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Stability Analysis of RC Isolated Footing Resting on Black Cotton Soil Subjected to Weather Condition

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Abstract : It is well known at the time of analysis and designing the load transfer part and load dispersion member plays an important role normally the structure and design for gravity loads which is considered to be vertically downward does the total load of superstructure is transmitted through the substructure putting the stability of the footing depend upon the perfect analysis and design considering the soil underneath it the behavior of the soil it changes with the change in season and thus its behavior with the contact structures is the properties of black cotton soil show large variation the study in this dissertation is done to analyze the effect of seasonal variation of black cotton soil on footing.Cases analyze case 1 for summer case 2 winter case 3 rainy for the same footing size and over acting load it is observed that in winter season the soil exerts more pressure on the footing where as the race against sliding and overturning in rainy season by 3 times even the amount of Steel requirement is three times more for the same footing for rainy season as compared to winter season does the importance of seasonal variation while analyzing and designing is necessary.

Key word- Black cotton soil ,Isolated Footing.Bearing capacity of soil .

I)Introduction :-

All the Black cotton soils are not expansive soils and all the expansive soil are not Black in colour. These soils possessed high strength in summer and decreased rapidly in winter. Swelling and shrinkage of expansive soil cause deferential settlement resulting in severe damage to the foundation, buildings, roads, retaining structures and canalLinings.It is the main concern of a foundation engineer who should take into consideration the various properties of soil before designing a structure. The behaviour of soil underneath the foundation should be studied for safe functioning of building. A rational design of the foundation is based upon the bearing capacity, which may be defined as the largest intensity of pressure that may be applied by a structure or a structural member to the soil which supports it without causing excessive settlement or danger of failure of the soil in shear.

1.1) Aim

To study stability analysis of RC Isolated footing on black cotton soil subjected to weather condition.

1.2) Objectives:

- To study various soil condition.
- To study construction properties of Black cotton soil
- Analyzing the examples on RC isolated footing
- Comparing results of different weather condition of soil and their effect of stabilty of foundation.

1.3)Need

Superstructure loads are transmitted to the underlying soil strata through a suitably designed foundation. Therefore, the foundation of a structure is considered the most crucial structural element in a building. Black cotton soil has a tendency to swell and shrink excessively. This alternate process of swelling and shrinking results in the differential settlement of the foundation which in turn causes cracks in building. Hence, it is very necessary to analyze the safety and stability of the foundation in black cotton soil.These is a very expansive soil due to present of montmorillonite and few little illite mineral are present. Due to this properties of soil swelling and shrinkage of the soil create a different problem in construction of foundation that why we have to need of study the properties of black cotton soil. Due to its expansive character, it increases in volume to the extent of 20% to 30% of original volume and exerts pressure.

II) Case Consideration Modelling and Analysis :

2.1)Computational Building Analysis:

It is a two storied R.C.C. frame structure comprising of three rooms; Living Room, Kitchen and a Bed constructed on a Black Cotton Soil. The dimensions of respective rooms are

Living Room = 5m × 4m ,Kitchen = 2.5m × 3m

Bed = 10' × 12' (3m × 3.5m)

