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DESIGN OF PILE FOUNDATION FOR (G+1) SPORTS COMPLEX

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Abstract - The possibility of construction structure in black cotton soil in difficult due to their poor load bearing capacity and deformation characteristics. To overcome that problem pile foundation is best choice .In this project the load carrying capacity of the circular pile is calculated with help of the soil characteristics by using that value that value the pile cap .Design is carried out the wind, earthquake also considered in the analysis .by using column base reaction the pile foundation analysis and design is carried on CYPE CAD structural software, by using available results structural drawings of pile cap and strap are prepared.

Key Words: Calculation of Pile Capacity, Design of Pile Cap

1. INTRODUCTION

Pile foundation is a type of foundation, is made up of materials such as concrete, steel, or timber, which are used to support the structure and transfer the load at desired depth either by end-bearing or skin friction.

Foundations provide support to the structure, transfers the loads from the superstructure to the soil (ground). But the layer at which the foundation moves the load shall have an adequate bearing capacity and suitable settlement characteristics.

2. Site Details

1	Type of structure	Sports complex
2	Type of building	Commercial building
3	Seismic zone	Belgaum region zone III(IS 1893-2000)
4	Number of storey storey	G+1
5	Floor height	3.65m
6	Live load	3 kN/m^2
7	Floor finish	1.5 kN/m^2
8	Type of soil	Soft (Black cotton soil)
9	Size of building	a) X- direction =60m b) Z-direction = 40m
10	Depth of slab	150mm
11	Size of column	0.60m x0.60m,1.00mx1.00m
12	Size of beam	1.0mx1.0x and 0.60mx0.60m
13	Size of strap beam	0.40m x 0.70m and 0.23m x 0.45m
13	Thickness of wall	230mm

