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STRUCTURAL DESIGN REPORT

PROPOSED CONSTRUCTION OF RESIDENTIAL BUILDING WITH 10 DWELLING UNITS (STILT FLOOR PARKING+5 UPPER FLOORS) AT DOOR NO.52/46, AS PER DOCUMENT DOOR NO.48/52, TAYLORS ROAD, KILPAUK, CHENNAI - 600 010. COMPRISED IN T.S. NO. 140/7, BLOCK NO.10, OF EGMORE VILLAGE, EGMORE TALUK, GREATER CORPORATION OF CHENNAI.

REPORT NO:

DATE: 16th March 2023

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1.0 INTRODUCTION

It is Proposed Construction of Residential Building With 10 Dwelling Units (Stilt Floor Parking+5 Upper Floors) at Door No.52/46, as per Document Door No.48/52, Taylors Road, Kilpauk, Chennai - 600 010 . Comprised In T.S. No. 140/7, Block No.10 , of Egmore Village, Egmore Taluk, Greater Corporation of Chennai . The proposed construction shall have RC frames along with lateral loading resisting elements. Based on the soil report furnished, the type of foundation to be adopted is finalized. The complete analysis is carried out for extreme loading conditions subsequently the design is carried out as per IS standards. The detailed analysis is carried out using ETABS software. The summary of the analysis and design is furnished in the subsequent sections.

2.0 MODELLING OF BUILDING USING ETABS SOFTWARE

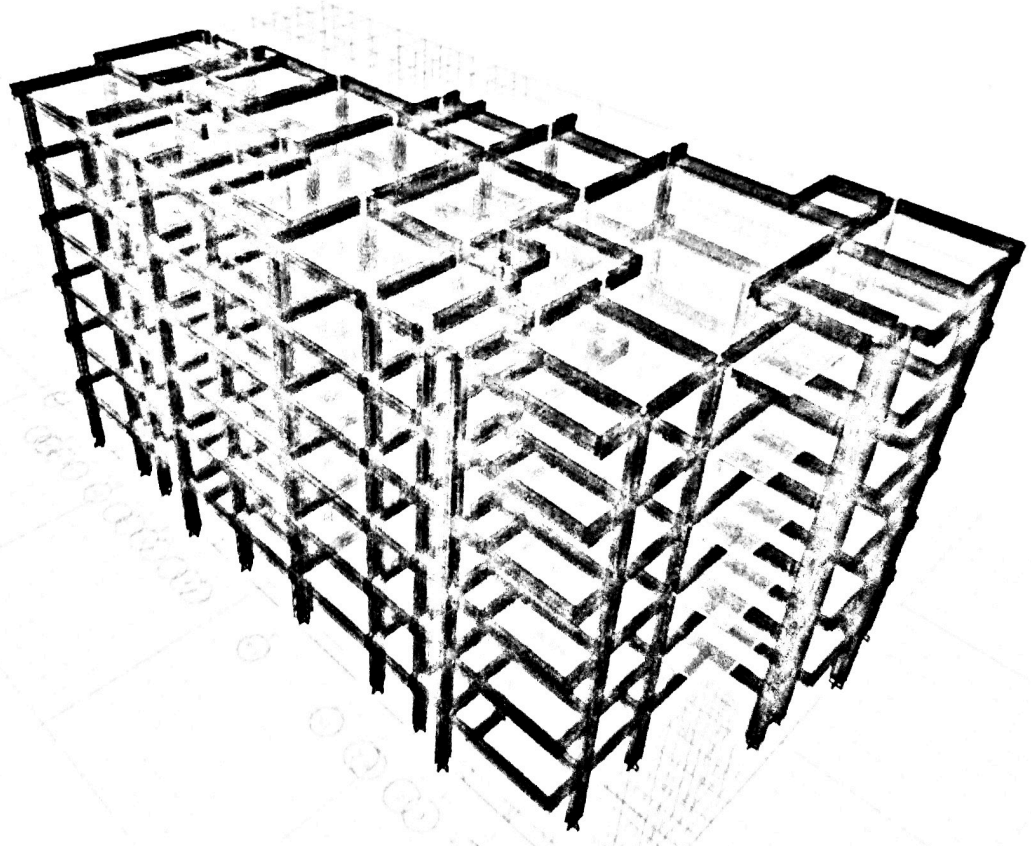


Fig. 1 3D Model of the Proposed Building (From ETABs software)

