International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 12, December-2018

ANALYSIS AND DESIGN OF HIGH RISE BUILDING ON A LOOSE SOIL WITH RAFT FOUNDATION USING ETABS AND SAFE

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***Abstract*— In the present scenario a foundation must convey load of a structure and transfer it to subsoil strata with no excessive settlement. Usually practice to initially study shallow foundation arrangement for any building. raft foundation covers the whole projection area of building. At the point when the foundation has satisfactory bearing limit however the settlement isn't inside permissible limit, a pile groups is added the to raft to decrease the settlement. The conduct of raft foundation framework is impacted by different factors, for example, raft thickness, pile length, pile spacing and quantity of piles, which should be must considered for a sparing and economical design. A mathematical study has been done by using geotechnical finite element software, to explore impact of above different variables. The point is to ideally use load bearing capability of the raft foundation.**

Raft foundation delivers an economical foundation as compared to conventional pile foundations. Minimizing the average settlement and optimizing the depth of raft. Some of existing methods for study of raft behavior offered by different scholars are viewed and their abilities and limits are discussed.

***Keywords*— raft foundation, pile groups, differential settlement, pile foundation.**

I. INTRODUCTION

Engineering expert specialty of applying science to proficient transformation of resources to help man. Engineering thusly requires over all inventive creative imaginative valuable application for natural phenomenon.

DESIGN PROCESS:
procedure of basic arranging and configuration requires creative ability reasoning sound learning of building of useful perspectives, ongoing plan codes, bye laws, upheld up by plentiful experience, instinct and judgment. The purpose of standards to guarentee and upgrade the wellbeing, keeping watchful harmany among economy and security.
Therefore, structure is ordered into the accompanying two composes:

[1] Functional design.
[2] Structural design.

FUNCTIONAL DESIGN:
building should give upbeat condition. Subsequently, the functioning arranging of a building must consider the correct courses of action of rooms/lobbies, great ventilation, lighting, acoustics, unhindered view on account of corridors, film lobbies, adequate head room, appropriate water supply and seepage game plans, planting of trees. remembering every viewpoints the engineer needs to choose should a load bearing structure.

STRUCTURAL DESIGN:
Structural design workmanship and study of conduct of basic individuals subjected to loads planning them with economy and style to give protected, useful and solid structure.
The standard components of a R.C building outline comprises of:
slabs covers expansive are

- beams to help slabs
- columns to support beams
- footings to disperse concentrated section stacks substantial of supporting soil with that the bearing limit soil isn't surpassed.

STRUCTURAL PLANNING:
the structural arranging of the building outline is finished. This includes assurance of the accompanying:

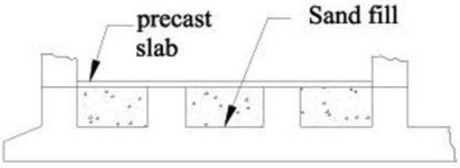
- Positioning of columns .
- Positioning of beams.

- Spanning slabs.
- Layout of staircase.

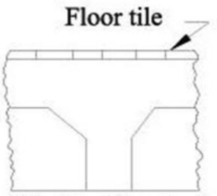
(a) Flat slab raft

(b) Flat slab raft with pedestals

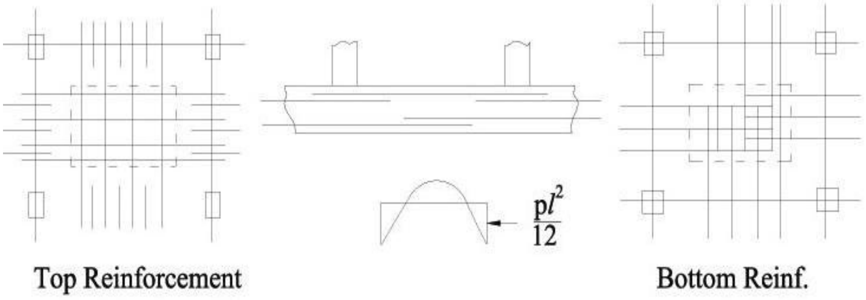
(c) Flat slab raft thickened under column



(d) Raft with rebs above slab



(e) Raft with rebs below slab



II. LITERATURE REVIEW

Gupta (1997), Behavior of raft foundation on super structure: -

Basically two approaches have been suggested for analyzing the behavior of raft foundations as;

1. Rigid foundation approach
2. Flexible foundation approach

Rigidity or flexibility of a raft depends on the relative stiffness of itself and the subsoil. The behavior of the foundation also depends on the rigidity of the superstructure (Gupta (1997)). It should be noted that the contribution of the rigidity of the superstructure to the rigidity of the foundation is not considered within this study.

Raft Stiffness:

Assuming a rigid raft, the raft stiffnessk_r has been given by Poulos and Davis (1974) as:

In addition to the above formula for the raft stiffness, various authors suggested different relative stiffness (K) factors for the raft foundations. Gupta (1997) relates the stiffness of raft with the underlying soil for:

Where,

E_r= Young’s modulus of the raft
E_s=Young’s modulus of the sub soil
B= length of the section in the bending axis
t=thickness of the raft
R=radius of the raft

Gupta (1997) considered raft as “rigid” if the K>0.5. Fraser and Wardle (1976) assumed that the raft is fully flexible for$K$<0.01 and rigid for the values of$K$ greater than unity. Furthermore, Horikoshi and Randolph (1997) reported that the raft is fully flexible for K=0.001 and is rigid for K=1000.