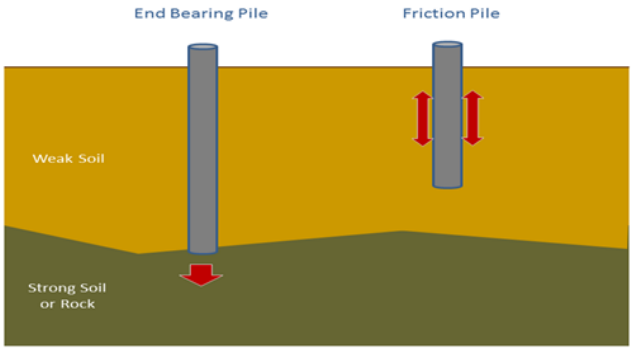

Figure 1.1 Types of Pile Foundation Based on Function

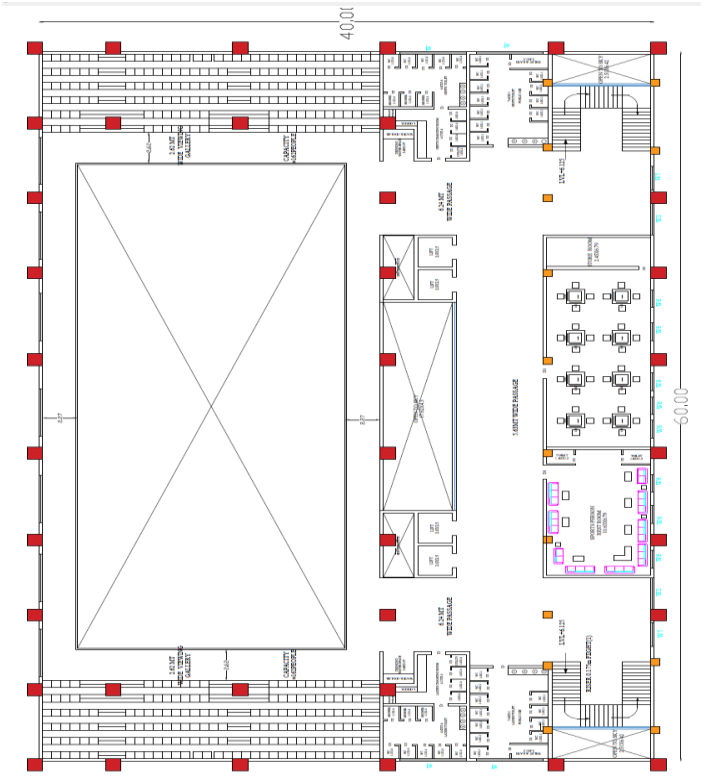

Figure 1.2 Ground floor plan

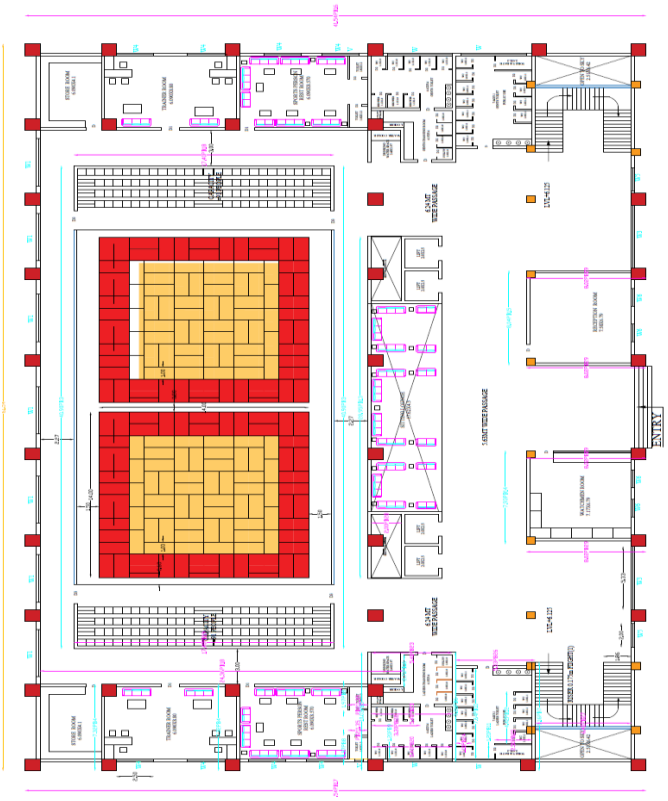

Figure 1.2 First floor plan

3. Manual calculation:

Load carrying capacity of single pile:

A. Single pile:

Assumed pile diameter=600mm and length of pile=3.6m

$\sum Qui = n1n2(Qp+Qs)$ ..... (4.1)

$Qp = Ap(9\ Cu(p))$ .....(4.2)

$= \pi /4(0.6)^2 \times (9x75) = 190.851$ kN

$Qs = \sum \alpha PCuL$ (We get the "α" value from graph).....(4.3)

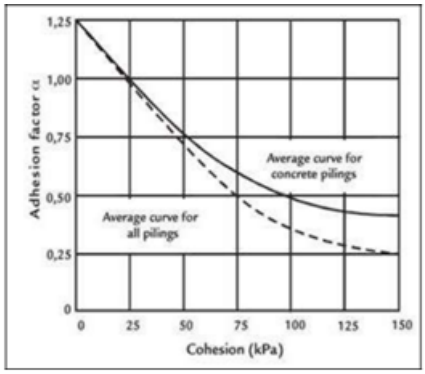

Fig 4.3 Single Pile graph

$Qs = \sum \alpha\ P\ Cu\ L$ .....(4.4)

$= 0.25x2\pi \times 0.3 \times 75x\ 10 = 353.429$kN

$\sum Qu = n1n2(Qp+Qs)$.....(4.5)

$Qu = 2 \times 2 \times (353.429+190.851)$

$Qui = 2177.12$ kN

Qui = Load bearing capacity of individual pile

Qs=Load bearing capacity of soil

Qp= Load bearing capacity of pile

Qgu= Load bearing capacity of group piles

Ap=Area of a pile

Cu(p)=Cohesion of individual pile

Cu=Cohesion of pile

P=Perimeter

α = Adhesion factor

L=Length of pile

N1= Number of piles in row

n2 = Number of piles in column

qp=Bearing capacity per unit area of group piles

pg=Perimeter of group pile

Nc=Shape Facto

4. CYPE CAD Software

Pile Cap Design Using Cype Cad Software: **CYPECAD** was brought about to carry out the analysis and design of reinforced concrete and steel structures, subject to horizontal and vertical forces, for houses, buildings and civil work projects.

Table no 4.5 Worst Load Combination Result for a columns (C1)

Col.	Span	Dimension (cm)	Position	Worst case forces					
				Nature	N (kN)	Mxx (kN·m)	Myy (kN·m)	Qx (kN)	Qy (kN)
C1	First Floor (4.25 - 7.9 m)	100x100	Head	DL, E	-9.9	165.1	33.5	-23.5	-162.7
				DL, E	-44.0	162.3	9.9	-6.7	-146.4
			6.3 m	DL, E	102.2	-340.7	-38.5	-23.9	-165.6
			5.25 m	DL, E	102.2	-340.7	-38.5	-23.9	-165.6
			Base	DL, E	102.2	-340.7	-38.5	-23.9	-165.6
	Gound Floor (0.6 - 4.25 m)	100x100	Head	DL, E	511.7	-46.1	24.5	-38.5	192.7
				DL, E	-28.4	-102.2	13.2	9.2	-155.2
			2.65 m	DL, E	511.7	-46.1	24.5	-38.5	192.7
				DL, E	-28.4	-102.2	13.2	9.2	-155.2
			1.6 m	DL, E	511.7	-46.1	24.5	38.5	192.7
				DL, E	-28.4	-102.2	13.2	9.2	-155.2
			Base	DL, E	623.9	541.6	-92.9	-38.5	192.7
				DL, E	40.9	-578.0	39.8	9.3	-160.1
	Plinth (-1.5 - 0.6 m)	100x100	Head	DL, E	797.7	455.4	-9.5	-68.4	184.0
				DL, E	50.7	-560.8	74.2	-5.7	-164.6
			Base	DL, E	852.9	731.4	-112.1	-68.4	184.0
				DL, E	86.7	-826.9	63.0	-5.0	-177.7
	Foundations	100x100	Column start	DL, E	852.9	731.4	-112.1	-68.4	184.0
				DL, E	86.7	-826.9	63.0	-5.0	-177.7

