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E-Mail : bournace@gmail.com

BOURNA
CONSULTANTS - ENGINEERS

S.P.S. Inbarajan, M.E. (Structural)
Structural Consultant

STRUCTURAL DESIGN STABILITY CERTIFICATE.

I hereby certify that The Proposed Construction Residential Building With 25 Dwelling Units Availing Premium Fsi At Plot No: 17 & 18,Manimegalai Street, Puzhudhivakkam, Chennai - 600091. Comprised In Old Survey Nos: 87/13 Part & 88/13 Part, Present T.S.No: 31 & 32, Block - 27 Of Thalakkananchery Village, Alandur Taluk, Zone-14, Division-186 ,Greater Corporation of Chennai to certify that the building will withstand against the Earthquake. (Seismic Zone III as per IS 1893 (Part I) 2002) loading stress parameters are within limits of National Building Code and Bureau of Indian standards code of practice for concrete and loading. The building consists of Stilt floor +Five floor upper floors. The R.C.C. building frame of the structure is designed as per the Indian Standard code of practice for concrete and loadings. The structure is constructed as per our structural design and detailing of reinforcements given in our drawing from foundation to roof slab and beam. For external and internal partition walls 230/115 thick brick work walls are used.

For **BOURNA CONSULTANTS ENGINEERS,**

(S.P.S. INBARAJAN.)
Chief Consultant.
S. P. S. INBARAJAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. SE
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kirupasankari Street,
West Mambalam, Chennai-600 033.

DESIGN BASIS REPORT

FOR

M/S. VIKAAN SHELTERS

THE PROPOSED CONSTRUCTION RESIDENTIAL BUILDING WITH 25 DWELLING UNITS AVAILING PREMIUM FSI AT PLOT NO: 17 & 18,MANIMEGALAI STREET, PUZHUDHIVAKKAM, CHENNAI - 600091. COMPRISED IN OLD SURVEY NOS: 87/13 PART & 88/13 PART, PRESENT T.S.NO: 31 & 32, BLOCK - 27 OF THALAKKANANCHERY VILLAGE, ALANDUR TALUK, WITHIN THE LIMIT OF GREATER CHENNAI COPORATION.ZONE-14, DIVISION-186

S. P. S. INBARAJAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. SE/GR-I/2024/02[illegible]
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kirupasankari Street,
West Mambalam, Chennai-600 033.

TABLE OF CONTENTS

S. P. S. INBARAJAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. SE/GR-I/2024/02009 dt. 27
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kirupasankari Street,
West Mambalam, Chennai-600 033.

1.0 OBJECTIVE

The Design basis covers the basic requirement that will be followed for the design of THE PROPOSED CONSTRUCTION RESIDENTIAL BUILDING WITH 25 DWELLING UNITS FOR M/S.VIKAAN SHELTERS AT PLOT NO: 17 & 18,MANIMEGALAI STREET, PUZHUDHIVAKKAM, CHENNAI - 600091. COMPRISED IN OLD SURVEY NOS: 87/13 PART & 88/13 PART, PRESENT T.S.NO: 31 & 32, BLOCK - 27 OF THALAKKANANCHERY VILLAGE, ALANDUR TALUK, WITHIN THE LIMIT OF GREATER CHENNAI COPORATION.ZONE-14, DIVISION-186

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The building is designed for Stilt + 5 Floors. The structural system comprises columns, beams, slabs and wall structure.

3-D Analysis of all the building structures will be carried out using STAAD PRO software package and analysis results shall be used for designing the various elements.

2.0 DESIGN LOADS

2.1 Dead Loads

The Dead loads that are envisaged to act permanently are considered as per IS: **875 (Part 1) – 1987 – Dead loads.** Indian Standard **"Code of Practice for Design Loads (other than earthquake) for Buildings and Structures"**.

1. Slab is assumed to be 150mm thick – 3.75 KN/m^2
2. Slab is assumed to be 125mm thick – 3.125 KN/m^2
3. Floor finish – 1.5KN/m^2
4. Brick work masonry walls 230thick are proposed to be used (location of walls per Architectural drawings) Unit weight is taken as 20 KN/m^3
5. Weathering course in Terrace finish – 3 KN/m^2

S. P. S. INBARAJAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. SE/GR-I/2024/02[illegible]
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kirupasankari Street,
West Mambalam, Chennai [illegible]

2.2 Imposed Loads

The imposed loads that are envisaged to act permanently are considered as per **IS : 875 (Part 2) – 1987** . Indian Standard **"Code of Practice for Design Loads (other than earthquake) for Buildings and Structures"**.

1. Living & Dining = 2 KN/m^2
2. Staircase = 3 KN/m^2
3. Toilets = 2 KN/m^2
4. Terrace floors = 1.5 KN/m^2

2.3 Earthquake Load

The loading due to earthquake is assessed based on the provisions of **IS:1893-2016**. Structure with ductile detailing is considered as per **IS:13920-2016.**

Chennai falls under Seismic Zone III

Zone factor	=	**0.16**
Response reduction factor	=	**5**
Importance factor	=	**1.0**

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

2.4 Load Combinations

The various loads shall be combined in accordance with the stipulations in IS: 875 (Part 5) – 1987. Whichever combinations produced the most unfavorable effect in the building, foundations or structural member concerned shall be adopted. The various load combinations considered in the analysis are as follows:

1. 1(DL+LL)
2. 1 DL+0.8 LL− 0.8 SQX +1
3. 1 DL+0.8 LL+ 0.8 SQX -1
4. 1 DL+0.8 LL+ 0.8 SQZ +1
5. 1 DL+0.8 LL+ 0.8 SQZ -1

6. 1.0 (DL+SQX +)
7. 1.0 (DL+SQX -1)
8. 1.0 (DL+SQZ +1)
9. 1.0 (DL+SQZ -1)
10. 1.5(DL+LL)
11. 1.5(DL+SQX +1)
12. 1.5(DL+SQX -1)
13. 1.5(DL+SQZ -1)
14. 1.5(DL+SQZ -1)
15. 1.2(DL+LL+SQX +1)
16. 1.2(DL+LL+SQX -1)
17. 1.2(DL+LL+SQZ +1)
18. 1.2(DL+LL+SQZ -1)
19. 0.9DL+1.5SQX+1
20. 0.9DL+1.5SQX -1
21. 0.9DL+1.5SQZ +1
22. 0.9DL+1.5SQZ -1

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

3.0 ANALYSIS METHODS

The analysis of the structures is carried out using the STAAD PRO. The entire super-structure is modeled using frame elements as appropriate. Beams and columns are modeled as frame elements. Appropriate loads and its combinations, as per relevant IS code clauses, for most unfavorable effects are chosen for design. Various load cases considered in the analysis are briefed above.