Depending on the raft geometry, relative stiffness of the raft can be found using the above equations. After the determination of relative stiffness*K*of the raft, settlement ρ of the rectangular raft may be found by the expression suggested by Fraser and Wardle (1976) as:

$$\rho = pb\frac{(1-\nu_s^2)}{E_s}\,I$$

Where,

P= Applied uniform pressure
I= Influence factor,

R. R. Chaudhary, Dr K. N. Kadam. Effect of Piled Raft Design on High-Rise Building Considering Soil Structure Interaction: -

R. R. Chaudhary, Dr K. N. Kadam Piled-raft foundations for important high-rise buildings have proved to be a valuable alternative to conventional pile foundations or mat foundations. The concept of using piled raft foundation is that the combined foundation is able to support the applied axial loading with an appropriate factor of safety and that the settlement of the combined foundation at working load is tolerable.Pile raft foundation behavior is evaluated with many researches and the effect of pile length; pile distance, pile arrangement and cap thickness are determined under vertical or horizontal static and dynamic loading. In the present paper the influence of pile length configurations on behavior of multi-storied are evaluated under vertical loading. In practice, the foundation loads from structural analysis are obtained without allowance for soil settlements and the foundation settlements are estimated assuming a perfectly flexible structure. However, the stiffness of the structure can restrain the displacements of the foundations and even tiny differential settlements of the foundations will also alter forces of the structural members. Hence, the interaction among structures, their foundations and the soil medium below the foundations alter the actual behavior of the structure considerably than what is obtained from the consideration of the structure alone. In this work, analysis of pile soil structure interaction has been studied by finite element software ANSYS 11.

Anuj Chandiwala. Fem Modelling for Piled Raft Foundation in Sand: -

Anuj Chandiwala. In recent years, there have been an increasing number of structures using piled rafts as the foundation to reduce the overall and differential settlements. For cases where a piled raft is subjected to a non-uniform loading, the use of piles with different sizes can improve the performance of the foundation. Extensive research work has been performed in the past to examine the behavior of piled rafts. However, most of the research was focused on piled rafts supported by identical piles, and the use of non-identical piles has not received much attention. In this paper, the behavior of piled raft is examined by the use of a computer program MIDAS GTS based on the finite layer and finite element methods. The finite layer method is used for the analysis of the layered soil system. The finite element method is used for the analysis of the raft and piles. Full interaction between raft, piles and soil which is of major importance in the behavior of piled rafts is considered in the analysis. Among the four different types of interaction present in the piled raft foundation. The interaction between piles plays an important role. Two dimensional (2D) finite element analyses of un-piled and piled raft foundations with sandy soil. For the un-piled raft, the normalized settlement parameter (IR) for the raft sizes of 8mx8m and 15mx15m ranged as 1.03-1.17mm and 0.66- 0.83mm respectively.

In the case of the piled raft with raft thickness of 0.25, 0.40, 0.80, 1.50, 3.0m, the corresponding maximum settlements are 66, 64, 63.7, 63mm. The results of these analyses are summarized into a series of design charts, which can be used in engineering practice

Poulos, H. G. (2001). "Piled Raft Foundations: Design and Applications": -

H.G. Poulos. This paper describes the philosophy of using piles as settlement reducers and the condition under which such an approach may be useful. Some of the characteristics of Piled raft behavior are also described. The design process of Piled raft is explained in three stages. The first is preliminary stage in which the effect of number of piles on the capacity and the settlement are assessed via an approximate analysis. The second is a more detail study to asses to find out where piles are required. The third is detailed design phase in which a more refined analysis is employed to confirm optimum number and locations of piles.

III. METHODOLOGY

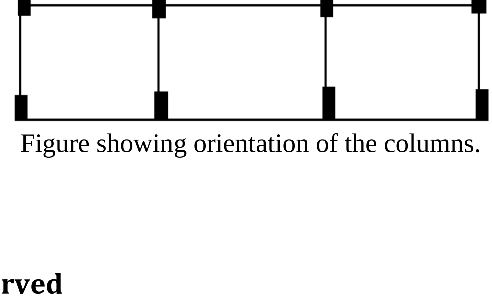
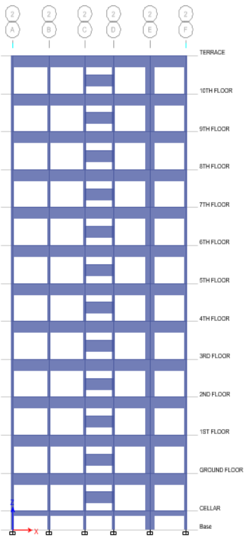
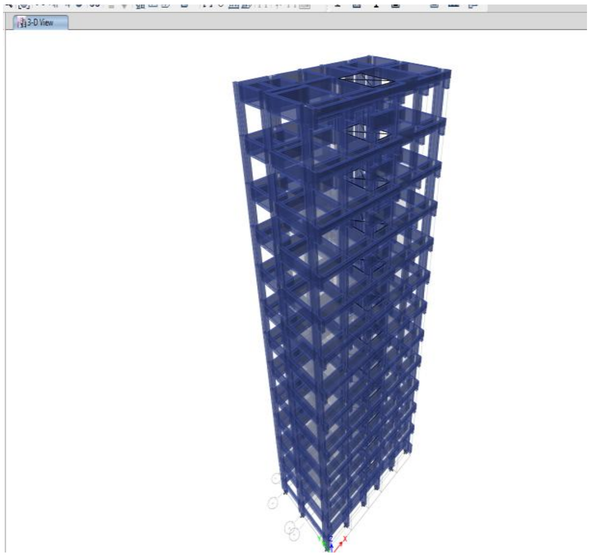


Figure showing orientation of the columns.





Elevation of the structure

3D view of the structure

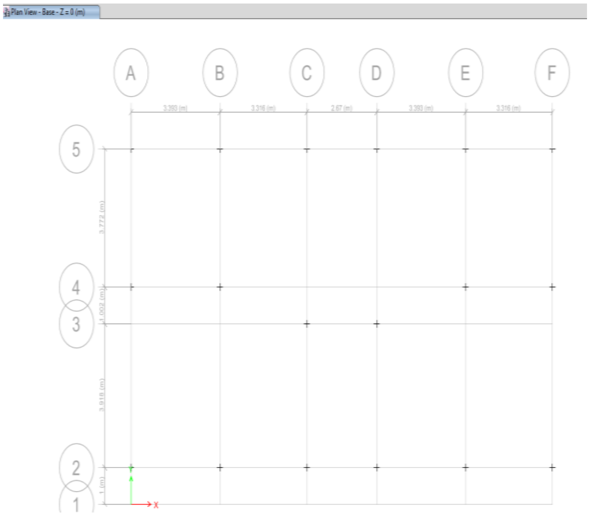


Figure showing the supports

3.2 specifications and loads considered:

All the factors considered are as per IS 1893-2002 and IS875 part 1,2 and 3

DEAD LOAD:

Dead load is calculated as per IS 875 part1

Assuming that slab is of 150mm thickness as per span/depth calculations of IS456.

