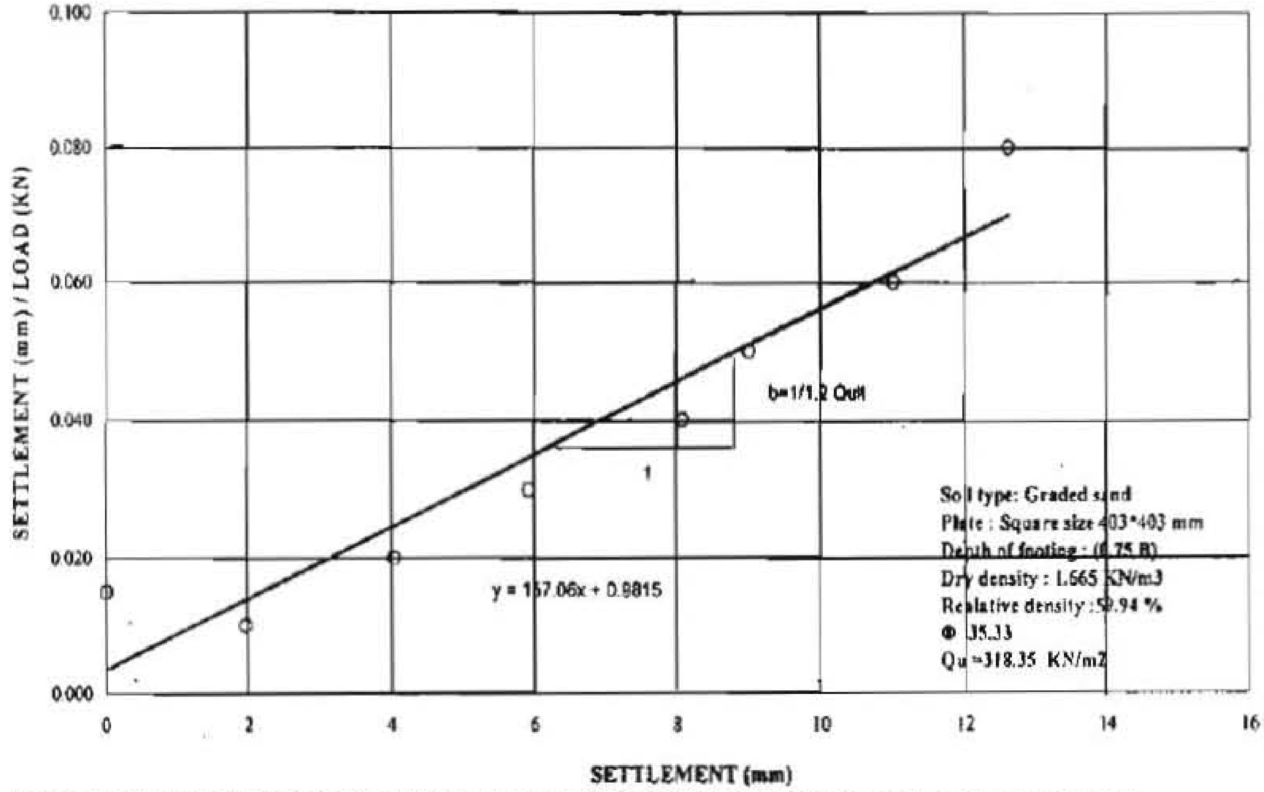

FIG.(4). DETERMINATION OF THE ULTIMATE BEARING CAPACITY FOR SQUARE PLATE 403 *403 MM BY MODIFIED CHIN METHOD.