4.0 DESIGNASSUMPTION

4.1.1 The Base of the Foundation is assumed to be PINNED

4.1.2 SBC of soil is taken as 250kN/m2 at a depth of 1.50m.

4.1.3 AllConcreteelementsshallbedesignedinaccordancewithIS456:2000LimitState Design.

4.1.4 Appropriate load sand its combinations, as per relevant clauses, for themostunfavorableeffectsarechosenfordesign.(ReferLoadCombinationbelow)

5.0 MATERIALS

Theself-

weightofthevariouselementsarecomputedbasedontheunitweightofmaterialsasgivenb elow:

S.no	Materials	Unit weight KN/m^3
1	Reinforced Cement Concrete	25
2	Solid Block/Brick	20
3	Steel	78.50

StructuralconcreteshallbeofgradeM20forallstructuralElements.

SteelreinforcementshallbeofGradeFe500confirmingtoIS:1786-2008.

6.0 NOMINAL COVER TO REINFORCEMENT

From Durability requirement, exposure condition is assumed as mild for structural elements above ground level and moderate for structural elements below ground level.

TheClearcovertoreinforcementtomeetdurabilityrequirementshallbeasfollows:

Column–40mm

Footing –50mm

Beam –25mm

Slab –20mm

DESIGN OF BEAM: 1

Beam size: 230mm x 450mm

Bending moment at support = 140kNm

Bending moment at mid span = 133kNm

Shear force, Vu = 149kN

Bending moment at support, Mu = 140kNm

$R = (140 \times 10^6)/230x409^2$

$= 3.64$

$Pt/100 = Ast/bd = fck/2fy\ [1-Sq.rt\ (1-4.598xR/fck)\backslash$

$fck = 20\ N/mm^2$

$fy = 415\ N/mm^2$

$Pt = 1.19\%$

$Ast\ required = 1119\ mm^2$

Provide 6nos of 16Y

$Ast\ provided = 1206\ mm^2$

Hence safe.

Bending moment at mid span, Mu = 133kNm

$R = (133 \times 10^6)/230 \times 409^2$

$= 3.46$

$Pt = 1.1\%$

$Ast\ required = 1035\ mm^2$

Provide 6nos of 16Y

$Ast\ provided = 1206\ mm^2$

Hence it is safe

Shear force, Vu, = 149kN

$\tau v = Vu/bd$

$= (149 \times 10^3)/ 230 \times 409$

= 1.58 N/mm^2

Hence ok.

Shear capacity of concrete:

Pt = 1.28 %

τc = 0.68

= τc bd

= 0.68 X 230 X 409

= 63968 N (or) 64 kN

Shear to be carried by stirrups

Vu = Vs τc bd

= 149 – 64 kN

= 85kN

Therefore, provide 2 legged 10Y @ 150 mm C/C at the supports.

Provide 2 legged 10Y @ 200mm C/C at the midspan.

DESIGN OF BEAM: 2

Beam size: 230mm x 525mm

Bending moment at support = 132kNm

Bending moment at mid span = 111kNm

Shear force, Vu = 96kN

Bending moment at support, Mu = 132kNm

R = (132 x 10^6)/230x484^2

= 2.44

Pt/100 =Ast/bd = fck/2fy [1-Sq.rt (1-4.598xR/fck)\

fck = 20 N/mm^2

fy = 415 N/mm^2

Pt = 0.81%

Ast required = 781 mm^2

Provide 4nos of 16Y

Ast provided = 804 mm^2

Hence safe.

Bending moment at mid span, Mu = 111kNm

R = $(111 \times 10^6)/230 \times 484^2$

= 2.06

Pt = 0.55%

Ast required = 612 mm^2

Provide 4 nos of 16Y

Ast provided = 804 mm^2

Hence it is safe

Shear force, Vu, = 96kN

τv = Vu/bd

= $96 \times 10^3 / 230 \times 484$

= 0.86 N/mm^2

Hence ok.

Shear capacity of concrete:

Pt = 0.72 %

τc = 0.55

= τc bd

= 0.55 X 230 X 484

= 61226 N (or) 61.23kN

Shear to be carried by stirrups

Vu = Vs – τc bd

$= \quad 96 - 61.23kN$

$= \quad 35kN$

Therefore, provide 2 legged 8Y @ 100 mm C/C at the supports.

Provide 2 legged 8Y @ 200 mm C/C at the midspan.

DESIGN OF COLUMN C1

Length of column	D	1500	mm
Breadth of column	b	300	mm
Unsupported length (longer direction)	L_x	2700	mm
Unsupported length (shorter direction)	L_y	2700	mm
Eff. Length (longer direction)	L_{ex}	2160	mm
Eff. Length (shorter direction)	L_{ey}	2160	mm
Factored Load	P_u	6200	kN
Factored moment (longer direction)	Mux	100	kNm
Factored moment (shorter direction)	Muz	201	kNm
Charac. comp strength of concrete	f_{ck}	20	N/mm^2
Yield stress of steel	f_y	415	N/mm^2
Dia of bar used	Φ	25	mm
Clear cover		40	mm
Effective cover	d'	52.5	mm
Effective depth	d	1447.5	mm
Check for slenderness			
Longer Direction			
Slenderness ratio	L_{ex}/D	1.44	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	7.20	**short**
Additional moment due to slenderness	M_{ay}	0	kN-m
Calculation of P_{uz}			
No of bars used		30	
Area of reinforcement	Ast	14718.75	
Provided steel		30 nos Y25	
Percentage of reinforcement	p_t	3.271	%
Area of concrete	Ag	450000	mm^2
Ultimate axial load (without moments)	P_{uz}	8499	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.035	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.219	From Sp16
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.545	
Axial load corresponding to balanced failure	P_{bx}	2773	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.175	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.189	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.245	
Axial load corresponding to balanced failure	P_{by}	2062	kN
Reduction factor for additional moments	k_y	0.357	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Check for moments due to min. eccentricity			
Longer Direction			
Minimum eccentricity	e_x	55.40	mm

Moment due to min. eccentricity			M_x	343.48	kN-m
Moment in longer direction			M_{ux}	343.48	kNm
Shorter direction					
Minimum eccentricity			e_y	15.40	mm
Moment due to min. eccentricity			M_y	95.48	kN-m
Moment in shorter direction			M_{uy}	201	kNm
Final design moments					
Moment in longer direction			M_{ux}	**343.48**	kNm
Moment in shorter direction			M_{uy}	**201.00**	kNm
Check for interaction					
			d'/D	0.035	
			d'/b	0.175	
p/f_{ck}			p/f_{ck}	0.164	
$P_u/f_{ck}bD$ value			$P_u/f_{ck}bD$	0.689	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)			$M_{ux1}/f_{ck}bD^2$	0.120	
Uniaxial moment capacity (longer direction)			M_{ux1}	**1620**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)			$M_{uy1}/f_{ck}bD^2$	0.110	
Uniaxial moment capacity (shorter direction)			M_{uy1}	**297**	kNm
P_u/P_{uz} ratio			P_u/P_{uz}	**0.730**	
Value of exponent				1.883	
Interaction ratio				**0.533**	
Percentage reinforcement satisfactory or not				**safe**	
b/D ratio			b/D	0.2	
Status of dimensions				OK	
Gross area			A_g	450000	mm^2
Area of core			A_k	328900	mm^2
Spacing of lateral ties			S	75	mm
Larger dimension of the hoop			H	230	mm
Cross sectional area of hoop			A_{sh}	55.10	mm^2

