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STABILITY CERTIFICATE

(To be furnished while filing application for registration of building)

The detailed engineering and structure design of the proposed building **MP Merlin with 50 dwelling units** comprising of Stilt + 5 Floors at Plot No. 1, S.No60/1A1A, 64/3A1, Moondramkattalai village, Kundrathur taluk, Kancheepuram district, Kundrathur Municipality Limit has been done by me based on the report of geotechnical investigation (soil test) done by **BOOSHNAM ASSOCIATES** Report No **BAG/M/s. M.P. DEVELOPERS/M-1727/23-24** dated 05.04.2023 and considering the functional requirement of the building.

2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I have checked various parameters and found that the proposed building would be safe.

3. I further certify that: (i) The minimum grade of concrete is M25 (ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS 875 Part I to V and design of earthquake resistant structure for Seismic Zone III as per IS 1893 (Part-I)-2016

4. The building will be safe and sound when used for the purpose for which it is designed.

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Encl.: Structural Design Calculation

DESIGN BASIS REPORT

FOR

RESIDENTIAL APPARTMENT (STILT+5 FLOORS)

MP MERLIN

PLOT NO 1, S.NO 60/1A1A, 64/3A1, MOONDRAMKATTALAI VILLAGE, KUNDRATHUR TALUK, KANCHEEPURAM DISTRICT, CHENNAI-600069.

mp developers

DEC –2024

1. DESIGN ASSUMPTION

a) STRUCTURAL SYSTEM

The structural system for the "PROPOSED **RESIDENTIAL APPARTMENT "MP Merlin" at Plot No. 1, S.No. 60/1A1A, 64/3A1, Moondramkattalai Village, Kundrathur Taluk, Kancheepuram District, Chennai-600069.**", consists of Stilt + 5 upper floors and OHT. The total height of the building is about 18 meter from Stilt floor level. The building designed for 9" & 4" thick AAC blocks. The structure is supported on Pile foundation below basement level as per the soil test report recommendation.

2. DESIGN LOADS

a) Dead Load:

Dead Load considered on slab: Self Weight + 1.5 kN/m² for Floor Finish.

Wall load	= 6 kN/m (230mm thick) (AAC Block)
Wall load	= 3 kN/m (100mm thick) (AAC Block)
Wall load (Parapet)	= 4 kN/m (115mm thick) (Red Brick)
Staircase load	= 15 kN/m (RCC staircase) (LL+DL)
Sunken load	= 4kN/m²
Water Tank	= 15kN/m² (1500 mm height)
Floor finish	= 2kN/m² (Terrace)

b) Roof Live Load:

The super imposed load or otherwise live load is assessed based on the occupancy

classifications as per IS	= 0.75 kN/m² on Solar panel roof.
Live Load considered on slab	=2 kN/m²
Live Load considered on slab	=3 kN/m² (Lobby & Staircase)
Live Load considered on slab	=1.5 kN/m² (Terrace)

c) Temperature Load:

As per Indian Standard code, IS-456:2000, buildings longer than 45m shall be analyzed for the thermal stresses and appropriate measures shall be taken during fixing the structural system. However, IS 1875 part-5 to follow in such kind of designs as well as on load factors to be considered in design combination of temperature load with gravity loads.

Minimum Temperature	=15 ⁰ C (Figure 1, IS875 PART V)
Minimum Temperature	=45 ⁰ C (Figure 1, IS875 PART V)

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3. EARTHQUAKE LOAD

The loading due to earthquake is assessed based on the provisions of IS: 1893(Part-1):2016

Seismic Zone	= III
Table-2 Zone factor (Z)	= 0.16
Table-6 Importance Factor (I)	= 1
Table-7 Response Reduction Factor (R)	= 5

Building frame system (SMRF) as per table 7 clause 6.4.2 of IS 1893 2016

Height of building (H) =18m

Base dimension of part of the building along the considered direction of lateral force (D)

Fundamental Natural time period

T_s = **$0.09H/\sqrt{d}$** from CL - 7.6.2 - IS 1893 (Part-I) 2016

S_a/g = from FIG-2 IS 1893 (part-I) 2016

The respective natural time period can be referred from the respective model.

