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PRESSURE SETTLEMENT BEHAVIOR OF SQUARE FOOTING ON JERASH EXPANSIVE SOIL

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Abstract

The results of pressure settlement of square footing resting on dry Jerash expansive soil, and on wet Jerash expansive soil show that as the dimension of square footing resting on dry Jerash expansive soil increase, the bearing capacity and the settlement also increase. on the other hand, the behavior of square footing resting on wet Jerash expansive soil show that there is on effect of the dimension of the square footing on the bearing capacity of the soil and on the two cases, the settlement of the footing is about 8%of the footing diameter.

Keywords: Pressure settlement, square footing, Jerash expansive soil, bearing capacity, Settlement, Footing, Live loads, Dead loads, Earth pressure.

INTRODUCTION

Footing (substructure) is defined as that part of structure which is below the surface of the ground and in direct contact with the soil which of transmits the load of the structure to the ground below.(Al-Rawas, Taha et al. 2002)

Which mean that all the loads of the super structure are to be transmitted to the soil and the soil should be capable of carrying the pressure without shear failure and the point of which the soil fails in shear as a result of pressure is called ultimate bearing capacity (Tripathy and Subba Rao 2009, Krishna, Viswanath et al. 2014, Reddy, Tahasildar et al. 2015). Expansive soils are found throughout the world and found in many places in Jordan (Masoud 2015). The design of foundation resting on expansive soil is a complex problem that requires a good understanding of the behavior of footing resting on the expansive soils under pressure (Mitchell and Soga 2005, Embaby, Halawa et al. 2017, Masoud, Suliman et al. 2019, Masoud and Alkherret 2020). The main objective of this study is to understanding the effect of the dimensions of square footing resting on Jerash expansive soil on the ultimate bearing capacity and the settlement of Jerash expansive. There are two approaches to estimation of bearing capacity first, from a knowledge of the shear strength characteristics of the soil by shear strength teats. These characteristics of soils can be measured by means of laboratory tests on samples extracted from the filed and these results of tests can be used to calculate the ultimate bearing capacity of the soils or the settlement magnitude or rate. The second approach is to determine the bearing

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capacity from experience and a knowledge of the characteristics of the ground or by empirical methods based on the results of certain type of in-situ test made on the soil.

When a load is applied to a foundation settlement will occur (Gueddouda, Goual et al. 2011, Thyagaraj, Rao et al. 2012). This settlement may be immediately or take time depended about the type of the soil and the condition of the soil (dry or wet) these loads maybe dead loads, live loads, earth pressure(Kumar and Chakraborty 2015). In this study only dead loads are used to study the bearing capacity and the settlement of the square footing on Jerash expansive soil in dry and wet condition test

The physical properties of Jerash expansive soil were given in table 1

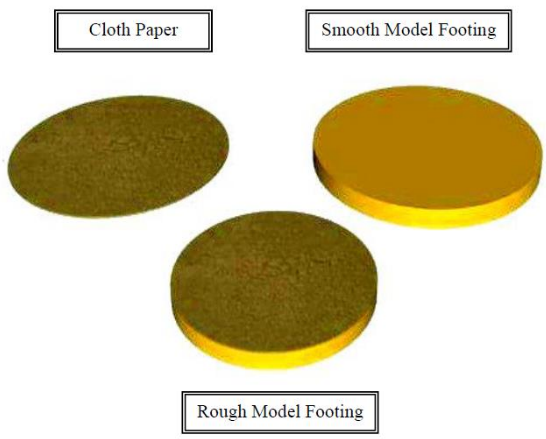
Table 1: The physical properties of Jerash expansive soil.

Color	Light yellow
Specific gravity	2.7%
Percentage of clay	71%
Liquid limit (LL)	72%
Plastic limit (PL)	27%
Shrinkage limit	15%

RESEARCH METHODOLOGY

To study the behavior of square footings on Jerash expansive soils, cast iron model footings with square shape with different dimension and sufficient thickness were used start from 30mm, 40mm, 50mm, 60mm, 70mm and 80mm with sufficient thickness of the footing. These footings were made rough by pasting emery cloth paper as shown in figure 1. And because of the significant effect of the water to the bearing capacity and settlement, the test conducted on the Jerash expansive soils in dry condition in wet condition. (Petry and Little 2002, Masoud and Alkherret 2020)