DESIGN OF COLUMN C2

Length of column	D	900	mm
Breadth of column	b	300	mm
Unsupported length (longer direction)	L_x	2700	mm
Unsupported length (shorter direction)	L_y	2700	mm
Eff. Length (longer direction)	L_{ex}	2160	mm
Eff. Length (shorter direction)	L_{ey}	2160	mm
Factored Load	P_u	4635	kN
Factored moment (longer direction)	Mux	91	kNm
Factored moment (shorter direction)	Muz	45	kNm
Charac. comp strength of concrete	f_{ck}	20	N/mm^2
Yield stress of steel	f_y	415	N/mm^2
Dia of bar used	Φ	25	mm
Clear cover		40	mm
Effective cover	d'	52.5	mm
Effective depth	d	847.5	mm
Check for slenderness			
Longer Direction			
Slenderness ratio	L_{ex}/D	2.40	**short**
Additional moment due to slenderness	M_{ax}	0	kN-m
Shorter Direction			
Slenderness ratio	L_{ey}/b	7.20	**short**
Additional moment due to slenderness	M_{ay}	0	kN-m
Calculation of P_{uz}			
No of bars used		20	
Area of reinforcement	Ast	9812.5	
Provided steel		20 nos Y25	
Percentage of reinforcement	p_t	3.634	%
Area of concrete	Ag	270000	mm^2
Ultimate axial load (without moments)	P_{uz}	5396	kN
Calculation of P_b:			
Longer Direction			
	d'/D	0.058	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1x}	0.217	From Sp16
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2x}	0.525	
Axial load corresponding to balanced failure	P_{bx}	1687	kN
Reduction factor for additional moments	k_x	1.000	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Shorter Direction			
	d'/b	0.175	
Coefficient k_1(from TABLE 60 of SP:1980)	k_{1y}	0.189	
Coefficient k_2(from TABLE 60 of SP:1980)	k_{2y}	0.245	
Axial load corresponding to balanced failure	P_{by}	1261	kN
Reduction factor for additional moments	k_y	0.184	
Moment due to slenderness	M_{ax}	**0.00**	kN-m
Check for moments due to min. eccentricity			
Longer Direction			
Minimum eccentricity	e_x	35.40	mm

Moment due to min. eccentricity		M_x	164.08	kN-m
Moment in longer direction		M_{ux}	164.08	kNm
Shorter direction				
Minimum eccentricity		e_y	15.40	mm
Moment due to min. eccentricity		M_y	71.38	kN-m
Moment in shorter direction		M_{uy}	71.379	kNm
Final design moments				
Moment in longer direction		M_{ux}	**164.08**	kNm
Moment in shorter direction		M_{uy}	**71.38**	kNm
Check for interaction				
		d'/D	0.058	
		d'/b	0.175	
p/f_{ck}		p/f_{ck}	0.182	
$P_u/f_{ck}bD$ value		$P_u/f_{ck}bD$	0.858	
$M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts)		$M_{ux1}/f_{ck}bD^2$	0.085	
Uniaxial moment capacity (longer direction)		M_{ux1}	**413.1**	kNm
$M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts)		$M_{uy1}/f_{ck}bD^2$	0.065	
Uniaxial moment capacity (shorter direction)		M_{uy1}	**105.3**	kNm
P_u/P_{uz} ratio		P_u/P_{uz}	**0.859**	
Value of exponent			2.000	
Interaction ratio			**0.617**	
Percentage reinforcement satisfactory or not			**safe**	
b/D ratio		b/D	0.33333333	
Status of dimensions			OK	
Gross area		A_g	270000	mm^2
Area of core		A_k	190900	mm^2
Spacing of lateral ties		S	75	mm
Larger dimension of the hoop		H	230	mm
Cross sectional area of hoop		A_{sh}	62.00	mm^2

DESIGN OF FOOTING F1

Basic Data

Material Data

Grade of Concrete	f_{ck}	=	M20
Yeild Strength of Reinforcement	f_y	=	500 N/mm^2
Unit Weight of Concrete	γ_c	=	25.0 kN/m^3
Unit Weight of Soil	γ_s	=	18.0 kN/m^3
Frictional Factor bet. Soil & Concrete	μ	=	0.35

Soil Data:

Type of soil in foundation			MEDIUM
Net Safe Bearing Capacity	SBC	=	250 kN/m^2

Clear cover to Reinforcement

Clear Cover to Footing Slab		=	50.0 mm
Clear Cover to Pedestal		=	40.0 mm

Basic Dimensions

Size of Pedestal

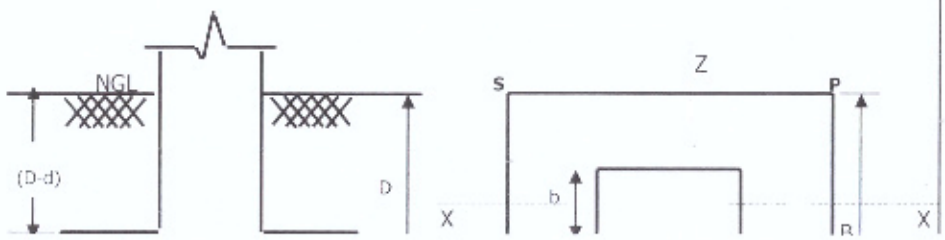
Length	l	=	1.500 m
Breadth	b	=	0.300 m
Depth of foundation from GL	D	=	2.100 m

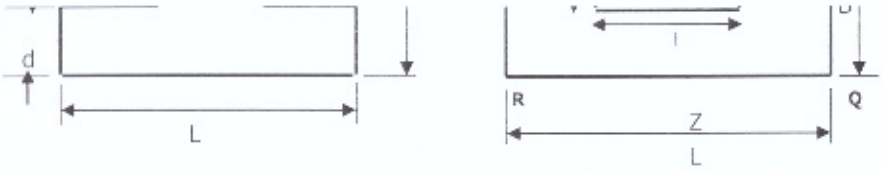
Size of Foundation Pad

Length	L	=	4.870 m
Breadth	B	=	3.960 m
Thickness of Base Slab	d	=	1.650 m
Thickness @ edge of footing	e	=	0.375 m