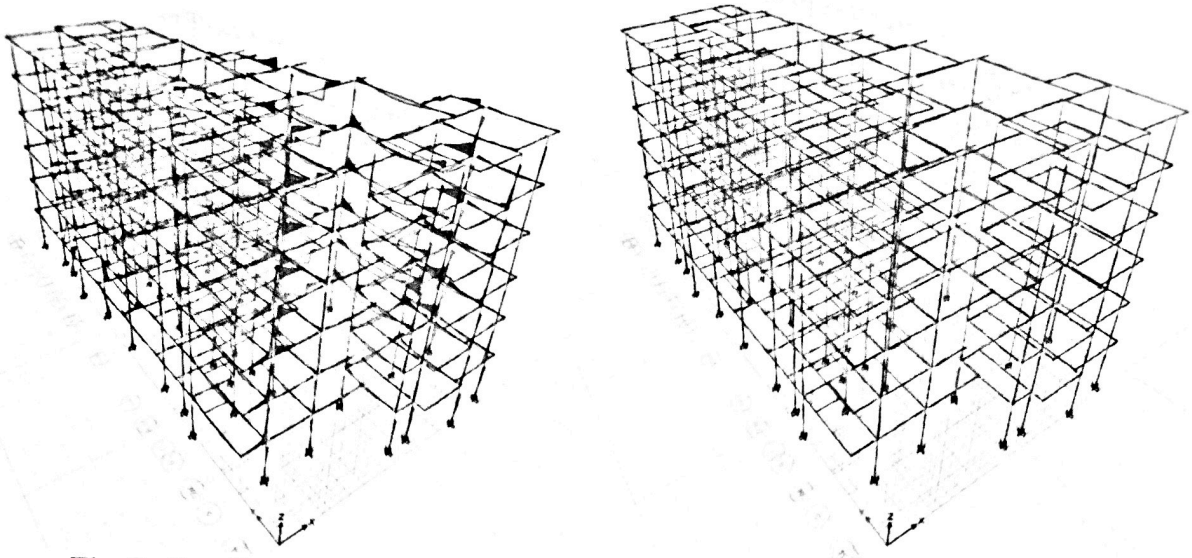


Fig. 2 Bending moment and Shear force Diagrams (From ETABs software)

