Detailed Study of R.C Isolated Footing Resting on Black Cotton Soil Subjected to Weather Condition

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Abstract- *In Civil Engineering aspects Black Cotton Soil is giving lots of Problems to engineers. The possibility of good construction sites to build structures on Black Cotton Soils is difficult due to their poor strength and deformation characteristics. The failures of structure are mostly due to the failure of foundations. Foundation is the most important part of the structure. The strength and durability of any structure depends upon the strength of its foundation. The main objective of this study is to design a suitable and feasible foundation for the black cotton soil.The main aim of this project is to check stability of isolated footing on black cotton soil the properties of black cotton soil changes due to weather condition . The climate change leads to a wide range of climatic and weather changes that can affect the performance of settlement of footing.This project is to to analysis of RC Isolated footing on black cotton soil due to changes in weather condition and analysed isolated footing manually and using STAAD FOUNDATION.The analysis method used in STAAD FOUNDATION are limit state design conforming to indian standard code of practice.*

Keywords- Soil, Isolated footing, Weather condition

I. INTRODUCTION

The foundation is part of the structure which transmits the loads to the soil. Each building demands the need to solve a problem of foundation.Foundation design and construction are two basic requirements of any earth retaining structure, which transfers its load to the underlying earth's crust. The materials that constitute the earth's crust are arbitrarily divided into two types, i.e. soil and rock, which are the main structural materials and in reality, there is no clear distinction between them. Soils and sites are so variable that it is not practicable to formulate any hard and fast rules.

The mechanical properties of soils are for more complex and difficult to determine. No material has greater variation of properties than soil, probably because it is not a manufactured standard product like steel. This is because the soil with which the engineer must work was placed by nature in a great variety of kinds and conditions. The selection of soils for foundation of any structure is not entirely within the engineer's control. The stability and function of a structure will largely depend upon the behaviour of the soil upon which and/ or of which it is built.

Aim

Study of RC Isolated footing on black cotton soil .

To study of properties of black cotton soil.

Objective

- To study the RC Isolated footing.
- The geometry of the foundation is selected so that any minimum requirements based on soils parameters
- To study various soil condition
- Collecting the necessary soils parameters
- Analyzing the examples on RC isolated footing
- Comparing results of different weather condition of soil and their effect of stabilty of foundation.

Need:-

The behavior of the structure changes with the various soil condition due to the weather effect. The calculated settlement of the footing, due to applied loads, needs to be less than the allowable settlement.To make footing better resistance of changing soil parameters Good stability of footing Perform well in different soil condition Suitable for any condition of soil due to changes of soil condition.

II. LITERATURE REVIEW

A.R.Gupta et al. [1]: In Civil Engineering aspects Black Cotton Soil is giving hazardous problems to engineers. With the rapid development in Soil improvement, construction technique and social need various constructions of structure are taking place. The possibility of good construction sites to build structures on Black Cotton Soils is difficult due to their poor strength and deformation characteristics. This study discussed Black Cotton Soil properties, effect of Black Cotton Soil on structures and covers the guidelines to construct the

