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EXPERIMENTAL INVESTIGATION OF DIFFERENT SHAPED ISOLATED FOOTINGS UNDER STATIC LOAD AND IMPACT LOADING ON SANDY SOIL AND BLACK COTTON SOIL

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ABSTRACT

Any Civil Engineering Structure must rest on a strong foundation or as per the strength criteria. Bearing capacity and settlement are the two major criteria for designing of foundation. Also it is not always subjected to monotonic loading but it may be subjected to impact loading. The examples are lifts, bridges foundation, machine foundation, offshore structure, wind waves etc. In this dissertation work, with the experimental investigations work an attempt has been made to study the behavior and suitability of various shaped footing specimens which may be a choice for laying of foundation. For this purpose the area of footing specimens has been kept same as 400 cm2 for all shapes of footings and thereafter the dimension are fixed accordingly. As a consideration for knowing of effect of settlement the dissertation work is studied under black cotton soil and sandy soil as two different strata.

Also, in this dissertation work, the loading on the footing has been differentiated as static and Impact loading so that settlement tests were conducted on all specimens and load intensity–settlement curves are to be plotted. It is also required to verify the suitability of the shape as per loading on different types of soil.

It is concluded after studying the load intensity settlement behavior that hexagonal footing shows least settlement while square and rectangular footing shows maximum settlement at same loading intensity. Experimentally it is found that hexagonal footing shows better performance while other footing shows considerable behavior.The study is carried out using two types of soil namely, sandy soil and black cotton soil as strata which suggest that penetration is more for black cotton soil. In this test study the density and moisture content of the soil were kept same as existing in the field. Load intensity –settlement curves are compared with standard behaviour and studied for further conclusions and scope.

KEYWORDS: Black Cotton Soil, Sand, Isolated footing, Impact loading and Static loading.

INTRODUCTION

Settlement of a structure is a gradual process by which generally soils decrease in volume and causes damage to the structure. According to Karl von Terzaghi "settlement is any process which involves a decrease in water content of saturated soil without replacement of water by air." In general it is the process in which reduction in volume takes place by expulsion of water under long term static loads. It occurs when stress is applied to a soil that causes the soil particles to pack together more tightly, therefore reducing its bulk volume. When this occurs in a soil that is saturated with water, water will be squeezed out of the soil.

The design of foundation requires fair knowledge of settlement of footing. The method of foundation design requires that they must possess sufficient safety against failure and settlement must be kept within the tolerable limit. These requirements are dependent on the bearing capacity and compressibility of soil. It is commonly believed that the settlement criterion is more critical than the bearing capacity in the designs of shallow foundations. By limiting the total settlements, differential settlements and any subsequent distresses the structure are ensured to be safe. The shape of footing may also play an important role in settlement of footing. Two different shaped footing may behave differently on same soil with different loading condition.

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Therefore, a proper analysis of the soil properties and the design of their foundations become necessary to ensure that these structures remain stable and are safe against collapse or unequal settlements and also most important the choice or suitability of choice of types of footing asper loading on different types of soil.

METHODOLOGY

In this chapter mainly the methods used to calculate bearing capacity or settlement are to be discussed. However the dissertation is based on suitability of different shapes of foundation as a part of settlement.

S No	Shape of Footing	Base Area	Relative Size	Thickness of Specimen
1	Square	400 Sq. cm	20 cm x 20 cm	7.5 cm
2	Rectangular	400 Sq. cm	16 cm x 25 cm	7.5 cm.
3	Hexagon	400 Sq. cm	12.4 cm per side	7.5 cm
Soil sample are cased in a brick box of uniform size.				

Materials:

For comparing different shapes of footings under different loading two different types of soil materials are used. This would benefit the dissertation in view of suitability of a shape of footing under different conditions. The soil sample used are Black cotton soil and Sandy soil.

A. Black cotton soil

Black cotton soil used in this present investigation was collected from Indore malwa region, which is tropical black clay formed from weathering of rocks. The soil was taken at depth of 1m below ground level. The geotechnical properties of soil are given in Table1.

