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Name of the Project: Proposed Construction of Group Housing Development with Combined Basement Consisting of 3 Blocks; Block A – Basement Floor + Ground Floor + 1st Floor Part + 2nd Floor Part + 3rd Floor Part + 4th Floor Part + 5th Floor Part (Height – 18.15 M) Residential Building with 119 Dwelling Units; Block B – Basement Floor + Ground Floor + 1st Floor Part + 2nd Floor Part + 3rd Floor Part + 4th Floor Part +5th Floor Part (Height – 18.15 M) Residential Building with 216 Dwelling Units with (Kids Play, Indoor Games Room, Gym & Yoga Room) with Swimming Pool; Block C – Basement Floor + Ground Floor + 1st Floor Part + 2nd Floor Part + 3rd Floor Part + 4th Floor Part +5th Floor Part (Height – 18.15 M) Residential Building with 66 Dwelling Units – Totally 401 Dwelling Units at Dhanlakshmi Nagar, Moulivakkam, Chennai Comprised In S.Nos.1/1A1B, 1/1A1C, 1/1A1D, 1/1A1E, 1/1C1B, 1/1C1C, 1/4A2, 1/5A, 1/39, 1/40, 1/41, 1/42A, 1/42B, 1/70, 1/71, 1/106 of Moulivakkam Village & S.No.166/5 of Kulathuvancheri Village within the Limits of Kundrathur Panchayat Union

STRUCTURAL DESIGN BASIS REPORT

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1. INTRODUCTION

The proposed Residential building consists of non - high rise group development consists of 3 blocks with combined basement : Block A – Basement Floor + Ground Floor + 1st Floor Part + 2nd Floor Part + 3rd Floor Part + 4th Floor Part + 5th Floor Part (Height – 18.15 M) Residential Building with 119 Dwelling Units; Block B – Basement Floor + Ground Floor + 1st Floor Part + 2nd Floor Part + 3rd Floor Part + 4th Floor Part +5th Floor Part (Height – 18.15 M) Residential Building with 216 Dwelling Units with (Kids Play, Indoor Games Room, Gym & Yoga Room) with Swimming Pool; Block C – Basement Floor + Ground Floor + 1st Floor Part + 2nd Floor Part + 3rd Floor Part + 4th Floor Part +5th Floor Part (Height – 18.15 M) Residential Building with 66 Dwelling Units. The structure is designed as a Reinforced concrete framed structure supported on pile foundation. The structure is built for Residential use. The columns, beams, R.C walls and slabs are considered and designed as reinforced concrete members.

Building size

BLOCK -1

Length (X-direction)	–	47.72m
Width (Y-direction)	–	114.02m
Height		
Basement floor	–	3.60m
Ground & Typical floor	–	2.90m

BLOCK -2

Length (X-direction)	–	101.07m
Width (Y-direction)	–	107.51m
Height		
Basement floor	–	3.60m
Ground & Typical floor	–	2.90m

BLOCK -3

Length (X-direction)	–	67.83m
Width (Y-direction)	–	70.41m
Height		
Basement floor	–	3.60m
Ground & Typical floor	–	2.90m

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2. GRADE OF MATERIALS

i) Concrete

Characteristic concrete strength (concrete grade) for the project shall be based on exposure condition and forces to be supported by specified structural elements. The minimum cement content and maximum water–cement ratio shall be as per IS code 456:2000. The minimum 28-day compressive strength of concrete for specified structural elements shall be as follows

Grade of Concrete for columns and shear wall is M40.

Grade of Concrete for Pile, pile cap and all other Structural elements is M30.

Concrete Properties

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Young's Modulus of Elasticity of Concrete	$5000\sqrt{fck}$
Poisson Ratio's Ratio v =	0.2

ii) Reinforcement

Grade of Steel reinforcement for all Structural elements is Fe500D.

The characteristictensile properties of steel in design shall be as follows.

