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CERTIFICATE FOR STRUCTURAL DESIGN SUFFICIENCY AND SAFE & SOUND

With respect to the proposed construction of

residential Non High Rise Apartment in stilt + 5 Floors in site Madurai District – Thiruparamkundram Taluk- Madurai Corporation – Ward No. 22-Block 34- T.S.No. 4/47,6/5, and Ward No.4 – Block -49 – T.S.No. 7/1, (Madakulam Village R.S.No. 19/1pt,2pt,3pt and 220/5A)-Site area of 2753.84 Sq.m)

we certify that the designs are being done after detailed soil investigation and the design is being done to meet all the structural stability requirements as stipulated in IS 456,IS 875 and other relevant codes, and it is structurally safe & sound.

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STRUCTURAL DESIGN STABILITY CERTIFICATE

This is to certify that the PROPOSED NEW CONSTRUCTION OF RESIDENTIAL FLATS IN PLOT NOS : 1 TO 8 , IN APPROVED LAYOUT NO : 163/2021, S.WARD NO : 22, BLOCK:34, T.S.NO: 4/47,6/5, (MADAKKULAM DD PLAN IV) AND S.WARD NO:4, BLOCK:49, T.S.NO:7/1, (NEW ELLIS NAGAR DD PLAN) IN MADURAI CORPORATION, (OLD R.S.NO : 19/1pt,2pt,3pt & 220/5A , AT MADAKULAM VILLAGE, THIRUPPARANKUNDRAM TALUK, MADURAI (DT). MADURAI CORPORATION WARD NO: 60, ZONE 3). (46 DWELLING UNITS)

1. IS: 456-2000, code of practice for plain and reinforced concrete, with M25 concrete grade tor RC.C. components.
2. IS: 875-1987, code of practice for design loads for building and structures.
3. IS: 1893-2002, criteria for earthquake resistant design of structures.

The building Designed by me consists of Stilt + Five floors + Stair Case Head Room, Lift Machine Room and Water Tank, The R.C.C. building frame of the structure is designed as per the Indian Standard code of practice for concrete and loadings. The loading stress parameters are within limits of practice of National Building Code and other Bureau of Indian standards code.

The Structure will be Constructed as per our structural Design and detailing of reinforcements given in our drawing from foundation to roof slab. Regular Site Inspection will be done to ensure Quality of Work and Materials used.

As per calculations & Detailing the above said building is structurally safe.

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STRUCTURAL DESIGN CALCULATIONS

(LOAD CALCULATIONS)

STRUCTURE:

The proposed Building has been envisaged as R.C Framed Structure with Stilt + Five Upper floors. The Stilt Floor is intended for Car Parking Utility. The upper Floors from 1st to 5th are intended for Residential Utility.

ANALYSIS & DESIGN:

The Structure has been idealized as 3D Frame, with R.C Slab & Beam. All Beams are interconnecting with Columns. The design of all R.C components is done using Limit State Method.

The following codes of the Indian Standards are adopted in the Structural Design:

IS: 456-2000	Plain and Reinforced Concrete-code of Practice (Fourth Revision)
IS: 875-1987	Code of Practice for Design loads (other than Earthquake) for Buildings and Structures.
	Part (1) - Dead Loads-Unit Weights of Building Materials and Stored Materials (second revision)
	Part (2) - Impact Loads (second revision)
	Part (3) - Wind Loads (second revision)
	Part (4) - Snow Loads (second revision)
	Part (5) - Special Loads and Load Combinations.
IS: 1893-2002	Criteria for Earthquake Resistant Design of Structures (Fifth Revision).

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IS: 13920-1993		Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-Code of Practice.
SP7:1983		National Building Code of India 1983.
SP: 34(S&T)-1987	-	Hand Book on Concrete Reinforcement and Detailing.
SP: 23(S&T)-1982	-	Hand Book on Concrete Mixes.
SP: 16(S&T)-1980	-	Design Aids for Reinforced Concrete to IS: 456-1978.

The concrete grade assumed for all R.C Column is M 25 and others M 25. The Steel grade considered in the design is Fe 500.

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COLUMN DESIGN

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COLUMN NO. 1909 DESIGN RESULTS

M20 Fe500 (Main) Fe500 (Sec.)

LENGTH: 3200.0 mm CROSS SECTION: 300.0 mm X 300.0 mm COVER: 40.0 mm

** GUIDING LOAD CASE: 151 END JOINT: 14 SHORT COLUMN

REQD. STEEL AREA : 735.76 Sq.mm.

REQD. CONCRETE AREA: 89264.24 Sq.mm.

MAIN REINFORCEMENT : Provide 4 - 16 dia. (0.89%, 804.25 Sq.mm.)

(Equally distributed)

TIE REINFORCEMENT : Provide 8 mm dia. rectangular ties @ 255 mm c/c

SECTION CAPACITY BASED ON REINFORCEMENT REQUIRED (KNS-MET)

Puz : 1079.29 Muz1 : 49.66 Muy1 : 49.66

INTERACTION RATIO: 0.99 (as per Cl. 39.6, IS456:2000)

SECTION CAPACITY BASED ON REINFORCEMENT PROVIDED (KNS-MET)

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WORST LOAD CASE: 151

END JOINT: 14 Puz : 1104.35 Muz : 60.44 Muy : 60.44 IR: 0.80

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BEAM DESIGN

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BEAM NO. 1164 DESIGN RESULTS

M20 Fe500 (Main) Fe500 (Sec.)

LENGTH: 2666.0 mm SIZE: 230.0 mm X 300.0 mm COVER: 25.0 mm

FLANGE WIDTH: 500.0 mm FLANGE DEPTH: 115.0 mm

SUMMARY OF REINF. AREA (Sq.mm)

SECTION	0.0 mm	666.5 mm	1333.0 mm	1999.5 mm	2666.0 mm
TOP REINF.	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)	0.00 (Sq. mm)
BOTTOM REINF.	0.00 (Sq. mm)	151.83 (Sq. mm)	211.07 (Sq. mm)	151.83 (Sq. mm)	0.00 (Sq. mm)

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SUMMARY OF PROVIDED REINF. AREA

SECTION	0.0 mm	666.5 mm	1333.0 mm	1999.5 mm	2666.0 mm
TOP REINF.	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)	2-12í 1 layer(s)
BOTTOM REINF.	2-12í 1 layer(s)	3-12í 1 layer(s)	3-12í 1 layer(s)	3-12í 1 layer(s)	2-12í 1 layer(s)
SHEAR REINF.	2 legged 8í @ 200 mm c/c	2 legged 8í @ 200 mm c/c	2 legged 8í @ 200 mm c/c	2 legged 8í @ 200 mm c/c	2 legged 8í @ 200 mm c/c

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SLAB DESIGN

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SHRI BALAJI CONSULTANCY

DESIGN OF TWO WAY SLAB - S1

1 MATERIAL PROPERTIES

Unit weight of reinforced concrete	γ_c	=	25.000 kN/m^3
Environmental exposure condition (Table 3 of IS 456)		=	Mild
Grade of concrete (Table 5 of IS 456)		=	M20
Grade of steel		=	Fe500
Characteristic strength of concrete (Table 2 of IS 456)	f_{ck}	=	20.000 N/mm^2
Characteristic strength of reinf. steel = Yield stress of reinf. steel (cl. 36.1 of IS 456)	f_y	=	500.000 N/mm^2

2 DIMENSIONS

Shorter span	lx	=	3920.000 mm
Longer span	ly	=	4360.000 mm
Span ratio	ly / lx	=	1.112
		≤	2.000

Hence it is a two way slab.

Thickness of slab		=	115.000 mm
Clear cover to reinforcements (Table 16 of IS 456)		=	15.000 mm
Width of slab considered for design (width of compression face)	= b	=	1000.000 mm

3 REINFORCEMENTS

Zone	Bar dia mm	Spacing mm	A_{st} mm2/m	Eff. Depth d mm
Along short span at bottom	8	200.000	251.327	96
Along long span at bottom	8	200.000	251.327	88
Top bars at short edge	8	200.000	251.327	88
Top bars at long edge	8	200.000	251.327	96

4 DEAD LOAD

Weight of finishes		=	1.150 kN/m^2
Self Weight of slab		=	25 * 0.115
		=	2.875 kN/m^2
Total		=	4.025 kN/m^2

5 LIVE LOAD

Live load on slab (Table 1 of IS 875 Part 2)		=	2.000 kN/m^2

6 FACTORED LOAD COMBINATION

Partial safety factor for DL (Table 18 of IS 456)		=	1.500
Partial safety factor for LL (Table 18 of IS 456)		=	1.500
Factored Load	= [1.5 DL + 1.5 LL] = w	=	9.038 kN/m^2

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7 BENDING MOMENTS

Edge condition : One long edge continuous

As Per Table 26 of IS 456:2000 the moment coefficients are as follows

Ratio of ly/lx	Short span coefficient αx	
	- ve moment at continuous Edge	+ ve moment at midspan
1.100	0.064	0.048
1.200	0.071	0.053
1.112	0.065	0.049