S. No	Properties	Values
1	Specific gravity	2.51
2	Liquid limit (%)	54
3	Plastic limit (%)	22.75
4	Plasticity index (%)	31.25
5	Shrinkage limit (%)	12.37
6	Silt and Clay content (%)	76
7	Sand (%)	24
8	Maximum dry density(KN/m3)	13.09
9	Optimum moisture content (%)	22

B. Sandy Soil

The sandy soil used in the study is procured from Narmada river basin. The geotechnical properties of soil are determined as per IS codes (9, 10, 11, 12, 13 & 14) and summarized in Table-1. The particle size distribution curve is shown in Fig.-1.

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Particulars	Values
Natural Moisture Content	4.26%
Bulk Density (KN/m³)	17.2
Specific Gravity	2.65
Uniformity Coefficient (C_u)	2
Coefficient of Curvature (C_c)	1.14
Maximum Dry Density (MDD) (KN/m³)	17.7
Optimum Moisture Content (OMC)	9.41%
Cohesion	0.0
Angle of Internal Friction	32°

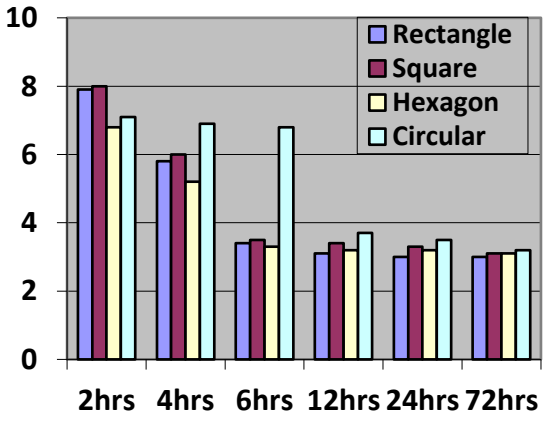
EXPERIMENTAL WORK

For testing the suitability of shape andsize of footing on settlement. Loading tests were performed on sandy soil which is a Narmada sand usually available in Indore zone and clayey soil as black cotton soil found abundantly in Indore malwa region. A loading frame of 1000 KN capacity, to find out the load- settlement behavior of layered soil by providing one soft layered soil to other soft layered soil under static and Impact loading conditions.
Loading Arrangement

The effect of shape and size with the different size of concrete of grade M20 is used. Loading tests were performed on sandy soil and clayey soil prepared in cuboidal brick mould tank, applied through concrete model footings resting on the surface of sand and clay layers which are filled in three or four layers are filled in the tank. A loading frame of 1000 KN capacity, to find out the load- settlement behavior of layered soil by providing one soft layered soil to other soft layered soil.

Case1: Static Loading by physical arrangements. Static Load= 1000N

Shape of Footing	*Time*	*Settlement (in mm)*	
		Sandy Soil	Black Cotton Soil
Rectangle	2 hours	7.9	8.5
	4 hours	5.8	6.3
	6 hours	3.4	4.0
	12 hours	3.1	3.9
	24 hours	3.0	3.8
	72 hours	3.0	3.6
Square	2 hours	8.0	8.5
	4 hours	6.0	6.5
	6 hours	3.5	4.0
	12 hours	3.4	3.8
	24 hours	3.3	3.6
	72 hours	3.1	3.2
Hexagon	2 hours	6.8	7.2
	4 hours	5.2	5.9
	6 hours	3.3	3.4
	12 hours	3.2	3.1
	24 hours	3.2	3.0
	72 hours	3.1	2.9
Circular	2 hours	7.1	7.5
	4 hours	6.9	7.2
	6 hours	6.8	7.1
	12 hours	3.7	3.9
	24 hours	3.5	3.6
	72 hours	3.2	3.6