structure in Black Cotton Soil. **Brajesh Mishra [2]:**In this paper by used of lime improved properties of soil Lime is added to black cotton soil and stabilization takes place by virtue of pozzolanic reaction. A reaction takes place between hydrated lime and clay particles and resulting in formation of permanent strong cementation matrix. Experimental work has been carried out with 3% and 5% of lime content.The mechanical behaviour of such nature of soil has to be improved by employing stabilization and reinforcement techniques to make it reliable for construction activities.by adding lime to improved stabilisation of soil. **Zulufqar et.al** [3], It is very important to know the behavior of black cotton soil and its problems so that construction could be done efficiently. This research paper examine the behavior of black cotton soil stabilized with different proportion 15%, 20% and 25% of fly ash added to the black cotton soil.The admixtures used in this project are easily available and are economical beneficial. The various tests on black cotton soil with addition of fly ash are performed after developing the samples. The main aim of this research was to find the optimum percentage of mixing fly ashwith the black cotton soil . **D neelam satyam** (4) The case of study is located at Guntur district in the state of AndhrPradesh, India. Standing on a bed of black cotton and plastic clays with water table as low as 0.5m, It also aids in prediction of the ground settlement on adjacent structures. The objective of this paper is to discuss the design of sheet pile, supporting structures and challenges faced in the construction of a sump in clayey soil site.**Kishankumar et.al,[5]**: the Abovepaper,limited studies have been conducted on the use of crushed coconut shells to improve the strength of the soil. In the present study, crushed coconut shells are added in different amounts to study the strength of the black cotton soil subgrade which is a weak soil. The results of the study indicate improvement in the CBR values of the weakSubgrade soil with the inclusion of crushed coconut shells. **MasoumehMokhtari et.al [6]:** This article presents description of expansive soil, shrink – swell behavior and control it, Factors Influencing Swelling and Structural damage.hence there are different test should be conducted and study their effect on soil behaviour due to soil contact in water table.all study of expansive soil**. S.V. Ramaswamy [7]:** In this paper, The thickness of each soil layer, their engineering properties and the environmental conditions should be carefully considered in the design and construction of foundations for lightly loaded structures such as roads, pavements, swimming pools, sumps, garages ,warehouses and parking lots. The strength properties and consolidation characteristics of soft clay and permeability of sand have a major influence on the response of expansive clay. Expansive shale which occurs in areas south west of Chennai disintegrates on exposure to weather. It loses strength on continuous exposure to water. **M.R.Mahmood[8]:**This paper presents an experimental and numerical study to investigate the load carrying capacity of piled raft foundation embedded within partially saturated sandy soil. The effect of matric suction on the bearing capacity of the foundation system was investigated. The experimental work consists of two models of foundation, circular raft foundation and circular piled raft foundation. The circular raft foundation has dimensions of 10cm in diameter, and 2.5cm thickness, while the piled raft foundation has the same dimensions of the circular raft model but with a single pile of 2.0cm in diameter and 40.0cm in length fixed at the center of the raft. Both models are loaded and tested under both fully saturated condition and unsaturated conditions which are achieved by, predetermined lowering water table. **Mr ArpitAgrawal et,al2016 [9]:**In this paper they are 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 and the effect of settlement is studied under black cotton soil and sandy soil as two different strata and also 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. 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.**Mahmoud Samir El-kady et.al[10]**In this paper is introducing an alternative foundation shape that reduces the cost of foundations by reducing the amount of reinforcing steel by minimizing or even eliminating the tension zones in the folded isolated footings. Also, achieving lower soil stresses through changing the isolated footing shape will consequently reduce the expected settlements and the footing stresses. that the folded isolated footings achieve economic design by decreasing the quantities of reinforcement. It also induced less soil settlements, and stresses. In addition, the tensile stresses in the reinforced concrete footing body are also less in folded isolated footings than the flat one. **Luévanos-Rojas et.al[11];** in this paper comparison is made between the optimal design and current design for rectangular footings .This paper shows an optimal design for reinforced concrete rectangularfootings using the new model. A numerical experimentation is presented to show the model capability to estimate the minimum cost design of the materials used for a rectangular footing the optimal design is more economical and more precise with respect to the current design, because standard design is done by trial and error. **PavanParashram et.al [12]:** In this paper,they determine the parameter of soil affected on settlement and do the calculation& A 4-storied building modeled is taken