Reinforcement Characteristic yield strength fy (N/mm^2)	Fe500D
Young's Modulus E (kN/mm^2)	$200kN/mm^2$
Poisson's ratio	0.3
Coefficient of Thermal expansion, α ($^oC^{-1}$)	$12x10^{-6}$
Density	$78.5\ kN/m^3$
Diameters [in mm]: 8, 10, 12, 16, 20, 25 & 32	

iii) Structural steel

All structural steel, if used, shall conform to Indian standard IS: 2062-2011.

Structural steel	Grade E=250	Grade E-350
Tensile strength	$410\ N/mm^2$	$490\ N/mm^2$
Yield stress t<20mm	$250\ N/mm^2$	$350\ N/mm^2$
Yield stress t = 20mm to 40mm	$240\ N/mm^2$	$330\ N/mm^2$
Yield stress t> 40mm	$230\ N/mm^2$	$320\ N/mm^2$
Young's Modulus (E)	$200,000\ N/mm^2$	$200,000\ N/mm^2$
Density	$78.5\ kN/m^3$	$78.5\ kN/m^3$

Self-weights are calculated on the basis of unit weights of materials given in IS 875 (Part 1) the data provided by consultant and other service consultants will be used for the specific materials.

Materials	Unit weight kN/m^3
Steel	78.50
Plain Cement Concrete	24.00
Reinforced Cement Concrete	25.00
Soil Fill	16.00
Water	10.00
Cement Concrete screed	24.00
AAC block	10.00
Solid block wall (Concrete)	22.00

Normal weight aggregates shall be considered for arriving at self-weight of all Concrete works.

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3. DESIGN STANDARDS

The relevant Indian Standard Codes, as given below, shall be followed for structural design:

Sl.No.	Code	Description
1.	IS-875 (Part 1) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material.
2.	IS-875 (Part 2) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Imposed loads.
3.	IS-875 (Part 3) – 2015	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Wind loads.
4.	IS-875 (Part 4) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Snow loads.
5.	IS-875 (Part 5) – 1987	Code of Practice for Design Loads (other than earthquake) for buildings and structures – Special loads and load combinations.
6.	IS: 456 – 2000	Code of Practice for Plain and Reinforced Concrete.
7.	IS: 1786 – 2008	High Strength Deformed Steel Bars and Wires for Concrete Reinforcement - Specification.
8.	IS: 13920 – 2016	Ductile detailing of reinforced concrete structures subjected to seismic forces - Code of practice
9	IS: 800 – 1984/2007	Code of Practice for General Construction in Steel.
10.	IS: 1893 (Part 1) – 2016	Criteria for Earthquake resistant design of structures.
11.	IS3370-(PART I & II)-2009	Code of Practice for Concrete structures for the storage of liquids – Reinforced concrete structures
12.	IS 2950 (Part I) -1981	Code of Practice for Design and construction of Raft foundation

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4. DESIGN DATA

1. No. of floors = Basement + Ground + 5 upper floors
2. Total height of building = 18.15m above GL
3. Pile vertical capacity for 500mm dia, 18m deep from EGL= 120MT & 600mm dia, 18m deep from EGL= 160MT as per soil report
   However since basement is to be constructed, 500mm & 600mm dia. Pile of 14.5m deep below pile cutoff level at basement floor will be used.
4. Density of Concrete = 25 kN/m^3
5. D.L. due to partitions (Light Partition as per IS 875) = 1.50 kN/m^2
6. D.L. due to flooring = 0.050x22=1.10 kN/m^2
7. Wall Load (200mm thick wall): Typical Floor = 2.95m-0.45m=2.5m x 0.20m x10 = 5.0 kN/m
8. Live Load in Stairs, corridor &lobby = 3.00 kN/m^2
9. Live Load in Rooms & Kitchen = 2.00 kN/m^2
10. Live Load in Terrace = 1.50 kN/m^2
11. Live Load in toilets = 2.00 kN/m^2
12. L.L in Lift Machine Room = 10.00 kN/m^2
13. Basic wind speed = 50 m/sec
14. Design wind pressure (Max.) = 1.34 kN/m^2
15. Seismic Zone = Zone III
16. Design mix = M40 for columns & shear wall, M30 for all other RC members

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5. ANALYSIS OF STRUCTURE

Computer-aided analysis using finite element method (FEM) shall be carried out for the Analysis of structure.