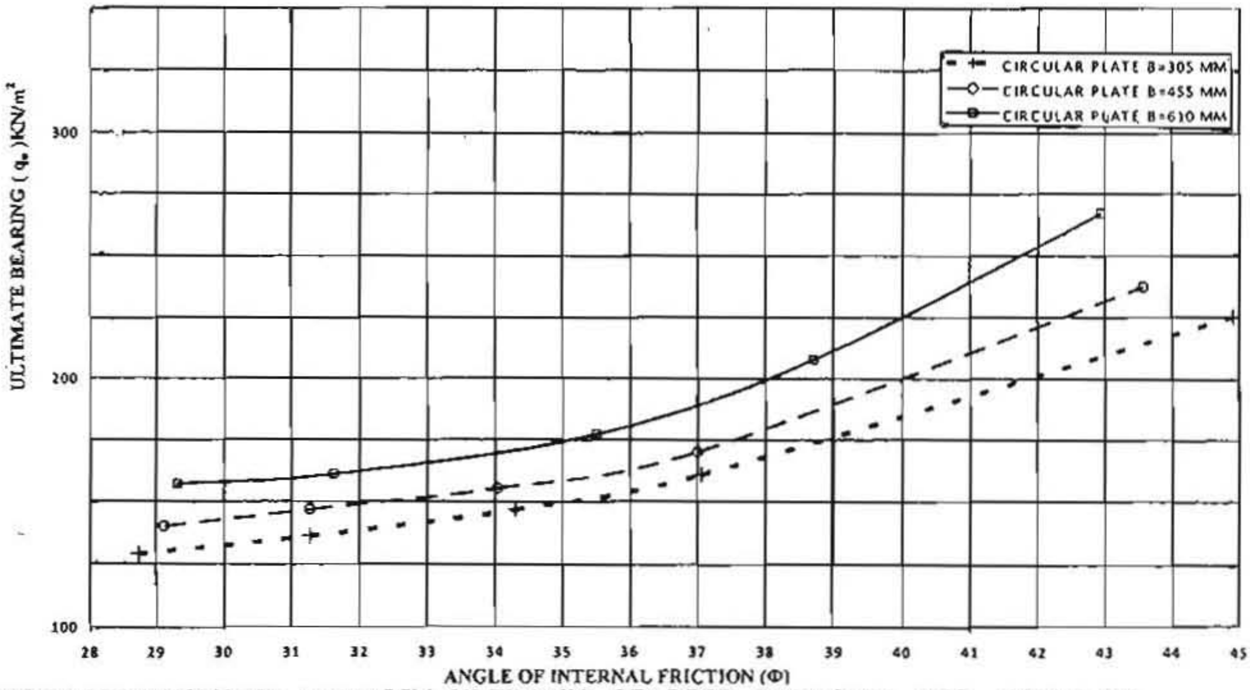

FIG.(5).RELATIONSHIP BETWEEN ULTIMATE BEARING CAPACITY AND ANGLE OF INTERNAL FRICTION UNDER DIFFERENT SIZES OF FOOTING FOR CIRCULARE PLATE

