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REVISIONS

Consultant:

Dynamic Associates

Client

Tamilnadu Housing Board, Anna Nagar Division

Project:

Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam

Total No. of Pages				**Title:**
	Name	Sign	Date	Design Basis Report
Designed	DA		26.09.2023	

Document No	2223019 - TNHB - Padikuppam	Rev.No	R0

Project	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	Document.No		Date
		2223019 - TNHB - Padikuppam		26.09.2023
Title	Content	Designed	Checked	Page
		RR	RR	

Contents:

Project	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	Document.No		Date
		2223019 - TNHB - Padikuppam		26.09.2023
Title	General	Designed	Checked	Page
		RR	RR	

1.0 General

Design Ground Elevation

Finished Ground Level (FGL) corresponds to EL (+) 0.00m

Grade of Concrete

Grade of concrete for Foundation shall be M30

All other RCC works shall be M30

Reinforcement Steel

Reinforcement steel shall be HYSD conforming to various requirements of IS:1786 (Cold twisted deformed steel bars and wires for concrete reinforcement Grade Fe 500

Cover to Reinforcement

Clear cover to main reinforcement is as follows:

	Top (mm)	Bottom (mm)	Sides (mm)
Pile	75	75	75
Plinth Beam	40	40	40
Column	-	-	40
Floor Beams	30	30	30
Slab	20	20	20

Project	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	Document.No		Date
		2223019 - TNHB - Padikuppam		26.09.2023
Title	Load Calculation	Designed	Checked	Page
		RR	RR	

2.0 Load Calculation

Project	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	Document.No		Date
		2223019 - TNHB - Padikuppam		26.09.2023
Title	Load Calculation	Designed	Checked	Page
		RR	RR	

2.0 Load Calculations

Reference:

The following Indian Codes and Standards shall be used for design of Civil & Structural works.

IS 456 : 2000 Code of practice for Plain & Reinforced Concrete

IS 875 : 2015 Code of Practice for design loads (other than Earthquake) for Buildings and Structures

IS 1893 : 2016 Criteria for Earthquake resistant design of structures

SP : 16 Design Aids for Reinforced Concrete

Unit weight of concrete	=	25	kN/m³
Unit weight of floor finish material	=	24	kN/m³
Unit weight of mortar	=	20	kN/m³
Unit weight of brick (including Plastering)	=	20	kN/m³
Unit weight of weathering course	=	20	kN/m³

I Dead Load (DL)

i) Slab Laod

a) Load on Roof Slab Floor Area:

Slab Thickness		=	0.125	m
Thickness of the floor finishes over the roof slab		=	0.012	m
Packing Mortar (50 mm)	0.05	=	1	kN/m^2
Tiles		=	0.2	kN/m^2
Self weight of slab	0.125 * 25	=	3.125	kN/m^2
Weight of the floor finishes over the roof slab	0.012 * 20	=	0.240	kN/m^2
Slab load including finishes		=	4.605	kN/m^2

ii) Brick Wall Load

Brick Wall on Floor beams for 230mm thick wall (including Plastering)				=	**12.42**	kN/m
(Max clear height of the wall =	3.00	-	0.30	= 2.70	m)	
Brick Wall on Floor beams for 115 mm thick wall (including Plastering)				=	**6.21**	kN/m
(Max clear height of the wall =	3.00	-	0.30	= 2.70	m)	
Parapet Wall on Terrace floor beams for 230 mm thick wall (including Plastering)				=	**4.60**	kN/m
(Height of the parapet wall =	1.00	m)				

Project	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	Document.No		Date
		2223019 - TNHB - Padikuppam		26.09.2023
Title	Load Calculation	Designed	Checked	Page
		RR	RR	

II Live Load (LL)

Live load at floor level	=	**2**	kN/m^2
Live load on terrace	=	**1.5**	kN/m^2

III Seismic Load Parameters

Seismic parameters considered for Zone-3 are:

Zone	=	0.16	(Zone 3)
RF	=	5.0	(Response reduction factor)
I	=	1.20	(Importance factor)
SS	=	2	(Soil type - Medium soil)

IV Water Tank Load

WaterTank Pressure at slab at height of 1.5 m tank height	=	**15**	kN/m^2

Project	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	Document.No		Date
		2223019 - TNHB - Padikuppam		26.09.2023
Title	Wind Load Calculation	Designed	Checked	Page
		RR	RR	

3 **Wind Load Calculations**

Basic wind speed V_b = 50 m/sec

Risk coefficient k_1 = 1.00

Terrain factor for k_2 - category - 2, Height of bldg < 10m = 1.00

Topography factor k_3 = 1.0

Importance factor k_4 = 1.00

(As per IS 875 (part-3) - 2015 Cl: 6.3)