Assumptions:

- The structure is idealized as 3D space frame and analyzed using Etabs software package for both vertical and lateral loads.
- The structure is analyzed for specific loads like dead load, live load, wind and seismic loads and for the load combinations as given in the relevant codes.
- Temperature load is applied on the terrace floor of the buildings.

Column	:	Frame Element
RC Wall	:	Wall (Shell) Elcment
Beam element:		Frame Element
Slab element	:	Membrane Element

For 3D or 2D structural frame analysis ETABS or SAFE software shall be used, verified in-house spreadsheets will be used for the design of reinforced concrete (RC) and steel elements in consideration of flexure,

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shear and axial forces.
The following are general parameters adopted in the analysis and design,
Consideration of Diaphragm – Semi Rigid Diaphragm.

6. DESIGN CONCEPT

Limit State concept of design will be used as per IS: 456-2000 & SP - 16. The detailing of reinforcement shall be done satisfying the requirements of IS: 456, SP-16, IS: 13920, IS: 4326 and SP-34.

The Slabs and beams are checked for deflection as per IS 456. Cover for Reinforcement is considered as per Table 16A of NBC, for a Fire resistance of **2 hrs.**

7. LOAD CASE

7.1 Primary Load

- Dead Load (DL)
- Live Load (LL)
- Earthquake Load (EL)
- Wind Load (WL)

7.2 Load Combinations

The following combinations of Loads as per IS 1893 is considered in the E Tabs Analysis.

1. 1.5(DL +LL)
2. 1.2(DL + LL ± WL)
3. 1.2(DL +LL ± EL)
4. 1.5(DL ± EL)
5. 1.5(DL ± WL)
6. 0.9DL ± 1.5EL
7. 0.9DL ± 1.5WL

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Load Combination	Limit State of Collapse			Limit State of Serviceability		
	DL	LL	WL/EL	DL	LL	WL/EL
DL + LL	1.5	1.5	--	1.0	1.0	--
DL +/- WL	1.5 or 0.9[$]	--	1.5	1.0	--	1.0
DL + LL +/- WL	1.2	1.2	1.2	1.0	0.8	0.8
DL +/- EL	1.5 or 0.9[$]	--	1.5	1.0	--	1.0
DL + LL +/- EL	1.2	1.2	1.2	1.0	0.8	0.8

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[$]This value is to be considered when stability against overturning or stress reversal is critical

DL	-	Dead load
LL	-	Live load
WL	-	Wind load
EL	-	Earthquake load

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Wind load and earthquake load shall be considered for both X & Y directions.

The above load combinations will be considered and effect of worst combinations will be taken for design of various building elements.

Whenever imposed load is combined with earthquake load the appropriate part of imposed load as specified in IS: 1893 – 2016 will be used both for evaluating earthquake effect and for combined load effects used in such combination.

General Load Combinations considered in the analysis are as follows:

Combinations considered for the design of the various building elements:					
COMB 1	1.5 DL	+	1.5 LL		
COMB 2	1.2 DL	+	1.2 LL	+	1.2 SPECX
COMB03	1.2 DL	+	1.2 LL	+	1.2 SPECY
COMB04	1.5 DL			+	1.5 SPECX
COMB05	1.5 DL			+	1.5 SPECY
COMB06	0.9 DL			+	1.5 SPECX
COMB07	0.9 DL			+	1.5 SPECY
COMB08	1.2 DL	+	1.2 LL	+	1.2 WLX
COMB09	1.2 DL	+	1.2 LL	-	1.2 WLX
COMB10	1.2 DL	+	1.2 LL	+	1.2 WLY
COMB11	1.2 DL	+	1.2 LL	-	1.2 WLY
COMB12	1.5 DL			+	1.5 WLX
COMB13	1.5 DL			-	1.5 WLX
COMB14	1.5 DL			+	1.5 WLY
COMB15	1.5 DL			-	1.5 WLY
COMB16	0.9 DL			+	1.5 WLX
COMB17	0.9 DL			-	1.5 WLX