Analysis Results

Loads	V	Mzz	Hx	Mxx	Hz
	kN	kN m	kN	kN m	kN
Dead Load	4325.00	0.00	0.00	0.00	0.00
Live Load	0.00	0.00	0.00	0.00	0.00
Wind or Seismic Load	± 0.00	± 0.00	± 0.00	± 0.00	± 0.00





Load Combination

Load Combination for Design

1) 1.5DL + 1.5LL
2) 1.2DL + 1.2LL + 1.2WL(OR)SL
3) 1.5DL + 1.5WL(OR)SL
4) 0.9DL + 1.5WL(OR)SL

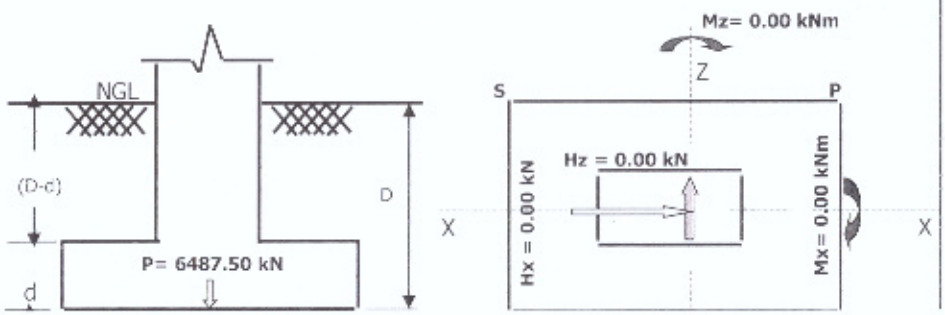
Unfactored Loads

Load Combinaion	V	Mzz	Hx	Mxx	Hz
	kN	kN m	kN	kN m	kN
Case 1) DL + LL	4325.00	0.00	0.00	0.00	0.00
Case 2) DL + LL + WL(OR)SL	4325.00	0.00	0.00	0.00	0.00
Case 3) DL + WL(OR)SL	4325.00	0.00	0.00	0.00	0.00

Factored loads

Load Combinaion	V	Mzz	Hx	Mxx	Hz
	kN	kN m	kN	kN m	kN
Case 1) 1.5DL + 1.5LL	6487.50	0.00	0.00	0.00	0.00
Case 2) 1.2DL + 1.2LL + 1.2WL(OR)SL	5190.00	0.00	0.00	0.00	0.00
Case 3) 1.5DL + 1.5WL(OR)SL	6487.50	0.00	0.00	0.00	0.00
Case 4) 0.9DL + 1.5WL(OR)SL	3892.50	0.00	0.00	0.00	0.00

Design of Footing for Case 3



R Q

Z

Calculation of Bearing Pressure under the Footing

eccentricity	e_z	=	M_{xx}/W	=	0.000 m	
			e_z/B	=	0.000	
			B/6	=	0.660	> 0.000
eccentricity	e_x	=	M_{zz}/W	=	0.000 m	
			e_x/L	=	0.000	
			L/6	=	0.812	> 0.000

Hence all the four edges are in contact with Soil

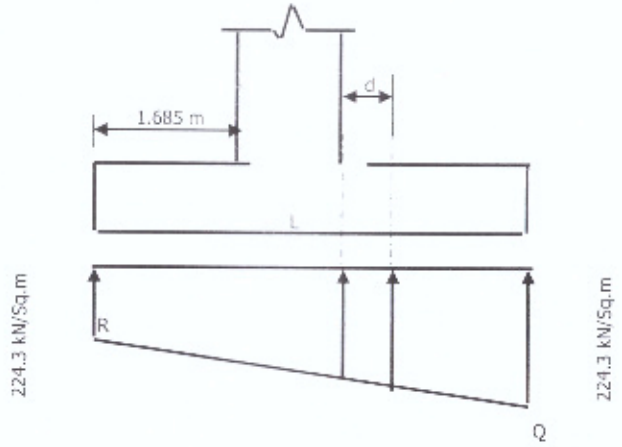
Soil Pressure at Point Q qmax = 224.265239 kN/m²

S.B.C. of Soil = **250** kN/m²

HENCE SAFE

Design of Foundation Pad along X direction

Bearing Pressure Distribution



PRESSURE DISTRIBUTION DIAGRAM

Depth of Pad	d	=	1650 mm
Therefore, effective depth	d_{eff}	=	1592 mm
Pressure at face of Pedestal		=	336.40 kN/m²
Pressure @ dist "d" from face of pedestal		=	336.40 kN/m²

Depth required for Bending Moment

Critical section for moment will be at the face of the pedestal.

Overhang distance	x	=	1.685 m
Bending Moment at face of Pedestal		=	**477.6** kNm/m
Depth reqd for the above moment	d_{eff}	=	424 mm
Provided Depth		=	1592 mm
		>	**424 HENCE OK**

Area of Steel Required for Bending

	$\frac{x}{d}$	=	
		=	0.0265
Lever Arm Depth	Z	=	
		=	1574.44 mm
Reinforcement Required	A_{sc}	=	$\frac{M_u}{0.87 f_y Z}$
		=	697.2808936 mm^2

Minimum Area of Steel Required

Minimum reinforcement required:		=	1980 mm^2

Reinforcement Provided

Spacing of Y 16 bars		=	101.5466667 mm
Provide Y **16** at **100** mm c/c		=	**2010.6** mm^2
		>	**1980.00 HENCE OK**
Percentage of Reinforcement Provided		=	**0.13%**

Check for One Way Shear

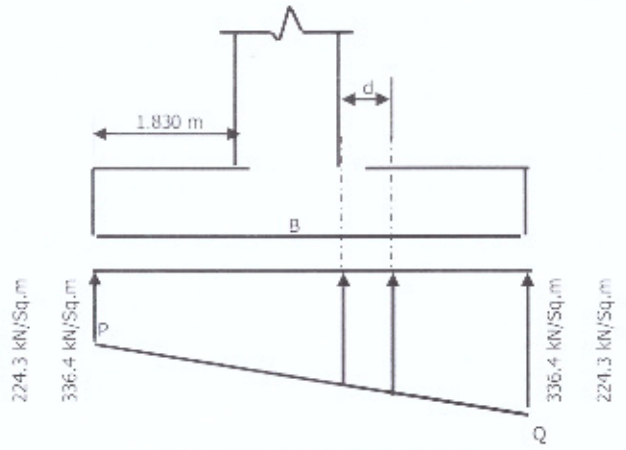
Design Shear Strength of Concrete	τ_c	=	0.27 N/mm^2
	K	=	1.00
τ_c for Solid Slab	$\tau_c k$	=	0.27 N/mm^2
Pressure at dist "d" from face of pedestal		=	336.40 kN/m^2
SF at dist "d" from face of pedestal	V	=	31.29 kN
Depth required for one way shear	d_{ef2}	=	117 mm
Provided Depth		=	420 mm
		>	**117 HENCE OK**