Long span coefficient αy	
- ve moment at continuous Edge	+ ve moment at midspan
0.000	0.043

Negative Bending moment at the short span	$= M_{-x} = \alpha_{-x} \times w \times lx^2$	=	9.007 kNm
Positive Bending moment at the short span	$= M_{+x} = \alpha_{+x} \times w \times lx^2$	=	6.751 kNm
Negative Bending moment at the long span	$= M_{-y} = \alpha_{-y} \times w \times lx^2$	=	0 kNm
Positive Bending moment at the long span	$= M_{+y} = \alpha_{+y} \times w \times lx^2$	=	5.972 kNm

8 LIMIT STATE OF COLLAPSE - FLEXURE & SHEAR

Minimum reinforcements (Cl. 26.5.2.1 of IS 456)		=	0.12 %
		=	138 mm^2

A REINFORCEMENTS ALONG SHORT SPAN AT BOTTOM

Positive Bending moment at the short span		=	6.751 kNm
Area of reinf. steel required is calculated as per Annex G of IS 456 :			
Area of tension reinforcement required =	Ast reqd.	=	169.109 mm^2
Spacing of 8 mm dia. bars required		=	297.237 mm
Maximum spacing allowed as per cl. 26.3.3. of IS 456 is three times the effective depth or 300mm which ever is smaller		=	288.000 mm
Hence spacing of 8 mm dia. bars required is the minimum of the above two values		=	288.000 mm
Spacing of 8 mm dia. bars provided		=	200.000 mm
Area of tension reinforcement provided =	Ast prov.	=	251.327 mm^2
		>	169.109 mm^2
			Hence Safe

Moment of resistance is calculated as per Annex G of IS 456 :

Ratio between depth of neutral axis and effective depth =	x_u / d	=	$(0.87 f_y A_{st})/(0.36 f_{ck} b d)$
		=	0.158
Depth of neutral axis =	x_u	=	0.158 * 96
		=	15.168 mm
As per cl. 38.1 of IS 456, the limiting value of xu/d =	$x_{u,max} / d$	=	0.460
		>	0.158
			Hence Safe

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Limiting value of the depth of neutral axis		=	44.160 mm
Moment of resistance Mu =	0.87 fy Ast d (1-(Ast fy / b d fck))	=	9.809 kNm
		>	6.751 kNm
			Hence Safe

Limiting moment of resistance of the section without compression reinforcement

= 0.36 * $x_{u,max}$/d (1-0.42 $x_{u,max}$ /d) * bd^2 fck =	$M_{u,lim}$	=	24.626 kNm
		>	9.809 kNm
			Hence compression reinforcements are not required.

Design stress in compression reinforcement =	f_{sc}	=	500.000 N/mm^2
Depth of compression reinf. from compression face =	d'	=	15 + 8/2
		=	19.000 mm
Area of compression reinforcement = (M_u - $M_{u,lim}$) / (f_{sc} (d-d')) = A_{sc}		=	0 mm^2
Area of compression reinforcement provided		=	0 mm^2
Additional tension reinforcement required =	A_{st2}	=	0 mm^2
Area of tension reinforcement required for a singly reinforced section for $M_{u,lim}$ =	A_{st1}	=	169.109 mm^2
Total tension reinforcement required = A_{st1} + A_{st2} =	Ast	=	169.109 mm^2

B REINFORCEMENTS ALONG LONG SPAN AT BOTTOM

Positive Bending moment at the long span		=	5.972 kNm
Area of reinf. steel required is calculated as per Annex G of IS 456 :			
Area of tension reinforcement required =	Ast reqd.	=	163.613 mm^2
Spacing of mm dia. bars required		=	307.221 mm
Maximum spacing allowed as per cl. 26.3.3. of IS 456 is three times the effective depth or 300mm which ever is smaller		=	264.000 mm
Hence spacing of mm dia. bars required is the minimum of the above two values		=	264.000 mm
Spacing of mm dia. bars provided		=	200.000 mm
Area of tension reinforcement provided =	Ast prov.	=	251.327 mm^2
		>	163.613 mm^2
			Hence Safe

Moment of resistance is calculated as per Annex G of IS 456 :

Ratio between depth of neutral axis and effective depth =	x_u / d	=	(0.87 fy Ast)/(0.36 f_{ck} b d)
		=	0.173
Depth of neutral axis =	x_u	=	0.173 * 88
		=	15.224 mm
As per cl. 38.1 of IS 456, the limiting value of xu/d =	$x_{u,max}$ / d	=	0.460
		>	0.173
			Hence Safe
Limiting value of the depth of neutral axis		=	40.480 mm

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	SHRI BALAJI CONSULTANCY
	DESIGN OF TWO WAY SLAB - S1

Moment of resistance Mu = 0.87 fy Ast d (1-(Ast fy / b d fck)) = 8.934 kNm

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		>	5.972 kNm
			Hence Safe
Limiting moment of resistance of the section without compression reinforcement			
= 0.36 * $x_{u,max}$/d (1-0.42 $x_{u,max}$ /d) * bd^2 fck =	$M_{u,lim}$	=	20.693 kNm
		>	8.934 kNm
			Hence compression reinforcements are not required.
Design stress in compression reinforcement =	f_{sc}	=	500.000 N/mm^2
Depth of compression reinf. from compression face =	d'	=	15 + 8/2
		=	19.000 mm
Area of compression reinforcement = (M_u - $M_{u,lim}$) / (f_{sc} (d-d')) =	A_{sc}	=	0 mm^2
Area of compression reinforcement provided		=	0 mm^2
Additional tension reinforcement required =	A_{st2}	=	0 mm^2
Area of tension reinforcement required for a singly reinforced section for $M_{u,lim}$ =	A_{st1}	=	163.613 mm^2
Total tension reinforcement required = A_{st1} + A_{st2} =	Ast	=	163.613 mm^2

C **REINFORCEMENTS AT LONG EDGE AT TOP**

Negative Bending moment at the short span		=	9.007 kNm
Area of reinf. steel required is calculated as per Annex G of IS 456 :			
Area of tension reinforcement required =	Ast reqd.	=	229.388 mm^2
Spacing of mm dia. bars required		=	219.129 mm
Maximum spacing allowed as per cl. 26.3.3. of IS 456 is three times the effective depth or 300mm which ever is smaller		=	288.000 mm
Hence spacing of mm dia. bars required is the minimum of the above two values		=	219.129 mm
Spacing of mm dia. bars provided		=	200.000 mm
Area of tension reinforcement provided =	Ast prov.	=	251.327 mm^2
		>	229.388 mm^2
			Hence Safe
Moment of resistance is calculated as per Annex G of IS 456 :			
Ratio between depth of neutral axis and effective depth =	x_u / d	=	(0.87 fy Ast)/(0.36 f_{ck} b d)
		=	0.158
Depth of neutral axis =	x_u	=	0.158 * 96
		=	15.168 mm
As per cl. 38.1 of IS 456, the limiting value of xu/d =	$x_{u,max}$ / d	=	0.460
		>	0.158
			Hence Safe
Limiting value of the depth of neutral axis		=	44.160 mm
Moment of resistance Mu = 0.87 fy Ast d (1-(Ast fy / b d fck))		=	9.809 kNm
		>	9.007 kNm

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Hence Safe

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Limiting moment of resistance of the section without compression reinforcement			
= 0.36 * $x_{u,max}$/d (1-0.42 $x_{u,max}$ /d) * bd^2 fck =	$M_{u,lim}$	=	24.626 kNm
		>	9.809 kNm
			Hence compression reinforcements are not required.
Design stress in compression reinforcement =	f_{sc}	=	500.000 N/mm^2
Depth of compression reinf. from compression face =	d'	=	15 + 8/2
		=	19.000 mm
Area of compression reinforcement = (M_u - $M_{u,lim}$) / (f_{sc} (d-d')) =	A_{sc}	=	0 mm^2
Area of compression reinforcement provided		=	0 mm^2
Additional tension reinforcement required =	A_{st2}	=	0 mm^2
Area of tension reinforcement required for a singly reinforced section for $M_{u,lim}$	A_{st1}	=	229.388 mm^2
Total tension reinforcement required = A_{st1} + A_{st2} =	Ast	=	229.388 mm^2

D REINFORCEMENTS AT SHORT EDGE AT TOP

Negative Bending moment at the long span		=	0 kNm
Area of reinf. steel required is calculated as per Annex G of IS 456 :			
Area of tension reinforcement required =	Ast reqd.	=	0.000 mm^2
Spacing of mm dia. bars required		=	#DIV/0! mm
Maximum spacing allowed as per cl. 26.3.3. of IS 456 is three times the effective depth or 300mm which ever is smaller		=	264.000 mm
Hence spacing of mm dia. bars required is the minimum of the above two values		=	NA mm
Spacing of mm dia. bars provided		=	200.000 mm
Area of tension reinforcement provided =	Ast prov.	=	251.327 mm^2
		>	138.000 mm^2
			Hence Safe
Moment of resistance is calculated as per Annex G of IS 456 :			
Ratio between depth of neutral axis and effective depth =	x_u / d	=	(0.87 fy Ast)/(0.36 f_{ck} b d)
		=	0.173
Depth of neutral axis =	x_u	=	0.173 * 88
		=	15.224 mm
As per cl. 38.1 of IS 456, the limiting value of xu/d =	$x_{u,max}$ / d	=	0.460
		>	0.173
			Hence Safe
Limiting value of the depth of neutral axis		=	40.480 mm
Moment of resistance Mu = 0.87 fy Ast d (1-(Ast fy / b d fck))		=	8.934 kNm
		>	0.000 kNm
			Hence Safe

Limiting moment of resistance of the section without compression reinforcement

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= 0.36 * $x_{u,max}$/d (1-0.42 $x_{u,max}$ /d) * bd^2 fck =	$M_{u,lim}$	=	20.693 kNm
		>	8.934 kNm

Hence compression reinforcements are not required.