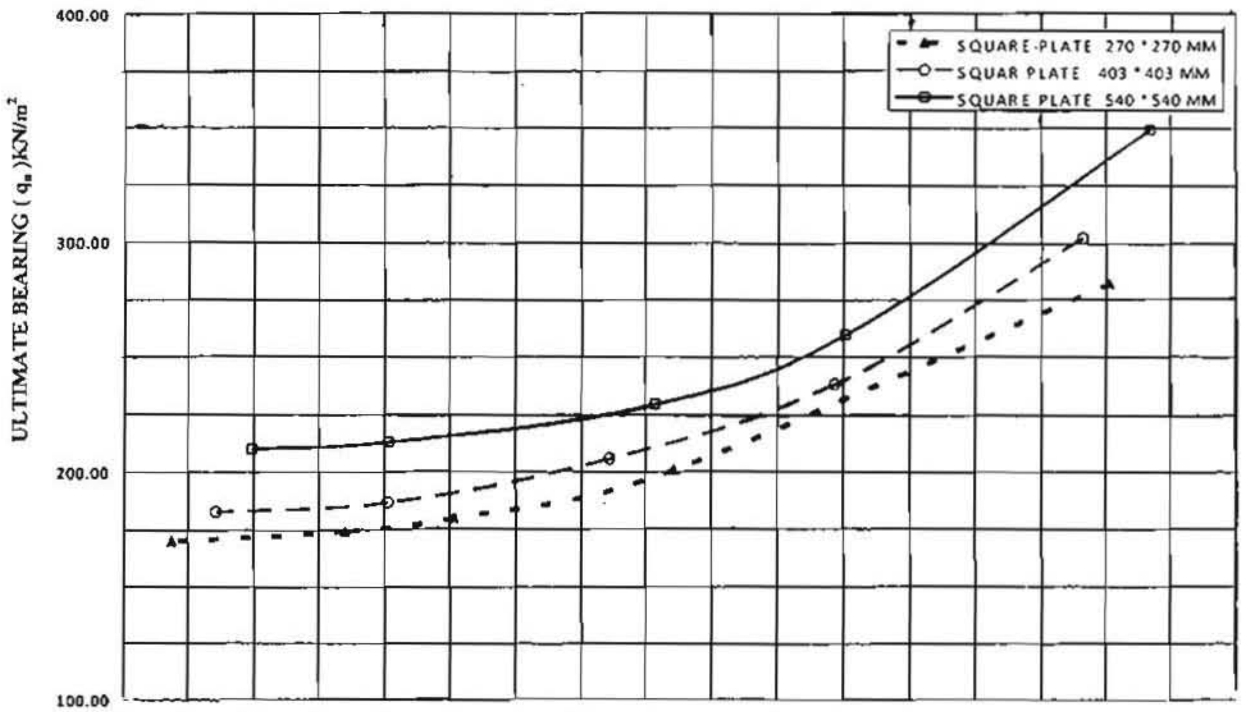

FIG.(6). RELATIONSHIP BETWEEN ULTIMATE BEARING CAPACITY AND ANGLE OF INTERNAL FRICTION UNDER DIFFERENT SIZE OF FOOTING FOR SQUARE PLATE