Then total dead load is calculated as:

$0.15 \times 24 = 3.6KN/m^2 + 1.5KN/m^2$ *(Floor finishing)* $= 5.1KN/m^2$

The value of $5.1KN/m^2$ *has been assigned to the structure as shown in the figure and its distributing pattern also shown.*

WALL LOADS:*Here two types of walls are considered, i.e. 9” thickness wall (230mm) and* $4\frac{1}{2}$*” thickness wall (115mm).230mm is given to external walls (perimeter) and 115mm is assigned to all internal walls.*

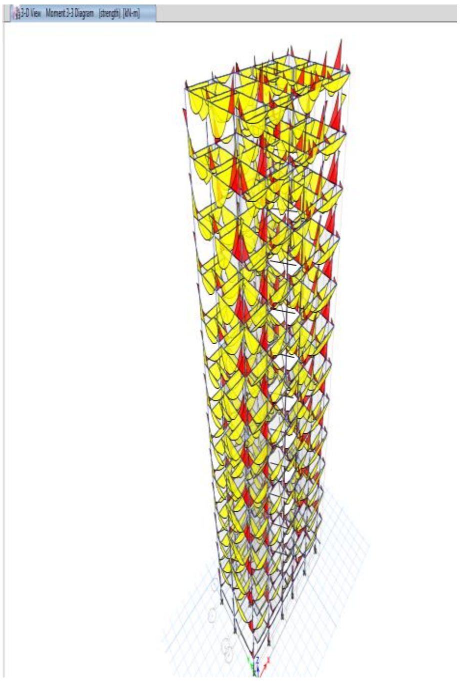
5.3.3 LIVE LOAD:

As per IS 875 part 2, the live load on the residential buildings should be taken as $2KN/m^2$*.So, here* $2KN/m^2$ *has been assigned to entire structure.*

For all the secondary beams, moment has been released, i.e. torsion effect has been removed and is treated as simply supported beams.