Design stress in compression reinforcement =	f_{sc}	=	500.000 N/mm^2
Depth of compression reinf. from compression face =	d'	=	15 + 8/2
		=	19.000 mm
Area of compression reinforcement = (M_u - $M_{u,lim}$) / (f_{sc} (d-d')) = A_{sc}		=	0 mm^2
Area of compression reinforcement provided		=	0 mm^2
Additional tension reinforcement required =	A_{st2}	=	0 mm^2
Area of tension reinforcement required for a singly reinforced section for $M_{u,lim}$ =	A_{st1}	=	0.000 mm^2
Total tension reinforcement required = A_{st1} + A_{st2} =	Ast	=	0.000 mm^2

E TORSIONAL REINFORCEMENTS

Torsion reinforcements at corners, whose two edges are simply supported (Cl. D.1.8 of IS 456)	=	3/4 * 169.109
	=	126.832 mm^2
Torsion reinforcements at corners, whose one edge is simply supported (Cl. D.1.9 of IS 456)	=	1/2 * 126.832
	=	63.416 mm^2

F CHECK FOR SHEAR

As per Table 3.15 of BS 8110-1 the shear coefficients are as follows

Ratio of ly/lx	Short span coefficient βx	
	continuous edge	discontinuous edge
1.100	0.480	0.320
1.200	0.510	0.340
1.112	0.484	0.322

Long span coefficient βy	
continuous edge	discontinuous edge
0.000	0.290

Shear force at the long continuous edge	= β_{cx} x W x lx =	V_{cx}	=	17.136 kN
Shear force at the long discontinuous edge	= β_{dx} x W x lx =	V_{dx}	=	11.424 kN
Shear force at the short continuous edge	= β_{cy} x W x lx =	V_{cy}	=	0 kN
Shear force at the short discontinuous edge	= β_{dy} x W x lx =	V_{dy}	=	10.274 kN

Check for shear near long edge :

Shear force due to design loads	Vu	=	17.136 kN
Effective depth	d	=	96.000 mm
Nominal shear stress (Cl. 40.1 of IS 456)	τ_v	=	Vu / bd
		=	0.179 N/mm^2
Maximum shear stress (Cl. 40.2.3.1of IS 456)	$\tau_{c\,max}$	=	1.400 N/mm^2
		>	0.179 N/mm^2

Hence SAFE

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Area of reinf. provided			=	251.327 mm^2
Percentage of reinf. provided	= 100As/bd =	pt	=	0.262

From table 19 of IS 456,

pt	τ_c
0.250	0.360
0.500	0.480
0.262	0.366

Factor k as per cl. 40.2.1.1 of IS 456	k	=	1.300
Design shear strength of concrete	τ_c k	=	0.475 N/mm^2
		>	0.179 N/mm^2
			Hence SAFE

Check for shear near short edge :

Shear force due to design loads	Vu	=	10.274 kN
Effective depth	d	=	88.000 mm
Nominal shear stress (Cl. 40.1 of IS 456)	τ_v	=	Vu / bd
		=	0.117 N/mm^2
Maximum shear stress (Cl. 40.2.3.1of IS 456)	$\tau_{c\,max}$	=	1.400 N/mm^2
		>	0.117 N/mm^2
			Hence SAFE

Area of reinf. provided		=	251.327 mm^2
Percentage of reinf. provided	= 100As/bd = pt	=	0.286

From table 19 of IS 456,

pt	τ_c
0.250	0.360
0.500	0.480
0.286	0.377

Factor k as per cl. 40.2.1.1 of IS 456	k	=	1.300
Design shear strength of concrete	τ_c k	=	0.490 N/mm^2
		>	0.117 N/mm^2
			Hence SAFE

9 *LIMIT STATE OF SERVICEABILITY - DEFLECTION & CRACKING*

A CHECK FOR DEFLECTION

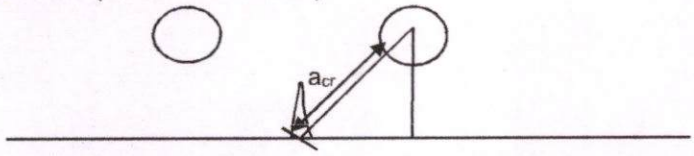
Allowable long term deflection (Cl. 23.2 of IS 456)		=	lx / 350
		=	11.200 mm
Basic allowable span to effective depth ratio (Cl. 23.2.1 of IS 456)		=	26.000 mm
Steel stress at service loads	fs	=	0.58 f_y $A_{st,reqd.}$ / $A_{st,prov.}$
		=	195.130 N/mm^2

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Modification factor for tension reinforcement (Fig. 4 of IS 456)	=	1.900
Modification factor for compression reinforcement (Fig. 4 of IS 456)	=	1.000
Allowable span to effective depth ratio	=	49.400
Actual span to effective depth ratio	=	40.833
	<	49.400
		Hence SAFE

B CHECK FOR CRACK WIDTH AT MIDSPAN

Allowable crack width (Cl. 35.3.2 of IS 456) = 0.3 mm

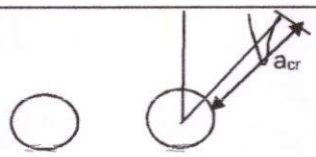


Distance of the point considered to the surface of the nearest longitudinal bar	a_{cr} =	97.789 mm
Minimum cover to the longitudinal bar	C_{min} =	15.000 mm
Overall depth of the member	h =	115.000 mm
Depth of neutral axis	x =	15.168 mm
Effective depth	d =	96.000 mm
Modulus of elasticity of steel reinf.	E_s =	200.000 kN/mm^2
Modulus of elasticity of concrete	E_c =	5000 $\sqrt{f_{ck}}$
	=	22.361 kN/mm^2
Modular ratio	m =	8.944 mm
Maximum moment	M =	6.751 kNm
Section modulus	Z =	$bd^2 / 6$
	=	1536000.000 mm^3
Maximum compressive stress in concrete	fc =	M/z
	=	4.395 N/mm^2
Maximum tensile stress in reinf. Steel	fs =	fc * m
	=	39.312 N/mm^2
Average steel strain at the level considered	=	fs / Es
	=	0.197
Maximum allowable strain	=	0.8 Fy / Es
	=	0.002
Average steel strain at the level considered	ε_m =	0.002
Design surface crack width (Annex F of IS 456)	W_{cr} =	$\frac{3\, a_{cr}\, \varepsilon_m}{1 + 2(a_{cr}-C_{min})/(h-x)}$
	=	0.221 mm
	<	0.300 mm

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C CHECK FOR CRACK WIDTH AT SUPPORT OF LONG EDGE

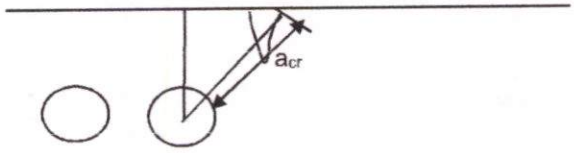
Allowable crack width (Cl. 35.3.2 of IS 456) = 0.3 mm



Distance of the point considered to the surface of the nearest longitudinal bar	a_{cr} =	101.789	mm
Minimum cover to the longitudinal bar	C_{min} =	15.000	mm
Overall depth of the member	h =	115.000	mm
Depth of neutral axis	x =	15.168	mm
Effective depth	d =	96.000	mm
Modulus of elasticity of steel reinf.	E_s =	200.000	kN/mm^2
Modulus of elasticity of concrete	E_c =	$5000 \sqrt{f_{ck}}$	
	=	22.361	kN/mm^2
Modular ratio	m =	8.944	mm
Maximum moment	M =	9.007	kNm
Section modulus	Z =	$bd^2 / 6$	
	=	1536000.000	mm^3
Maximum compressive stress in concrete	fc =	M/z	
	=	5.864	N/mm^2
Maximum tensile stress in reinf. Steel	fs =	fc * m	
	=	52.449	N/mm^2
Average steel strain at the level considered	=	fs / Es	
	=	0.262	
Maximum allowable strain	=	0.8 Fy / Es	
	=	0.002	
Average steel strain at the level considered	ε_m =	0.002	
Design surface crack width (Annex F of IS 456)	W_{cr} =	$\frac{3\, a_{cr}\, \varepsilon_m}{1 + 2(a_{cr}-C_{min})/(h-x)}$	
	=	0.223	mm
	<	0.300	mm
		Hence Safe	