Horizontal Seismic Co-efficient

Ah = $(Z/2) \times (I/R) \times (S_a/g)$

Seismic Base Shear

Vb = Ah x W

Structure with ductile detailing is considered as per IS: 13920-2016

As per IS: 1893 – 2016, percentage of imposed loads to be considered for seismic weight calculation is mentioned below:

Imposed Uniformity Distributed Floor Load Loads (kN/ m2)	Percentage of Imposed
Up to & including 3.0	25
Above 3.0	50

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4. LOAD COMBINATIONS

Strength combinations:

- 1.5DL + 1.5 LL + TEMP. LOAD
- 1.5DL (+/-) 1.5 WL/EQ Load + TEMP. LOAD
- 1.2DL +1.2LL (+/-) 1.5 WL/EQ Load + TEMP. LOAD
- 0.9DL (+/-) 1.5 WL/EQ Load + TEMP. LOAD

Serviceability combinations:

- DL + LL+ TEMP. LOAD
- DL +0.8 LL(+/-) 0.8 WL/EQ Load + TEMP. LOAD
- DL (+/-) WL/EQ Load + TEMP. LOAD

5. ANALYSIS METHOD

The structure is analyzed by static for gravity due to Earthquake loads and its combinations.

6. DESIGN METHODOLOGY

All structures have been designed according to the Limit State Method as specified in IS: 456-2000 & IS 1893 - 2016. Appropriate loads and its combinations, as per relevant clauses in IS 456:2000 code, for the most unfavorable effects are chosen for design.

7. MATERIALS

The self-weight of the various elements is computed based on the built weight of materials as given below: -

Materials	Unit weight in kN/m^3
Steel	78.5
Plain concrete	24
Reinforced concrete	25
Soil	18
AAC BLOCKS	6.5

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8. CONCRETE

All the concrete items for the construction have the following characteristics

Grade of Concrete = M25

Aggregate = 20mm and down size, mechanically crushed Aggregate.

9. STEEL

Steel reinforcement shall be of Grade Fe500 & Fe550 conforming to IS: 1786-2008.

10. COVER TO REINFORCEMENT

The clear cover to main reinforcement shall be as follows.

Foundation	= PILE: 50mm, PILE CAP: 75mm
Slab	= 20mm
Columns	= 40mm
Beams	= 25m

11. FOUNDATION SYSTEM

Foundation systems are based on recommendations given as per soil investigation report by BOOSHNAM ASSOCIATES , report Number **BAG/M/s. M.P. DEVELOPERS/M-1727/23-24** dated 05.04.2023

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12. CODES & STANDARDS

All the design are conforming to the relevant Indian Standards. Some of the relevant Indian Standard Codes, which have been followed for the structural design are given below.

	Description
IS:875 (Part-1)-1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures-Unit Weights of Buildings Materials and Stored Material.
IS:875 (Part-2)-1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures-Imposed loads
IS:875 (Part-3)-2015	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures –Wind Load.
IS:875 (Part-5)-1987	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures –Temperature Load.
IS:456 (Part-1)-2000	Code of Practice for Plain and Reinforced Concrete
IS:1893 (Part-1)-2016	Indian Standard Criteria for Earthquake Resistant Design of Structures.
IS:432 (Part-2)-1982	Specification of Mild Steel and Medium Tensile Steel bars and Hard Drawn Steel Wire for concrete reinforcement – Hard drawn Steel Wire.
IS:1786-2008	Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
IS:1904	Indian Standard Code of practice for Design & Construction Foundations in Soil: General Requirements.
IS:1642-1989	Indian Standard Code of practice for Fire Safety Of Buildings (General): Details Of Construction.