Check for Two Way Shear

Maximum shear stress= $0.25(fck)^{0.5}$	τ_c	=	1.12 N/mm^2
Vertical load punching the base slab		=	6487.50 kN
Preimeter		=	9968 mm
Depth required for two way shear	d_{ef3}	=	582 mm
Provided Depth		=	1298 mm
		>	**582 HENCE OK**

Design of Foundation Pad along Z direction

Bearing Pressure Distribution



PRESSURE DISTRIBUTION DIAGRAM

Depth of Pad	d	=	1650 mm
Therefore, effective depth	d_{eff}	=	1576 mm
Pressure at face of Pedestal		=	336.40 kN/m^2
Pressure at dist "d" from face of pedestal		=	336.40 kN/m^2

Depth required for Bending Moment

Critical section for moment will be at the face of the pedestal.

Overhang distance	y	=	1.830 m
Bending Moment at face of Pedestal		=	**563.28** kNm/m
Depth reqd for the above moment	d_{eff1}	=	460 mm
Provided Depth		=	1576 mm
		>	**460 HENCE OK**

Area of Steel Required for Bending

$$\frac{x}{d} = 0.0320$$

Lever Arm Depth $Z = 1555.03$ mm

Reinforcement Required

$$A_{st} = \frac{M_u}{0.87 f_y Z} = 832.72 \text{ mm}^2$$

Minimum Area of Steel Required

Minimum reinforcement required: = 1980.00 mm^2

Reinforcement Provided

Spacing of Y 16 bars	=	101.55	mm
Provide Y **16** at **100** mm c/c	=	**2010.62**	mm^2
	>	**1980.00**	**HENCE OK**
Percentage of Reinforcement Provided	=	**0.13%**	

Check for One Way Shear

Design Shear Strength of Concrete	t_c	=	0.27	N/mm^2
	K	=	1.00	
t_c for Solid Slab	$t_c k$	=	0.27	N/mm^2
Pressure at dist "d" from face of pedestal		=	336.40	kN/m^2
SF at dist "d" from face of pedestal	V	=	85.45	kN
Depth required for one way shear	d_{eff2}	=	319	mm
Provided Depth		=	490	mm
		>	**319**	**HENCE OK**

Check for Two Way Shear

Maximum shear stress= $0.25(fck)^{0.5}$	τ_c	=	1.12	N/mm^2
Vertical load punching the base slab		=	6487.50	kN
Preimeter		=	9904	mm
Depth required for two way shear	d_{eff3}	=	586	mm
Provided Depth		=	1009	mm
		>	**586**	**HENCE OK**

DESIGN OF FOOTING F2

Basic Data

Material Data

Grade of Concrete	f_{ck}	=	M20
Yeild Strength of Reinforcement	f_y	=	500 N/mm^2
Unit Weight of Concrete	γ_c	=	25.0 kN/m^3
Unit Weight of Soil	γ_s	=	18.0 kN/m^3
Frictional Factor bet. Soil & Concrete	μ	=	0.35

Soil Data:

Type of soil in foundation			MEDIUM
Net Safe Bearing Capacity	SBC	=	250 kN/m^2

Clear cover to Reinforcement

Clear Cover to Footing Slab		=	50.0 mm
Clear Cover to Pedestal		=	40.0 mm

Basic Dimensions

Size of Pedestal

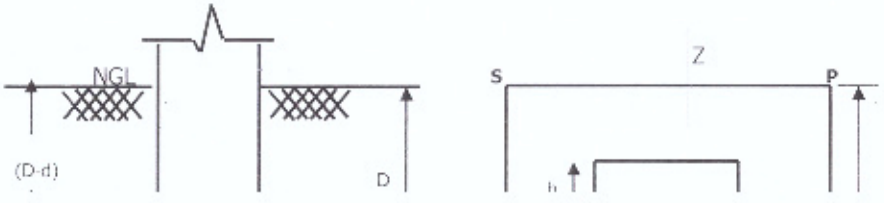
Length	l	=	1.500 m
Breadth	b	=	0.300 m
Depth of foundation from GL	D	=	2.100 m

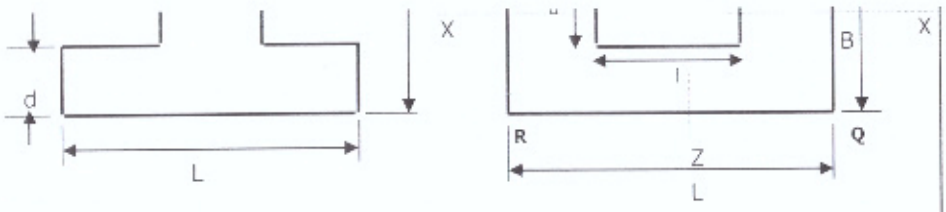
Size of Foundation Pad

Length	L	=	4.260 m
Breadth	B	=	3.600 m
Thickness of Base Slab	d	=	1.100 m
Thickness @ edge of footing	e	=	0.375 m

Analysis Results

Loads	V	Mzz	Hx	Mxx	Hz
	kN	kN m	kN	kN m	kN
Dead Load	3090.00	0.00	0.00	0.00	0.00
Live Load	0.00	0.00	0.00	0.00	0.00
Wind or Seismic Load	± 0.00	± 0.00	± 0.00	± 0.00	± 0.00





Load Combination

Load Combination for Design

1) 1.5DL + 1.5LL
2) 1.2DL + 1.2LL + 1.2WL(OR)SL
3) 1.5DL + 1.5WL(OR)SL
4) 0.9DL + 1.5WL(OR)SL

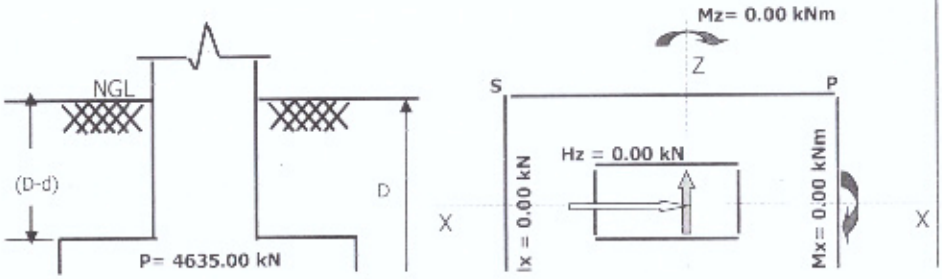
Unfactored Loads

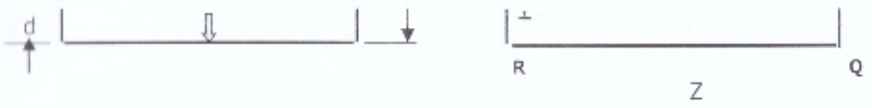
Load Combinaion	V	Mzz	Hx	Mxx	Hz
	kN	kN m	kN	kN m	kN
Case 1) DL + LL	3090.00	0.00	0.00	0.00	0.00
Case 2) DL + LL + WL(OR)SL	3090.00	0.00	0.00	0.00	0.00
Case 3) DL + WL(OR)SL	3090.00	0.00	0.00	0.00	0.00