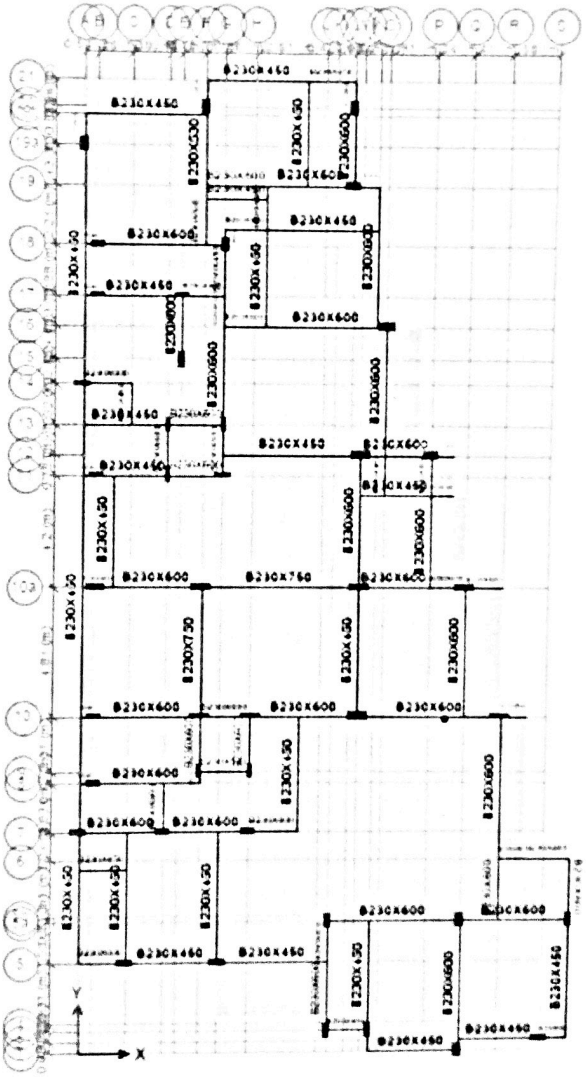


Fig. 3. Stilt Floor Roof beam layouts

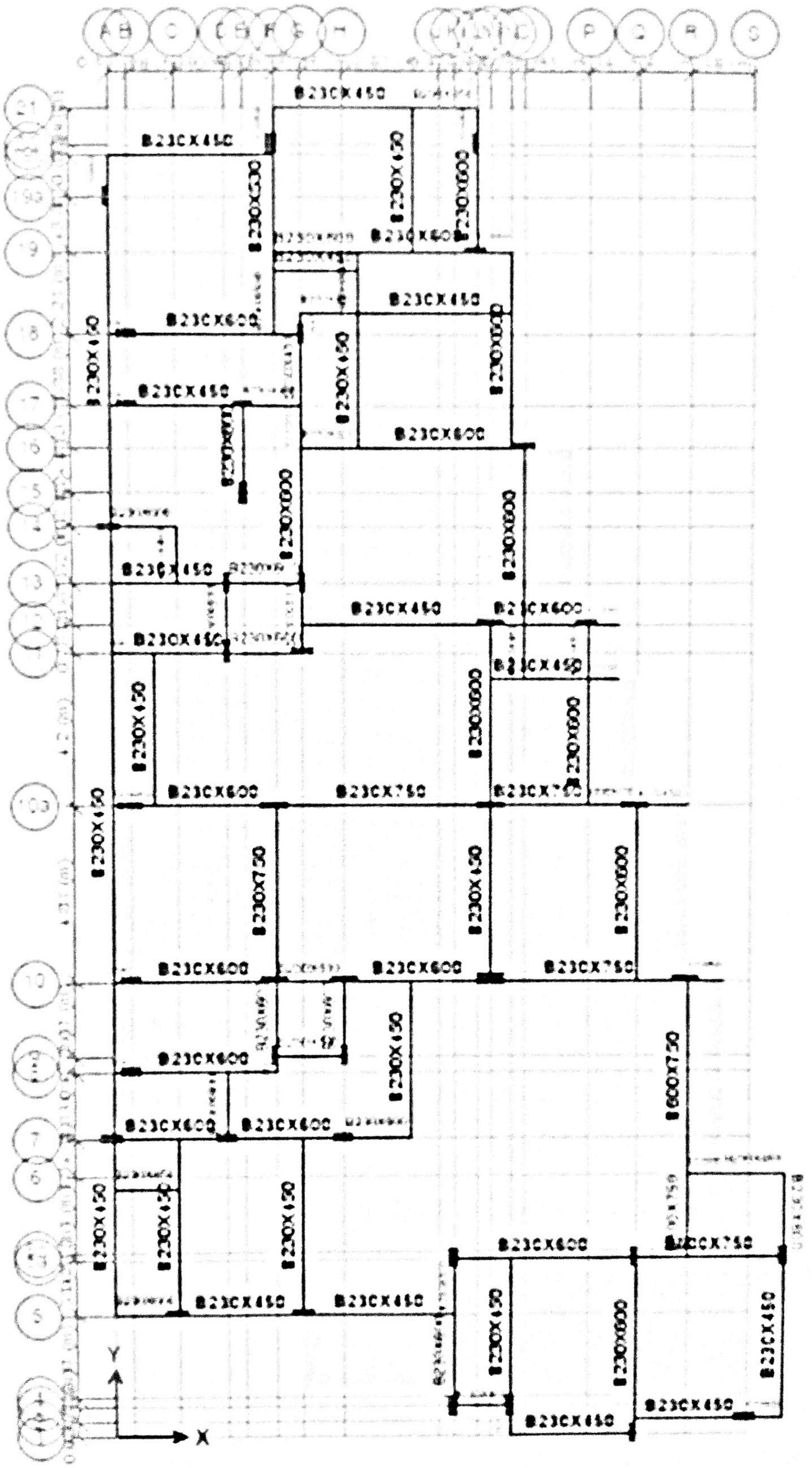


Fig. 4. First to Terrace Floor Roof beam layouts

3.0 DATA FOR ANALYSIS

Table 1 Loads and Material Properties

LOADING STANDARDS	
IS codes:	IS: 875-1987-Part-3; IS: 456-2000 and IS 1893-2016(Part-I) IS-13920-2016.
Types of Loads	Dead load, Live load and Earthquake loads.
Dead Loads	Unit weight of concrete – 25 kN/m^3; Unit weight of brick work – 20 kN/m^3; Floor finish – 1.50kN/m^2; All Toilets sunken portions – 4kN/m^2. Unit weight of light weight blocks – 10 kN/m^3
Live Loads	As per IS code all Floor areas 2.5 kN/m^2, Corridors, Staircases and Balcony 3.5 kN/m^2, Toilet portions 3.5 kN/m^2
Earthquake Load	As per IS:1893-2016 Part -1.
Load Combinations [ELx- Earthquake load in x direction; Ely- Earthquake load in y direction]	Ultimate Conditions 1. 1.5(Dead Load + Live Load) 2. 1.2(Dead Load + Live Load+ELx+0.3ELy) 3. 1.2(Dead Load + Live Load+ELy+0.3ELx) 4. 1.5(Dead Load +ELx+0.3ELy) 5. 1.5(Dead Load +ELy+0.3ELx) 6. 0.9 Dead Load +1.5 (ELx+0.3ELy) 7. 0.9 Dead Load +1.5 (ELy+0.3ELx) Serviceability Conditions 1. 1.0(Dead Load + Live Load) 2. 1.0(Dead Load + Live Load+ELx+0.3ELy) 3. 1.0(Dead Load + Live Load+ELy+0.3ELx) 4. 1.0(Dead Load +ELx+0.3ELy) 5. 1.0(Dead Load +ELy+0.3ELx)
Wind Load	As per IS:875-1987 Part -3.
Number and Height of Floors	S +5 Floors; Total height 18.30 m
Method of Analysis	Linear Elastic dynamic analysis.
Type of software used	ETABS V 18.2