IS: 1786-2008 Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement. IS: 1904 Indian Standard Code of practice for Design & Construction foundations in Soil: General Requirements IS: 1642-1989 Indian Standard Code of practice for Fire Safety of buildings (General): Details of Construction.

13. STRUCTURAL ANALYSIS

The Building structures are analyzed using STAAD for various load combination as per Indian Codes.

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CMDA BLOCK-1(MERLIN)		
Along Grid :(26-28/G-M)		slab Reff. S3

INPUT DATA

Slab					Loads			
Shorter Span	Lx	=	3.600	m	Dead Load	DL =	3.13	kN/m²
Longer Span	Ly	=	4.950	m	Live load	LL =	2.00	kN/m²
Thickness of Slab	D	=	125	mm	Floor Finishes	FF =	1.50	kN/m²
Clear Cover	d'	=	20	mm	False Ceilling Load	=	0.25	kN/m²
Ly/Lx ratio	k	=	1.38	Two-Way Slab	Total Load	w =	6.88	kN/m²

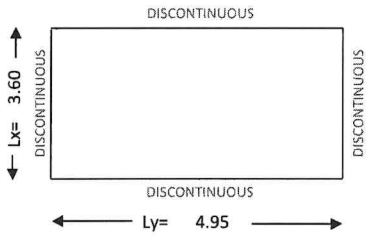
Panel Type			Materials			
Basic L/d ratio	=	26	Grade of Concrete	=	25	N/mm²
Edge Condition:	=	9	Grade of Reinf. Steel	=	550	N/mm²
Four Edges Discontinuous			Young's Modulus E		2.50E+04	N/mm²

DESIGN

Direction	BM Coefficients (IS:456-2000)		Flexural Design			dia & Required Spacing				Provided Reinforcement			
			Mu	Ast_{req}	Ast_{pro}	8	10	12	16				
			kNm	mm²	mm²	mm	mm	mm	mm				
Shorter Span	αx (-) =	0.0000	0.000	121	452	300	300	297	291	8	@	125	Safe
	αx (+) =	0.0835	11.160	244	452	206	300	297	291	8	@	125	Safe
Longer Span	αy (-) =	0.0000	0.000	121	302	279	270	261	243	8	@	200	Safe
	αy (+) =	0.0560	7.484	161	302	279	270	261	243	8	@	200	Safe

CHECK FOR DEFLECTION

Area of Steel required = 244 mm²
Area of Steel Provided = 452 mm²
Steel stress of service load = 172.03 N/mm²
Provided reinforcement (%) = 0.45%
Modification ratio MF = 1.783
Effective depth required for deflection point of view
d_{req} = 77.67313 mm
Eff. depth provided d = 101 mm Safe



SLAB SUMMARY

Shorter Span: Provide T 8 @ 125 mm c/c + 1 T 10 Extra between the two cranked bars
Longer Span : Provide T 8 @ 200 mm c/c + 1 T 10 Extra between the two cranked bars

CHECK FOR SHEAR

Max Shear Force = 19 KN
Actual Shear stress τv = 0.184 N/mm2
P_t of A_{st} = 0.45%
Design Shear Stress τc = 0.46 N/mm²
Shear is less than Design Shear Stress, Hence Safe against shear

NOTES

1. Crank alternate bars at 0.3 times the respective span.
2. Provide 12mm dia chairs at 1000mm c/c in both directions.
3. Provide 5 mm thick cover blocks at 600mm c/c in both directions.