D CHECK FOR CRACK WIDTH AT SUPPORT OF SHORT EDGE

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Distance of the point considered to the surface of the nearest longitudinal bar	a_{cr} =	101.789 mm
Minimum cover to the longitudinal bar	C_{min} =	15.000 mm
Overall depth of the member	h =	115.000 mm
Depth of neutral axis	x =	15.224 mm
Effective depth	d =	88.000 mm
Modulus of elasticity of steel reinf.	E_s =	200.000 kN/mm^2
Modulus of elasticity of concrete	E_c =	5000 $\sqrt{f_{ck}}$
	=	22.361 kN/mm^2
Modular ratio	m =	8.944 mm
Maximum moment	M =	0.000 kNm
Section modulus	Z =	$bd^2 / 6$
	=	1290666.667 mm^3
Maximum compressive stress in concrete	fc =	M/z
	=	0.000 N/mm^2
Maximum tensile stress in reinf. Steel	fs =	fc * m
	=	0.000 N/mm^2
Average steel strain at the level considered	=	fs / Es
	=	0.000
Maximum allowable strain	=	0.8 Fy / Es
	=	0.002
Average steel strain at the level considered	ε_m =	0.000
Design surface crack width (Annex F of IS 456)	W_{cr} =	$\frac{3\, a_{cr}\, \varepsilon_m}{1 + 2(a_{cr}-C_{min})/(h-x)}$
	=	0.000 mm
	<	0.300 mm
		Hence Safe

10 SLAB REACTIONS

Refer code SP 24-1983 Cl:23.5

On the long span, $wl_x/6*(3-(l_x/l_y)^2)$

Unfactored long beam UDL reaction due to dead load

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Unfactored load = 4.025 kN/m^2

= ***5.763*** kN/m

Unfactored long beam UDL reaction due to live load

Unfactored load = 2.000 kN/m^2

= ***2.864*** kN/m

On the short span, $wl_x/3$

Unfactored long beam UDL reaction due to dead load

Unfactored load = 4.025 kN/m^2

= ***5.259*** kN/m

Unfactored long beam UDL reaction due to live load

Unfactored load = 2.000 kN/m^2

= ***2.613*** kN/m

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FOUNDATION DESIGN

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1 MATERIAL PROPERTIES

Unit weight of reinforced concrete	γc	=		25.000 kN/m3
Environmental exposure condition (Table 3 of IS 456)		=		Mild
Grade of concrete (Table 5 of IS 456)		=		M20
Grade of steel		=		Fe500
Characteristic strength of concrete (Table 2 of IS 456)	fck	=		20.000 N/mm2
Characteristic strength of reinf. steel = Yield stress of reinf. steel (cl. 36.1 of IS 456)	fy	=		500.000 N/mm2

2 DIMENSIONS

Footing plan dimension along X axis	L	=		2.134 m
Footing plan dimension along Z axis	W	=		2.134 m
Thickness of footing	t	=		0.450 m
Column plan dimension along X axis	a	=		0.450 m
Column plan dimension along Z axis	b	=		0.230 m
Depth of footing below NGL	D	=		3.000 m
Eccentricity of the column along X axis	ex	=		0.000 m
Eccentricity of the column along Z axis	ez	=		0.000 m

3 SOIL PROPERTIES

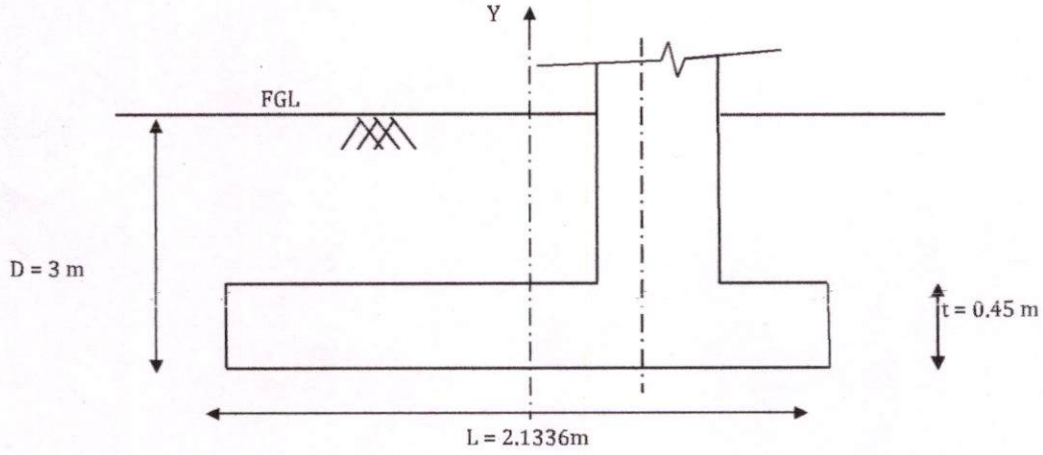
Density of soil	γsoil	=		18.000 kN/m3
Net bearing capacity of soil (from soil report)		=		117.000 kN/m2
Allowable gross SBC		=	117 + 18*3	
		=		171.000 kN/m2
Coefficient of soil friction, μ		=		0.400
Depth of water table from NGL in m		=		NA
Uplift force due to water table		=		0.000 kN

4 DESIGN PARAMETERS

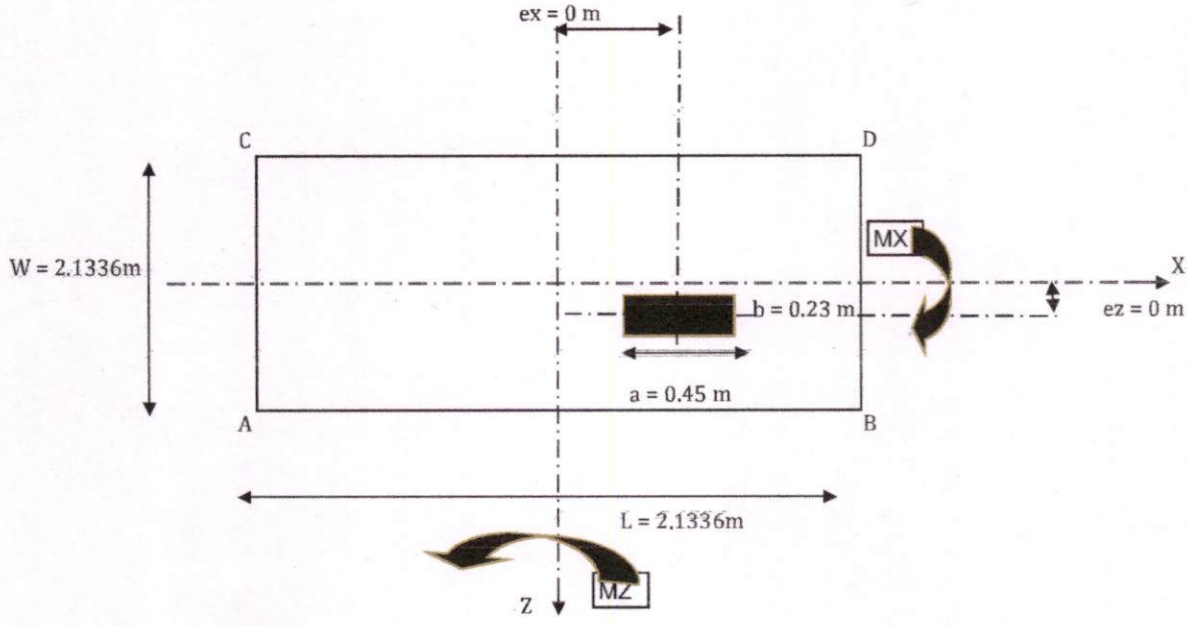
Factor of safety against overturning (Cl. 8.1 of IS:875 (Part 5)	=		1.400
Factor of safety against uplift	=		1.200
Factor of safety against sliding (with 0.9 DL) (Cl. 8.1 of IS:875 (Part 5)	=		1.400
% increase in SBC for load combinations with seismic loads	=		25.000 %
Table 1 of IS:1893 (part1):2002			
% increase in SBC for load combinations with wind loads	=		25.000 %
Cl.8.1 of IS: 875 (part 5) - 1987			

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5 *GEOMETRICAL SKETCH*



Section



Plan

Note :

The above sketch is not to scale. The dimensions are shown only for illustrative purpose.

The sign conventions followed are same as that of STAAD.

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6 *LOADS AT TOP OF FOOTING*

The signs of the STAAD reactions are reversed to transfer it as loads in the appropriate directions.