Design wind speed V_z = $V_b.k_1.k_2.k_3.k_4$

= 50.00 m/sec

Wind pressure P_z = $0.6.V_z^2$

= 1.500 kN/m²

Design Wind pressure P_d = $K_d.K_a.K_c.P_z$

Wind directionality factor K_d = 1.00

Area averaging factor K_a = 1.00

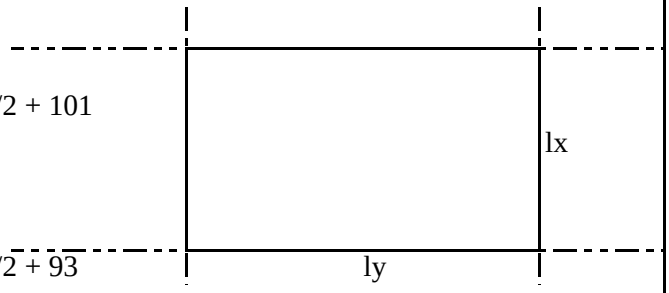
Combination factor K_c = 1.00

P_d = 1.5000 kN/m²

3.0 Typical Design of Slab

PROJECT	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	DOCUMENT NO		DATE
		2223019 - TNHB - Padikuppam		26.09.2023
TITLE	Design of Two way Slab	DESIGNED	CHECKED	SHEET
		RR	RR	

1.0 .Design of Two Way Slab **1. Interior Panel**



Span along shorter side = 3.800 m

lx = 3800 - 230 /2 - 230 /2 + 101

= 3.671 m

Span along longer side = 6.15 m

ly = 6150 - 230 /2 - 230 /2 + 93

= 6.013 m

ly / lx = 6.013 / 3.671

= 1.64 < 2 Hence, Two Way Slab

Cl. D-1.1 of IS 456:2000

Depth of Slab

Assume Depth of Slab = 125 mm

Clear Cover = 20 mm

Dia of Reinforcement = 8 main & 8 mm secondery

Effective depths of slab

d_x = 125 - 20 - 8 /2 d_y = 125 - 20 - 8 - 8/2

= 101 mm in x- & = 93 mm in y- direction

Materials

Grade of Steel = 500 N/mm^2

Grade of Concrete = 30 N/mm^2

Load on Slab

Density of concrete = 25 kN / m^3

Self Weight of Slab = 0.125 x 25

= 3.125 kN / m^2

Live Load = 2.00 kN / m^2 *(From Tech Spec)*

Roof weathering course = 1.000 kN / m^2

False ceining, elec ,mech req = 0.50 kN / m^2

Total load, w = 3.125+2+1+0.5 Note:

= **6.625** kN / m^2 Factor of safty 1.5 is multiplied with Moment

Edge Condition : 1. Interior Panel

$Mx = \alpha_x w l_x^2$

$My = \alpha_y w l_x^2$

From Table 26 of IS:456-2000	**Short Span Co-efficeint, αx**	**Long Span Co-efficeint, αy**
Negative Moment at Continuous edge	0.053	0.032
Positive Moment at Mid span	0.041	0.024

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		2223019 - TNHB - Padikuppam		26.09.2023
TITLE	Design of Two way Slab	DESIGNED	CHECKED	SHEET
		RR	RR	