&analyzed in E-TABS software to get final load acting on the footings,also The minimum depth of the foundation & the sizes of the footings were computed for isolated footings and the parameter change of soil the settlements for depths lesser than minimum depth of foundation and the settlements are also computed using SAFE software. **B. Ravi Sankar[13]** in this paper , design the size of footing for cohesive and non-cohesive soils for a building and to find which soil is economical for building ,different test are conducted on soil to find the bearing capacity of cohesive and non-cohesive soil.a mathematical model is developed to take into account the real pressure of soil acting on the contact surface of the footings and these pressures are presented in terms of the mechanical elements,The classical model takes into account only the maximum pressure of the soil for design of footings . also find out depth should be varying. **KenechiKurtisOnochie et.al [14]:** For the purpose of this study, emphasis was placed on the expansive soil. This type of soil is common in North Cyprus due to the nature of its soil and the extremes in its weather conditions. The Haspolat region in the capital Lefkosa was studied. Relevant data such as soil test data, and other documents related to the research subject were obtained and analyzed. A reconnaissance survey was conducted based on an in depth interview with public officials, private sector entities and the inhabitants of Haspolat. Data was obtained from on the spot observation of the site and recorded for analysis. **Facultad de Ingenieria et.al[15]:** In this paper, the design of reinforced concrete rectangular footings subject to axial load and exure in two directions, there are different pressures in the four corners, these are exercised by soil.hence a mathematical model is developed to take According to the maximum moments acting on the isolated footing, it is observed that it is greater in traditional model with respect to the proposed model. This isa logical situation, because in traditional model, the design pressure is the same in all the contact area of the footing on soil, being this the maximum pressure that is presented in said structural member so that observation carried out traditional method is suited for classical method.

III. DETAILED STUDY

A) Nature Of Soil-

Soil is considered by the engineer as a complex material produced by the weathering of the solid rock. The formation of soil is as a result of the geologic cycle continually taking place on the face of earth.Soil is a natural aggregate of mineral grains with or without organic matters, that can be separated by gentle mechanical means, such as agitation of water, wind, frost, etc. Soil may be defined as that which comprises accumulations of solid particles, loose or cohesive deposits, such as gravel, sand, silt, clay or any combination thereof which is loose enough to be removed with a spade or shovel in a dry or saturated state. Rock is a natural aggregate of mineral grains connected by strong and permanent cohesive forces. The term 'rock' may be applied to materials, which are natural beds or large hard fragments or original igneous, sedimentary or metamorphic formations.

B) Study of Black cotton soil :-

Black cotton soil and other expansive soils have typical characteristics of shrinkage and swelling due to moisture movement through them due to rainy seasons moisture penetrates into these soil due to which they swell .Expansive soils are mostly found in the arid and semi-arid regions and it covers very large area of the world. It covers nearly 20% of the landmass in India and includes almost the entire Deccan plateau, Western Madhya Pradesh, parts of Gujarat, Andhra Pradesh, Uttar Pradesh, Karanataka, and Maharastra. The swelling soils are commonly known by the name of Black Cotton Soils. For swelling to occur, these soils must be initially unsaturated at some water content. If the unsaturated soil gains water content, it swells. On the other hand, if a decrease in water content occurs the soil shrinks. The presence of montmorillonite clay in these soils imparts them high swell–shrink potentials.

C) Behaviour of Soil due to Seasonal Weather changes

During periods of hot, dry weather a deficiency of water develops near the ground surface and in soils, this is associated with a decrease of volume or ground shrinkage and the development of cracks.

The shrinkage of black cotton soil will be increased by drying effect produced by fast growing and water seeking trees. The range of influence depends on size and number of trees and it increases during dry periods.

In periods of wet weather, black cotton soils swell and the cracks lend to close, the water deficiency developed in the previous dry periods may be partially replenished and a sub-surface zone or zones deficient in water may persist for many years. Leakage from water mains and underground sewers may also result in large volume changes.

D) Safe bearing capacity of soil

Sr No	Type of soil	Weather condition	Safe bearing capacity
1	In dry state	Summer	125 kn/m^2
2	In wet state or		160 kn/m^2
3	Saturated state	Rainy	100 kn/m^2

E) Types of shallow Footing

a) Isolated footing
b) Combined Footing
c) Mat/Raft Footing
d) Strap footing
e) Strip footing

a) Isolated Footing

An isolated footing is used to support the load on a single column, It is usually either squarer or rectangular in plan .It represent the simplest ,most economical type and most widely used footong.Whenever possible ,square footing are provided so as to reduce the bending moment and shearing forces at their critical section .Isolated footing are used in case of light column loads when column are not closely spaced and in case of good homogeneous soil, under the effect of upward soil pressure.the footing bends in shaped form.An isolated footing must therefore be provided by two sets of reinforced bars placed on top of the other near the bottom of the footing.In case of property line restriction footing may be designed for eccentric loading or combined footing is used as an alternative to isolated footing.