Horizontal load in X direction at top of footing	=	Fxt
Vertical load in Y direction at top of footing	=	Fyt
Horizontal load in Z direction at top of footing	=	Fzt
Moment about X axis at top of footing	=	Mxt
Moment about Z axis at top of footing	=	Mzt

Table 1 : Loads at top of footing (from the reactions from STAAD)

Load cases	Fxt (kN)	Fyt (kN)	Fzt (kN)	Mxt (kNm)	Mzt (kNm)
DEAD LOAD (DL)	2.390	-469.105	0.342	0.000	0.000
LIVE LOAD (LL)	0.109	-44.831	0.042	0.000	0.000
WIND LOAD IN +X -CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN +X +CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN -X +CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN -X -CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN +Z +CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN +Z -CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN -Z +CPI	0.000	0.000	0.000	0.000	0.000
WIND LOAD IN -Z -CPI	0.000	0.000	0.000	0.000	0.000
SEISMIC LOAD IN +X direction	0.000	0.000	0.000	0.000	0.000
SEISMIC LOAD IN -X direction	0.000	0.000	0.000	0.000	0.000
SEISMIC LOAD IN +Z direction	0.000	0.000	0.000	0.000	0.000
SEISMIC LOAD IN -Z direction	0.000	0.000	0.000	0.000	0.000
LIVE LOAD ON ROOF (LLR)	0.000	-13.794	-0.002	0.000	0.000

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Table 2 : Load combinations (Unfactored - Serviceability load combinations) - as per table 18 of IS 456 : 2000 - Loads at top of footing

Load combinations	Fxt (kN)	Fyt (kN)	Fzt (kN)	Mxt (kNm)	Mzt (kNm)
1.0 DL + a*1.0 LL+a*1.0 LLR	2.455	-504.280	0.366	0.000	0.000
1.0 DL + 1.0 WL +X +CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL +X -CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL -X +CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL -X -CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL +Z +CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL +Z -CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL -Z +CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 WL -Z -CPI	2.390	-469.105	0.342	0.000	0.000
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X+CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X-CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X+CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X-CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z+CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z-CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z+CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z-CPI	2.442	-497.245	0.361	0.000	0.000
1.0 DL + 1.0 EL +X	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 EL -X	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 EL +Z	2.390	-469.105	0.342	0.000	0.000
1.0 DL + 1.0 EL -Z	2.390	-469.105	0.342	0.000	0.000
1.0 DL + b*0.8 LL + 0.8 EL +X	2.412	-478.071	0.350	0.000	0.000
1.0 DL + b*0.8 LL + 0.8 EL -X	2.412	-478.071	0.350	0.000	0.000
1.0 DL + b*0.8 LL + 0.8 EL +Z	2.412	-478.071	0.350	0.000	0.000
1.0 DL +b* 0.8 LL + 0.8 EL -Z	2.412	-478.071	0.350	0.000	0.000

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Table 3 : Load combinations (Factored - Strength load combinations) - as per table 18 of IS 456 : 2000 - Loads at top of footing

Load combinations	Fxt (kN)	Fyt (kN)	Fzt (kN)	Mxt (kNm)	Mzt (kNm)
1.5 DL + C*1.5 LL + C*1.5 LLR	3.683	-756.420	0.549	0.000	0.000
1.5 DL + 1.5 WL +X +CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL +X -CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL -X +CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL -X -CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL +Z +CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL +Z -CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL -Z +CPI	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 WL -Z -CPI	3.585	-703.658	0.513	0.000	0.000
0.9 DL + 1.5 WL +X +CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL +X -CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL -X +CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL -X -CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL +Z +CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL +Z -CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL -Z +CPI	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 WL -Z -CPI	2.151	-422.195	0.308	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X +CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X -CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X+CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X-CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z +CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z -CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z +CPI	2.946	-605.136	0.439	0.000	0.000
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z -CPI	2.946	-605.136	0.439	0.000	0.000
1.5 DL + 1.5 EL +X	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 EL -X	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 EL +Z	3.585	-703.658	0.513	0.000	0.000
1.5 DL + 1.5 EL -Z	3.585	-703.658	0.513	0.000	0.000
0.9 DL + 1.5 EL +X	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 EL -X	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 EL +Z	2.151	-422.195	0.308	0.000	0.000
0.9 DL + 1.5 EL -Z	2.151	-422.195	0.308	0.000	0.000
1.2 DL + b*1.2 LL + 1.2 EL +X	2.901	-576.375	0.423	0.000	0.000
1.2 DL + b*1.2 LL + 1.2 EL -X	2.901	-576.375	0.423	0.000	0.000
1.2 DL + b*1.2 LL + 1.2 EL +Z	2.901	-576.375	0.423	0.000	0.000
1.2 DL + b*1.2 LL + 1.2 EL -Z	2.901	-576.375	0.423	0.000	0.000

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7 *LOADS AT BOTTOM OF FOOTING (Load combinations for serviceability check)*

Self weight of footing	SW =	25 * 2.1336 * 2.1336 * 0.45
	=	-51.213 kN
Weight of soil above footing	WS =	18 * (2.1336*2.1336 - 0.45*0.23)
	=	-204.198 kN
Uplift force due to water table	Fu =	0.000 kN
Horizontal load in X direction at bottom of footing	Fx =	Fxt
Vertical load in Y direction at bottom of footing	P =	Fyt + SW + WS - Fu
Horizontal load in Z direction at bottom of footing	Fz =	Fzt
Moment about X axis at bottom of footing	Mx =	Mxt + Fzt * t + Fy*ez
Moment about Z axis at bottom of footing	Mz =	Mzt - Fxt * t + Fy*ex

Table 4 : Loads at bottom of footing (Unfactored load combinations for pressure & overturning check)

Load Combinations	Fx (kN)	P (kN)	Fz (kN)	Mx (kNm)	Mz (kNm)
1.0 DL + a*1.0 LL+a*1.0 LLR	2.455	-759.690	0.366	-0.165	1.105
1.0 DL + 1.0 WL +X +CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL +X -CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL -X +CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL -X -CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL +Z +CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL +Z -CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL -Z +CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 WL -Z -CPI	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X+CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X-CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X+CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X-CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z+CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z-CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z+CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z-CPI	2.442	-752.655	0.361	-0.163	1.099
1.0 DL + 1.0 EL +X	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 EL -X	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 EL +Z	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + 1.0 EL -Z	2.390	-724.515	0.342	-0.154	1.076
1.0 DL + b*0.8 LL + 0.8 EL +X	2.412	-733.482	0.350	-0.158	1.085
1.0 DL + b*0.8 LL + 0.8 EL -X	2.412	-733.482	0.350	-0.019	1.085
1.0 DL + b*0.8 LL + 0.8 EL +Z	2.412	-733.482	0.350	-0.158	1.085
1.0 DL +b* 0.8 LL + 0.8 EL -Z	2.412	-733.482	0.350	-0.158	1.085

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Table 5 : Loads at bottom of footing (Unfactored load combinations) - for sliding check

Load Combinations	Fx s (kN)	P s (kN)	Fz s (kN)	Mx s (kNm)	Mz s (kNm)
0.9 DL + a*1.0 LL +a*1.0 LLR	2.216	-696.895	0.332	-0.149	0.997
0.9 DL + 1.0 WL +X +CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL +X -CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL -X +CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL -X -CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL +Z +CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL +Z -CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL -Z +CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 WL -Z -CPI	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +X +CPI	2.203	-680.204	0.327	-0.147	0.991
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +X -CPI	2.203	-680.204	0.327	-0.147	0.991
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -X +CPI	2.203	-680.204	0.327	-0.147	0.991
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -X -CPI	2.203	-680.204	0.327	-0.147	0.991
0.9DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +Z +CPI	2.203	-680.204	0.327	-0.147	0.991
0.9DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +Z -CPI	2.203	-680.204	0.327	-0.147	0.991
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -Z +CPI	2.203	-680.204	0.327	-0.147	0.991
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -Z -CPI	2.203	-680.204	0.327	-0.147	0.991
0.9 DL + 1.0 EL +X	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 EL -X	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 EL +Z	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + 1.0 EL -Z	2.151	-652.064	0.308	-0.139	0.968
0.9 DL + b*0.8 LL + 0.8 EL +X	2.173	-661.030	0.316	-0.142	0.978
0.9 DL + b*0.8 LL + 0.8 EL -X	2.173	-661.030	0.316	-0.017	0.978
0.9 DL + b*0.8 LL + 0.8 EL +Z	2.173	-661.030	0.316	-0.142	0.978
0.9 DL +b* 0.8 LL + 0.8 EL -Z	2.173	-661.030	0.316	-0.142	0.978

8 ***CHECK FOR PRESSURE***

Base area — A = 2.1336 * 2.1336 = 4.552 m2

Section modulus (X axis) — Zx = 2.1336 * 2.1336^2 / 6 = 1.619 mm3

Section modulus (Z axis) — Zz = 2.1336 * 2.1336^2 / 6 = 1.619 mm3

Pressure at corner A — PA = -P/A + Mx/ Zx + Mz / Zz

Pressure at corner B — PB = -P/A + Mx/ Zx - Mz / Zz

Pressure at corner C — PC = -P/A - Mx/ Zx + Mz / Zz

Pressure at corner D — PD = -P/A - Mx/ Zx - Mz / Zz

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Table 6 : Pressures at four corners of the footing