$w\ l_x^2$ = 6.625 x 3.671^2
= 89.280 kN

Shorter Span

At Midspan

Mx (+ve) = 0.0410 x 89.280
= 3.66 kNm

M_u/bd^2 (+ve) = (3.66 x 10^6 x 1.5)/(1000 x 101^2)
= 0.538

From Table 2 of SP-16

Pt (+ve) = 0.126

Ast (+ve) = (0.126/100) x (1000 x 101)
= 127.3 mm²

Ast Min = 150.0 mm²

Hence provide 8 dia bars @ 150 c/c

= (3.142/4) x 8^2 x 1000/150

Ast provide = 335.1 mm² > 150.00

Hence Safe

At Support

Mx (-ve) = 0.053 x 89.280
= 4.73 kNm

M_u/bd^2 (-ve) = (4.73 x 10^6 x 1.5)/(1000 x 101^2)
= 0.70

From Table 2 of SP-16

Pt (-ve) = 0.164

Ast (-ve) = (0.164/100) x (1000 x 101)
= 165.64 mm²

Ast Min = 150.0 mm²

Hence provide 8 dia bars @ 150 c/c

= (3.142/4) x 8^2 x 1000/150

Ast provide = 335.1 mm² > 165.64

Hence Safe

Longer Span

My (+ve) = 0.024 x 89.280
= 2.14 kNm

M_u/bd^2 (+ve) = (2.14x10^6x1.5)/(1000x93^2)
= 0.37

From Table 2 of SP-16

Pt (+ve) = 0.087

Ast (+ve) = (0.087/100) x (1000 x 93)
= 80.91 mm²

Ast Min = 150.0 mm²

Hence provide 8 dia bars @ 150 c/c

= (3.142/4) x 8^2 x 1000/150

Ast provided = 335.1 mm² > 150.00

Hence Safe

Mx (-ve) = 0.032 x 89.280
= 2.86 kNm

M_u/bd^2 (-ve) = (2.86x10^6x1.5)/(1000x93^2)
= 0.50

From Table 2 of SP-16

Pt (-ve) = 0.116

Ast (-ve) = (0.116/100) x (1000 x 93)
= 107.88 mm²

Ast Min = 150.0 mm²

Hence provide 8 dia bars @ 150 c/c

= (3.142/4) x 8^2 x 1000/150

Ast provided = 335.1 mm² > 150.00

Hence Safe

Check for Deflection

Actual lx / d = 3.671 / 0.101
= 36.35

Pt provided = (335.1 x 100)/(1000 x 101)
= 0.33 %

PROJECT	Proposed Construction of Stilt + 5 Floors Residential Building at Padikuppam	DOCUMENT NO		DATE
		2223019 - TNHB - Padikuppam		26.09.2023
TITLE	Design of Two way Slab	DESIGNED	CHECKED	SHEET
		RR	RR	

Steel Stress of service loads fs = $\frac{0.58 \times fy \times Ast\ req}{Ast\ prov}$ *Fig. 4 - IS 456 : 2000*

= 0.58 x 500 x 127.26 / 335.1

= 110.13 N/mm^2

For contiouous edges lx/d = 26 *Clause 23.2.1 (a):IS 456*

Modification factor = 2.00 *Fig. 4 - IS 456 : 2000*

lx/d = 2 x 26 *Clause 23.2.1 (c):IS 456*

= 52.00

Actual lx/d = 36.35 < 52.0 Hence safe

4.0 Typical 2-Pile Cap Design

PILE CAP ID : PC 2 - A

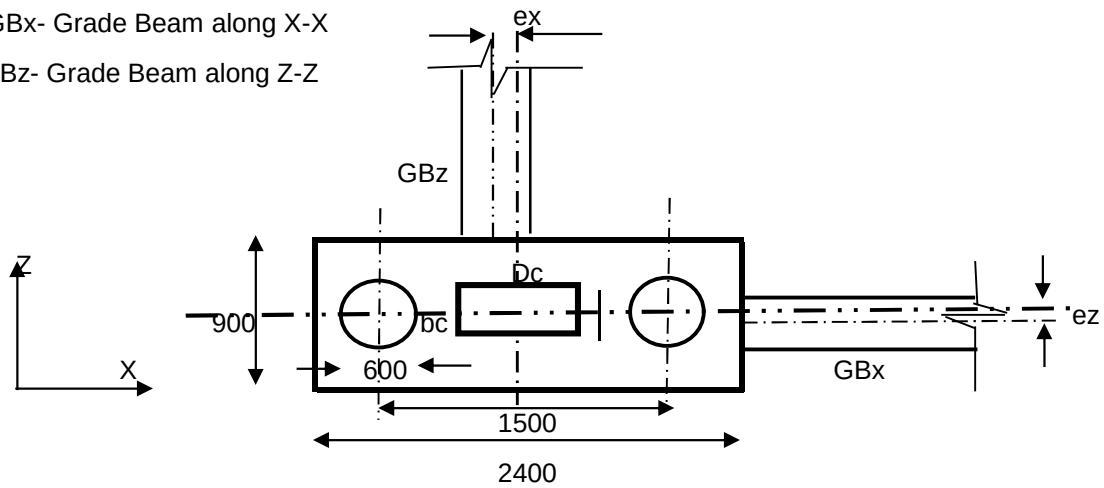
LOAD COMB-1 : DL+LL

DATA

Grade of Concrete	f_{ck}	=	30	N/mm²
Grade of Steel	f_y	=	500	N/mm²
Axial load	P	=	1770	kN
Moment at column base (about X-X axis)	Mx	=	15.90	kNm
Moment at column base (about Z -Zaxis)	M_z	=	18.10	kNm
Lateral load at X-X axis	F_X	=	1.33	kN
Lateral load at Z-Z axis	F_z	=	1.24	kN
Load Due to Grade Beam along X-X axis	P1	=	0.00	kN
Load Due to Grade Beam along Z-Z axis	P2	=	0.00	kN
Eccentricity of Grade beam load on pile cap along X-X	ex	=	0.00	mm
Eccentricity of Grade beam load on pile cap along Z-Z	ez	=	0.00	mm
Moment due to eccentric load from Grade beam about X-X = P1 X ez		=	0.00	kNm
Moment due to eccentric load from Grade beam about Z-Z = P2 X ex		=	0.00	kNm
Total moment about X-X direction	M_{X1}	=	15.90	kNm
Total moment about Z-Z direction	M_{z1}	=	18.10	kNm
No of piles		=	2	Nos
Dia of pile	h_p	=	600	mm
Column Size	b_c	=	300	mm
	D_c	=	530	mm
Clear cover		=	50	mm
Projection from the pile	tp	=	150	mm