Reinforcement Summary:

Along Shorter Span

Provided T8@ 125mm c/c

Along Longer Span

Provided T8@ 200mm c/c

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BEAM DESIGN:

Drawing	:	**FF BEAM**	
Beam No	:	**B221 (9"X21")**	
Along Grid	:	**M/(1-5)**	
Beam Length	:	6600	mm
Breadth (B)	:	230	mm
Depth (D)	:	530	mm
Effective Depth (d)	:	475	mm
Design Code	:	IS 456	
Beam Type	:	Regular Beam	
Grade Of Concrete (Fck)	:	M25	N/sqmm
Grade Of Steel	:	Fe550	N/sqmm
Clear Cover (Cmin)	:	25	mm
Es	:	2x10^5	N/sqmm

Flexure Design

	Beam Bottom			Beam Top		
	Left	**Mid**	**Right**	**Left**	**Mid**	**Right**
Critical L/C - Analysis	147	101	139	120	120	128
Critical L/C - RCDC	47	1	39	20	20	28
Mu (kNm)	68.69	123.77	58.52	245.39	76.97	246.45
Tu (kNm)	0.76	0.44	0.75	0.26	0.26	0.25
M_{Tu} (kNm)	1.48	0.85	1.46	0.5	0.5	0.49
Mud (kNm)	70.17	124.62	59.98	245.89	77.47	246.94
MuLim (kNm)	169	169	169	169	169	169
R	1.352	2.401	1.156	4.738	1.493	4.759
Ptmin (%)	0.2	0.2	0.2	0.2	0.2	0.2
Ptclc (%)	0.303	0.575	0.256	1.185	0.337	1.189
Pcclc (%)	0	0	0	0.394	0	0.4
PtPrv (%)	0.518	0.621	0.518	1.267	0.368	1.267
AstCalc (sqmm)	330.87	628.14	279.71	1294.23	368.32	1299.44
AstPrv (sqmm)	565.5	678.6	565.5	1383.86	402.12	1383.86
Reinforcement Provided	2-T16	2-T16 2-T20	2-T16	2-T16 2-T25	2-T16	2-T16 2-T25

Shear Design

	Left	Mid	Right
Critical L/C - Analysis	120	131	131
Critical L/C - RCDC	20	31	31
PtPrv (%)	1.267	0.621	0.518
Vu (kN)	133.36	100.96	142.21
Tu (kNm)	0.26	0.88	0.88
V_{Tu} (kN)	1.79	6.12	6.12
Vut (kN)	135.15	107.08	148.33

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Tv (N/sqmm)	1.24	0.98	1.36
Tc (N/sqmm)	0.7	0.53	0.5
Vc (kN)	76.4	58.3	54.17
Vus=Vut-Vc (kN)	58.75	48.78	94.16
Legs	2	2	2
Stirrup Rebar	8	8	8
Asv Torsion (sqmm)	334.835	273.09	380.834
Asv Torsion Prv (sqmm)	591.41	591.41	591.41
Asv Reqd (sqmm/m)	342.54	284.45	549.07
SvCalc (mm)	170	170	170
SvPrv (mm)	170	170	170
Asv Total Prv (sqmm)	591.41	591.41	591.41

Maximum Spacing Criteria

Basic

Spc1 =0.75d = 356 mm

Spc2 = 300 mm

For Torsion

(X1 = 190, Y1 = 490)

Spc3 = X1 = 190 mm

Spc4=(X1+Y1)/4 = 170 mm

SFR Design

Beam Width = 230 mm

Beam Depth = 530 mm

Torsion = 0.88 > 0 kNm

Beam Depth >750 Or Torsion > 0,

Hence SFR Provided

Asr = 121.9 sqmm

SFR Provided = T8@100mm c/c

ASFR Provided = 502.65 sqmm

Spacing Criteria

Provided Spacing = 100 mm

1.<= beam Width = 230 mm

2. Not Greater Than = 300 mm

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COLUMN DESIGN:

COLUMN NO: C18
ALONG GRID: M/35

M25 Fe550 (Main) Fe550 (Sec.)

LENGTH: 3000.0 mm CROSS SECTION: 300.0 mm X 600.0 mm COVER: 40.0 mm

LOAD CASE: 124 END JOINT (1.5DL+1.5EQZ+0.45EQX+TLMIN)

REQD. STEEL AREA : 4671.42 Sq.mm.

REQD. CONCRETE AREA: 175328.58 Sq.mm.