Load Combinations	Gross pr. at four corners (kN/m2)			
	PA	PB	PC	PD
1.0 DL + a*1.0 LL+a*1.0 LLR	167.46	166.10	167.67	166.30
1.0 DL + 1.0 WL +X +CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL +X -CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL -X +CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL -X -CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL +Z +CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL +Z -CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL -Z +CPI	159.72	158.40	159.91	158.59
1.0 DL + 1.0 WL -Z -CPI	159.72	158.40	159.91	158.59
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X+CPI	165.92	164.56	166.12	164.76
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X-CPI	165.92	164.56	166.12	164.76
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X+CPI	165.92	164.56	166.12	164.76
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X-CPI	165.92	164.56	166.12	164.76
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z+CPI	165.92	164.56	166.12	164.76
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z-CPI	165.92	164.56	166.12	164.76
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z+CPI	165.92	164.56	166.12	164.76
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z-CPI	165.92	164.56	166.12	164.76
1.0 DL + 1.0 EL +X	159.72	158.40	159.91	158.59
1.0 DL + 1.0 EL -X	159.72	158.40	159.91	158.59
1.0 DL + 1.0 EL +Z	159.72	158.40	159.91	158.59
1.0 DL + 1.0 EL -Z	159.72	158.40	159.91	158.59
1.0 DL + b*0.8 LL + 0.8 EL +X	161.70	160.36	161.89	160.55
1.0 DL + b*0.8 LL + 0.8 EL -X	161.78	160.44	161.81	160.47
1.0 DL + b*0.8 LL + 0.8 EL +Z	161.70	160.36	161.89	160.55
1.0 DL +b* 0.8 LL + 0.8 EL -Z	161.70	160.36	161.89	160.55

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Table 7 : Pmax

Load Combinations	Pmax kN/m2	Net SBC kN/m2	% increase in SBC	Allowable net SBC kN/m2	Overburden pr. kN/m2	Gross SBC kN/m2
1.0 DL + a*1.0 LL+a*1.0 LLR	167.67	117.000	0	117	54	171
1.0 DL + 1.0 WL +X +CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL +X -CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL -X +CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL -X -CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL +Z +CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL +Z -CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL -Z +CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 WL -Z -CPI	159.91	117.000	25	146.25	54	200.25
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X+CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X-CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X+CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X-CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z+CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z-CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z+CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z-CPI	166.12	117.000	25	146.25	54	200.25
1.0 DL + 1.0 EL +X	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 EL -X	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 EL +Z	159.91	117.000	25	146.25	54	200.25
1.0 DL + 1.0 EL -Z	159.91	117.000	25	146.25	54	200.25
1.0 DL + b*0.8 LL + 0.8 EL +X	161.89	117.000	25	146.25	54	200.25
1.0 DL + b*0.8 LL + 0.8 EL -X	161.81	117.000	25	146.25	54	200.25
1.0 DL + b*0.8 LL + 0.8 EL +Z	161.89	117.000	25	146.25	54	200.25
1.0 DL +b* 0.8 LL + 0.8 EL -Z	161.89	117.000	25	146.25	54	200.25

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Table 8 : Pmin

Load Combinations	Pmin kN/m2	Uplift	% loss of contact
1.0 DL + a*1.0 LL+a*1.0 LLR	166.10	No Uplift	0.000
1.0 DL + 1.0 WL +X +CPI	158.40	No Uplift	0.000
1.0 DL + 1.0 WL -X +CPI	158.40	No Uplift	0.000
1.0 DL + 1.0 WL +Z +CPI	158.40	No Uplift	0.000
1.0 DL + 1.0 WL -Z +CPI	158.40	No Uplift	0.000
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +X+CPI	164.56	No Uplift	0.000
1.0 DL +a*0.8 LL+a*0.8 LLR + 0.8 WL -X+CPI	164.56	No Uplift	0.000
1.0 DL + a*0.8 LL+a*0.8 LLR + 0.8 WL +Z+CPI	164.56	No Uplift	0.000
1.0 DL + a*0. 8LL+a*0.8 LLR + 0.8 WL -Z+CPI	164.56	No Uplift	0.000
1.0 DL + 1.0 EL +X	158.40	No Uplift	0.000
1.0 DL + 1.0 EL -X	158.40	No Uplift	0.000
1.0 DL + 1.0 EL +Z	158.40	No Uplift	0.000
1.0 DL + 1.0 EL -Z	158.40	No Uplift	0.000
1.0 DL + b*0.8 LL + 0.8 EL +X	160.36	No Uplift	0.000
1.0 DL + b*0.8 LL + 0.8 EL -X	160.44	No Uplift	0.000
1.0 DL + b*0.8 LL + 0.8 EL +Z	160.36	No Uplift	0.000
1.0 DL +b* 0.8 LL + 0.8 EL -Z	160.36	No Uplift	0.000

P max Without Wind load	=	**167.67**	kN/m2	
	<	171.00	kN/m2	**Hence Safe.**
P max With Wind load	=	**166.12**		
	<	213.75	kN/m2	**Hence Safe.**
% loss of contact	=	**0.0**	%	
	≤	0.0	%	**Hence Safe.**

The Bearing pressure reached upto 98% of SBC

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9 CHECK FOR OVERTURNING

Table 9 : Factor of safety against overturning

Load Combinations	Moment about X axis (kNm)			Moment about Z axis (kNm)		
	Overturning	Resisting	FOS	Overturning	Resisting	FOS
1.0*1.2 DL + a*1.0*1.4 LL+a*1.0*1.4 LLR	-0.200	-810.4377	Safe	1.332	-810.438	Safe
1.0*1.2 DL + 1.0 WL +X +CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL +X -CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL -X +CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL -X -CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL +Z +CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL +Z -CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL -Z +CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 WL -Z -CPI	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL +a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL +a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 V	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 V	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL + a*0. 8*1.4LL+a*0.8*1.4 LLR + 0.8 V	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL + a*0. 8*1.4LL+a*0.8*1.4 LLR + 0.8 V	-0.197	-802.9328	Safe	1.324	-802.933	Safe
1.0*1.2 DL + 1.0 EL +X	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 EL -X	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 EL +Z	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + 1.0 EL -Z	-0.185	-772.913	Safe	1.291	-772.913	Safe
1.0*1.2 DL + b*0.8*1.4 LL + 0.8 EL +X	-0.190	-782.4781	Safe	1.085	-782.478	Safe
1.0*1.2 DL + b*0.8*1.4 LL + 0.8 EL -X	-0.023	-782.4781	Safe	1.304	-782.478	Safe
1.0*1.2 DL + b*0.8*1.4 LL + 0.8 EL +Z	-0.190	-782.4781	Safe	1.304	-782.478	Safe
1.0*1.2 DL +b* 0.8*1.4 LL + 0.8 EL -Z	-0.221	-782.4781	Safe	1.304	-782.478	Safe

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10 CHECK FOR SLIDING

Table 10 : Factor of safety against sliding

Load Combinations	Along X axis (kN)			Along Z axis (kN)		
	Sliding force	Resisting force	FOS	Sliding force	Resisting force	FOS
0.9 DL + a*1.0 LL +a*1.0 LLR	2.216	-278.7579	125.771	0.332	-278.758	840.138
0.9 DL + 1.0 WL +X +CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL +X -CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL -X +CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL -X -CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL +Z +CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL +Z -CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL -Z +CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 WL -Z -CPI	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +X +CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +X -CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -X +CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -X -CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +Z +CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9DL + a*0.8 LL + a*0.8 LLR + 0.8 WL +Z -CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -Z +CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9 DL + a*0.8 LL + a*0.8 LLR + 0.8 WL -Z -CPI	2.203	-272.0815	123.487	0.327	-272.082	832.054
0.9 DL + 1.0 EL +X	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 EL -X	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 EL +Z	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + 1.0 EL -Z	2.151	-260.8255	121.258	0.308	-260.826	847.386
0.9 DL + b*0.8 LL + 0.8 EL +X	2.173	-264.412	121.692	0.316	-264.412	836.218
0.9 DL + b*0.8 LL + 0.8 EL -X	2.173	-264.412	121.692	0.316	-264.412	836.218
0.9 DL + b*0.8 LL + 0.8 EL +Z	2.173	-264.412	121.692	0.316	-264.412	836.218
0.9 DL +b* 0.8 LL + 0.8 EL -Z	2.173	-264.412	121.692	0.316	-264.412	836.218