Response spectrum used for seismic analysis	Using IS:1893-2016-Part-1
Type of soil conditions	As per soil report (medium)
Design Methodology	Limit state method using Design aids SP:16-1986
Reinforcements detailing	IS: 456-2000 and IS: 1893-2016(Part-I); IS-13920-2016

4.0 ANALYSIS AND DESIGNS RESULTS

COLUMNS:

Table. 2 Column Reinforcements based on axial forces and moments.

Column Grid and its Sizes	Axial force P_u (kN)	Moment M_u (kNm)	f_{ck}	% A_{st} Required	A_{st} Provided
O1 (0.23/0.30 ×0.60)	958	37	30	1.49	6Y20+4-Y16
Q2 (0.23/0.30 ×0.60)	853	65	30	1.14	10-Y16
J3 (0.23/0.30 ×0.60)	645	28	30	1.47	6Y20+4-Y16
L3 (0.23/0.30 ×0.60)	916	23	30	1.46	6Y20+4-Y16
C4 (0.23/0.30 ×0.60)	1281	41	30	2.46	4-Y16+6-Y12
G4 (0.23/0.30 ×0.60)	1227	35	30	1.49	6Y20+4-Y16
J5 (0.23/0.30 ×0.60)	1630	26	30	2.76	4Y25+6-Y20
O5 (0.23/0.30 ×0.60)	1924	70	30	2.2	10-Y16
R5 (0.23/0.30 ×0.60)	1791	79	30	2	10-Y16
A6 (0.23×0.60)	1065	10	30	1.98	10-Y16
D6(0.23×0.60)	845	24	30	1.98	10-Y16
H6(0.23×0.60)	1431	51	30	2	10-Y16
B7(0.23×0.60)	649	10	30	1.67	6Y20+4-Y16
F8(0.23×0.60)	584	15	30	0.9	10-Y16
H8(0.23×0.60)	595	11	30	0.96	10-Y16
B9(0.23×0.60)	1182	11	30	1.6	14-Y16
F9(0.23×0.60)	1440	79	30	1.6	14-Y16
H9(0.23×0.60)	1203	32	30	1.6	14-Y16
J9 (0.23/0.30 ×0.60)	2402	102	30	2.9	6-Y25+8-Y20
P9 (0.23/0.30 ×0.60)	1291	30	30	3.23	10-Y25+4-Y20
B10 (0.23/0.30 ×0.60)	1637	16	30	2.31	14-Y20
F10 (0.23/0.30 ×0.60)	1842	34	30	3	6-Y25+8-Y20
J10 (0.23/0.30 ×0.60)	2280	24	30	2.31	14-Y20
O10 (0.23/0.30 ×0.60)	1650	39	30	2.56	14-Y20