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COMB18	0.9 DL			+	1.5 WLY
COMB19	0.9 DL			-	1.5 WLY
COMB21	0.9 DL			+	1.5 TL
COMB22	1.5 DL			+	1.5 TL
COMB23	1.5 DL	+	1.5 LL	+	1.5 TL
COMB24	1.2 DL			+	1.2 TL
Un-factored Loads to be taken for foundation design:					
FOUN01	1.0 DL	+	1.0 LL		
FOUN02	1.0 DL	+	0.8 LL	+	0.8 SPECX
FOUN03	1.0 DL	+	0.8 LL	+	0.8 SPECY
FOUN04	1.0 DL			+	1.0 SPECX
FOUN05	1.0 DL			+	1.0 SPECY
FOUN06	1.0 DL	+	0.8 LL	+	0.8 WLX
FOUN07	1.0 DL	+	0.8 LL	-	0.8 WLX
FOUN08	1.0 DL	+	0.8 LL	+	0.8 WLY
FOUN09	1.0 DL	+	0.8 LL	-	0.8 WLY
FOUN10	1.0 DL			+	1.0 WLX
FOUN11	1.0 DL			-	1.0 WLX
FOUN12	1.0 DL			+	1.0 WLY
FOUN13	1.0 DL			-	1.0 WLY
FOUN14	1.0 DL			+	1.0 TL
FOUN15	1.0 DL	+	1.0 LL	+	1.0 TL

DL - Dead Load

LL - Live Load

EL - Earthquake Load

WL - Wind Load

* Note - Seismic Load Cases have both "MAX" and "MIN" Load Cases for +ve & -ve Directions respectively.

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8. WIND LOAD

Wind loads and pressures are calculated based on the static design wind pressure. This pressure has been considered for the load analysis and applied to the model. The wind pressure shall be calculated based on the data furnished below and other provisions laid in IS: 875 (Part 3) – 2015.

The design wind velocity at any given height and at a given site is given by,

$Vz = V_b\, k_1 k_2\, k_3\, k_4$

where,

V_b- basic wind speed in m/s at 18m height

k_1 - probability or risk factor

k_2 - terrain, height and structure size factor

k_3 - local topography factor

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Basic wind speed	= 50 m/sec
Risk coefficient, k_1	= 1.0
Terrain category	= 2
Height factor- k_2	= Varies with height
Terrain, size height & structure factor, k_2 up to 16 m height (as per Cl. 6.3.2 of IS 875 Part 3 - 2015)	= 1.05
Topography factor k_3 as per Cl. 6.3.3 of IS 875 Part 3 - 2015)	= 1.0
k_4 – Importance factor (As per cl.6.3.4 of IS875 part 3 - 2015)	= 1.0 (Other buildings)
Design wind speed at any height z, V_z	$= 50 \times 1 \times 1.05 \times 1 \times 1$
	= 52.50 m/sec

The design wind pressure, Pz in MPa at any height above mean ground level is given by,