Factored loads

Load Combinaion	V	Mzz	Hx	Mxx	Hz
	kN	kN m	kN	kN m	kN
Case 1) 1.5DL + 1.5LL	4635.00	0.00	0.00	0.00	0.00
Case 2) 1.2DL + 1.2LL + 1.2WL(OR)SL	3708.00	0.00	0.00	0.00	0.00
Case 3) 1.5DL + 1.5WL(OR)SL	4635.00	0.00	0.00	0.00	0.00
Case 4) 0.9DL + 1.5WL(OR)SL	2781.00	0.00	0.00	0.00	0.00

Design of Footing for Case 3





Calculation of Bearing Pressure under the Footing

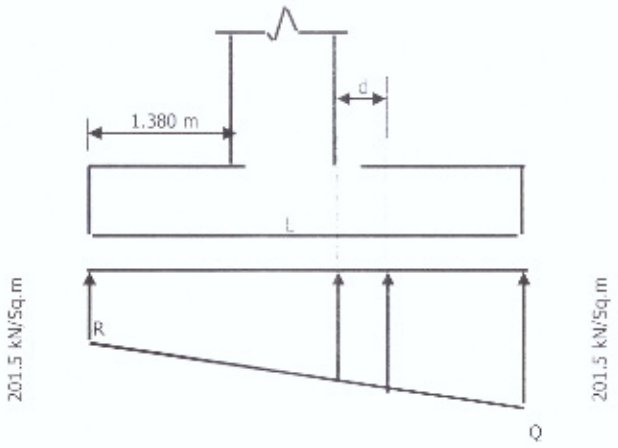
eccentricity	e_z	=	M_{xx}/W	=	0.000 m	
			e_z/B	=	0.000	
			B/6	=	0.600	> 0.000
eccentricity	e_x	=	M_{zz}/W	=	0.000 m	
			e_x/L	=	0.000	
			L/6	=	0.710	> 0.000

Hence all the four edges are in contact with Soil

Soil Pressure at Point Q qmax	=	201.486698	kN/m^2
S.B.C. of Soil	=	**250**	kN/m^2
		HENCE SAFE	

Design of Foundation Pad along X direction

Bearing Pressure Distribution



PRESSURE DISTRIBUTION DIAGRAM

Depth of Pad	d	=	1100 mm
Therefore, effective depth	d_{eff}	=	1042 mm
Pressure at face of Pedestal		=	302.23 kN/m^2
Pressure @ dist "d" from face of pedestal		=	302.23 kN/m^2

Depth required for Bending Moment

Critical section for moment will be at the face of the pedestal.

Overhang distance	x	=	1.380 m
Bending Moment at face of Pedestal		=	**287.8** kNm/m
Depth reqd for the above moment	d_{eff1}	=	329 mm
Provided Depth		=	1042 mm
		>	**329 HENCE OK**

Area of Steel Required for Bending

	$\frac{x}{d}$	=	
		=	0.0375
Lever Arm Depth	Z	=	
		=	1025.76 mm
Reinforcement Required	A_{st}	=	$\frac{M_u}{0.87 f_y Z}$
		=	644.9588159 mm^2

Minimum Area of Steel Required

Minimum reinforcement required:		=	1320 mm^2

Reinforcement Provided

Spacing of Y 16 bars		=	152.32 mm
Provide Y **16** at **100** mm c/c		=	**2010.6** mm^2
		>	**1320.00 HENCE OK**
Percentage of Reinforcement Provided		=	**0.19%**

Check for One Way Shear

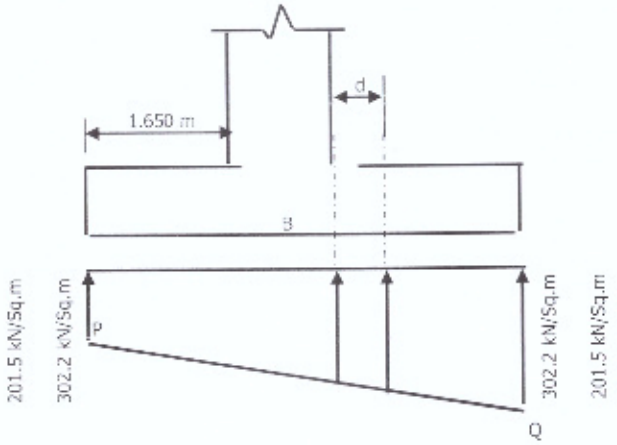
Design Shear Strength of Concrete	τ_c	=	0.32 N/mm^2
	K	=	1.00
τ_c for Solid Slab	$\tau_c k$	=	0.32 N/mm^2
Pressure at dist "d" from face of pedestal		=	302.23 kN/m^2
SF at dist "d" from face of pedestal	V	=	102.15 kN
Depth required for one way shear	d_{eff2}	=	318 mm
Provided Depth		=	568 mm
		>	**318 HENCE OK**

Check for Two Way Shear

Maximum shear stress= $0.25(fck)^{0.5}$	τ_c	=	1.12 N/mm^2
Vertical load punching the base slab		=	4635.00 kN
Preimeter		=	7768 mm
Depth required for two way shear	d_{eff3}	=	534 mm
Provided Depth		=	956 mm
		>	**534 HENCE OK**

Design of Foundation Pad along Z direction

Bearing Pressure Distribution



PRESSURE DISTRIBUTION DIAGRAM

Depth of Pad	d	=	1100 mm
Therefore, effective depth	d_{eff}	=	1026 mm
Pressure at face of Pedestal		=	302.23 kN/m^2
Pressure at dist "d" from face of pedestal		=	302.23 kN/m^2

Depth required for Bending Moment

Critical section for moment will be at the face of the pedestal.