B11 (0.23×0.60)	825	94	30	1.73	6Y20+4-Y16
D11 (0.23×0.60)	585	10	30	2.6	4-Y16+6-Y12
G11 (0.23×0.60)	725	17	30	2.9	10-Y25
J12 (0.23/0.30 ×0.60	573	26	30	2.01	14-Y20
N12 (0.23/0.30 ×0.60	1788	104	30	2.61	4-Y16+6-Y12
D13 (0.23×0.60)	765	13	30	2.6	4-Y16+6-Y12
G13 (0.23×0.60)	790	52	30	2.43	4-Y16+6-Y12
A14(0.23×0.60)	818	43	30	2.9	10-Y25
E15(0.23×0.60)	542	11	30	1.1	10-Y16
N16 (0.23/0.30 ×0.60	1984	83	30	2.9	10-Y25
B17(0.23×0.60)	787	118	30	1.71	6Y20+4-Y16
E17(0.23×0.60)	842	20	30	1.5	6Y20+4-Y16
B18 (0.23/0.30 ×0.60	845	33	30	2	10-Y20
G18 (0.23/0.30 ×0.60	1880	35	30	2.9	10-Y25
K19 (0.23/0.30 ×0.60	1515	70	30	2.9	10-Y25
A20 (0.23/0.30 ×0.60	790	14	30	2.9	10-Y25
F21 (0.23/0.30 ×0.60	828	17	30	1.29	10-Y16
K21 (0.23/0.30 ×0.60	933	18	30	2.68	4-Y25+6-Y20

Note:

a) Column sizes provided are safe against shear based on the analysis (considering uni-axial and bi-axial bending)

b) The area of the reinforcements provided are well within the limits prescribed by the code.

c) Columns are designed for additional amplified moments due to eccentric positions of beams

All designed are carried out using Design Aids

BEAMS: -

All beams are modeled and interconnected with column members. The beam-column connections are rigid which are capable of resisting moments and shear forces induced from gravity and lateral seismic loads. At the junction between primary and secondary beams, the moments are relieved. Considering all possible load combinations, moments obtained from analysis are utilized for flexure

and shear designs as per IS standards. Also, serviceability check is carried. Typical beams from selected grids are considered and shown in Table. 3.

Table. 3 Ground Floor to Terrace Floor Roof Beam Design Check

Grid	B (mm)	D (mm)	Moment from analysis (kNm)	% Pt Required	Pt % Provided	Check for Shear		Check for Deflection
						Shear force (kN)	Shear capacity (kN)	
R1	230	450	24	0.24	0.58	48	158	Less than permissible Hence safe
R2	230	450,600	22	0.27	0.68	45	158	Less than permissible Hence safe
R3	230	450	6	0.3	0.58	15	158	Less than permissible Hence safe
R4	230	450,600	41	0.42	0.68	75	158	Less than permissible Hence safe
R5	230	600	102	0.75	0.97	124	211	Less than permissible Hence safe
R5a	230	450	16	0.22	0.58	26	158	Less than permissible Hence safe
R6	230	450	55	0.54	0.58	79	158	Less than permissible Hence safe
R7	230	600	185	0.43	0.68	138	211	Less than permissible Hence safe
R8	230	600	23	0.22	0.68	47	211	Less than permissible Hence safe
R9	230	600	11	0.22	0.68	23	211	Less than permissible Hence safe
R10	230	600	198	0.72	1.3	182	211	Less than permissible Hence safe
R11	230	600	107	0.86	1.3	126	211	Less than permissible Hence safe
R12	230	450	22	0.28	0.56	30	158	Less than permissible Hence safe
R13	230	450,600	25	0.44	0.68	41	158	Less than permissible Hence safe
R14	230	450,600	51	0.68	1.3	64	158	Less than permissible Hence safe