Where GBx- Grade Beam along X-X

GBz- Grade Beam along Z-Z



PILE CAP SIZE:-

Minimum Spacing of pile required ($3*h_p$)			=	1800	mm
No of rows in pile group		m	=	1	Nos
No of columns in pile group		n	=	2	Nos
For 100% Eff spacing reqd, (1.57B *mn - 2B) / (m+n-2)		S_{req}	=	684	mm
Spacing of pile provided		S_{pro}	=	1500	mm
Depth of pile cap		D	=	900	mm
Effective depth of pile cap, d		d	=	840	mm
Length of pile cap required		$L=S+t_p+t_p+h_p$	=	2400	mm
Breadth of pile cap required		$B=t_p+t_p+h_p$	=	900	mm
Length of pile cap provided		L	=	2400	mm
Breadth of pile cap provided		B	=	900	mm
Self Weight of the pile cap	P3 = L*B*d*Density of concrete		=	48.6	kN

LOADS ON PILE CAP

LOAD CALCULATON ABOUT X-X

Moment at base of pilecap about XX direction		M_{X1}	=	15.90	kNm
Horizontal shear at pile cap level		F_z	=	1.2	kN
Twisting moment in pile cap	$M_{Tx} = M_{x1}+(F_z*D/1000)$		=	17.016	kNm
		$Z_i = S_z/2$		0	mm
Moment at bottom of pile cap due to shear Fz		$(F_z*D/1000)$	=	1.116	kNm
Total moment at bottom of pile cap	$M_x* = (F_z*D/1000)+M_{x1}$		=	17.02	kNm
Vertical reaction on each pile due to $M_X*=(M_x* Z_i / \Sigma Z_i^2)$		P4	=	0.00	kN

LOAD CALCULATON ABOUT Z-Z

Moment at base of pilecap about ZZ direction		Mz1	=	18.1	kNm
Horizontal shear at pile cap level		F_X	=	1.33	kN
Twisting moment in pile cap		M_{Tz}	=	0	kNm
		$X_i = S_x/2$	=	750.0	mm
Total moment at bottom of pile cap	$M_z* = (F_x*D/1000)+M_z1$		=	19.30	kNm
Vertical reaction on each pile due to Moment $(M_z*X_i/\Sigma X_i^2)$		P5	=	25.73	kN
Total Vertical load	P+P1+P2+P3+P4+P5		=	1844.33	kN
Total Vertical Load / pile	(P+P1+P2+P3+P4+P5)/2	W	=	922.16	kN

CHECK FOR COMPRESSION CAPACITY

Unfact max Compression load on each pile	Wc=W	Wc	=	922.16	kN
Compression load capacity of pile			=	1000	kN Hence Safe
Factored maximum load on each pile		$W_{fac} = Wc*1.5$	=	1383.25	kN

CHECK FOR TENSION CAPACITY

Unfact max Tension load on each pile WT=(P+P1+P2+P3-P4-P5)/2		=	0	kN
Tension capacity of theb Pile		=	300	kN Hence Safe

Bending about ZZ-direction

Max unfactored moment at the face of column	W X (S_{pro}/2 - D_c/2)	=	447.25	kNm	
Equivalent bending moment	M_e=Mu+M_T((1+(D/B))/1.7)	=	467.27	kNm	
Effective depth of pile cap required	d_{req}= (1.5xMe)/(0.138 X fck X B)	=	433.72	<	840
			Hence depth provided is ok		

A_{st} CALCULATION

Percentage of steel required	From SP-16, P	=	0.266	%	
Area of steel required	$A_{st\ req}$ = (P/100)*B*d	=	2008.03	mm²	
Dia of reinforcement		=	20.00	mm	
Spacing required	$(\pi*d^2/4)*B/A_{st\ req}$	=	140.81	mm	
Spacing provided		=	**100.00**	mm C/C	
Percentage of steel provided		=	0.374	%	
Area of steel provided	$A_{st\ pro}$	=	2827.43	mm²	Hence Ok

Provide 20mm Dia bars @ 100mm C/C - Both ways

Top Reinforcement

Ast required	$A_{st\ req}$ = (P/100)*B*d	=	972.00	mm²	
Dia of bars used		=	**16**	mm	
Spacing requierd	$(\pi*d^2/4)*B/A_{st\ req}$	=	186.17	mm	
Spacing provided		=	**150**	mm	
Area of steel provided	$A_{st\ pro}$	=	1206.37	mm²	Hence Ok

Provide 16mm Dia bars at 150mm Spacing - Top Both the Direction

Horizontal Reinforcement

Ast required (20% of max ast provided)	$A_{st\ req}$ = (P/100)*B*d	=	605.88	mm²	
Dia of bars used		=	**12**	mm	
Spacing required	$(\pi*d^2/4)*B/A_{st\ req}$	=	168.00	mm	
Spacing provided		=	**150**	mm	
Area of steel provided	$A_{st\ pro}$	=	678.58	mm²	Hence Ok