Minimum factor of safety = 121.258

Allowable factor of safety = 1.400

< 121.258 **Hence Safe**

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11 CHECK FOR UPLIFT

Table 11 : Factor of safety against uplift

Load combinations	Uplift	Downward load	FS
1.0*1.2 DL + a*1.0*1.4 LL+a*1.0*1.4 LLR	0.000	-759.6904	100
1.0*1.2 DL + 1.0 WL +X +CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL +X -CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL -X +CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL -X -CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL +Z +CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL +Z -CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL -Z +CPI	0.000	-724.5154	100
1.0*1.2 DL + 1.0 WL -Z -CPI	0.000	-724.5154	100
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL +a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL +a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL + a*0.8*1.4 LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL + a*0. 8*1.4LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL + a*0. 8*1.4LL+a*0.8*1.4 LLR + 0.8 W	0.000	-752.6554	100
1.0*1.2 DL + 1.0 EL +X	0.000	-724.5154	100
1.0*1.2 DL + 1.0 EL -X	0.000	-724.5154	100
1.0*1.2 DL + 1.0 EL +Z	0.000	-724.5154	100
1.0*1.2 DL + 1.0 EL -Z	0.000	-724.5154	100
1.0*1.2 DL + b*0.8*1.4 LL + 0.8 EL +X	0.000	-733.4816	100
1.0*1.2 DL + b*0.8*1.4 LL + 0.8 EL -X	0.000	-733.4816	100
1.0*1.2 DL + b*0.8*1.4 LL + 0.8 EL +Z	0.000	-733.4816	100
1.0*1.2 DL +b* 0.8*1.4 LL + 0.8 EL -Z	0.000	-733.4816	100

Minimum factor of safety	=	100	
Allowable factor of safety	=	1.200	
	<	100.000	**Hence Safe**

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12 *LOADS AT BOTTOM OF FOOTING (Load combinations for strength check)*

Table 12 : Loads at bottom of footing (Factored load combinations)

Load Combinations	Fx (kN)	P (kN)	Fz (kN)	Mx (kNm)	Mz (kNm)
1.5 DL + C*1.5 LL + C*1.5 LLR	3.683	-1139.536	0.549	0.247	-1.657
1.5 DL + 1.5 WL +X +CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL +X -CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL -X +CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL -X -CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL +Z +CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL +Z -CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL -Z +CPI	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 WL -Z -CPI	3.585	-1086.773	0.513	0.231	-1.613
0.9 DL + 1.5 WL +X +CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL +X -CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL -X +CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL -X -CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL +Z +CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL +Z -CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL -Z +CPI	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 WL -Z -CPI	2.151	-805.310	0.308	0.139	-0.968
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X +CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X -CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X+CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X-CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z +CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z -CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z +CPI	2.946	-988.252	0.439	0.198	-1.326
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z -CPI	2.946	-988.252	0.439	0.198	-1.326
1.5 DL + 1.5 EL +X	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 EL -X	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 EL +Z	3.585	-1086.773	0.513	0.231	-1.613
1.5 DL + 1.5 EL -Z	3.585	-1086.773	0.513	0.231	-1.613
0.9 DL + 1.5 EL +X	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 EL -X	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 EL +Z	2.151	-805.310	0.308	0.139	-0.968
0.9 DL + 1.5 EL -Z	2.151	-805.310	0.308	0.139	-0.968
1.2 DL + b*1.2 LL + 1.2 EL +X	2.901	-959.491	0.423	0.190	-1.305
1.2 DL + b*1.2 LL + 1.2 EL -X	2.901	-959.491	0.423	0.190	-1.305
1.2 DL + b*1.2 LL + 1.2 EL +Z	2.901	-959.491	0.423	0.190	-1.305
1.2 DL + b*1.2 LL + 1.2 EL -Z	2.901	-959.491	0.423	0.190	-1.305

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13 *PRESSURE AT BASE FOR STRENGTH CHECK*

Table 13 : Pressures at four corners of the footing

Load Combinations	Gross pr. at four corners (kN/m2)			
	PA	PB	PC	PD
1.5 DL + C*1.5 LL + C*1.5 LLR	249.45	251.50	249.15	251.19
1.5 DL + 1.5 WL +X +CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL +X -CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL -X +CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL -X -CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL +Z +CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL +Z -CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL -Z +CPI	237.88	239.87	237.59	239.59
1.5 DL + 1.5 WL -Z -CPI	237.88	239.87	237.59	239.59
0.9 DL + 1.5 WL +X +CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL +X -CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL -X +CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL -X -CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL +Z +CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL +Z -CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL -Z +CPI	176.39	177.59	176.22	177.42
0.9 DL + 1.5 WL -Z -CPI	176.39	177.59	176.22	177.42
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X +CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X -CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X+CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X-CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z +CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z -CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z +CPI	216.39	218.03	216.15	217.79
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z -CPI	216.39	218.03	216.15	217.79
1.5 DL + 1.5 EL +X	237.88	239.87	237.59	239.59
1.5 DL + 1.5 EL -X	237.88	239.87	237.59	239.59
1.5 DL + 1.5 EL +Z	237.88	239.87	237.59	239.59
1.5 DL + 1.5 EL -Z	237.88	239.87	237.59	239.59
0.9 DL + 1.5 EL +X	176.39	177.59	176.22	177.42
0.9 DL + 1.5 EL -X	176.39	177.59	176.22	177.42
0.9 DL + 1.5 EL +Z	176.39	177.59	176.22	177.42
0.9 DL + 1.5 EL -Z	176.39	177.59	176.22	177.42
1.2 DL + b*1.2 LL + 1.2 EL +X	210.08	211.70	209.85	211.46
1.2 DL + b*1.2 LL + 1.2 EL -X	210.08	211.70	209.85	211.46
1.2 DL + b*1.2 LL + 1.2 EL +Z	210.08	211.70	209.85	211.46
1.2 DL + b*1.2 LL + 1.2 EL -Z	210.08	211.70	209.85	211.46

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14 *REINFORCEMENTS & ONE WAY SHEAR ALONG X AXIS*

Mu= (0.87*fy*Ast*d) * (1 - (fy*Ast)(fck*b*d))

Reinforcements	Bar dia (mm)	Spacing (mm)
Along X axis	10	145.000

Effective depth = 395 mm

Minimum Ast = 1152.144 mm2

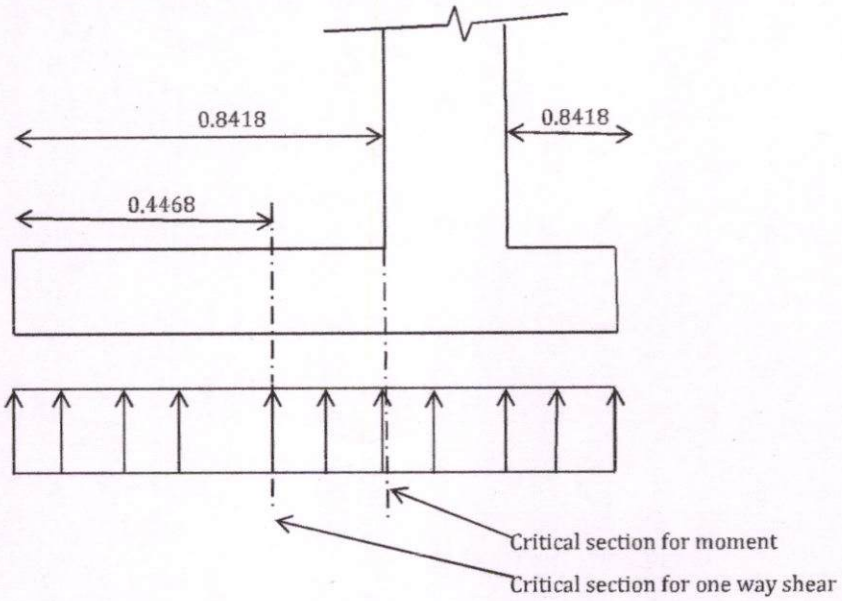
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Table 14 : Pressures at edges, moment and shear

Load Combinations	Edge pressures (kN/m2)		Moment	Ast reqd.	Shear
	PAC	PBD	(kNm)	mm2	kN/m
1.5 DL + C*1.5 LL + C*1.5 LLR	249.300	251.348	126.076	750.450	157.836
1.5 DL + 1.5 WL +X +CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL +X -CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL -X +CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL -X -CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL +Z +CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL +Z -CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL -Z +CPI	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 WL -Z -CPI	237.737	239.730	117.301	697.094	146.802
0.9 DL + 1.5 WL +X +CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL +X -CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL -X +CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL -X -CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL +Z +CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL +Z -CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL -Z +CPI	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 WL -Z -CPI	176.306	177.502	70.381	414.709	88.081
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X +CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X -CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X+CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X-CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z +CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z -CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z +CPI	216.272	217.910	100.860	597.588	126.269
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z -CPI	216.272	217.910	100.860	597.588	126.269
1.5 DL + 1.5 EL +X	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 EL -X	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 EL +Z	237.737	239.730	117.301	697.094	146.802
1.5 DL + 1.5 EL -Z	237.737	239.730	117.301	697.094	146.802
0.9 DL + 1.5 EL +X	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 EL -X	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 EL +Z	176.306	177.502	70.381	414.709	88.081
0.9 DL + 1.5 EL -Z	176.306	177.502	70.381	414.709	88.081
1.2 DL + b*1.2 LL + 1.2 EL +X	209.967	211.579	96.079	568.761	120.253
1.2 DL + b*1.2 LL + 1.2 EL -X	209.967	211.579	96.079	568.761	120.253
1.2 DL + b*1.2 LL + 1.2 EL +Z	209.967	211.579	96.079	568.761	120.253
1.2 DL + b*1.2 LL + 1.2 EL -Z	209.967	211.579	96.079	568.761	120.253

Note : The maximum of PAC and PBD is considered for moment calculation.