Figure 1: Rough Model Footing



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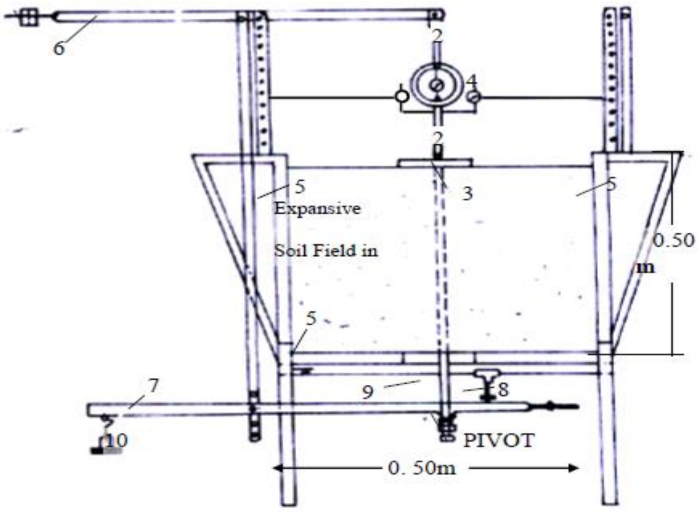
Bearing capacity test on dry soil

The dry soil was placed on the tank as a layer and each layer was compacted by a vibration to and the density of the soil was determined the footing was adjusted at the top of the soil in the testing tank so as to receive the load application point at its center. The size of the tank was 50cm X 50cm in plan and 50 cm in depth, which provided sufficient edge distance, and depth for the largest size of the footing footing as shown in Figure 2.

The loading was allowed by moving the load over the lever arm till it touched the center of the model footing without applying any load. The load was applied in convenient increments by placing the weights in the pan attached to the lever arm of the testing tank. The settlement corresponding to all load increments were observed by dial gauges till the soil failed. The pressure versus settlement were recorded for every model footing the results of the bearing capacity and the corresponding settlement of the Jerash expansive soil at dry condition for different footing dimension at ρd =1.77 gm/$cm^3$are shown in table 2

Fig. 2: Testing Tank at Dry Condition



1. Proving Ring (5 tonne Capacity) **2. Adopter.**

3. Circular Footing **4. Settlement Measuring Dial Gauges**

5. Tank Walls **6. Balancing Arm**

7. Loading Lever Arm **8. Adjusting Screw**

9. Load Transferring Vertical Arm **10. Loading Pan**

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Table 2: Results of the bearing capacity and the corresponding settlement of the Jerash expansive soil at dry condition for different footing dimension at ρd =1.77 gm/cm³

Footing dimension mm	Bering capacity Kg/cm2	Settlement Mm	$\frac{\text{settlement}}{\text{footing}} \times 100\ \%$
30	5.4	2.5	8.3%
40	6.1	3.4	8.5%
50	7.1	4.1	8.4%
60	9.4	4.8	8.0%
70	10.2	5.3	7.6%
80	10.4	5.7	7.1%

Figures 3and 4 are shown the bearing capacity of the Jerash expansive soil at dry condition for different footing dimensions at ρd =1.77 gm/cm³

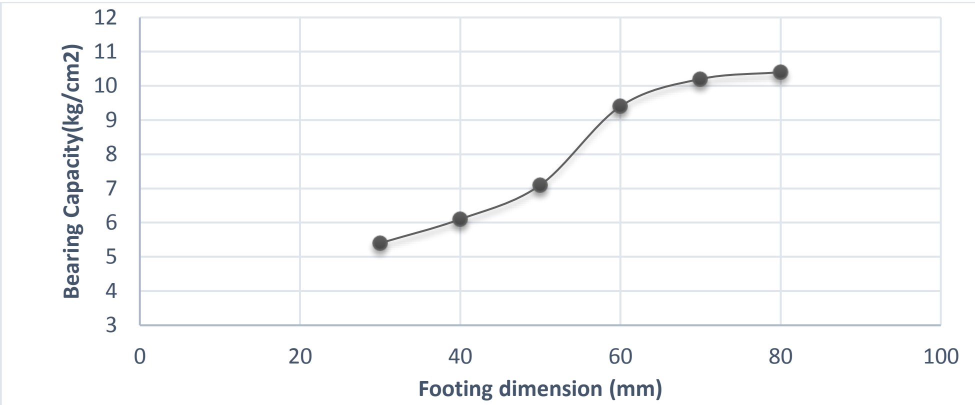

Figure 3: Relationship between the bearing capacity of the jerash expansive soil and the dimension of the footing at dry condition at ρd =1.77 gm/cm³