Overhang distance	y	=	1.650 m
Bending Moment at face of Pedestal		**=**	**411.41** kNm/m
Depth reqd for the above moment	d_{eff1}	=	393 mm
Provided Depth		=	1026 mm
		>	**393 HENCE OK**

Area of Steel Required for Bending

$$\frac{x}{d} = 0.0557$$

Lever Arm Depth $Z = 1002.23$ mm

Reinforcement Required

$$A_{st} = \frac{M_u}{0.87\, f_y\, Z} = 943.66 \text{ mm}^2$$

Minimum Area of Steel Required

Minimum reinforcement required: = 1320.00 mm^2

Reinforcement Provided

Spacing of Y 16 bars		=	152.32	mm
Provide Y **16** at **100** mm c/c		=	**2010.62**	mm^2
		>	**1320.00**	**HENCE OK**
Percentage of Reinforcement Provided		=	**0.20%**	

Check for One Way Shear

Design Shear Strength of Concrete	t_c	=	0.32	N/mm^2
	K	=	1.00	
t_c for Solid Slab	t_ck	=	0.32	N/mm^2
Pressure at dist "d" from face of pedestal		=	302.23	kN/m^2
SF at dist "d" from face of pedestal	V	=	188.59	kN
Depth required for one way shear	d_{ef2}	=	583	mm
Provided Depth		=	597	mm
		>	**583**	**HENCE OK**

Check for Two Way Shear

Maximum shear stress= $0.25(fck)^{0.5}$	τ_c	=	1.12	N/mm^2
Vertical load punching the base slab		=	4635.00	kN
Preimeter		=	7704	mm
Depth required for two way shear	d_{ef3}	=	538	mm
Provided Depth		=	796	mm
		>	**538**	**HENCE OK**

DESIGN OF SLAB S1

ROOF LEVEL SLAB

Design of two way Slab

Basic Data

Grade of concrete (fck)	=	M 20	
Grade of steel (fy)	=	Fe 415	
Thickness of slab (D)	=	125	mm
Clear cover (cc)	=	15	mm
Effective thickness of slab (deff) = 125 - 15 - 8 /2	=	106	mm
Unit weight of concrete	=	25	KN/m^3
Effective Shorter Span (Lx)	=	3.15	m
Effective Longer Span (Ly)	=	3.75	m
Aspect ratio Ly/Lx	=	1.19	**Two way slab**

Edge Condition : **Two adjacent Edges Discontinous**

Load Data

Dead Load = 0.13 x 25	=	3.125	KN/m^2	
Floor finish	=	1.50	KN/m^2	
Imposed Load	=	2.00	KN/m^2	
Total load	=	6.63	KN/m^2	
Design load (Wu) = 1.5 x 6.625	=	**9.94**	KN/m^2	

Moment and Shear Calculations

Short Span Direction

ax for positive moment	1.1	→	0.04	
	1.2	→	0.045	
	for 1.19	αx	= 0.045	
Positive moment Mx = 0.045 x 9.94 x 3.15 ^2	=	**4.39**	KN-m	
ax for negative moment	1.1	–	0.053	
	1.2	→	0.060	
	for 1.19	αx	= 0.059	
Negative moment Mx : 0.059 x 9.94 x 3.15 ^2	=	**5.85**	KN-m	

Long Span Direction

For positive moment	αy	=	0.035	
Positive moment My : 0.035 x 9.94 x 3.15 ^2	=	**3.45**	KN-m	
For negative moment	αy	=	0.047	
Negative moment My : 0.047 x 9.94 x 3.15 ^2	=	**4.63**	KN-m	

Shear force V_u = 9.94 x 3.2 x 0.5 = **15.65** KN

Check Effective Depth for Bending

Depth required = $(M_x / (0.138x\ fck \times b))^{1/2}$ = 46.04 mm

Depth provided = 125 - 15 - 8 /2 = 106 mm

Hence O.K

Reinforcement calculations

Short Span Direction @ Support

Mu/bd^2 = $\frac{5.85 \times 10 \wedge 6}{1000 \times 106 \times 106}$ = **0.521**

Pt = **0.15** %

Area of steel Ast = 0.00149 x 1000 x 106 = 157.82 mm^2

Minimum area of steel 0.0012 x 1000 x 125 = 150.00 mm^2

Spacing of Y **8** bars 50.27 x 1000 / 157.82 = 318.33 mm

Ast provided = 335.1 mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm

2) = 300 mm

3) = 318.33 mm

Therefore provide Y **8** @ **150** mm C/C

Short Span Direction @ Mid Span

Mu/bd^2 = $\frac{4.39 \times 10 \wedge 6}{1000 \times 106 \times 106}$ = 0.391

Pt = 0.111 %

Area of steel Ast = 0.00111 x 1000 x 106 = 117.47 mm^2

Minimum area of steel 0.0012 x 1000 x 125 = 150.00 mm^2

Spacing of Y **8** bars 50.27 x 1000 / 150.00 = 334.93 mm

Ast provided = 335.1 mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm

2) = 300 mm

3) = 334.93 mm

Therefore provide Y **8** @ **150** mm C/C

Provided % of Tension Reinforcement (pt) = **0.316** %

100

Long Span Direction @ Support

$Mu/bd^2 = \frac{1.63 \times 10^6}{1000 \times 106 \times 106} = 0.432$

Pt = 0.117 %

Area of steel Ast = 0.00117 x 1000 x 106 = 124.17 mm^2

Minimum area of steel 0.0012 x 1000 x 125 = 150.00 mm^2

Spacing of Y **8** bars 50.27 x 1000 / 150.00 = 334.93 mm

Ast provided = 335.1 mm^2

Check for Spacing

Minimum of 1) 3d = 318 mm

2) = 300 mm

3) = 334.93 mm

Therefore provide Y **8** @ **150** mm C/C

Long Span Direction @ mid Span

$Mu/bd^2 = \frac{3.45 \times 10^6}{1000 \times 106 \times 106} = 0.307$

Pt = 0.087 %

Area of steel Ast = 0.00087 x 1000 x 106 = 91.874 mm^2

Minimum area of steel 0.0012 x 1000 x 125 = 150.00 mm^2

Spacing of Y **8** bars 50.27 x 1000 / 150.00 = 334.93 mm

Ast provided = 335.1 mm^2

Check for Spacing

Minimum of 1) 3d = 318 mm

2) = 300 mm

3) = 334.93 mm

Therefore provide Y **8** @ **150** mm C/C

Check for Deflection:

Basic Span/depth Ratio = 23

% of Tension Reinforcement provided (pt) = 0.316 %

Service stress of steel (fs) : $0.58fy(Ast\_r/Ast\_p)$ = 84.38 N/mm^2

Modification Factor for Tension Reinforcement (F1) = 2.00

Allowable Span/Eff Depth Ratio = 46

Actual Span/Eff Depth Ratio = 3.15 x 1000 / 106 = 29.72

Hence O.K

DESIGN OF SLAB S2

ROOF LEVEL SLAB

Design of two way Slab

Basic Data

Grade of concrete (fck)	=	M 20	
Grade of steel (fy)	=	Fe 415	
Thickness of slab (D)	=	125	mm
Clear cover (cc)	=	15	mm
Effective thickness of slab (deff) = 125 - 15 - 8 /2	=	106	mm
Unit weight of concrete	=	25	KN/m^3
Effective Shorter Span (Lx)	=	3.375	m.
Effective Longer Span (Ly)	=	3.8	m.
Aspect ratio Ly/Lx	=	1.13	**Two way slab**