R15	230	450,600	24	0.22	0.68	50	158	Less than permissible Hence safe
R16	230	600	41	0.31	0.68	57	211	Less than permissible Hence safe
R17	230	450	143	1.09	1.51	228	158	Less than permissible Hence safe
R18	230	450,600	45	0.56	0.68	54	158	Less than permissible Hence safe
R19	115	600	55	0.65	0.68	130	211	Less than permissible Hence safe
R20	230	450	38	0.29	0.56	40	158	Less than permissible Hence safe
R20a	230	450	129	0.24	0.56	150	158	Less than permissible Hence safe
R21	230	600	129	0.6	0.68	150	211	Less than permissible Hence safe
R22	230	450	53	0.44	0.56	67	158	Less than permissible Hence safe
R23	230	450	57	0.40	0.56	67	158	Less than permissible Hence safe
R24	230	450	68	0.56	0.97	88	158	Less than permissible Hence safe
R25	230	450	46	0.35	0.58	68	158	Less than permissible Hence safe
R26	230	450	30	0.22	0.58	40	158	Less than permissible Hence safe
R26a	230	450	18	0.22	0.58	38	158	Less than permissible Hence safe
R27	230	600	16	0.28	0.68	32	211	Less than permissible Hence safe
R28	230	600	27	0.22	0.68	25	211	Less than permissible Hence safe
R29	230	450	15	0.26	0.56	22	158	Less than permissible Hence safe
R30	230	600	48	0.31	0.68	54	211	Less than permissible Hence safe

R31	230	600	86	0.49	0.68	185	211	Less than permissible Hence safe
R32	230	600	115	1.04	1.3	116	211	Less than permissible Hence safe
R33	230	600	67	0.97	1.3	72	211	Less than permissible Hence safe
R34	230	450	35	0.26	0.56	46	158	Less than permissible Hence safe
R35	230	450,600	12	0.27	0.56	31	158	Less than permissible Hence safe
R36	230	450	24	0.33	0.56	31	158	Less than permissible Hence safe
R37	230	450	47	0.47	0.56	50	158	Less than permissible Hence safe
R38	230	450	52	0.22	0.56	62	158	Less than permissible Hence safe
R39	230	450	31	0.22	0.56	37	158	Less than permissible Hence safe
R40	230	600	69	0.44	0.68	84	211	Less than permissible Hence safe
R41	230	450	87	0.8	0.56	90	158	Less than permissible Hence safe
R42	230	600	46	0.32	0.68	61	211	Less than permissible Hence safe
R43	230	450	32	0.35	0.56	48	158	Less than permissible Hence safe
R44	230	600	33	0.35	0.68	49	211	Less than permissible Hence safe
R45	230	600	82	0.34	0.68	98	211	Less than permissible Hence safe
R45a	230	450	21	0.28	0.56	28	211	Less than permissible Hence safe
R46	230	600	70	0.34	0.68	90	211	Less than permissible Hence safe
R47	230	600	227	0.24	0.68	131	211	Less than permissible Hence safe

R48	230	600	81	0.24	0.68	87	211	Less than permissible Hence safe
R49	230	600	179.45	0.42	0.68	152	211	Less than permissible Hence safe
R50	230	450	51	0.76	1.5	65	158	Less than permissible Hence safe

SLABS:-

Slabs are modeled as membrane elements with appropriate in-plane and out of plane bending. The loading on all slabs are taken as load per unit pressure. For lateral load analysis, all slabs are assumed to act as a diaphragm. The seismic loads are assumed to act at the centre of mass locations. They centre of mass and stiffness locations are determined from the loading and stiffness considerations. Table. 4 shows the typical slab moments obtained from analysis from selected grids are considered for design.

Table. 4 Design Check for Slabs

Slab Panel Floor wise	Moment obtained from analysis M (kNm)	Thickness (mm)	10 mm Spacing (mm)	Deflection	Remarks
Stilt Floor-SF	28	150	Y12-125 c/c	Within permissible limit	safe
First Floor-FF	48	150	Y12-125 c/c	Within permissible limit	safe
Second Floor-SF	28	150	Y12-125 c/c	Within permissible limit	safe
Third Floor-SF	27	150	Y12-125 c/c	Within permissible limit	safe
Fourth Floor-FOF	28	150	Y12-125 c/c	Within permissible limit	safe
Terrace Floor-TEF	20	150	Y12-125 c/c	Within permissible limit	safe

PILE FOUNDATION DESIGN: -

Based on the soil investigation report, the pile foundation is adopted at a depth of 6.54m from NGL.

Table. 5 Area of Footing required and area of footing provided.