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Ast required		=	1152.144 mm2	
Spacing of 10mm dia bars required		=	145.444 mm	
Provided spacing		=	145.000 mm	**Hence Safe.**
Dear shear force		=	157.836 kN/m	
Design shear stress		=	Vu/bd	
		=	0.187 N/mm2	
100Ast/bd		=	0.064	
Allowable shear stress	Tc	≤	0.280 N/mm2	
		>	0.187 N/mm2	**Hence Safe.**

100Ast/bd	Tc
0.15	0.28
0.25	0.36
0.064	0.280

15 *REINFORCEMENTS & ONE WAY SHEAR ALONG Z AXIS*

Mu= (0.87*fy*Ast*d) * (1 - (fy*Ast)(fck*b*d))

Reinforcements	Bar dia (mm)	Spacing (mm)
Along X axis	10	140.000

Effective depth	=	385 mm	
Minimum Ast	=	1152.144 mm2	

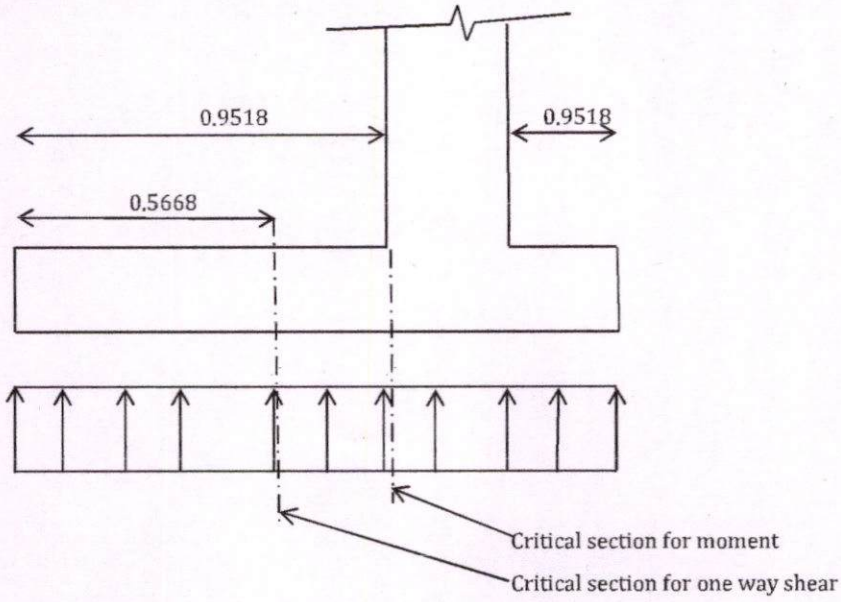
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Table 15 : Pressures at edges, moment and shear

Load Combinations	Edge pressures (kN/m2)		Moment	Ast reqd.	Shear
	PAB	PCD	(kNm)	mm2	kN
1.5 DL + C*1.5 LL + C*1.5 LLR	250.476	250.171	160.484	987.961	200.860
1.5 DL + 1.5 WL +X +CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL +X -CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL -X +CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL -X -CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL +Z +CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL +Z -CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL -Z +CPI	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 WL -Z -CPI	238.876	238.591	149.289	917.004	186.849
0.9 DL + 1.5 WL +X +CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL +X -CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL -X +CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL -X -CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL +Z +CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL +Z -CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL -Z +CPI	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 WL -Z -CPI	176.989	176.818	89.573	543.848	112.109
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X +CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X -CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X+CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X-CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z +CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z -CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z +CPI	217.213	216.969	128.387	785.376	160.688
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z -CPI	217.213	216.969	128.387	785.376	160.688
1.5 DL + 1.5 EL +X	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 EL -X	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 EL +Z	238.876	238.591	149.289	917.004	186.849
1.5 DL + 1.5 EL -Z	238.876	238.591	149.289	917.004	186.849
0.9 DL + 1.5 EL +X	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 EL -X	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 EL +Z	176.989	176.818	89.573	543.848	112.109
0.9 DL + 1.5 EL -Z	176.989	176.818	89.573	543.848	112.109
1.2 DL + b*1.2 LL + 1.2 EL +X	210.891	210.655	122.284	747.154	153.050
1.2 DL + b*1.2 LL + 1.2 EL -X	210.891	210.655	122.284	747.154	153.050
1.2 DL + b*1.2 LL + 1.2 EL +Z	210.891	210.655	122.284	747.154	153.050
1.2 DL + b*1.2 LL + 1.2 EL -Z	210.891	210.655	122.284	747.154	153.050

Note : The maximum of PAB and PCD is considered for moment calculation.

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Ast required		=	1152.144	mm2	
Spacing of 10mm dia bars required		=	145.444	mm	
Provided spacing		=	140.000	mm	**Hence Safe.**
Dear shear force		=	200.860	kN/m	
Design shear stress		=	Vu/bd		
		=	0.245	N/mm2	
100Ast/bd		=	0.068		
Allowable shear stress	Tc	=	0.280	N/mm2	
		>	0.245	N/mm2	**Hence Safe.**

100Ast/bd	Tc
0.15	0.28
0.25	0.36
0.068	0.280

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CHECK FOR TWO WAY SHEAR

16 Check for punching shear

Load Combinations	Edge pressures (kN/m2)		s.w of footing + above soil +load	soil pressure at centre (kN/m2)	shear (kN)
	PAB	PCD			
1.5 DL + C*1.5 LL + C*1.5 LLR	250.476	251.348	-927.328	250.865	-417.881
1.5 DL + 1.5 WL +X +CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL +X -CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL -X +CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL -X -CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL +Z +CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL +Z -CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL -Z +CPI	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 WL -Z -CPI	238.876	239.730	-874.566	239.257	-388.692
0.9 DL + 1.5 WL +X +CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL +X -CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL -X +CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL -X -CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL +Z +CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL +Z -CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL -Z +CPI	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 WL -Z -CPI	176.989	177.502	-593.103	177.218	-233.215
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X +CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +X -CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X+CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -X-CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z +CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL +Z -CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z +CPI	217.213	217.910	-776.044	217.524	-334.305
1.2 DL + C*1.2 LL + C*1.2 LLR + 1.2 WL -Z -CPI	217.213	217.910	-776.044	217.524	-334.305
1.5 DL + 1.5 EL +X	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 EL -X	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 EL +Z	238.876	239.730	-874.566	239.257	-388.692
1.5 DL + 1.5 EL -Z	238.876	239.730	-874.566	239.257	-388.692
0.9 DL + 1.5 EL +X	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 EL -X	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 EL +Z	176.989	177.502	-593.103	177.218	-233.215
0.9 DL + 1.5 EL -Z	176.989	177.502	-593.103	177.218	-233.215
1.2 DL + b*1.2 LL + 1.2 EL +X	210.891	211.579	-747.283	211.198	-318.391
1.2 DL + b*1.2 LL + 1.2 EL -X	210.891	211.579	-747.283	211.198	-318.391
1.2 DL + b*1.2 LL + 1.2 EL +Z	210.891	211.579	-747.283	211.198	-318.391
1.2 DL + b*1.2 LL + 1.2 EL -Z	210.891	211.579	-747.283	211.198	-318.391

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Shear force	=	417.881 kN
Perimeter of the critical section (b0)	=	2920 mm
Effective depth	=	385 mm
Punching shear stress	=	0.372 N/mm2
Ratio of short side to long side of the column βc		
	=	0.511111
Allowable punching shear stress	=	{0.5+βc} * 0.25 * √fck
	=	1.118 N/mm2
	>	0.372 N/mm2

Hence Safe.

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MDTCP

GOVERNMENT OF TAMILNADU
TOWN AND COUNTRY PLANNING DEPARTMENT
MADURAI DISTRICT OFFICE

Sector-VI, Anaiyur - Mudakkathan Main Road, Koodalpudur, Madurai – 625 017.
Phone: 0452-2530544, E.mail –ID : dtcpmadurai@gmail.com

PROFESSIONAL REGISTRATION CERTIFICATE

Roc. No.1433/2019/CC **dated :28.04.2022**

This is to certify that **THIRU.R.MANIVANNAN** has enrolled as **STRUCTURAL ENGINEER GRADE-I (SE)** with Madurai District Town and Country Planning (**MDTCP**), who has the qualification of **Degree of Master of Engineering in Civil Engineering (A) Structural Engineering** and experience in the relevant field for **5 years above.**

He has been given the **Registration No.SE. 03/2022 (Gr.I) on 28.04.2022.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide **G.O.(Ms)No.18, MAWS (MA1) Department, Dated: 04.02.2019.**

This Registration is valid upto **27.04.2027**



28 APR 2022

ASSISTANT DIRECTOR /
MEMBER SECRETARY (I/C),
DISTRICT TOWN AND COUNTRY
PLANNING OFFICE,
MADURAI DISTRICT.

28.04.2022 28.4.2022



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