Provide 12mm Dia bars at 150mm Spacing - as Horizontal Reinforcement

Shear Along XX direction

Equivalent Shear	V_{eX} = (P+P1+P2)/2) + 1.6MT_x/B	=	1327.55	kN	
Nominal shear stress	$\zeta_v = V_{ex}/B*d$	=	1.756	N/mm²	
Allowable Shear stress	from IS456 ζ_c	=	0.439	N/mm²	
Critical shear area av=(1/2)*Lv - hp/2-Dc/2+hp/5	a_v	=	305	mm	
Design shear stress for critical area ($\zeta'c=\zeta c.(2d/av)$	ζ'_c	=	2.420	N/mm²	> ζv
					Hence safe in shear
Bond stress	ζ_{bd}	=	2.4	N/mm²	
Development length to be provided	(0.87XfyXΦ)/(4Xζbd)		L_d	906	mm

5.0 Geotechnical Report For Pile Calculation

Pile Diameter 600 mm taken for calculating Number Piles required

GEOTECHNICAL INVESTIGATION REPORT FOR THE PROPOSED CONSTRUCTION OF (STILT +7) RESIDENTIAL BUILDING AT PADI VILLAGE, AMBATTUR TALUK, THIRUVALLUR DISTRICT.

Under each column there should be a pile cap to transfer the support load to the carrying piles. The bottom level of the all pile caps shall be kept at 1.0 m below the ground level in case of bored in situ pile. The plan and dimensions of pile caps could be estimated according to the required number of piles and considered centre to center spacing between piles.

Bored In situ Pile Foundation

A Pile length of 26.00m has been analysed below and the corresponding Pile capacities are given. Selection of Pile length was estimated according to soil profile and soil stiffness as obtained from SPT values.

PILE CAPACITIES

Bedrock was not encountered up to a maximum explored depth. Hence, the Piles utilizing friction and also end bearing capacities shall be adopted for the proposed structures. The Pile capacities of the bored, cast in situ piles are worked out considering a depth of 26.00 meter below ground level as the top of pile level. Estimation of Pile capacities are given below with reference to the boreholes drilled at site.

PILE CAPACITY CALCULATIONS				
Pile Depth (m)	Pile Diameter (mm)	Factor of Safety = 2.5 Allowable Pile Load Capacity (kN)	Lateral load bearing capacity(kN)	Uplift Resistance (kN)
26.00	600	1010	80.8	860
26.00	800	1420	113.6	1150
26.00	1200	1870	149.6	1440

Note:

The above recommendation is given by assuming similar soil strata in the whole site area. In case of any variations in the soil profile the above recommendation need to be validated.

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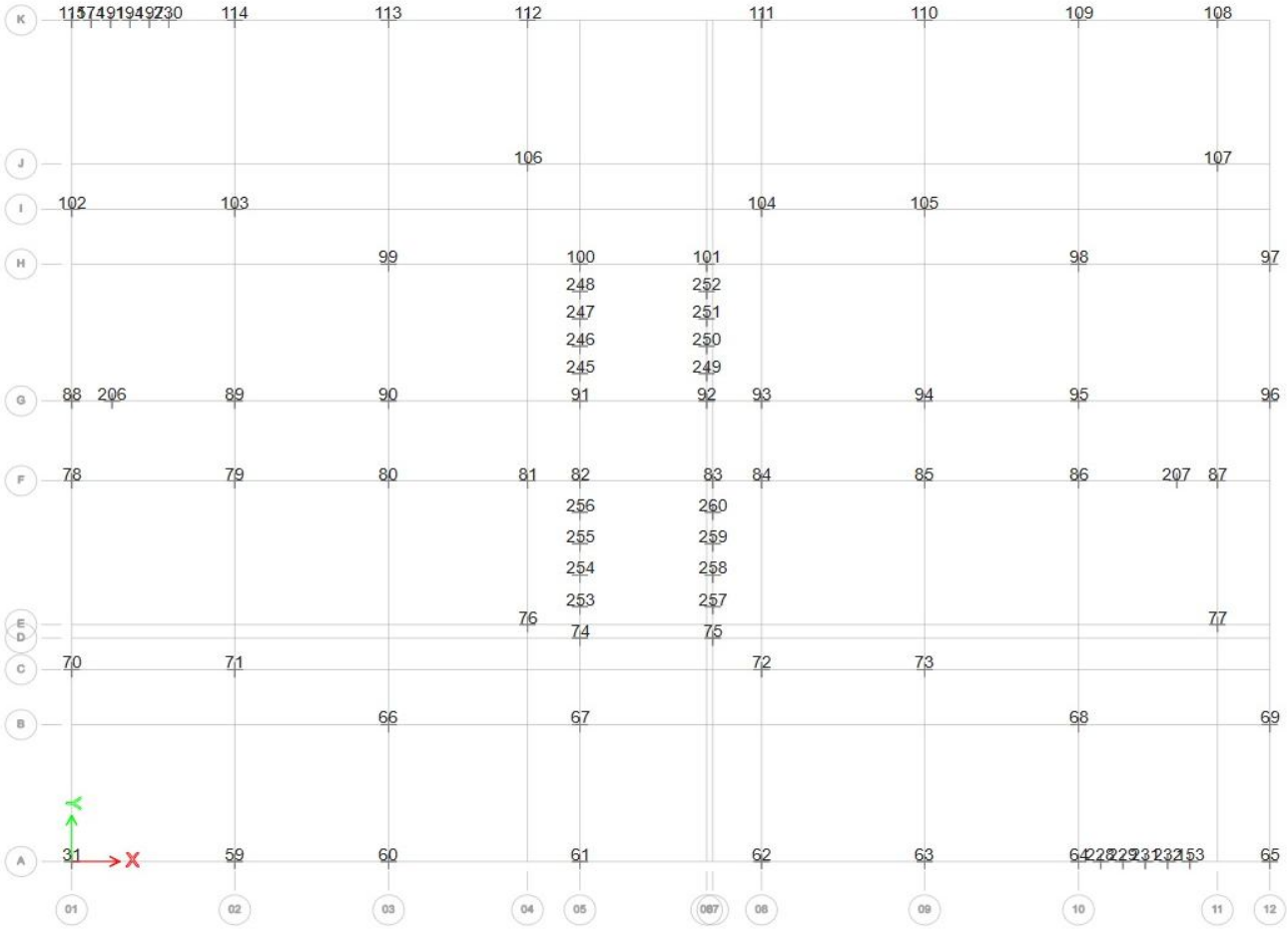
Etabs Model Grid with Label