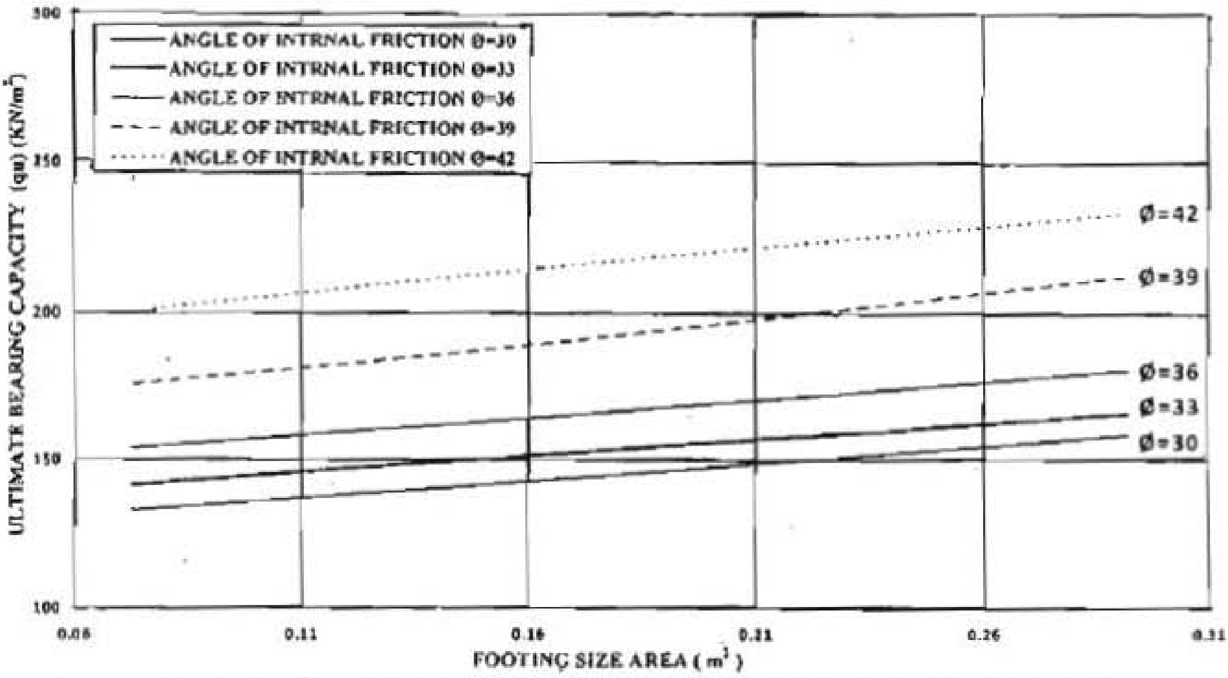

FIG.(7). RELATIONSHIP BETWEEN ULTIMATE BEARING CAPACITY AND FOOTING SIZES AT SURFACE UNDER DIFFERENT SIZE OF FOOTING FOR CIRCULAR PLATES .

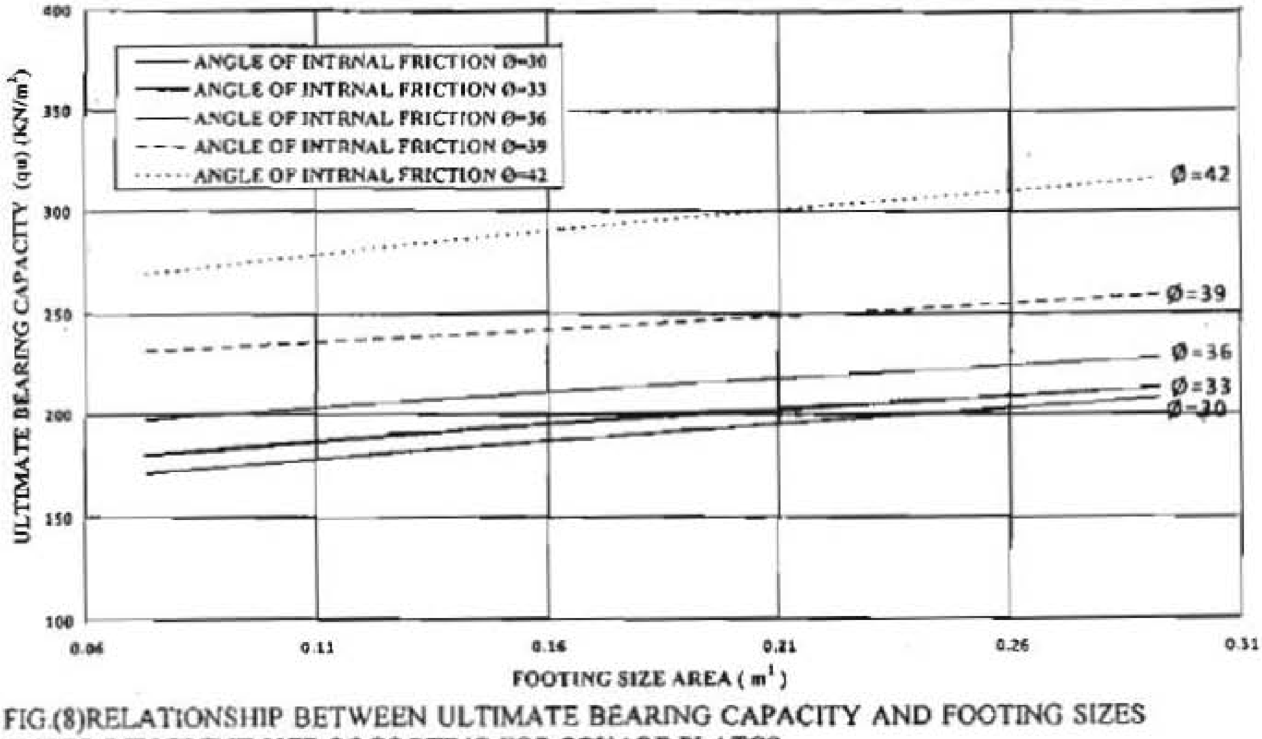

FIG.(8)RELATIONSHIP BETWEEN ULTIMATE BEARING CAPACITY AND FOOTING SIZES UNDER DIFFERENT SIZE OF FOOTING FOR SQUARE PLATES.