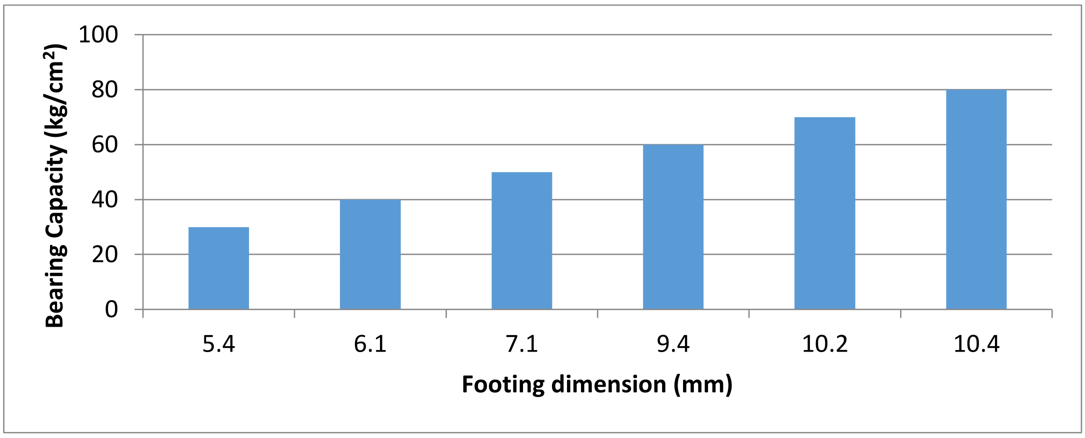

Figure 4: Relationship between the bearing capacity of the Jerash expansive soil and the dimension of the footing at dry condition at ρd =1.77 gm/cm³

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The relationship between the settlement of Jerash expansive soil and the dimension of the footing at dry condition at ρd =1.77 gm/cm^{3}are shown in figure 5 and figure 6

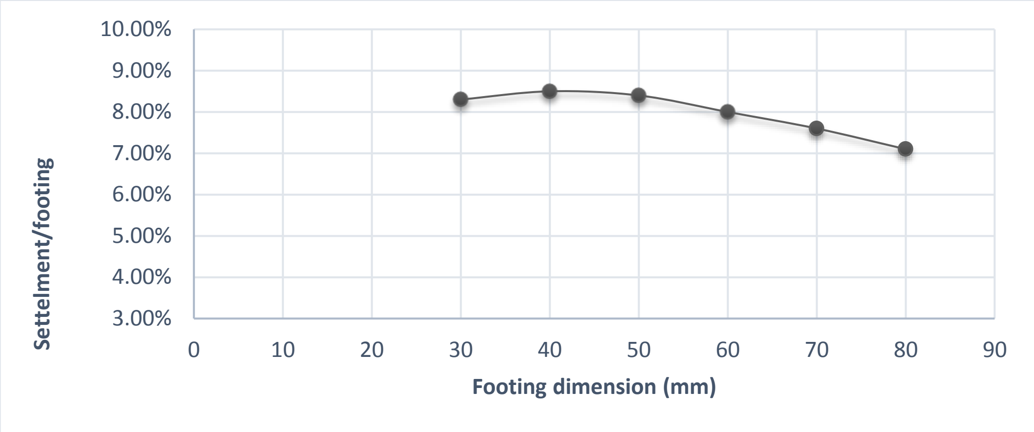

Figure 5: Relationship between the settlement of the Jerash expansive soil and the dimension of the footing at dry condition at ρd =1.77 gm/cm^3

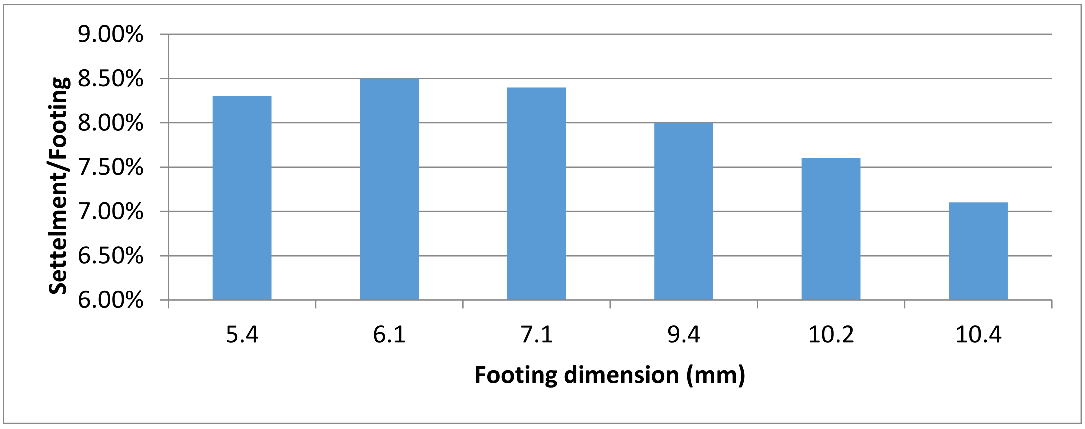

Figure 6: Relationship between the settlement of the Jerash expansive soil and the dimension of the footing at dry condition at ρd =1.77 gm/cm^3