1) These are independent footings which are provided for each column. This type of footing is chosen when

1) SBC is generally high
2) Columns are far apart
3) Loads on footings are less

2) The isolated footings can have different shapes in plan. Generally it depends on the shape of column cross section Some of the popular shapes of footings are;

- Square
- Rectangular
- Circular

The isolated footings essentially consists of bottom slab. These bottom Slabs can be either flat, stepped or sloping in nature. The bottom of the slab is reinforced with steel mesh to resist the two internal forces namely bending moment and shear force.

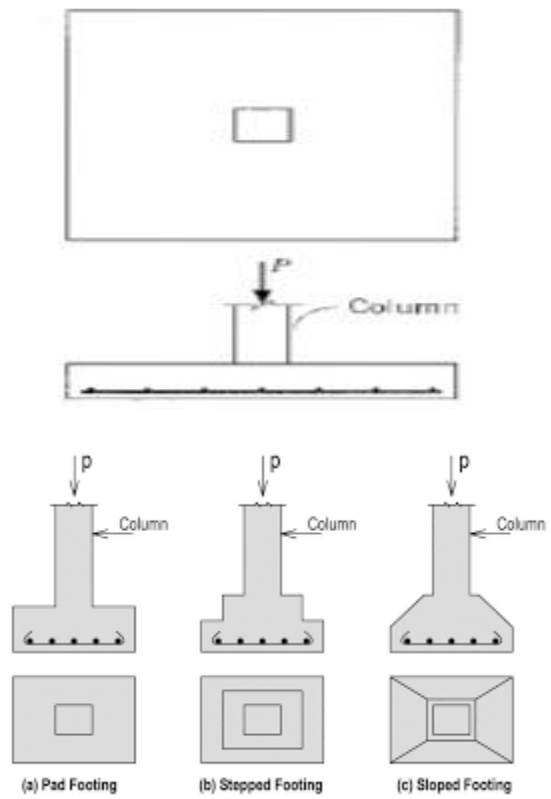

Fig 1.1 Plan and section of typical isolated footing

b) Combined Footing

It supports two columns as shown in figure below. It is used when the two column are so close to each other that their individual footings would overlap. A combined footing is also provided when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line. By combining it with that of an interior column, the load is evenly distributed. A combine footing may be rectangular or trapezoidal in plan. Trapezoidal footing is provided when the load on one of the column is larger than the other column.

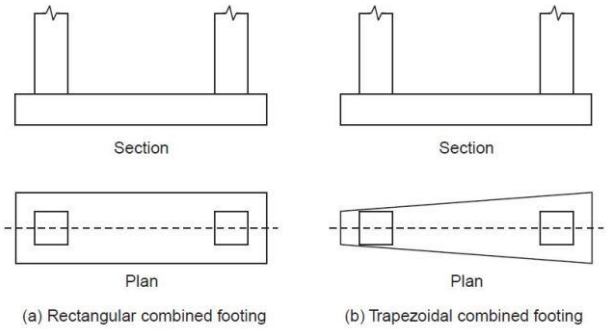

Fig 1.2 Plan and section of combined footing

Combined footings are provided when:-

1) SBC is generally less
2) Columns are closely spaced
3) Footings are heavily loaded

c) Strap Footing

An alternate way of providing combined footing located close to property line is the strap footing. In strap footing, independent slabs below columns are provided which are then connected by a strap beam. The strap beam does not remain in contact with the soil and does not transfer any pressure to the soil. Generally it is used to combine the footing of the outer column to the adjacent one so that the footing does not extend in the adjoining property.

d) Mat/Raft Footing

It is a large slab supporting a number of columns and walls under entire structure or a large part of the structure. A mat is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each other. Mat foundations are useful in reducing the differential settlements on non-homogeneous soils or where there is large variation in the loads on the individual columns.