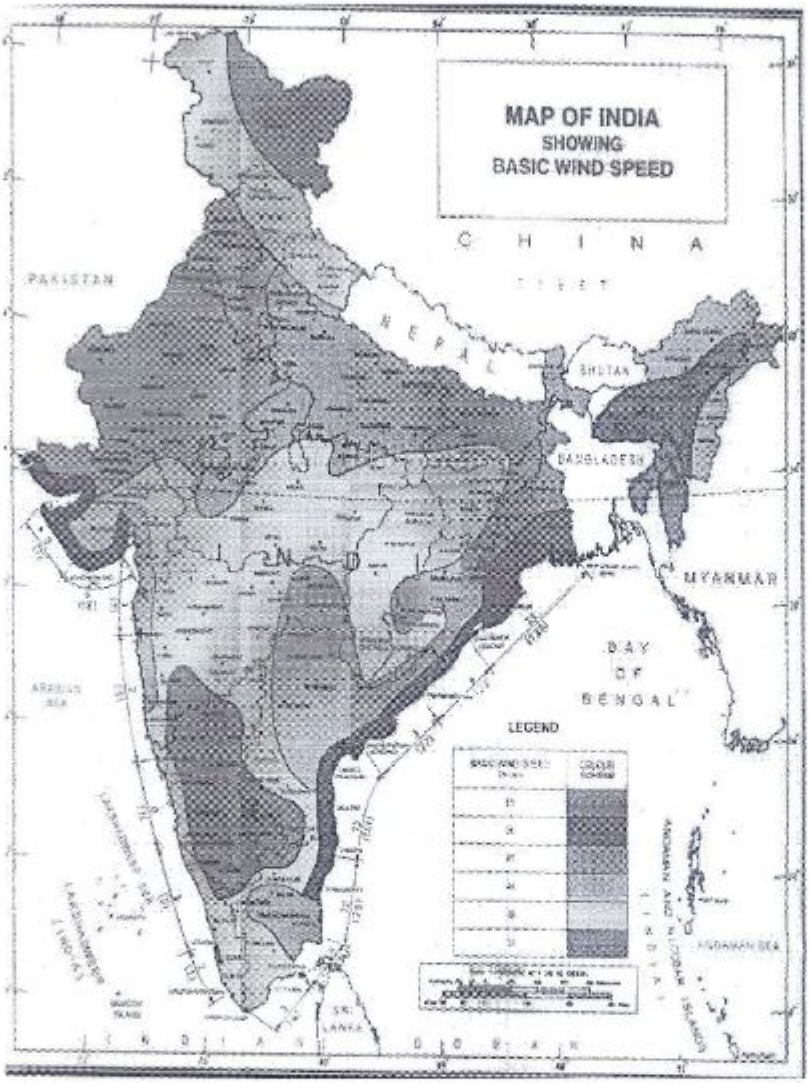
p_z	$= 0.6\, V_z^2$
	$= 0.6 \times 52.5^2$
	$= 1653\ N/m^2$
p_z	$= 1.653\ kN/m^2$

$p_d = K_d \times K_a \times K_c \times p_z$ where, as per IS875 PART 3 - 2015

K_d - wind directionality factor	= 1.0
K_a - area averaging factor	= 0.9
K_c - combination factor	= 0.9
Therefore, p_d= 1.0 x 0.9 x 0.9 x 1.653	= 1.34 kN/m^2 >0.7 p_z

The wind pressure of 1.34 kN/m^2 is applied along the height of the column.

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9. SEISMIC LOAD

The Proposed Residential building at Chennai falls under Zone III as per the IS Code. Response spectrum method shall be used, for seismic analysis of R.C. Frames as recommended by IS: 1893-2016

Seismic Zone	=Zone III
Zone Factor 'Z'	=0.16
Response Reduction Factor 'R' (for SMRF)	=5.00
Importance Factor 'I'	=1.20
Type of Structure	=1.00

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SEISMIC ANALYSIS:

9.1. STATIC ANALYSIS:

Design of lateral force under seismic condition shall be as per IS1893 – 2016. Total lateral force (base shear) of the building shall be estimated as per clause 7.2.1 of IS1893 – 2016 which provides by

$$V_b = A_h W$$

Ah is horizontal seismic coefficient and W is seismic weight of the building, Horizontal seismic coefficient depends on location of the building (Zone factor Z), usage of the building (Importance factor, I), building lateral resisting system (Response reduction factor, R) and design acceleration coefficient (Sa /g) which is based on subsoil condition and fundamental natural period (Ta).

For the proposed building is for residential use. Considering it, the seismic weight is summation of total dead load and 50% of live load where live load is greater than 3 KN/sq:m, 25% for live load equal or lesser than 3 KN/sq.m.