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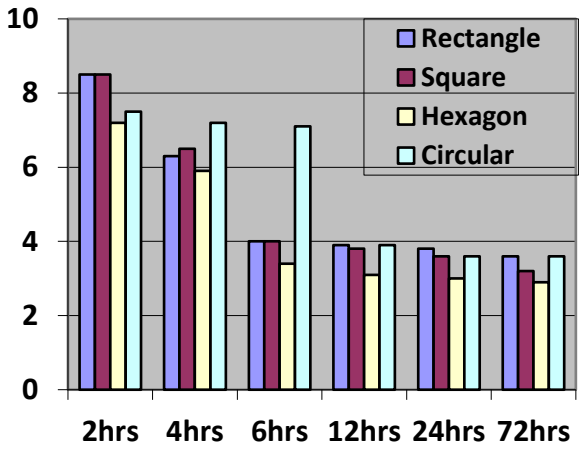
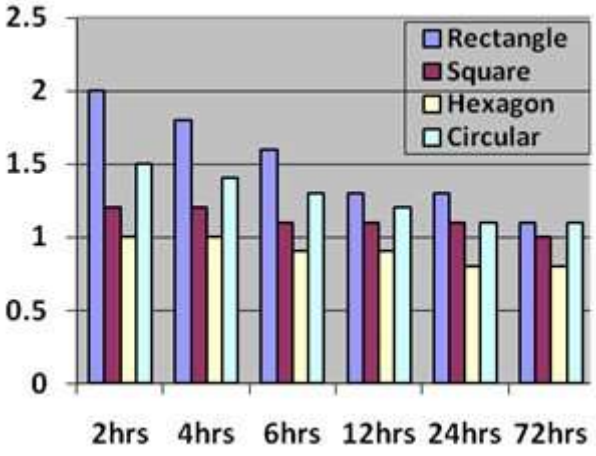


Case2 Impact Loading by physical arrangements. Impact Load= 500N

Shape of Footing	*Time*	*Settlement (in mm)*	
		Sandy Soil	Black Cotton Soil
Rectangle	2 hours	2.0	1.5
	4 hours	1.8	1.4
	6 hours	1.6	1.3
	12 hours	1.3	1.1
	24 hours	1.3	1.1
	72 hours	1.1	1.0
Square	2 hours	1.2	1.4
	4 hours	1.2	1.3
	6 hours	1.1	1.3
	12 hours	1.1	1.2
	24 hours	1.1	1.2
	72 hours	1.0	1.0
Hexagon	2 hours	1.0	1.2
	4 hours	1.0	1.1
	6 hours	0.9	1.0
	12 hours	0.9	1.0
	24 hours	0.8	0.8
	72 hours	0.8	0.8
Circular			
	2 hours	1.5	1.6
	4 hours	1.4	1.4
	6 hours	1.3	1.1
	12 hours	1.2	1.0
	24 hours	1.1	1.0
	72 hours	1.1	0.9



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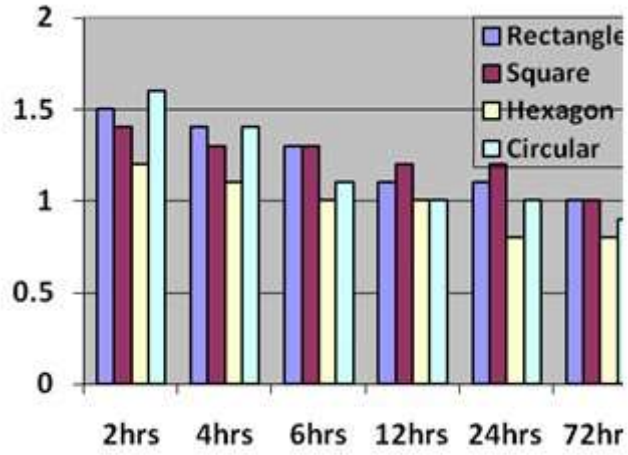

CONCLUSIONS

On the basis of the experimental results obtained by physical load tests carried out on sandy soil and black cotton soil with soil bed blended prepared of the soil in layers subjected to compaction and boundaries with brick masonry, the following conclusions may be drawn:

1. Hexagonal footing results better in terms of less settlement for both black cotton soil and sandy soil under static & Impact loading cases. This may be due to the reason that a hexagonal footing possess the following;It has more axis and as axis increases, load distribution results better.The critical area is large in hexagonal footing. As area increases the settlement decreases.
2. Settlement were more in Black Cotton Soil (cohesive soil) than Sandy Soil (cohesion less soil).Cohesive soil has less permeability, so more water is expelled out in consolidation process.
3. Settlement under static & impact load is more in Rectangular shaped footing.It does not have a symmetrical shape.
4. Bearing pressure decreases with the increase in the size of the modeled footing.

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