1 Pile Group Calculation									
Grid	Label	Forces from Etabs			No of Pile Calculation				
		FX	FY	FZ	Max Lateral Force	No of Piles for lateral force (F/80.8)	Plus 10 % Axial (Self Weight)	No of Piles for Axial force	Total No of Pile required
F	84	42.1879	16.572	956.4171	42.19	0.522127	1052.06	1.041642	1.0
G	93	31.3781	17.3885	925.6583	31.38	0.388343	1018.22	1.008143	1.0

2 Pile Group Calculation									
Grid	Label	Forces from Etabs			No of Pile Calculation				
		FX	FY	FZ	Max Lateral Force	No of Piles for lateral force	Plus 10 % Axial (Self Weight)	No of Piles for Axial force	Total No of Pile required
A	31	15.81	17.83	1073.5	17.83	1	1180.82	2	2
	59	38.06	17.51	1225.6	38.06	1	1348.12	2	2
	60	25.36	19.26	923.6	25.36	1	1015.97	2	2
	61	27.53	18.07	623.4	27.53	1	685.70	1	1
	62	39.88	10.25	1061.0	39.88	1	1167.05	2	2
	63	43.18	15.81	1242.3	43.18	1	1366.56	2	2
	65	45.02	18.87	960.9	45.02	1	1056.95	2	2
B	66	41.0048	19.1749	1769.2	41.00	1	1946.08	2	2
	67	19.6155	42.6667	810.6	42.67	1	891.68	1	1
	68	31.0119	19.3582	1817.3	31.01	1	1998.98	2	2
	69	17.4629	35.0943	911.5	35.09	1	1002.64	1	1
C	70	25.2931	26.3241	1763.1	26.32	1	1939.46	2	2
	71	22.4872	20.8243	1867.4	22.49	1	2054.11	2	2
	72	18.4978	15.6861	1680.9	18.50	1	1848.96	2	2
	73	16.2094	17.473	1856.0	17.47	1	2041.55	2	2
E	76	28.9532	10.7944	827.3	28.95	1	910.02	1	1
	77	21.3469	24.9172	922.6	24.92	1	1014.91	2	2
F	78	15.2132	26.1613	977.4	26.16	1	1075.10	2	2
	81	35.6232	11.4788	781.3	35.62	1	859.38	1	1
	207 & 87	96.5208	17.3819	1747.3	96.52	2	1747.26	2	2
		-5.7998	-1.7513	952.3					
G	88 & 206	97.5114	23.6241	1734.2	97.52	2	1734.17	2	2
		12.0294	-1.328	1034.3					
	96	16.1386	16.1206	872.7	16.14	1	960.02	1	1
H	99	8.6008	23.5285	1769.3	23.53	1	1946.23	2	2
	98	28.7874	28.7936	1820.6	28.79	1	2002.65	2	2
	97	33.334	33.0591	892.8	33.33	1	982.03	1	1
I	102	19.1646	19.5222	1587.6	19.52	1	1746.37	2	2
	103	16.994	22.8039	1864.5	22.80	1	2050.91	2	2
	104	25.8509	14.0359	1410.7	25.85	1	1551.75	2	2
	105	23.0309	19.2963	1729.5	23.03	1	1902.49	2	2
J	106	24.613	9.1912	824.2	24.61	1	906.67	1	1
	107	28.2522	34.6178	906.1	34.62	1	996.72	1	1
K									
	113	39.7313	14.6628	1251.8	39.73	1	1376.97	2	2
	112	41.4815	10.0187	739.9	41.48	1	813.91	1	1
	111	26.202	11.5323	927.5	26.20	1	1020.24	2	2
	110	32.0788	14.096	1257.2	32.08	1	1382.92	2	2
	109	40.0047	18.8789	1273.8	40.00	1	1401.22	2	2
	108	16.5825	19.8158	740.2	19.82	1	814.20	1	1