From IS 1893:2016 clause 6.4.2, Design horizontal seismic coefficient

$$Ah = \frac{Z\ I\ Sa}{2\ R\ g}$$

Where, Z for Zone III = 0.16
Importance factor = 1.2
R for SMRF = 5.0

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i. T = 0.09 h / √d (Refer IS 1893 - 2016 clause 7.6.2c),
ii. T = (0.075 h0.75) / (√Aw) (Refer IS 1893 - 2016 clause 7.6.2b)
iii. T = (0.075 h0.75) (Refer IS 1893 - 2016 clause 7.6.2a);

The time period has been calculated for all above specified cases and it ensured that the case (ii) time period is not greater than case (iii) and not lesser than case-(i).

Where,

T is Fundamental natural period

For the building height with reference to IS: 1893-2016 the building is well connected with basement wall in all four sides, so for the time period calculation the heights are considered as follows,

h = Height of the structure from Stilt Floor to Roof.
d = Width of the building along the direction of lateral force.
Aw = Total effective wall area in square meter

9.2. DYNAMIC ANALYSIS:

Response spectrum method of Dynamic Analysis carried out with following parameters pertaining to dynamic analysis.

Number of modes Considered	: 12 Numbers (Minimum)
Modal Combination Method Used	: Complete Quadratic combination (CQC).
Directional Combination Method used	: Square root of the sum of Square (SRSS).
Modal case type	: Eigen vector Method

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10. COVER FOR REINFORCEMENT:

Cover for Reinforcement is considered as per Table 16A of NBC, for a Fire resistance of **2 hrs.**

Pile	= 50 mm
Pile cap bottom	= 75mm
Columns	= 40 mm
Beams	= 30 mm
Slabs	= 25 mm
Retaining wall	= 40 mm for earth side and 25mm for inner side
Shear wall	= 25 mm

11. FOUNDATION SYSTEM:

As per Soil Report,

Table:- 4.1 Recommended Safe Load Carrying Capacities of Bored Cast-in Situ Piles

Sl.No	Reference Bore hole No.	Length of Pile below E.G.L	Assumed Length of Cut-Off Below E.G.L	Length of Pile below Cut-off	Dia.of Pile in (mm)	SAFE LOAD CARRYING CAPACITY (kN)		
						Vertical Load Carrying Capacity	Pull Out Capacity	Lateral Load Carrying Capacity
1	BH-03	18.0	3.5	14.50	400	700	350	25
2					450	900	400	28
3					500	1200	450	32
4					550	1450	500	35
5					600	1600	550	38
6					650	1900	600	41
7					750	2400	700	48

We have considered 500mm dia pile of 120T & 600mm dia pile of 160T Vertical load Capacity with 18m deep from GL, based on the above soil report. However since basement is to be constructed, 600mm dia. Pile of 14.5m deep below pile cutoff level at basement floor will be used.

It is proposed to have pile and pile cap to resist floor loads. The support condition for columns in ETABS model is considered as fixed support.

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12. CONSTRUCTION JOINT:

Construction joints and shrinkage strips will be planned with the contractor and only be used in locations pre-approved by consultants.

1) No construction joint is allowed in the sunken portion.
2) Preferred at l/3 from support.
3) Construction joint shall be placed at accessible location for maintenance purpose.
4) Joints are common source of weakness, therefore it is desirable to avoid or at least minimize the same.

13. EXPANSION JOINT:

Length of the building is more than 45m. It is proposed to provide expansion joints in one location in block -1 & three locations in block-2.

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14 FLOOR LOADING

a) FLOOR SLABS LOAD

The floor slab and beams are designed as conventional slab members for floor loads as mentioned below.