It is normally provided when

1) Soil pressure is low
2) Loads are very heavy
3) Spread footings cover > 50% area .

IV. CASE CONSIDERATION

Manual design of isolated footing foe dry state

Case –I Summer Seasons

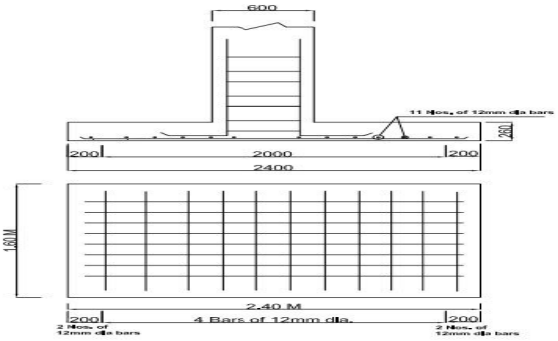

Fig 1.2 Reinforced detailing of footing in dry state

For wet state

Case – II For winter Season

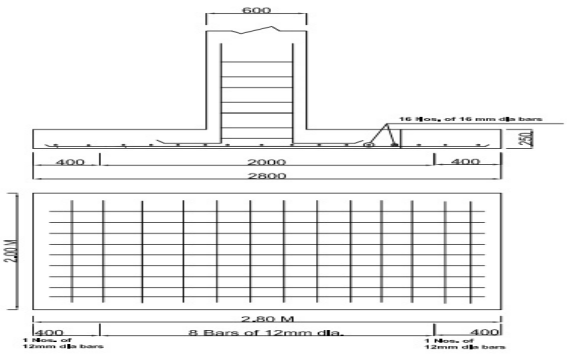

Fig 1.3 Reinforced detailing of footing in wet state

V. CONCLUSION

The mostimportant aspect of the foundation design is the necessary check for the stability .Stability analysis aims at removing the possibility of failure of foundationby sliding due to load intensity imposed on soil foundation being in excess of the ultimate capacity of the soil.The stability of foundations should be checked for the following aspects.

In this project,due to soil condition of black cotton soil as per weather condition divided in two type such as:

CASE I : Dry soil in summer seasons .

CASE II: Wet or saturated soil in Rainyseasons

From the above cases it is observed that the maximum bending moment is achieved in dry soil in summer seasons.The summary of the bending moment & one way shear ,two way shear at the footing for all two cases is tabulated below.

Sr. no	Case	Dry State	Wet State
1	Bending moment about section x-x	$181.31*10^6$ N.mm	150.66 $*10^6$ N.mm
2	Bending moment about section y-y	$134.4*10^6$ N.mm	$66.96*10^6$ N.mm
3	Depth of One way shear	345mm	340mm
4	Check of Two way shear	$\tau v < \tau c$ 0.756 N/mm^2 <1.118 N/mm^2 Hence it is safe.	$\tau v < \tau c$ 0.696 N/mm^2 <1.118 N/mm^2 Hence it is safe.

In the above analysis the bending moment of section x-x is greater than dry state in rainy seasons and bending

moment of section y-y is greater than dry state.Also conclude that the depth of one way shear is greater than in dry state also the permissible shear stress is greater than shear stress in dry state.So the stability of footing of isperform greater in dry state .

Thus, for making footing safe and durable,it is atmost important to analyse the footing for various possible practical conditions and design on the base of it. Some important parameters that should be considered are bending moment, depth of one way shear, two way shear etc. and the factors responsible for making difference are geometry, dimensions, material used and boundary conditions. One such factors influence is suited in this report and stability of footing is studied for two soil condition. Thus, this study helps to analyse and stability of footing and probable design consideration.

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