Bearing capacity test on wet soil

In this study the same tank and the same footing dimension were used to study the pressure settlement behavior of the expansive soil at saturated condition the water was allowed to come to the expansive soil from the top and from the side of the tank as shown in Figure 7(Pathak, Kamat et al. 2008, Qasaimeh, AlSharie et al. 2015). After the soils became saturated, the load was applied in convenient increments by placing weight in the pan attached to lever arm (Muthyalu and Ramu , Wray and Meyer 2004, Masoud 2020). The load increment was kept applied to the model footing until the settlement of the model footing stopped. Then further increase of the load and recording of the settlement against the increments of load up to the settlement equal to 30% of the model footing diameter. All results of this test are shown in table 3

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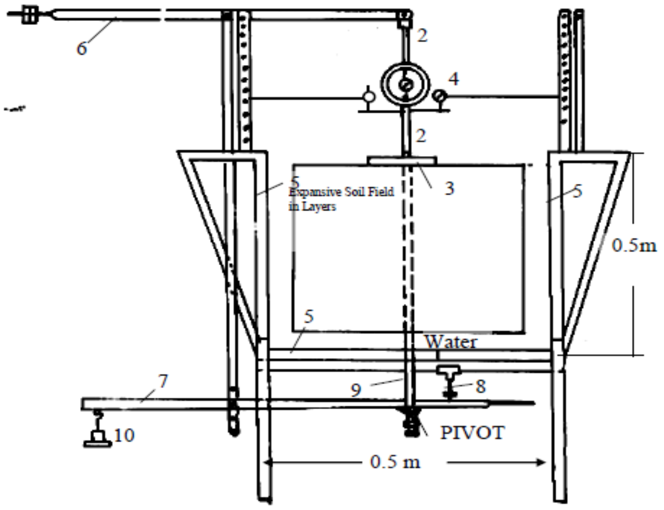
Fig. 7: Testing Tank at Wet Condition



1. Proving Ring (1 tonne Capacity) 2. Adopter. 3. Footing
4. Settlement Measuring Dial Gauges 5. Tank Walls 6. Balancing Arm
7. Loading Lever Arm 8. Adjusting Screw
9. Load Transferring Vertical Arm 10. Loading Pan.

Table 3: The results of the bearing capacity and the corresponding settlement of the Jerash expansive soil at wet condition for different footing dimension at ρ =1.75 gm/cm^3

Footing dimension mm	Bering capacity Kg/cm2	Settlement Mm	$\frac{\text{settlement}}{\text{footing}} \times 100$ %
30	1.65	2.2	7.3%
40	1.6	3.1	7.8%
50	1.7	3.6	7.2%
60	1.6	4.2	7.0%
70	1.65	5.1	7.3%
80	1.7	6.0	7.5%

Figures 8 shown the bearing capacity of the Jerash expansive soil at wet condition for different footing dimensions at ρ =1.75 gm/cm^3

The relationship between the settlement of Jerash expansive soil and the dimension of the footing at wet condition at ρ =1.75 gm/cm^3 are shown in figure 9

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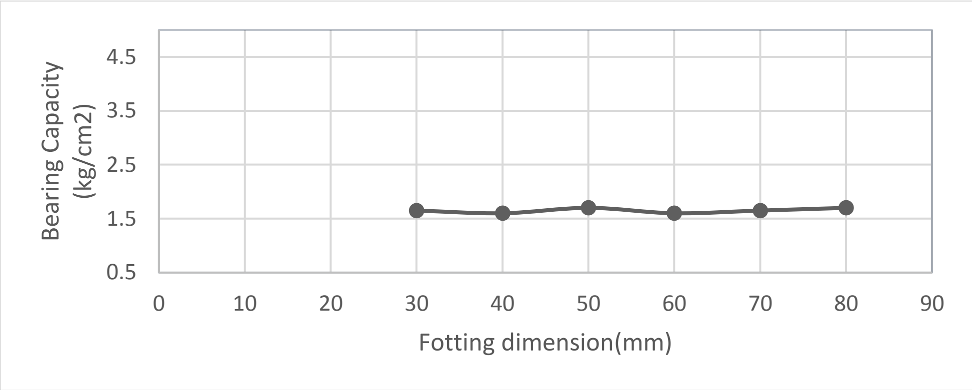