RC Conventional Slab:

Self-Weight of 130 thk. slab	= 3.25 kN/m ^{2}
Load due to Floor Finish	= 1.10 kN/m ^{2}
Load due to Partition load	= 1.50 kN/m ^{2}
Live load	= 2.00 kN/m^2
	7.85 kN/m^2

15. SERVICEABILITY CHECK

a. For Deflections:

The final deflection due to all loads including the effect of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, roofs and all other horizontal members should not normally exceed span / 250.

The deflection including the effect of temperature, creep and shrinkage occurring after the erection of partitions and the application of finishes should not normally exceed Span / 350 or 20 mm whichever is less.

b. Lateral drift : Under transient wind load the lateral sway at the top should not exceed H/500, where H is the total height of the building.

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The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1, shall not exceed 0.004 times the storey height.

c. For Cracking

Surface crack width shall not exceed 0.3 mm in general and for water retaining structure it is limited to 0.2 mm.

16. TYPICAL DESIGN CALCULATION

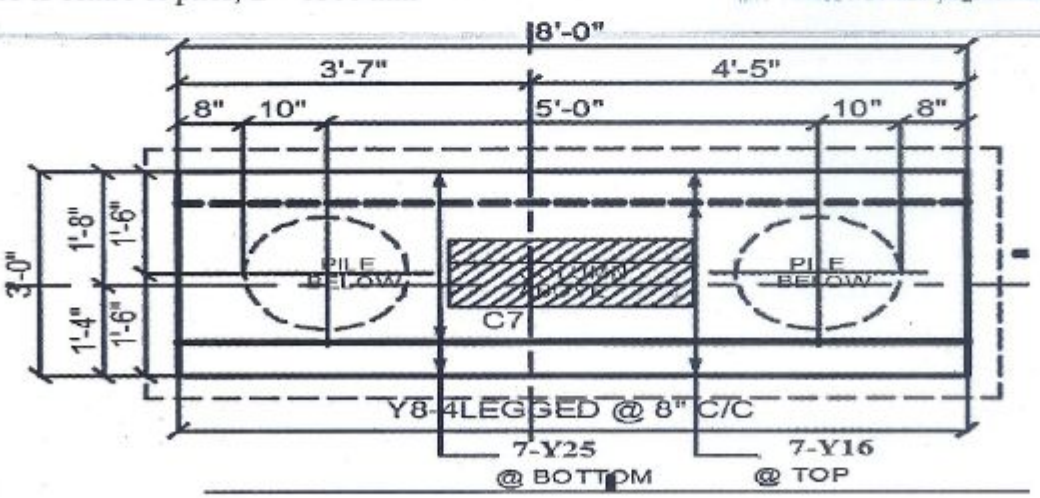
Typical Design of Pile cap

Pile cap is analyzed using the Truss Analogy theory.

DESIGN OF PILE CAP PC2 WITH 2 PILES:

Grade of Concrete	= M30
Grade of Steel F_y	= Fe 500
Pile cap depth,	= 900 mm
Cover	= 75 mm
Carrying capacity of Pile	= 1600 kN(as per soil report)
Max. unfactored load on column	= 1910 kN
Diameter of pile	= 600 mm
Number of piles	= 2
Centre to centre of piles, L = 1500 mm	

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Column size

Length along X axis, **a = 800 mm**

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Length along Y axis, b = **300 mm**

Tensile force to be resisted by reinforcement

Tension along X-X = $\frac{P(3L^2-a^2)}{12LD}$

Tension along Y-Y = $1910(3x1.5^2-0.8^2)/(12x1.5x0.825)$ = **786 kN**

Area of steel = $\frac{\text{Tensile Force}}{0.87\ F_y}$ = $786 \times 10^3 \times 1.5/0.87 \times 500 = 2710\ mm^2$

Tension along Y-Y = $\frac{P(3L^2-b^2)}{12LD}$

Tension along Y-Y = $1910(3x1.5^2-0.3^2)/(12x1.5x0.825)$ = **857 kN**

Area of steel = $\frac{\text{Tensile Force}}{0.87\ F_y}$ = $857 \times 10^3 \times 1.5/0.87 \times 500 = 2955\ mm^2$

Minimum percentage of steel $0.12 \times 900 \times 900 = 972\ mm^2$

Provide 7nos-Y25 at Bottom

Provide 7nos-Y16 at Top.