3 Pile Group Calculation									
Grid	Label	Forces from Etabs			No of Pile Calculation				
		FX	FY	FZ	Max Lateral Force	No of Piles for lateral force	Plus 10 % Axial (Self Weight)	No of Piles for Axial force	Total No of Pile required
G & F	89	40.88	31.94	1306.00	40.88	0.51	1436.59	1.42	3
	79	28.71	31.53	1379.91	31.53	0.39	1517.91	1.50	
G & F	90	28.7194	26.9942	1256.3802	28.72	0.36	1382.02	1.37	3
	80	28.3199	25.3831	1515.9104	28.32	0.35	1667.50	1.65	
G & F	94	28.9721	28.0779	1364.288	28.97	0.36	1500.72	1.49	2
	85	33.9919	29.1906	1373.2931	33.99	0.42	1510.62	1.50	
G & F	95	29.6911	33.4925	1254.4676	33.49	0.41	1379.91	1.37	3
	86	48.8582	30.2679	1576.2472	48.86	0.60	1733.87	1.72	

6.0 GENERAL DESIGN CONSIDERATIONS

A) PILE FOUNDATION

1. As per the soil test report, we are using Bored Cast In-situ Concrete Pile foundation.

2. Piles of 600 mm or less in diameter are commonly known as small diameter piles while piles greater than 600m diameter are called large diameter piles. Minimum pile diameter shall be 450 mm.

3. The spacing of the piles means the center-to-center distance between adjacent piles.

4. Initial Load Test: A test pile is tested to determine the load-carrying capacity of the pile by loading either to its

5. Routine Test Pile: A pile which is selected for load testing may form a working pile itself, if subjected to routine load test up to one and 1.5 times the safe load.

6. Spacing of Piles - The minimum centre-to-centre spacing of piles is considered from three aspects,

   a) Practical aspects of installing the piles,

   b) Diameter of the pile, and

   c) Nature of the load transfer to the soil and possible reduction in the load capacity of piles group.

7. In case of piles founded on hard stratum and deriving their capacity mainly from end-bearing the minimum spacing shall be 2.5 times the diameter of the circumscribing circle corresponding to the cross-section of the pile shaft. In case of piles resting on rock, the spacing of two times the said diameter may be adopted.

8. The minimum area of longitudinal reinforcement of any type or grade within the pile shaft shall be 0.4 percent of the cross-sectional area of the pile shaft. The minimum reinforcement shall be provided throughout the length of the shaft.

9. The slump should be 150 to 180 mm at the time of pouring.

10. The minimum grade of concrete to be used for bored piling shall be M25. For sub aqueous concrete, the requirements specified in IS 456 shall be followed. The minimum cement content shall be 400 kg/m3. However, with proper mix design and use of proper admixture the cement content may be reduced but in no case the cement content shall be less than 350 kg/m3.

B) COLUMN:

1. The minimum dimensions of the column shall not be less 300mm

2. Lap Splices: When adopted, closed links shall be provided over the entire length over which the longitudinal bars are spliced. Further

a. The spacing of these links shall not exceed 100mm

b. The lap length shall not be less than the development length of thr largest longitudinal reinforcement bar in tension.

c. Lap splices shall be provided only in the central half of clear column height and not

within a joint, or

within a distance of 2d from face of the beam.

d. Not more than 50 percent of area of steel bars shall be spliced at any one section.

e. Lap splices shall not be used for bars of diameter larger than 32mm for which mechanical splicing shall be adopted.