topography factor(k2) : 1.0

IV. RESULTS



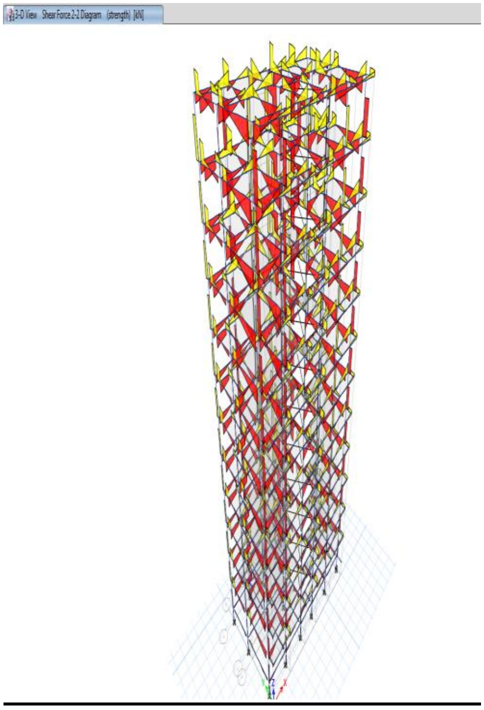


FIG 4.1 showing bending moment of the structure

FIG 4.2 showing shear force of the structure

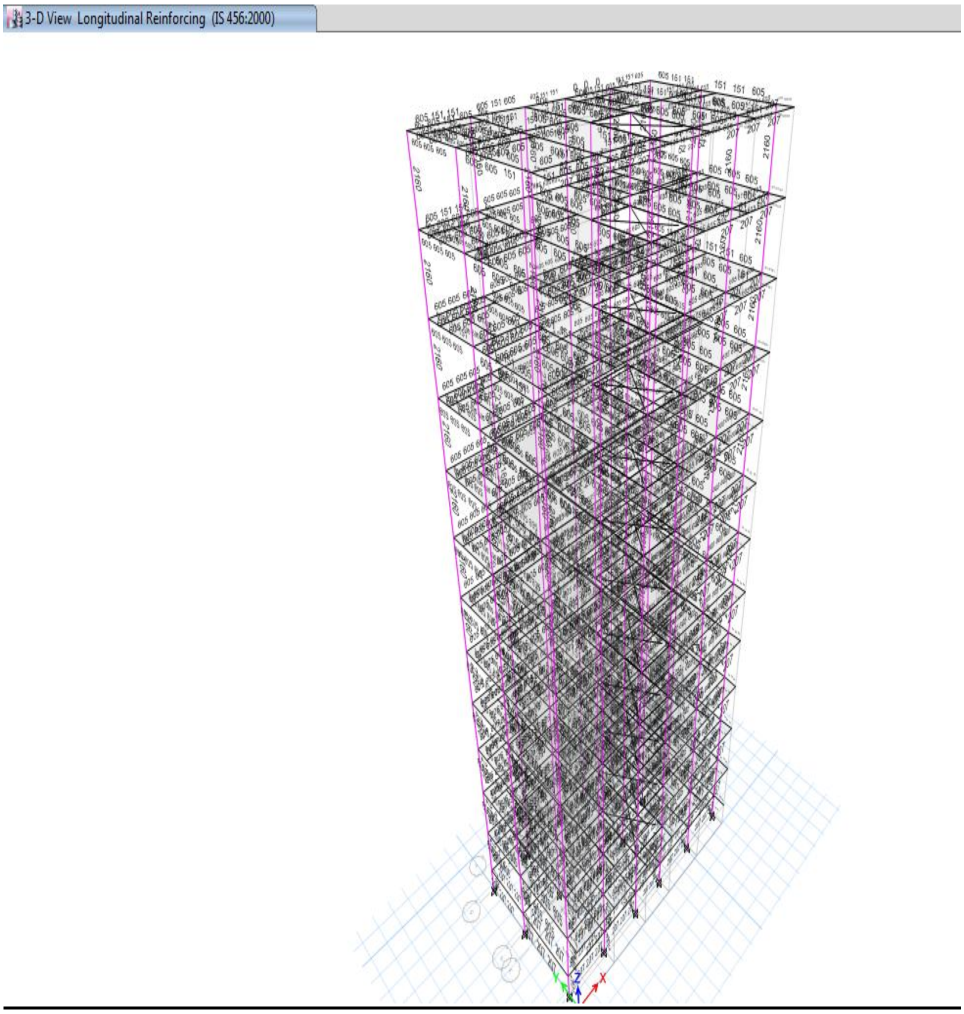
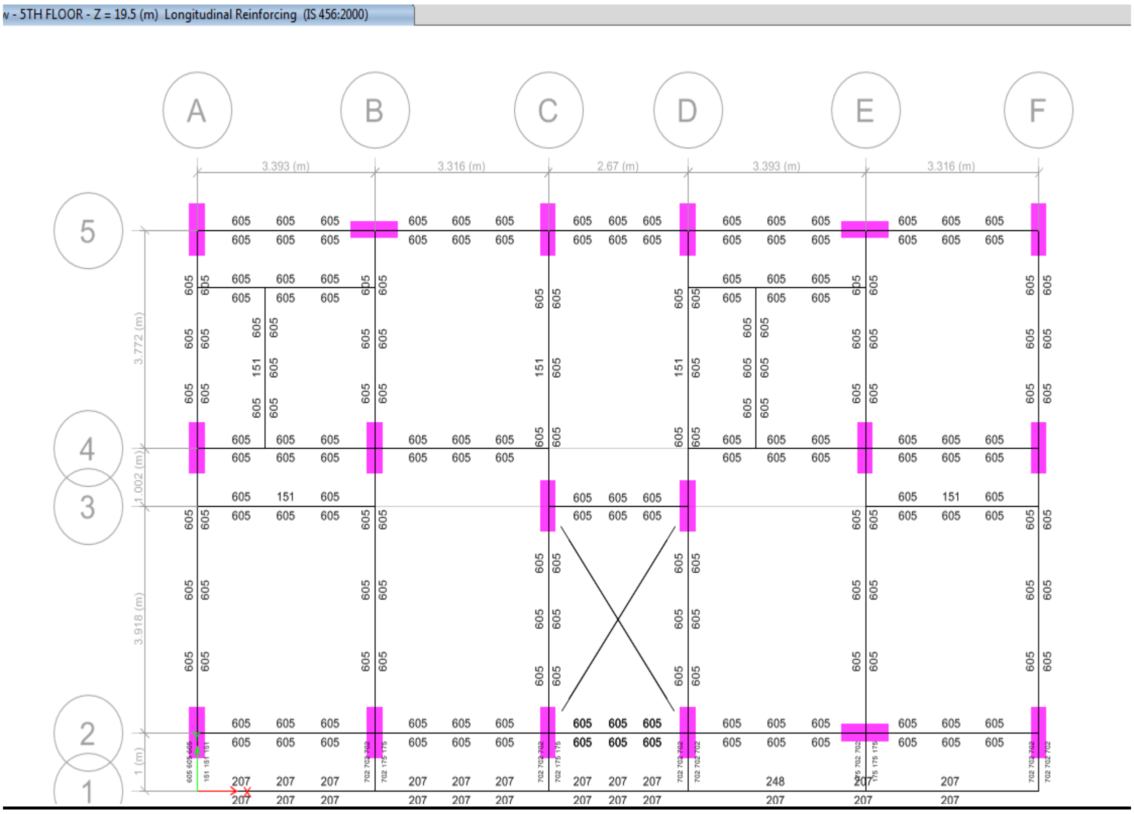