5. RESULTS AND DISCUSSIONS:

References	Geometry	Reinforcement
C1, C10	Pile cap for 4 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@10 Bottom reinforcement mesh Y: Ø20@10 Top reinforcement mesh X: Ø12@25 Top reinforcement mesh Y: Ø12@25 Parallel beam X: Bottom reinforcement: 5Ø12 Parallel beam Y: Bottom reinforcement: 5Ø12

References	Geometry	Reinforcement
C2, C9	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø25@16 Bottom reinforcement mesh Y: Ø25@16 Top reinforcement mesh X: Ø12@25 Top reinforcement mesh Y: Ø12@25 Parallel beam X: Bottom reinforcement: 6Ø12 Parallel beam Y: Bottom reinforcement: 6Ø12 Diagonal beam: Bottom reinforcement: 6Ø12
C3	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 10Ø12 Parallel beam Y: Bottom reinforcement: 10Ø12 Diagonal beam: Bottom reinforcement: 10Ø12
C4, C7	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@8 Bottom reinforcement mesh Y: Ø16@8 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 9Ø16 Parallel beam Y: Bottom reinforcement: 9Ø16 Diagonal beam: Bottom reinforcement: 9Ø16
C5, C6	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@8 Bottom reinforcement mesh Y: Ø16@8 Perimeter reinf.: 7Ø12 Parallel beam X: Bottom reinforcement: 4Ø25 Parallel beam Y: Bottom reinforcement: 4Ø25 Diagonal beam: Bottom reinforcement: 4Ø25
C8	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 5Ø16 Parallel beam Y: Bottom reinforcement: 5Ø16 Diagonal beam: Bottom reinforcement: 5Ø16
C11, C45	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø25@16 Bottom reinforcement mesh Y: Ø25@16 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 8Ø12 Parallel beam Y: Bottom reinforcement: 8Ø12 Diagonal beam: Bottom reinforcement: 8Ø12

References	Geometry	Reinforcement
C12, C46	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 6Ø16 Parallel beam Y: Bottom reinforcement: 6Ø16 Diagonal beam: Bottom reinforcement: 6Ø16
C13, C48	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 9Ø16 Parallel beam Y: Bottom reinforcement: 9Ø16 Diagonal beam: Bottom reinforcement: 9Ø16
C14, C16, C47	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø25@16 Bottom reinforcement mesh Y: Ø25@16 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 5Ø16 Parallel beam Y: Bottom reinforcement: 5Ø16 Diagonal beam: Bottom reinforcement: 5Ø16
C15	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 7Ø16 Parallel beam Y: Bottom reinforcement: 7Ø16 Diagonal beam: Bottom reinforcement: 7Ø16
C17, C22	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 5Ø20 Parallel beam Y: Bottom reinforcement: 5Ø20 Diagonal beam: Bottom reinforcement: 5Ø20
C18, C21	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@12 Bottom reinforcement mesh Y: Ø20@12 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 9Ø16 Parallel beam Y: Bottom reinforcement: 9Ø16 Diagonal beam: Bottom reinforcement: 9Ø16

References	Geometry	Reinforcement
C19, C20	Rectangular pile cap for 5 piles Overhang X: 60.0 cm Overhang Y: 60.0 cm Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@12 Bottom reinforcement mesh Y: Ø20@12 Perimeter reinf.: 7Ø12 Parallel beam X: Bottom reinforcement: 4Ø25 Parallel beam Y: Bottom reinforcement: 4Ø25 Diagonal beam: Bottom reinforcement: 4Ø25
C23	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 7Ø16 Parallel beam Y: Bottom reinforcement: 7Ø16 Diagonal beam: Bottom reinforcement: 7Ø16
C24	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø25@16 Bottom reinforcement mesh Y: Ø25@16 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 8Ø12 Parallel beam Y: Bottom reinforcement: 8Ø12 Diagonal beam: Bottom reinforcement: 8Ø12
C25, C36	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø25@16 Bottom reinforcement mesh Y: Ø25@16 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 8Ø12 Parallel beam Y: Bottom reinforcement: 8Ø12 Diagonal beam: Bottom reinforcement: 8Ø12
C26	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@10 Bottom reinforcement mesh Y: Ø20@10 Parallel beam X: Bottom reinforcement: 5Ø12 Parallel beam Y: Bottom reinforcement: 5Ø12 Diagonal beam: Bottom reinforcement: 5Ø12
C27	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@10 Bottom reinforcement mesh Y: Ø20@10 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 7Ø12 Parallel beam Y: Bottom reinforcement: 7Ø12 Diagonal beam: Bottom reinforcement: 7Ø12