Figure 8: Relationship between the bearing capacity of the Jerash expansive soil and the dimension of the footing at wet condition at ρ =1.75 gm/cm^3

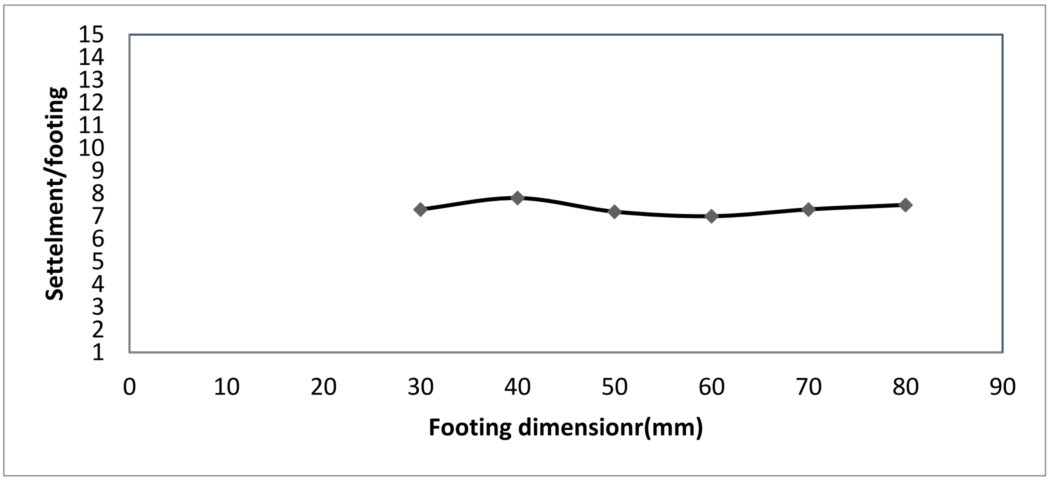

Figure 9: Relationship between the settlement of the Jerash expansive soil and the dimension of the footing at wet condition at ρ =1.75 gm/cm^3

DISCUSSION

The pressure-settlement behavior of square footing resting on dry expansive soils show that the ultimate bearing capacities (ultimate pressure) of the Jerash expansive soils depend about the dimension of square footing. The significant increase of pressure capacity of a circular footing as the increase of the dimension of the footing also the settlement of the circular footing at ultimate pressure was increase as a result of increase the dimension of the circular footing as show in fig. 6.16. Also the curves of the pressure-settlement indicated that circular footing on dry expansive soil fails suddenly with pronounced peak resistance when the settlement reaches about (8%) of the diameter of the circular footing.

The failure is accompanied by the appearance of failure surfaces and by considerable bulging of sheared mass of the soil as shown in Fig. 1 and Table 2. And according to Terzaghi, this

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type of failure is designated as general shear failure and similar to the failure take place on the foundations on dense sand

On the other hand, the pressure settlement behavior of square footing resting on saturated Jerash expansive soils show that the footing penetrates into the soil without any bulging of the soil surface. Using the tangent intersection method, the ultimate bearing capacity was found for the square footing.

These results show that the ultimate bearing capacity of the soil approximately the same and there is no effect of dimension of the square footing in the ultimate bearing capacity. The settlement of the footing about 8%of the footing dimension. as shown in Figures 5an 6 and Table 3

CONCLUSIONS

The test carried out in the laboratory under controlled condition show that the ultimate bearing capacity of the square footing is increase as the dimension of the square footing increase in dry condition.

On the other hand, the ultimate bearing capacity is no affected by the dimension of the square footing on wet condition, and on the two cases, the settlement is found to be about 8% of the diameter of footing.

The ultimate bearing capacity of the expansive soils on saturated condition found to be about 1.6 gm/cm2 to 1.9 gm/cm2 and with settlement equal to 8% of the dimension of the footing and the allowable bearing capacity may take to be 0.5 kg/cm2 to be within the allowable settlement.

The results of the present investigation will help to understand the phenomenon of bearing capacity and settlement behavior of circular footing in expansive soil and to study the factors affecting both the bearing capacity and the settlement of the expansive soils.

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