Height of each floor = 3m

Depth of footing = 2.2m

Size of beam = 400mm × 250mm

Size of column =400×400 mm

Total Height of building =8.2 mm

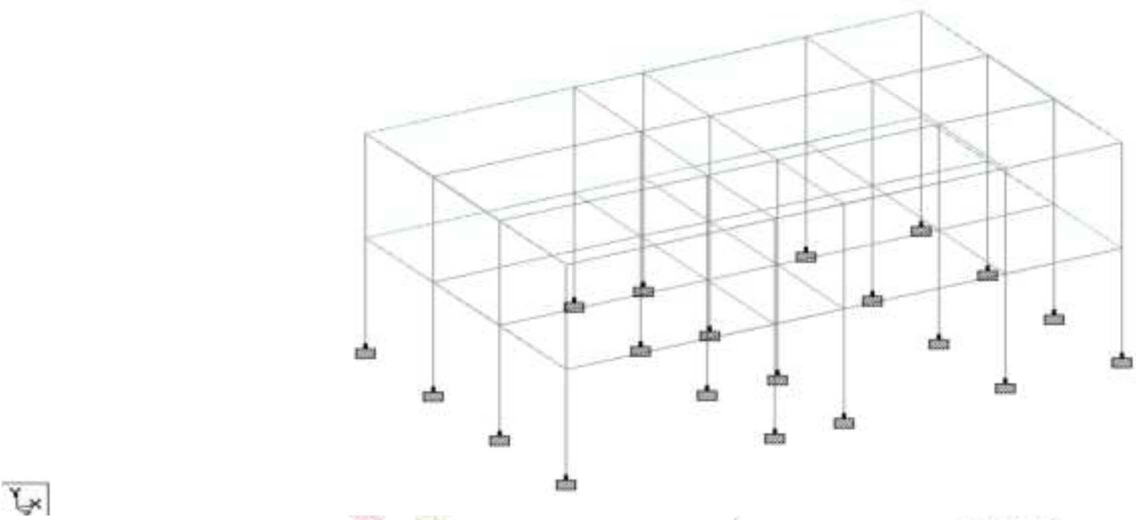

Fig 1 .Staad Pro Structure

Table 1, Reaction Table

Max & Min Reaction	Node No	Horizontal	Vertical	Horizontal	Moment		
		FX	FY	FZ	MX	MY	MZ
Max FX	16	**4.110**	125.887	-0.228	-0.231	0.024	**-4.022**
Min FX	17	-3.329	**150.308**	0.068	0.078	0.002	**3.419**
Max FY	1	2.226	**272.062**	0.304	0.280	-0.009	-2.030
Min FY	5	-0.107	4.571	0.093	0.089	0.001	0.130
Max FZ	4	-0.562	104.442	0.994	1.005	-0.001	0.746
Min FZ	49	-0.562	104.442	-0.994	-1.005	0.001	0.746
Max MX	4	-0.562	104.442	0.994	1.005	-0.001	0.746
Min MX	49	-0.562	104.442	-0.994	-1.005	0.001	0.746
Max MY	16	4.110	125.867	-0.228	-0.231	0.024	-4.022
Min MY	31	4.110	125.867	0.228	0.231	-0.024	-4.022
Max MZ	17	-3.329	150.308	0.068	0.078	0.002	3.419
Min MZ	16	4.110	125.867	-0.228	-0.231	0.024	-4.022

From above table, it can be seen that maximum load acts on footing no 1 and 17. Hence, footing no.1 & 17 is considered for further studies. The output of STAAD design for various cases are.