References	Geometry	Reinforcement
C28, C33	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@10 Bottom reinforcement mesh Y: Ø20@10 Parallel beam X: Bottom reinforcement: 7Ø12 Parallel beam Y: Bottom reinforcement: 7Ø12 Diagonal beam: Bottom reinforcement: 7Ø12
C29, C30, C31, C32	Pile cap for 4 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø25@16 Bottom reinforcement mesh Y: Ø25@16 Parallel beam X: Bottom reinforcement: 8Ø12 Parallel beam Y: Bottom reinforcement: 8Ø12
C34	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@10 Bottom reinforcement mesh Y: Ø20@10 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 7Ø12 Parallel beam Y: Bottom reinforcement: 7Ø12 Diagonal beam: Bottom reinforcement: 7Ø12
C35	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@10 Bottom reinforcement mesh Y: Ø20@10 Parallel beam X: Bottom reinforcement: 5Ø12 Parallel beam Y: Bottom reinforcement: 5Ø12 Diagonal beam: Bottom reinforcement: 5Ø12
C37, C44	Pile cap for 4 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 5Ø20 Parallel beam Y: Bottom reinforcement: 5Ø20
C38, C43	Pile cap for 4 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 9Ø16 Parallel beam Y: Bottom reinforcement: 9Ø16
C39, C42	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø16@7 Bottom reinforcement mesh Y: Ø16@7 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 9Ø16 Parallel beam Y: Bottom reinforcement: 9Ø16 Diagonal beam: Bottom reinforcement: 9Ø16

References	Geometry	Reinforcement
C40, C41	Rectangular pile cap for 5 piles Depth: 165.0 cm Distance between X axes of piles: 1.80 m Distance between Y axes of piles: 1.80 m	Bottom reinforcement mesh X: Ø20@12 Bottom reinforcement mesh Y: Ø20@12 Perimeter reinf.: 6Ø12 Parallel beam X: Bottom reinforcement: 6Ø20 Parallel beam Y: Bottom reinforcement: 6Ø20 Diagonal beam: Bottom reinforcement: 6Ø20

6. CONCLUSIONS AND FUTURE SCOPE OF STUDY:

Conclusions:

1) Based on the soil characteristics, strength requirement and shape factor the RCC circular pile suitable for this condition

2) From Analysis the worst load combination is 1.5(DL+EQ) for 30 columns (62.5%) and 1.2 (DL+LL+WL) for 18 column (37.5%).

3) The pile caps are design for the vertical load only, the moments coming from the column are to be resist by the strap beam .In this project the maximum moment Reqired is Mxx=4365.2 kN/m and Myy=1638.8 kN/m and Provided Bending moments are Mxx=5577.10 kN/m and Myy=2507.02 kN/m , the size of strap beam used is 0.40m x0.70m and 0.23m x0.45 m.

4) In this design a 4 group piles and 5 group piles area provided.

5) For C1 Pile

i) Required load bearing capacity is 2125.00 kN For Normal Condition and 2656.25 kN for Seismic consideration and provided load bearing capacity are 2721.375 kN and 3401.18 kN respectively,

ii) Required Compressive strength is 12.32 N/mm^2 and provided Compressive strength is 15.235 N/mm^2, 23% more than the required.

ii) Required tensile strength is 265.23 N/mm^2 and provided Compressive strength is 410.26 N/mm^2 , 28% more than the required

7. SCOPE FOR FURTHER STUDY

However, further study can be undertaken in the following areas:

1). By considering different type of pile building analysis can be done.

2). By varying the story height and increasing story number the analysis can be done.

3). Varying the column and beam dimensions for same models can be analyzed.

4). For same models compare with Manual Calculation and Using Another Software.

5). The moment resisting frames may be designed to independently resist at least 25% of design seismic base shear. For better ductility beam-column junction study can also be made.

6). The study could be extended by including various other parameters such as torsional effects and soft story effects in a building.

7). Nonlinear dynamic analysis, response spectrum method, push over analysis & time history method may be carried out for further study for better and realistic evaluation of structural response under seismic forces.

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