Column Grid and its Sizes	Number of piles required	Number of piles provided	Remarks
O1 (0.23/0.30 ×0.60)	<2	2	SAFE
Q2 (0.23/0.30 ×0.60)	<2	2	SAFE
J3 (0.23/0.30 ×0.60)	<2	2	SAFE
L3 (0.23/0.30 ×0.60)	<2	2	SAFE
C4 (0.23/0.30 ×0.60)	<3	3	SAFE
G4 (0.23/0.30 ×0.60)	<2	2	SAFE
J5 (0.23/0.30 ×0.60)	<2	2	SAFE
O5 (0.23/0.30 ×0.60)	<3	3	SAFE
R5 (0.23/0.30 ×0.60)	<2	2	SAFE
A6 (0.23×0.60)	<2	2	SAFE
D6(0.23×0.60)	<2	2	SAFE
H6(0.23×0.60)	<2	2	SAFE
B7(0.23×0.60)	<2	2	SAFE
B9(0.23×0.60)	<2	2	SAFE
F8(0.23×0.60)	<9	9	SAFE
H8(0.23×0.60)			
F9(0.23×0.60)			
H9(0.23×0.60)			
J9 (0.23/0.30 ×0.60)	<4	4	SAFE
P9 (0.23/0.30 ×0.60)	<3	3	SAFE
B10 (0.23/0.30 ×0.60)	<3	3	SAFE
F10 (0.23/0.30 ×0.60)	<3	3	SAFE
J10 (0.23/0.30 ×0.60)	<4	4	SAFE
O10 (0.23/0.30 ×0.60)	<3	3	SAFE

B11 (0.23×0.60)	<2	2	SAFE
D11 (0.23×0.60)	<9	9	SAFE
G11 (0.23×0.60)			
D13 (0.23×0.60)			
G13 (0.23×0.60)			
J12 (0.23/0.30 ×0.60	<3	3	SAFE
N12 (0.23/0.30 ×0.60	<2	2	SAFE
A14(0.23×0.60)	<2	2	SAFE
E15(0.23×0.60)	<2	2	SAFE
N16 (0.23/0.30 ×0.60	<3	3	SAFE
B17(0.23×0.60)	<2	2	SAFE
E17(0.23×0.60)	<2	2	SAFE
B18 (0.23/0.30 ×0.60	<2	2	SAFE
G18 (0.23/0.30 ×0.60	<3	3	SAFE
K19 (0.23/0.30 ×0.60	<3	3	SAFE
A20 (0.23/0.30 ×0.60	<2	2	SAFE
F21 (0.23/0.30 ×0.60	<3	3	SAFE
K21 (0.23/0.30 ×0.60	<2	2	SAFE

5.0 SUMMARY OF ANALYSIS & DESIGN

Table 6.0 Design summary

Project	Proposed Construction of Residential Building With 10 Dwelling Units (Stilt Floor Parking+5 Upper Floors) at Door No.52/46, as per Document Door No.48/52, Taylors Road, Kilpauk, Chennai - 600 010. Comprised In T.S. No. 140/7, Block No.10, of Egmore Village, Egmore Taluk, Greater Corporation of Chennai
Design Methodology	Limit state method using Design aids SP:16-1986
Reinforcements detailing for Footing, columns, beams and slab	IS: 456-2000 and IS: 1893-2016(Part-I). IS-13920-2016.
FRAME ANALYSIS RESULTS	
STOREY Drifts from analysis	The lateral drift values obtained from the analysis are well within the limits prescribed by the code.
Frame analysis resultants from software	Storey shears, drifts and axial forces the ends of the supports are lesser than the capacity.
Axial forces and moments in basement storey columns.	The axial forces and moments obtained from analysis are then compared with the capacity of the slab, beams and column sections. Based the analysis, it is found that the capacities provided are sufficient against extreme load combinations.
FRAME & FOUNDATION DESIGN	
Column sizes	230×600, 300×600,230x750,300x750
Grade of concrete and steel for column	M30 & Fe 500.
Column reinforcements	It ranges from 1% to 2.5% of steel.
Floor Beam sizes concrete	230×450, 230×530, 230×600, with 0.3,0.6, 0.8% of steel.
Floor and Roof slab Grade and thickness	M30 and 125, 150 mm THK.
Staircase waist slab grade of concrete and thickness	M25; 150 mm thick.
Type of Foundation	Pile foundation is recommended at a depth of 15.5m to sustain the service load of the structure
Conclusion: Structure is analyzed and designed as per Indian stands and it is found structurally safe in all respects	

Report checked and approved by

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