Edge Condition : **Four Edges Discontinuous**

Load Data

Dead Load	= 0.13 x 25	=	3.125	KN/m^2
Floor finish		=	1.50	KN/m^2
Imposed Load		=	2.00	KN/m^2
Total load		=	6.63	KN/m^2
Design load (Wu) = 1.5 x 6.625		=	**9.94**	KN/m^2

Moment and Shear Calculations

Short Span Direction

ax for positive moment		1.1	→	0.064	
		1.2	→	0.072	
	for	1.13	αx =	0.066	
Positive moment Mx	0.066 x 9.94 x 3.375 ^2		=	**7.48**	KN-m
ax for negative moment		1.1	→	0.000	
		1.2	→	0.000	
	for	1.13	αx =	0.000	
Negative moment Mx :	0.000 x 9.94 x 3.375 ^2		=	**0.00**	KN m

Long Span Direction

For positive moment		αy	=	0.056	
Positive moment My :	0.056 x 9.94 x 3.375 ^2		=	**6.34**	KN m
For negative moment		αy	=	0.000	
Negative moment My :	0.000 x 9.94 x 3.375 ^2		=	**0.00**	KN-m

S. P. S. INBARAJAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. SE
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kirupasankari Street,
West Mambalam, Chennai-600 033.

Shear force V_u = 9.94 x 3.4 x 0.5 = **16.77** KN

Check Effective Depth for Bending

Depth required = $(M_x / (0.138 \times fck \times b))^{1/2}$ = 52.06 mm

Depth provided = 125 - 15 - 8 /2 = 106 mm

Hence O.K

Reinforcement calculations

Short Span Direction @ Support

$$Mu/bd^2 = \frac{0.00 \times 10^6}{1000 \times 106 \times 106} = \mathbf{0.000}$$

Pt = **0.00** %

Area of steel Ast	=	0.00000	x	1000 x	106	=	0 mm^2
Minimum area of steel		0.0012	x	1000 x	125	=	0.00 mm^2
Spacing of Y 8 bars		50.27	x	1000 /	0.00	=	0 mm
Ast provided						=	402.12 mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm

2) = 300 mm

3) = 0.00 mm

Therefore provide Y **8** @ **125** mm C/C

Short Span Direction @ Mid Span

$$Mu/bd^2 = \frac{7.48 \times 10^6}{1000 \times 106 \times 106} = 0.666$$

Pt = 0.192 %

Area of steel Ast	=	0.00192	x	1000 x	106	=	203.64 mm^2
Minimum area of steel		0.0012	x	1000 x	125	=	150.00 mm^2
Spacing of Y 8 bars		50.27	x	1000 /	203.64	=	246.71 mm
Ast provided						=	402.12 mm^2

Check for Spacing

Minimum of

1) 3d = 318 mm

2) = 300 mm

3) = 246.71 mm

Therefore provide Y **8** @ **125** mm C/C 100

Provided % of Tension Reinforcement (pt) = **0.379** %

Long Span Direction @ Support

S. P. S. INBARAJAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. [illegible]
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kirupasankari Street,
West Mambalam, Chennai 600 033

$Mu/bd^2 = \frac{0.00 \times 10 \wedge 6}{1000 \times 106 \times 106} = 0.000$

Pt = 0.000 %

Area of steel Ast	=	0.00000	x	1000 x	106	=	0 mm²
Minimum area of steel		0.0012	x	1000 x	125	=	0.00 mm²
Spacing of Y **8** bars		50.27	x	1000 /	0.00	=	0 mm
Ast provided						=	335.1 mm²

Check for Spacing

Minimum of

1) 3d = 318 mm
2) = 300 mm
3) = 0.00 mm

Therefore provide Y **8** @ **150** mm C/C

Long Span Direction @ mid Span

$Mu/bd^2 = \frac{6.34 \times 10 \wedge 6}{1000 \times 106 \times 106} = 0.564$

Pt = 0.162 %

Area of steel Ast	=	0.00162	x	1000 x	106	=	171.47 mm²
Minimum area of steel		0.0012	x	1000 x	125	=	150.00 mm²
Spacing of Y **8** bars		50.27	x	1000 /	171.47	=	293 mm
Ast provided						=	335.1 mm²

Check for Spacing

Minimum of

1) 3d = 318 mm
2) = 300 mm
3) = 293.00 mm

Therefore provide Y **8** @ **150** mm C/C

Check for Deflection:

Basic Span/depth Ratio	=	20	
% of Tension Reinforcement provided (pt)	=	0.379	%
Service stress of steel (fs) : 0.58fy(Ast_r/Ast_p)	=	121.89	N/mm²
Modification Factor for Tension Reinforcement (F1)	=	2.00	
Allowable Span/Eff Depth Ratio	=	40	
Actual Span/Eff Depth Ratio = 3.375 x 1000 / 106	=	31.84	

Hence O.K

(S. P. S. NARAYANAN, M.E., (Struct)
Registered Structural Engineer
Grade-I (SE) in CMDA
Reg. No. SE/GI-[illegible]
Grade-I (RSE) in Greater Chennai Corporation
Reg. No. RSE 100302019 Dt. 30.09.2019
Door No.50, Kaipesankari Street,
West Mambalam, Chennai-600 033.

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Building plan approvals, construction, layout and sub-division approvals, zone conversion, and occupancy certification.

NRI & Investment Services

Escrow Services, Rentals, Litigation Solutions, Property Valuation and Property Management

Compliance & Special Services

Demolition, Vaasthu checks, regularization of unauthorized buildings, and office space solutions.

empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

Guideline Value, Apartment Composite Value, Stamp Duty & Registration Fees Calculator, Building Value Calculator, Capital Gains Calculator, Area Unit Converter, Length Unit Converter

Ownership, Compliance & Legal Verification

Encumbrance Certificate (EC) Search, Find Your SRO, Temple Property Check, WAQF Property Check, View Patta/Chitta, View FMB, Patta Analyzer, EC Analyzer

Zoning & Land Use Analysis

Land Use Zone Finder, CRZ Zone Check, Aquifer Zone Check, CBA Check, EWS Check, Road Width Check, Proposed Road Widening Check, FSI Calculator

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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3/350/2 Mettukuppam,
OMR Thoraipakkam,
Chennai, India

hello@verified.realestate
+91 9996 12 9996
www.verified.realestate