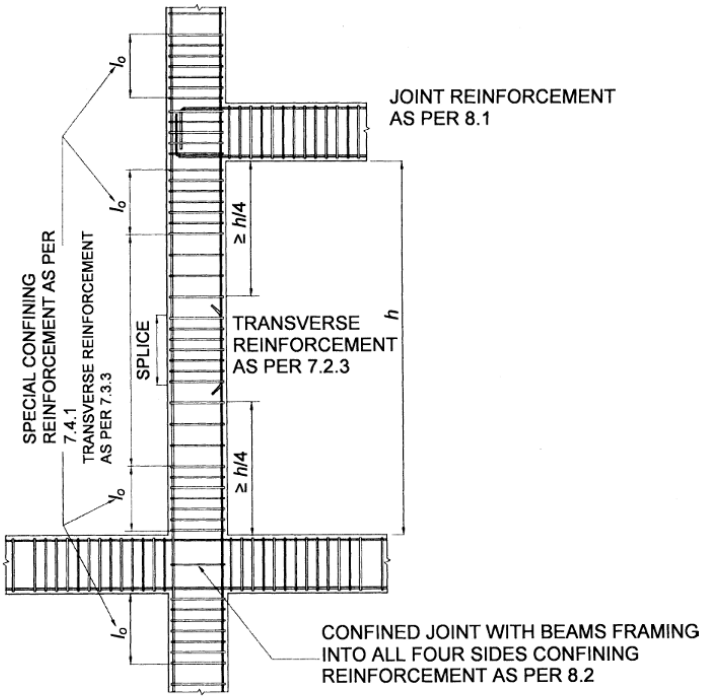


FIG. 12 COLUMN AND JOINT DETAILING

3. The cross-sectional area of longitudinal reinforcement, shall be not less than 0.8 percent nor more than 6 percent of the gross cross-sectional area of the column.

4. The minimum number of longitudinal bars provided in a column shall be four in rectangular columns and six in circular columns.

5. The bars shall not be less than 12mm in diameter.

C) BEAMS:

1. Beams shall preferably have width to depth ratio of more than 0.3

2. Beams shall have at least two 12mm diameter bars each at top and bottom faces.

3. The minimum longitudinal steel ratio Pmin for M30 and Fe 500 steel on any face at any section is 0.0026

4. Maximum longitudinal steel ration Pmax provided on any face at any section in 0.025.

5. While lap splices, closed links shall be provided over the entire length over which the longitudinal bars are spliced.

a. The spacing of these links shall not exceed 150mm

b. The lap length shall not be less than the development length of the largest longitudinal reinforcement bar in tension.

c. Lap splices shall not be provided (i) within a joint, (ii) within a distance of 2d from face of the column and (iii) within a quarter length of the beam adjoining the location where flexural yielding may occur under earthquake effects.

d. not more than 50 percent of area of steel bars on either top or bottom face shall be spliced at any one section.

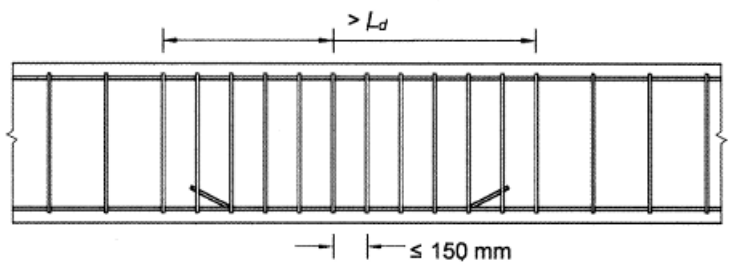


FIG. 3 LAP LENGTH AT LOCATION OF SPLICING OF LONGITUDINAL BARS IN BEAM

6. The minimum diameter of a link shall be 8mm.

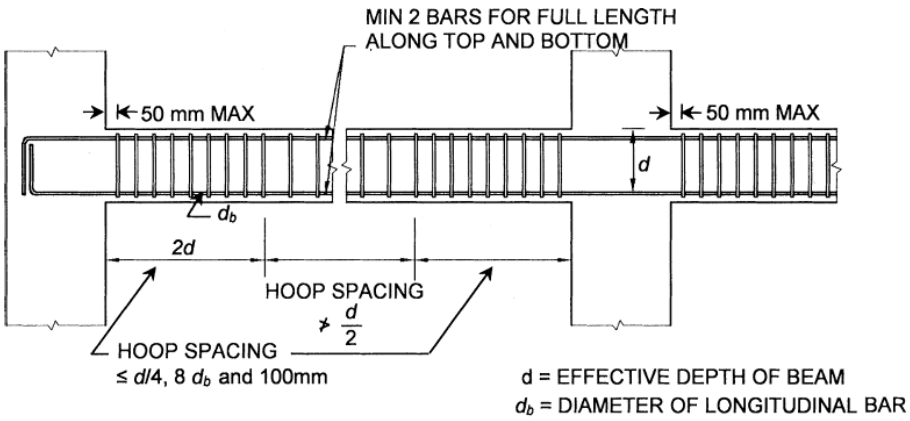


FIG. 6 DETAILS OF TRANSVERSE REINFORCEMENT IN BEAMS

7. Spacing of links over a length od 2d at either end of a beam shall not exceed

    a. d/4,

    b. 8 times the diameter of the smallest longitudinal bar and

    c. 100mm

8. The first link shall be at a distance not exceeding 50mm from the joint face.

D) SLABS:

1. As per 2hrs fire rating minimum slab thickness is 125mm.

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hello@verified.realestate
+91 9996 12 9996
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