MAIN REINFORCEMENT: Provide 12 - 25 dia. (3.267%, 5880. Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT: Provide 8 mm dia. rectangular ties @ 150 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz: 3899.41 Muz1: 407.82 Muy1: 165.41

INTERACTION RATIO: 0.95 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

WORST LOAD CASE: 124

END JOINT: 223 Puz : 4041.90 Muz : 432.81 Muy : 173.47 IR: 0.92

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PILE CAP DESIGN:

Design Code	:	IS 456 + IS 13920 - 2016	
Pilecap No	:	PC1	
Column No	:	C18	(300mm X 600mm)
Concrete Grade	:	M25	
Steel Grade	:	Fe550	
Clear Cover	:	50	mm
Top of pile-cap below ground	:	0.25	m
Density of Soil	=	18	kN/cum
Founding Depth	=	1	m
Pile Capacity in Compression	=	900	kN
Pile Capacity in Tension	=	310	kN
Pile Capacity in Shear	=	40	kN
Pile Capacity Reduction	=	0	%
Pile Overloading	=	10	%
Pile Group Overloading	=	10	%
Pile Capacity Increase for EQ	=	25	%
Pile Capacity Increase for Wind	=	25	%
Live Load Reduction	=	0	%
Consider Capacity Design	:	No	
Consider Overburden Pressure	:	Yes	
No. of Piles	=	2	
Pile Diameter	=	550	mm
Pilecap Offset	=	150	mm
Pile Spacing	=	2.5	x Ø
Pilecap Size	=	2225 X 850	mm
Pilecap Depth	=	750	mm
Soil Wt. + Pile-cap Wt.	=	43.972	kN

For design, moments along shorter direction of pile cap has been ignored

Check for Maximum Load on One Pile:

Critical Analysis Load Combination	:	228	
Critical Load Combination	:	[79] : (LOAD 3: DL) +0.8 (LOAD 4: LL) +0.8 (LOAD 1: EQX) +0.24 (LOAD 2: EQZ) +(LOAD 6: TL-MAX)	
Pcomb	=	1651.67	kN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1695.64	kN

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Mx	=	27.6	kNm
My	=	21.68	kNm
P	=	Ptotal/ No. of Piles	
	=	847.82	kN
Pmx	=	20.072	kN
Pmy	=	0	kN
Maximum load on pile	=	867.89	kN
Allowable load on pile	=	900 x 1.25	
	=	1125	kN

Check for Maximum Load on Pile Group:

Critical Analysis Load Combination	:	203	
Critical Load Combination	:	[54] : (LOAD 3: DL) +(LOAD 4: LL) +(LOAD 6: TL-MAX)	
Pcomb	=	1301.88	kN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1345.85	kN
Mx	=	-4.29	kNm
My	=	-1.03	kNm
Maximum load on pile group	=	1345.85	kN
Allowable load on pile group	=	2 x 900 x 1.1	
	=	1980	kN

Check for Maximum shear on Pile Group:

Critical Analysis Load Combination	:	216	
Critical Load Combination	:	[67] : (LOAD 3: DL) +0.3 (LOAD 1: EQX) +(LOAD 2: EQZ) +(LOAD 6: TL-MAX)	
Pcomb	=	1470.4	kN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	1514.37	kN
Mx	=	25.89	kNm
My	=	44.22	kNm
Vx	=	34.29	kNm
Vy	=	11.35	kNm
Maximum shear on pile group	=	$\text{sqrt}(34.29^2 + 11.35^2)$	
	=	36.12	kN
Shear capacity of pile group	=	2 x 40 x 1 x 1.25	
	=	100	kN

Check for Uplift Load on Pile:

No uplift in any pile

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Design for Bending:

Bottom Reinforcement Along Column-D

Critical Analysis Load Combination	:	128	
Critical Load Combination	:	[114] : 1.5 (LOAD 3: DL) +1.5 (LOAD 1: EQX) +0.45 (LOAD 2: EQZ) +(LOAD 6: TL-MAX)	
Pcomb	=	2386.14	kN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	2452.097	kN
Mx	=	53.51	kNm
My	=	40.89	kNm
Ppile	=	Max Load on pile	
	=	1264.96	kN
Deff	=	690	mm
Beff	=	850	mm
DfCol	=	0.39	m
BMux	=	Ppile X DfCol	
	=	490.17	kNm
PtReq	=	0.27	%
AstReq (BM)	=	1857	sqmm/m
AstPrv	=	T16 @ 105 C/C	
	=	1914.86	sqmm/m

Top Reinforcement Along Column-D

D	=	750	mm
	<=	1000	mm, Hence
AstReq (BM)	=	Min Pt for Top Reinforcement X D X 1000	
	=	0.06% X 750 X 1000	
	=	450	sqmm/m
AstPrv	=	T10 @ 170 C/C	
	=	462	sqmm/m

Bottom Reinforcement Along Column-B

AstReq (BM)	=	0.2 x (D/2) x 1000/100	
	=	0.2 x 375 x 1000/100	
	=	750	sqmm/m
AstPrv	=	T10 @ 100 C/C	
	=	785.4	sqmm/m

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Top Reinforcement Along Column-B

D	=	750	mm
	<=	1000	mm, Hence
AstReq (BM)	=	Min Pt for Top Reinforcement X D X 1000	
	=	0.06% X 750 X 1000	
	=	450	sqmm/m
AstPrv	=	T10 @ 170 C/C	
	=	462	sqmm/m

Design for One Way Shear:

Along Column-D

Critical Analysis Load Combination	:	128	
Critical Load Combination	:	[114] : 1.5 (LOAD 3: DL) +1.5 (LOAD 1: EQX) +0.45 (LOAD 2: EQZ) +(LOAD 6: TL-MAX)	
Pcomb	=	2386.14	kN
Ptotal	=	Pcomb + Soil Wt. + Pilecap Wt.	
	=	2452.1	kN
Mx	=	53.51	kNm
My	=	40.89	kNm
Ppile	=	Max Load on pile	
	=	1264.962	kN

Location of critical section is at d/2 from face of column

Section Location from column center = 645 mm

Data for Piles

Pile No	Load (kN)	% covered	Shear (kN)
P1	1187.13	42.27	685.3
P2	1264.96	42.27	730.23

Design Shear Force (Vu)	=	Max. of (Shear due to P1, P2)	
	=	730.23	kN
Deff	=	690	mm
Beff	=	850	mm
Tv	=	Vu/(Beff x Deff)	
	=	1.25	N/sqmm
Tc	=	0.38	N/sqmm
Av	=	42.5	mm
Shear enhancement factor	=	2 X Deff / Av	
	=	32.47	
Enhanced shear strength (Tce)	=	3.1	N/sqmm
Tv	<	Tce, Hence Shear Reinforcement is not required	

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Along Column-B

One way shear check do not applicable for 2 pile pile-cap design

Design of Face Reinforcement:

AsfrReq	=	SFR % X D X Beffsfr	
	=	0.05 X 750 X 500 / 100	
	=	188	sqmm
Asfr Prv	=	3-T10	
	=	236	sqmm

Check for Load Transfer from Column to PileCap

Critical Analysis Load Combination	=	128	
Critical Load Combination	:	[114] : 1.5 (LOAD 3: DL) +1.5 (LOAD 1: EQX) +0.45 (LOAD 2: EQZ) +(LOAD 6: TL-MAX)	
P	=	2386.14	kN
A2	=	0.18	sqm
A1	=	1.89	sqm
Base Area	=	1.89	sqm
A1	<	Base Area	
Modification Factor	=	SquareRoot(A1/A2) < = 2	
SquareRoot(A1/A2)	=	3.24	
Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 X Fck X Modication Factor X Column Area	
	=	4050	kN
Concrete Bearing Capacity	>	P, Hence Safe.	

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