Table 4.2 showing structural elements



Graph 4.2 longitudinal reinforcement details

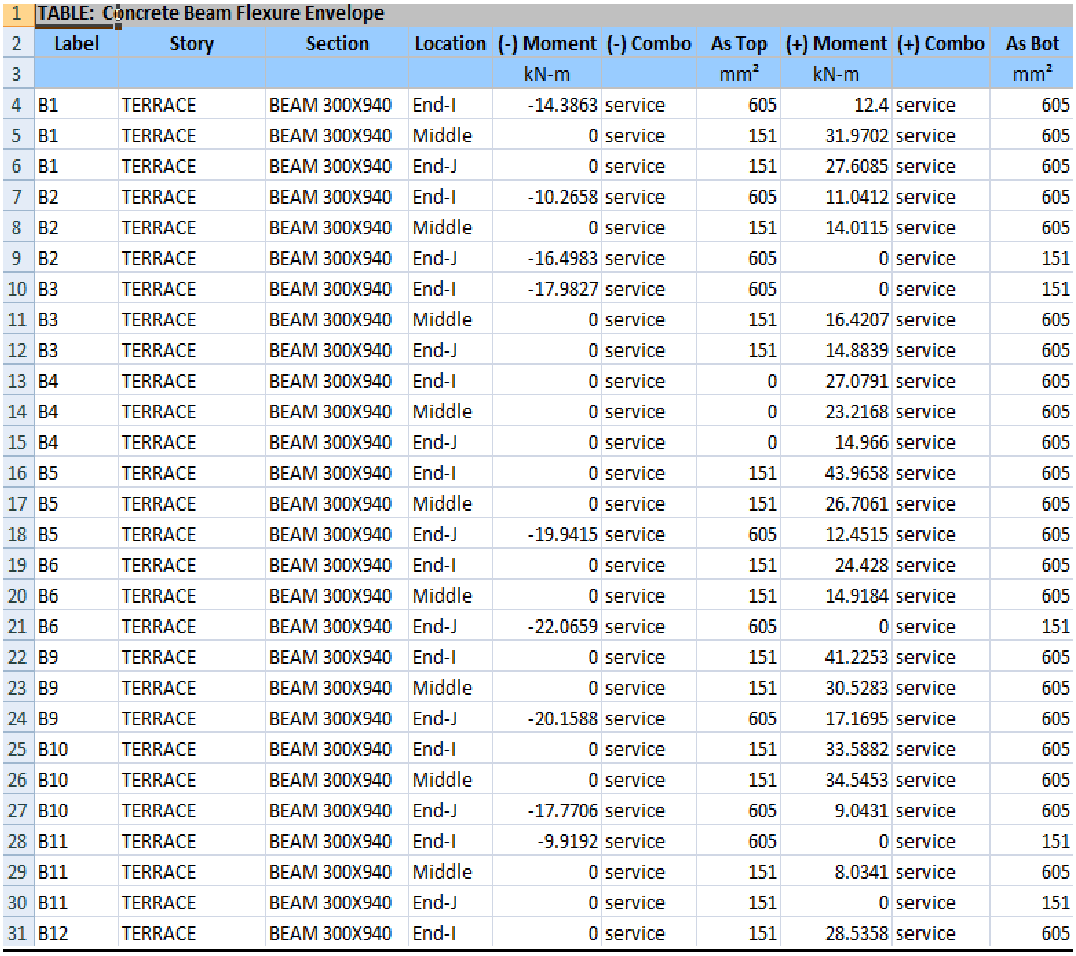
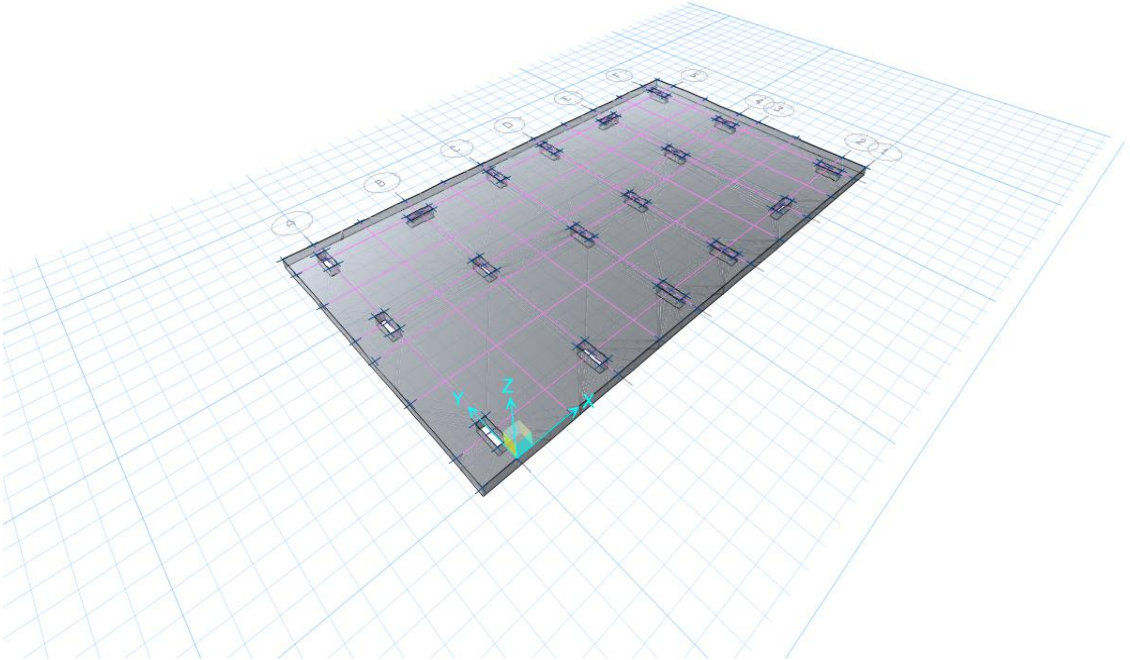