Case 1: Summer Season

Isolated Footing 1

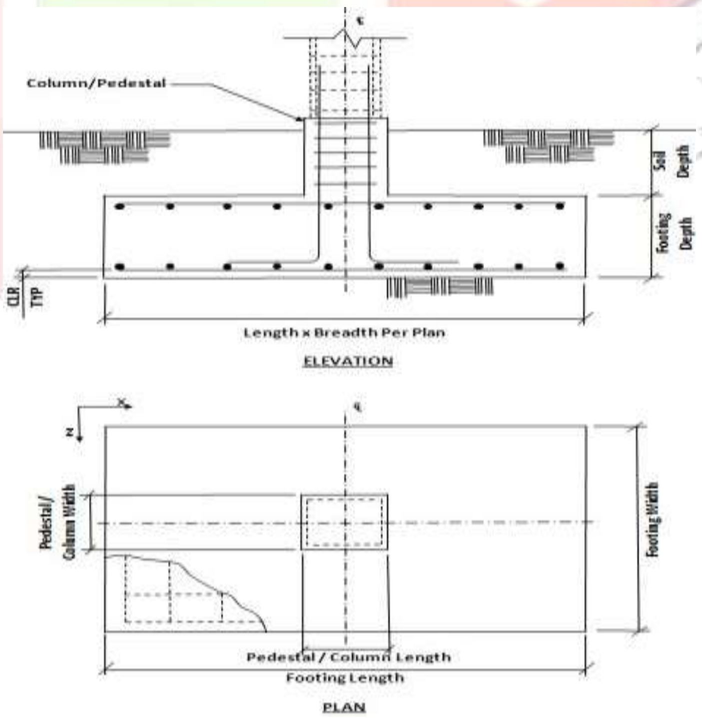

Fig 1.1 Isolated Footing for case 1

Input Value

Footing Geometry

Design Type : Calculate Dimension Footing

Thickness (Ft) : 250.000 mm

Footing Length –X (Fl) : 2800.00 mm

Footing Width –(Fw) : 1890 .00 mm

Eccentricity along x (oxd): 0.000 mm

Eccentricity along z (ozd) : 0.000 mm

Column Dimention

Column Shape :Rectangular

Column Length : -X (PI) : 0.400

Column Width - Z (PW) : 0.400

Design Parameter

Concrete and Rebar Properties

Unit Weight of concrete : 25.000 KN/m3

Strength Of Concrete : 25.000 N/mm2

Yield Strength of steel : 415.000 N/mm2

Minimum Bar Size : Ø6

Maximum Bar Size : Ø32

Minimum Bar Spacing : 50.000 mm

Maximum Bar Spacing : 500.000 mm

Pedestal C;ear Cover (p,CL) :50.000 mm

Footing Clear cover (F,CL) : 50.000 mm

Soil Properties

Soil Type : Drained

Unit Weight : 14.000 KN/mm3

Soil Bearing Capacity : 125.000 KN /mm2

Soil Surcharge :31.440 KN/ mm2

Depth of soil above Footing : 2200.00 mm

Cohesion : 15 KN/mm2

Min Percentage of slab : 0.000

Sliding and Overturning

Coefficient of Friction : 0.500

Factor of Safety against sliding :1.500

Factor of safety against overturning : 1.500

III)Observation and Remark

For the study undertaken the superstructure was analyzed and the footing design is done for exterior and interior footing resting on black cotton soil .Case –I is the modeling analysis and design of footing for summer season .Case –II is for winter season and Case-III for rainy season .

Table 2. Input soil properties of Black Cotton Soil in different seasons

	Case 1 Summer	Case 2 Winter	Case 3 Rainy
Soil Type	Drained	Drained	Undrained
Unit Weight	14.000 kN/m³	17.000 kN/m³	18.55 kN/m³
Soil Bearing Capacity	125.000 kN/m²	160.000 kN/m²	100.000 kN/m²
Soil Surcharge	31.440kN/m²	36.410 kN/m²	39.570 kN/m²
Depth of soil above Footing	2.200 m	2.200 m	2.200 m
Cohesion	15.000 kN/m²	15.000 kN/m²	-

Undrained Shear Strength	-	-	15.570 kN/m²

Remark – Table 2 shows the input values for the soil parameter with the change in season the bearing capacity is max for the same soil in winter season

Table 3. Applied Load- Service Stress For Node 1

Case No.	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
Case I	1067.781	-7.130	-0.808	-0.726	6.461
Case II	1067.781	-7.130	-0.808	-0.726	6.461
Case III	1067.781	-7.130	-0.808	-0.726	6.461

Table 4. Applied Load- Service stress Level For node 17

Case No.	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
Case I	504.899	10147	-0.201	-0.231	-10.510
Case II	504.899	10147	-0.201	-0.231	-10.510
Case III	504.899	10147	-0.201	-0.231	-10.510

Remark- From the table 3 & 4 it is very clear that the footing needs to be design for the same action and magnitude in all the three cases

Table 5 Applied Load -Strength For Node 1

Case No.	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
Case I	1601.672	-10.694	-1.212	-1.089	9.691
Case II	1601.672	-10.694	-1.212	-1.089	9.691
Case III	1601.672	-10.694	-1.212	-1.089	9.691

Table 6. Applied Load- Strength Level For Node 17

Case No.	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
Case I	757.349	15.221	-0.301	-0.346	-15.765
Case II	757.349	15.221	-0.301	-0.346	-15.765
Case III	757.349	15.221	-0.301	-0.346	-15.765

Remark – From the table 5 & 6 it can be make out that the footing is subjected for vertical gravity force as well as thrust in X & Z direction .The moment in the Z direction much more as compare to X.

Table no 7. Pressure At Four Corner For Node 1

Case No.	**Pressure at corner 1 (q_1) (kN/m2)**	**Pressure at corner 2 (q_2) (kN/m2)**	**Pressure at corner 3 (q_3) (kN/m2)**	**Pressure at corner 4 (q_4) (kN/m2)**
Case I	124.0875	122.9036	122.7703	123.9542
Case II	158.1573	156.0193	155.7787	157.9166
Case III	99.9681	99.87890	99.8690	99.9580

Remark – Table 7 the exterior footing (Node 1) pressure is compared at all four corner ,it can be observed that the pressure is maximum for the case no .I & then for case III the value of pressure development is almost 80% more for winter season as compare to rainy season .

Table no 8. Pressure At Four Corner For Node 17

Case No.	**Pressure at corner 1 (q_1) (kN/m2)**	**Pressure at corner 2 (q_2) (kN/m2)**	**Pressure at corner 3 (q_3) (kN/m2)**	**Pressure at corner 4 (q_4) (kN/m2)**

Case I	119.3193	124.8922	124.7722	119.1993
Case II	144.2881	151.9986	151.8191	144.1085
Case III	99.2375	99.8475	99.8344	99..2245

Remark – From table 8 the comparison is done for the interior footing again it is observed that the pressure development is more for winter season followed by summer & then rainy .