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DESIGN OF COLUMNS:

Typical Design of Column:

C1 - COLUMN (up to ground floor roof - 300 X 800)

Total load on column	=	**1928KN**
Max. Moment in Y-Direction	=	**154KN-m**
Max. Moment in Z-Direction	=	**95 KN-m**
Concrete grade for column	=	**M30**

A_{st} = $3120\ mm^2$
p = 1.30%
p/f_{ck} = 0.04
$P_u / f_{ck}\, bd$ = 0.27
$M_u / f_{ck}\, b^2d$ = 0.080
$M_u / f_{ck}\, bd^2$ = 0.090

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Muy_1 = 173KN-m
Muz_1 = 518KN-m
Puz/Ag = 18N/mm^2
Muy/Muy_1 = 0.893
Muz/Muz_1 = 0.183
∞n = 1.43

$(Muy/Muy_1)^{\infty n} + (Muz/Muz_1)^{\infty n}$ = 0.938 (For Max. My with corresponding axial load & Mz)

Hence safe.

Provide <u>300 x 800</u> columns with 16 Nos Y16 with Y8 rings @ 8" c/c(as per drawing)

DESIGN OF TYPICAL FLOOR BEAM:

Mu (+)	= 42 kN.m
Mu (-)	= 86 kN.m
Shear	= 111 kN
Beam size	= 200 X 450mm
b_f	= 500 mm
Effective depth	= 410mm
Grade of Concrete	= M25
Grade of Steel	= Fe500

Tension Reinforcement Details:

Mu (+) / (bf * d^2) = (42 x 10 ^ 6) / (500 * 410 * 410)
= 0.50 N/mm^2

For 0.50 N/mm^2; p_t = 0.12%
Then Ast = 0.12 * 500 * 410/100
= 246mm^2

No of bars = 246 / ((π * 16^2) / 4)
= 1.22Nos.

Provide 2-Y16 (throughout) @ bottom

Mu (-) / (B * d^2) = (86* 10 ^ 6) / (200 * 410 * 410)
= 2.56 N/mm^2

For 2.56 N/mm^2; p_t = 0.68%;
Then Ast = 0.66 * 200 * 410/100
=560 mm^2
= 560 / ((π * 16^2) / 4)

No of bars = 2.78 Nos.

Provide 2-Y16 throughout + 2-Y12 @ support in top.

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Shear Reinforcement Details:

τv = Vu / (B*d)
τv = 111*10^3 / (200 * 410)
= 1.35
τc = 0.54

Hence $\tau v > \tau c$
Provide 8mm dia stirrup

Vus = ($\tau v - \tau c$) * B *d
Sv = (0.87 *fy* d * Asv) / (Vus)
Sv = 180mm

Reinforcement Details:

Provide 8mm dia rod with 4" C/C at supports and 8mm with 6" at mid span
Provide 2-Y16 (throughout) @ bottom,
Provide 2-Y16 throughout + 2-Y12 @ support in top.

DESIGN OF TYPICAL FLOOR SLAB:

Design of floor slab (S1): (R.C.C. Slab)

Size of the Slab	=	4.00m X 3.40m
Thickness of Slab	=	130mm
l_y / l_x = 1.17		
- ve B.M 0.065 x 3.40^2 x 7.85 kN/m^2	=	5.90 kN.m
+ ve B.M 0.050x 3.40^2 x 7.85 kN/m^2	=	4.54 kN.m

Provide 130 mm thick slab.

$M_u / bd^2 = 0.8$, $p_t = 0.19$, $A_{st} = 200 sq.mm^2$
$M_u / bd^2 = 0.62$, $p_t = 0.15$, $A_{st} = 158 sq.mm^2$

PROVIDE:
Y8 @ 150mm c/c (shorter span)
Y8 @ 200mm c/c (longer span)

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