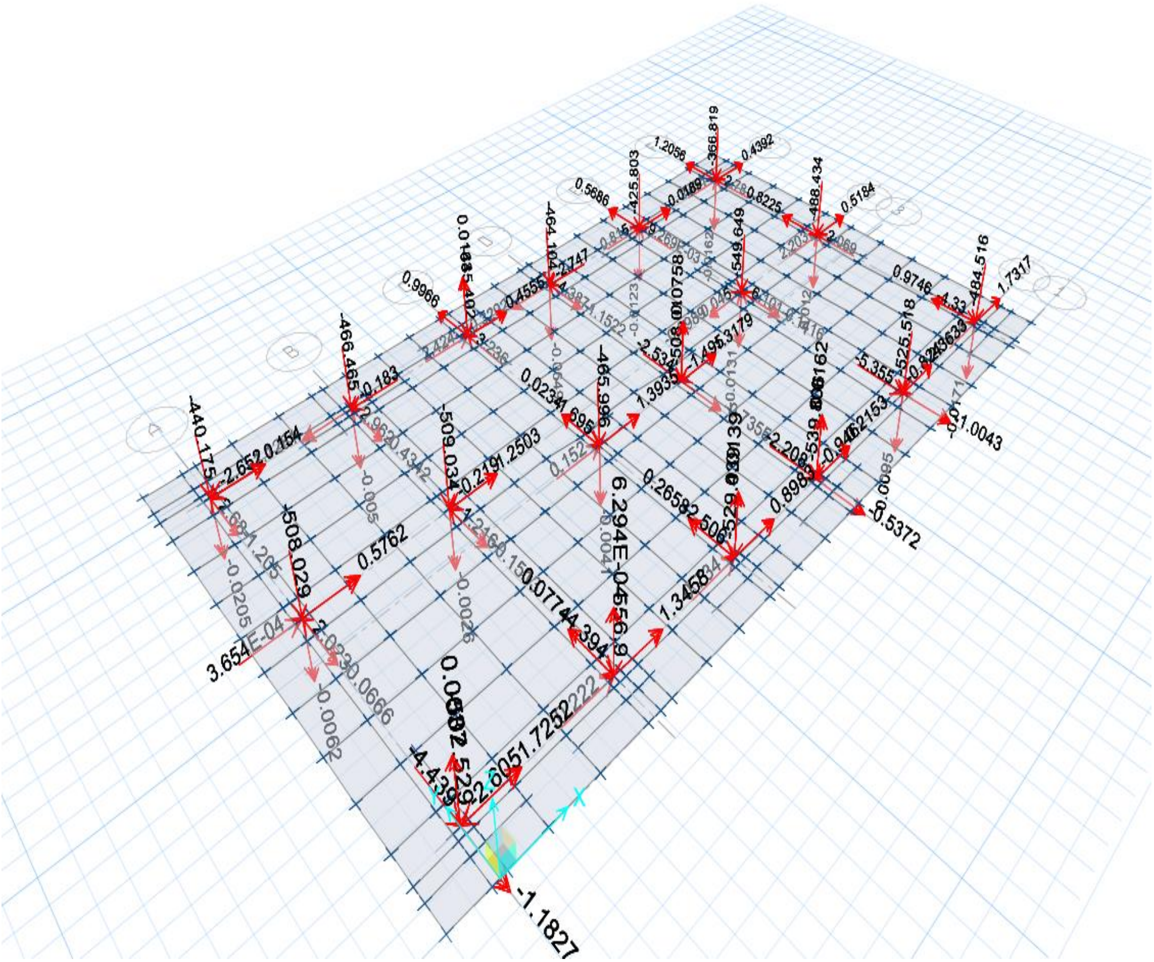
TABLE: Concrete Beam Flexure Envelope

Label	Story	Section	Location	(-) Moment	(-) Combo	As Top	(+) Moment	(+) Combo	As Bot
				kN-m		mm²	kN-m		mm²
B1	TERRACE	BEAM 300X940	End-I	-14.3863	service	605	12.4	service	605
B1	TERRACE	BEAM 300X940	Middle	0	service	151	31.9702	service	605
B1	TERRACE	BEAM 300X940	End-J	0	service	151	27.6085	service	605
B2	TERRACE	BEAM 300X940	End-I	-10.2658	service	605	11.0412	service	605
B2	TERRACE	BEAM 300X940	Middle	0	service	151	14.0115	service	605
B2	TERRACE	BEAM 300X940	End-J	-16.4983	service	605	0	service	151
B3	TERRACE	BEAM 300X940	End-I	-17.9827	service	605	0	service	151
B3	TERRACE	BEAM 300X940	Middle	0	service	151	16.4207	service	605
B3	TERRACE	BEAM 300X940	End-J	0	service	151	14.8839	service	605
B4	TERRACE	BEAM 300X940	End-I	0	service	0	27.0791	service	605
B4	TERRACE	BEAM 300X940	Middle	0	service	0	23.2168	service	605
B4	TERRACE	BEAM 300X940	End-J	0	service	0	14.966	service	605
B5	TERRACE	BEAM 300X940	End-I	0	service	151	43.9658	service	605
B5	TERRACE	BEAM 300X940	Middle	0	service	151	26.7061	service	605
B5	TERRACE	BEAM 300X940	End-J	-19.9415	service	605	12.4515	service	605
B6	TERRACE	BEAM 300X940	End-I	0	service	151	24.428	service	605
B6	TERRACE	BEAM 300X940	Middle	0	service	151	14.9184	service	605
B6	TERRACE	BEAM 300X940	End-J	-22.0659	service	605	0	service	151
B9	TERRACE	BEAM 300X940	End-I	0	service	151	41.2253	service	605
B9	TERRACE	BEAM 300X940	Middle	0	service	151	30.5283	service	605
B9	TERRACE	BEAM 300X940	End-J	-20.1588	service	605	17.1695	service	605
B10	TERRACE	BEAM 300X940	End-I	0	service	151	33.5882	service	605
B10	TERRACE	BEAM 300X940	Middle	0	service	151	34.5453	service	605
B10	TERRACE	BEAM 300X940	End-J	-17.7706	service	605	9.0431	service	605
B11	TERRACE	BEAM 300X940	End-I	-9.9192	service	605	0	service	151
B11	TERRACE	BEAM 300X940	Middle	0	service	151	8.0341	service	605
B11	TERRACE	BEAM 300X940	End-J	0	service	151	0	service	151
B12	TERRACE	BEAM 300X940	End-I	0	service	151	28.5358	service	605