Table 9 .Sliding and Overturning For Node 1

Case No.	Sliding		Overturning	
	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
Case I	1618.805	55405.629	133397.332	6047.517
Case II	1174.589	40209.241	80493.284	3712.867
Case III	11320.621	358890.956	1843211.600	80176.912

Remark – From table 9 the stability check against the sliding & overturning shows that the sliding & overturning is max for rainy season followed by summer season & then winter season the values are around 103 % more for rainy season at that of winter season .

Table no 10.Sliding and Overturning For Node 17

Case No.	Sliding		Overturning	
	Along X-Direction	Along Z-Direction	About X-Direction	About Z-Direction
Case I	738.963	56718.784	113449.418	1645.136
Case II	641.301	49222.756	79023.731	1314.998
Case III	3838.688	294636.796	1169668.782	16898.242

Remark – From table 10 it is same for the interior footing (Node 17) that tyhe value are maximum for case –III (Rainy) followed by summer & winter .

Table 11 Ast Provide for Node 1

Case No.	Ast Provided
Case I	5267.666
Case II	4092.115
Case III	13891.696

Table 12 Ast Provide for Node 17

Case No.	Ast Provided
Case I	2635.610
Case II	1929.956
Case III	6163.525

Remark – From table 11 keeping the dimension of footing same that is length- 2800,Width – 1890 , Depth -250 at the depth level of 2.2 m the maximum amount of steel is required for the case- III followed by case –I (Summer) & the case –II (Winter).The amount of steel for the same loading on footing is around 3 times higher for rainy season as that of winter season .the same can be observed that table 12.

IV)Conclusion

to study the effect of seasonal variation of black cotton soil on footing the superstructure of G + 1 is analysed as per IS 456-2000 further for the reaction value the footing is analysis and design considering black cotton soil and changes in seasonal condition.

Three cases analyzed are case I (Summer) case II (Winter) case III (Rainy) season from the analyse it can be concluded that for the same footing dimension and for the same overlying load following observation are mark. The footing is subjected to more pressure in winter season followed by summer and then .rainy similarly it is observed that for the stability against sliding and overturning the footing is 10 times at the higher risk in rainy season as that to winter and summer season.The amount of total still provision is almost three times more for rainy season at that to Winter season. From this study it can be understand very well that while designing the substructure the soil behaviour with the structure with change seasonal in seasonal conditions should not be avoided. while stresses are more in winter season the Steel provision is more for rainy season since the seasonal variation are unvoidable the footing shall be design for all higher values.

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VI)References

[1] A.R.Gupta ,Ruchira.R.Bobade “Study of foundation for black cotton soil’’,International journal for research in applied science science and engineering technology , ISSN -2321-9653, vol- 7,issue –v May 2019.

[2] BrajeshMishra , “A Study on Engineering Behaviour of Black Cotton Soil and its Stabilization by use of lime’’,International Journal of Science and Research,ISSN 2319-7064 ,2013.

[3] Er Zulufquar bin Rashid ,Amendra Prasad yadav “Behaviour of black cotton soil stabilized with fly ash’’ ,international journal of research,ISSN 2348-795X vol-3 ,issue -14 ,octomber 2016.

[4] Neelima Satyam, ManneAkhila “Design of Support System for Excavation inBlack Cotton Soils in Guntur,’ India, International Conference on Geotechnique, ISBN -978 ,November 2012.

[5] J.ranjitha, kishankumar, k.guruankith, nithinkumar “,Laboratory study on CBR Value of black cotton soil treated with crushed coconut shells,’’ international journal of advancein mechanical and civil engineering ,ISSN 2394-2827,Sep 2016

[6]MasoumehMokhtari,MasoudDehghani,Swell shrink behaviour of expansive soils Damage and Control,EJGE ,Vol-17,2012.

[7] V. ramaswamy, I.V. Anirudhan ,Experience with expansive soils and shales in and around Chennai,Geotide IGC ,2009.

[8] M.R.Mahood,S.F.A.AL-wakel,Experimental and numerical analysis of pile raft foundation embedded within partially saturated soil,Engineering and technology journal,Vol-35 2017.

[9] Arpit Agrawal,MrArpitChawda,Experimental investigation of different shaped isolated footings under static load and impact loading on sandy soil and black cotton soil ,International journal of Engineering research technology ISSN- 2277-9665,Sep-2016.

[10] **Mahmoud SamirEl-kadya ,Essam Farouk Badrawic** Performance of isolated and folded footing ,science direct,Sep 2016.