Table 4.3 table illustrating concrete beam flexural envelope



Graph 4.3 safe model for raft footing



Graph 4.4 load details in safe

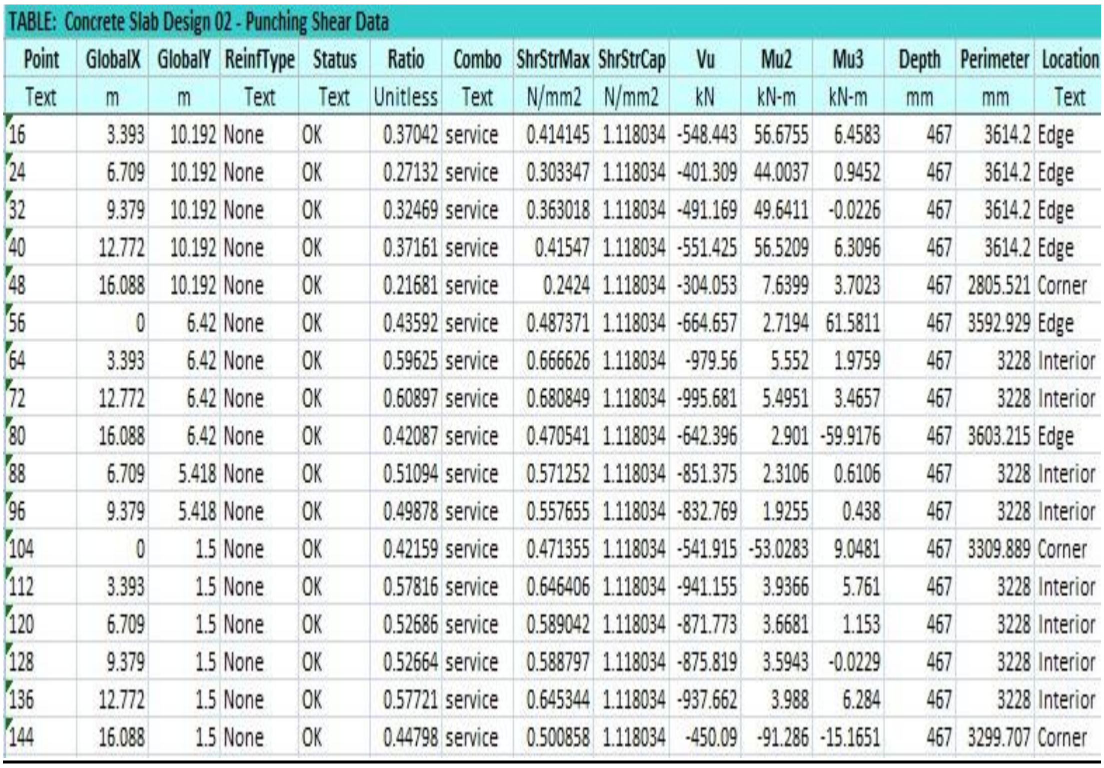
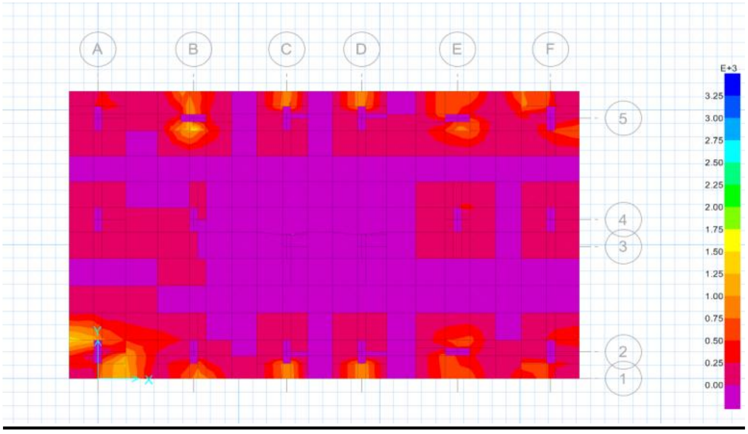


TABLE: Concrete Slab Design 02 - Punching Shear Data

Point	GlobalX	GlobalY	ReinfType	Status	Ratio	Combo	ShrStrMax	ShrStrCap	Vu	Mu2	Mu3	Depth	Perimeter	Location
Text	m	m	Text	Text	Unitless	Text	N/mm2	N/mm2	kN	kN-m	kN-m	mm	mm	Text
16	3.393	10.192	None	OK	0.37042	service	0.414145	1.118034	-548.443	56.6755	6.4583	467	3614.2	Edge
24	6.709	10.192	None	OK	0.27132	service	0.303347	1.118034	-401.309	44.0037	0.9452	467	3614.2	Edge
32	9.379	10.192	None	OK	0.32469	service	0.363018	1.118034	-491.169	49.6411	-0.0226	467	3614.2	Edge
40	12.772	10.192	None	OK	0.37161	service	0.41547	1.118034	-551.425	56.5209	6.3096	467	3614.2	Edge
48	16.088	10.192	None	OK	0.21681	service	0.2424	1.118034	-304.053	7.6399	3.7023	467	2805.521	Corner
56	0	6.42	None	OK	0.43592	service	0.487371	1.118034	-664.657	2.7194	61.5811	467	3592.929	Edge
64	3.393	6.42	None	OK	0.59625	service	0.666626	1.118034	-979.56	5.552	1.9759	467	3228	Interior
72	12.772	6.42	None	OK	0.60897	service	0.680849	1.118034	-995.681	5.4951	3.4657	467	3228	Interior
80	16.088	6.42	None	OK	0.42087	service	0.470541	1.118034	-642.396	2.901	-59.9176	467	3603.215	Edge
88	6.709	5.418	None	OK	0.51094	service	0.571252	1.118034	-851.375	2.3106	0.6106	467	3228	Interior
96	9.379	5.418	None	OK	0.49878	service	0.557655	1.118034	-832.769	1.9255	0.438	467	3228	Interior
104	0	1.5	None	OK	0.42159	service	0.471355	1.118034	-541.915	-53.0283	9.0481	467	3309.889	Corner
112	3.393	1.5	None	OK	0.57816	service	0.646406	1.118034	-941.155	3.9366	5.761	467	3228	Interior
120	6.709	1.5	None	OK	0.52686	service	0.589042	1.118034	-871.773	3.6681	1.153	467	3228	Interior
128	9.379	1.5	None	OK	0.52664	service	0.588797	1.118034	-875.819	3.5943	-0.0229	467	3228	Interior
136	12.772	1.5	None	OK	0.57721	service	0.645344	1.118034	-937.662	3.988	6.284	467	3228	Interior
144	16.088	1.5	None	OK	0.44798	service	0.500858	1.118034	-450.09	-91.286	-15.1651	467	3299.707	Corner

Table 4.5 punching shear data



Graph 4.5 bottom steel intensity details in direction 1

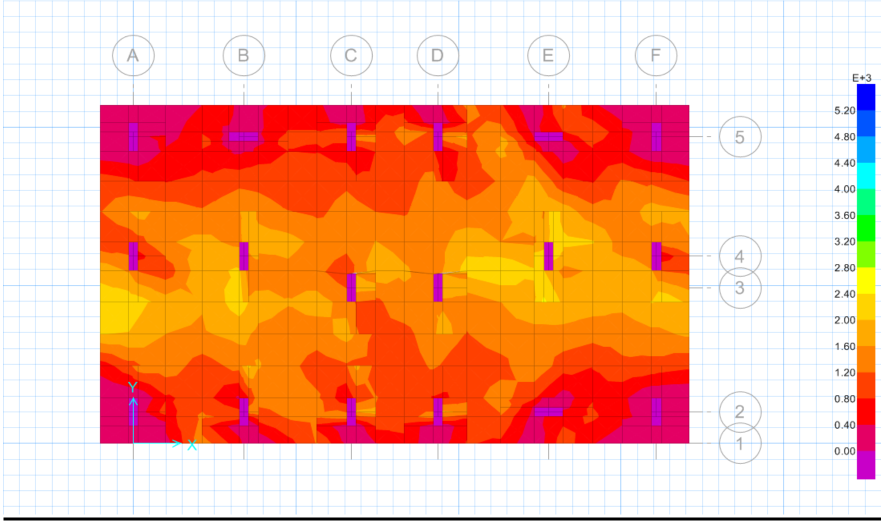


Table 4.6 bottom steel intensity details in direction 2

TABLE: Concrete Slab Design Summary 01 - Flexural And Shear Data

Strip	SpanID	Location	TopComb	TopMome	FTopArea	BotComb	BotMome
Text	Text	Text	Text	kN-m	mm2	Text	kN-m
CSA4	Span 1	Start	service	-90.437	462.041	service	66.3789
CSA4	Span 1	Middle	service	-184.269	959.487	service	126.0799
CSA4	Span 1	End	service	-7.5798	38.118	service	164.5993
CSB7	Span 1	Start	service	-43.6826	222.482	service	60.4497
CSB7	Span 1	Middle	service	-48.8167	249.054	service	71.3232
CSB7	Span 1	End	service	-34.218	173.79	service	45.6512
CSB8	Span 1	Start	service	-68.3876	350.583	service	179.1336
CSB8	Span 1	Middle	service	-83.1487	428.39	service	64.1215
CSB8	Span 1	End	service	-57.6018	294.587	service	168.4278
CSB9	Span 1	Start	service	-58.888	300.837	service	82.3006
CSB9	Span 1	Middle	service	-32.8272	166.619	service	152.8183
CSB9	Span 1	End	service	-53.8049	274.536	service	72.5793
MSB2	Span 1	Start	service	-100.378	510.994	service	51.5842
MSB2	Span 1	Middle	service	-114.341	583	service	63.3755
MSB2	Span 1	End	service	-85.9364	437.059	service	40.2109
MSB3	Span 1	Start	service	-88.0592	449.989	service	11.0627
MSB3	Span 1	Middle	service	-162.358	841.708	service	37.1524
MSB3	Span 1	End	service	-56.0127	284.547	service	58.0332
MSB4	Span 1	Start	service	-118.041	603.243		0
MSB4	Span 1	Middle	service	-91.6139	466.623	service	94.9643
MSB4	Span 1	End	service	-101.404	516.874	service	0
MSB5	Span 1	Start	service	-108.737	557.675	service	12.1712
MSB5	Span 1	Middle	service	-122.971	632.578	service	39.9174
MSB5	Span 1	End	service	-51.6065	262.015	service	72.6833
MSB6	Span 1	Start	service	-108.59	556.823	service	8.9251
MSB6	Span 1	Middle	service	-117.368	602.975	service	41.9263
MSB6	Span 1	End	service	-43.9671	222.872	service	75.1217

MSB6	Span 1	End	service	-43.9671	222.872	service	75.1217	382.837
MSB7	Span 1	Start	service	-84.1058	429.565	service	14.886	75.21
MSB7	Span 1	Middle	service	-154.801	801.274	service	45.0535	228.745
MSB7	Span 1	End	service	-61.2223	311.163	service	56.5706	287.262
CSA10	Span 1	Start	service	-106.722	547.231	service	100.0183	512.302
CSA10	Span 1	Middle	service	-174.577	907.381	service	124.072	638.348
CSA10	Span 1	End	service	-111.346	571.586	service	221.7227	1164.987
CSA11	Span 1	Start	service	-117.591	604.027	service	52.1249	264.374
CSA11	Span 1	Middle	service	-158.111	818.755	service	134.1254	691.193
CSA11	Span 1	End	service	-0.1421	0	service	200.6383	1048.318
CSA12	Span 1	Start	service	-118.018	606.235	service	71.7767	365.513
CSA12	Span 1	Middle	service	-158.788	822.377	service	129.6885	667.734
CSA12	Span 1	End	service	-8.1041	40.759	service	211.593	1108.047
CSA13	Span 1	Start	service	-112.458	577.296	service	217.6113	1142.472
CSA13	Span 1	Middle	service	-171.967	893.297	service	128.1919	660.297
CSA13	Span 1	End	service	-87.0345	444.623	service	105.7219	542.016
CSA14	Span 1	Start	service	-74.8982	381.73	service	47.2332	239.466
CSA14	Span 1	Middle	service	-171.581	891.097	service	130.3055	671.279
CSA14	Span 1	End	service	-7.9388	39.955	service	152.9621	791.69
CSB10	Span 1	Start	service	-68.1221	349.036	service	45.9391	234.015
CSB10	Span 1	Middle	service	-81.9973	421.995	service	113.923	591.855
CSB10	Span 1	End	service	-56.4535	288.263	service	48.7795	248.633

Graph 4.6 concrete slab design for flexural shear data

V. CONCLUSIONS

1. It is observed that using raft foundation, the settlement of the foundation can be reduced.
2. It is observed that raft foundation supported by soil only, settles more as compared to raft foundation with piles supported by soil.
3. From analysis of raft foundation for cohesive soil. Settlement can be reduced by 60% by introducing raft foundation.
4. It´s clear that there are several methods for analyzing raft foundation systems. Some are quite simple and can be implemented with minimal computer requirements, while others are more complex such as the safe.
5. raft foundation tend to be economical quicker to use than any other footings.
6. various foundations that makes raft foundation suitable are due to their benefits. They are good for poor ground conditions where other footings will not cope well.
7. raft foundations can reduce differential settlement where it occurs at different rates across the surface of the building. Which reduces cracking and other problems.
8. the footing and slab floor is combined which saves time and it will be economical and hence less excavation is required.
9. raft or mat foundation is casted where shallow foundation is necessary and soil condition is poor. And it requires less earth excavation.
10. it distributes loads over large area. Decrease of tilt in consideration of eccentric loads and inhomogeneous soil conditions.

VI. Refrences

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