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DIGITALLY VERIFIED RECORD

The Proposed construction of Basement Floor(mechanized car parking and Lumber room) + Ground floor (Part) + Stilt Floor(part) + 3 Floors Commercial Building (Office-Height-17.90m) at Old Door No.45 & 45A, New Door No.165 & 166, North Usman Road, T.Nagar, Chennai Comprised in Old S.No.101/1 Part, T.S.No.5254, Block no.18(As per Document), Block No.119 (As per Patta) of T.Nagar Village Within the Limits of Greater Chennai Corporation.

STRUCTURAL DESIGN BASIS REPORT

Signature of the Certified Engineer

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.

TITLE : STRUCTURAL DESIGN BRIEF REPORT

DOCUMENT NO : STR - DBR/Rev-R0

DATE	ISSUE	PREPARED	CHECKED	REVISION
23/6/2023	Final report	A.Y	P.J	R0

1.0 INTRODUCTION

The proposed Commercial Building is located at T. Nagar, Chennai. The proposed development consists of Part Basement + Stilt + 3 floors + Terrace.

This report provides the information on Codes of Practice, Design loadings, Material Strength considered for the Design and Analysis of the building. In addition, this report includes Structural system, Foundation system, Method statement of structural analysis which will be adopted for design and analysis for the building.

2.0 CODES OF PRACTICE

The relevant Indian Standard codes below are followed.

CODE	DESCRIPTION
IS 875(Part 1) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Unit weights of buildings materials and stored material
IS 875 (Part 2) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Imposed Loads
IS 875 (Part 3) 2015	Code of practice for Design Loads (other than earthquake) for buildings and structures – Wind Loads
IS 875 (Part 5) 1987	Code of practice for Design Loads (other than earthquake) for buildings and structures – Special Loads and load combinations
IS 456 – 2000	Code of Practice for Plain and Reinforced Concrete
IS 1786 – 2008	Specification for High Strength Deformed bars and Wires for concrete reinforcement
IS 432 (Part 2) 1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete reinforcement – Hard Drawn Steel Wire
IS 1343 – 2012	Code of Practice for Prestressed Concrete
IS 2062 – 1999	Steel for General Structural Purposes – Specification
IS 1893 – 2016	Criteria for earthquake resistant design of structures
IS 4326 −1993	Code of practice for Earthquake Resistant Design and Construction of Buildings

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IS 3370 – 2009	Code of Practice for Concrete structures for the storage of liquids
IS 1904-1995	Code of Practice for design and construction of Foundation
IS 1080 – 1997	Code of Practice for design and construction of shallow Foundation
IS 2950 - 1998	Code of Practice for design and construction of Raft Foundation
IS 800 − 2007	Code of practice for General Construction in steel
BS 8110 : 1997	Plain and reinforced concrete-code of practice(British standard)
ACI 318	Plain and reinforced concrete-code of practice (American standard)
IS 13920: 2016	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces
IS 3414	Code of practice for joints in the buildings
IS 16700-2017	Criteria for structural safety for tall buil

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3.0 DESIGN OF LOADINGS

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Sr. No.	Area Description	Floor Finish	Services	Live load	Super imposed dead load KN/sq.m	Remark / comment
		KN/sq.m	KN/sq.m	KN/sq.m		
1	Single Parking	1.80	0.5	3.0	-	Including 20% impact loads
2	Stack parking	1.80	0.50	5.0		
3	Commercial space	2.80	0.5	4.0	-	1.80 for floor finish (75mm floor finish) and 1.0 for partition
5	Lobby/corridor	1.80	0.5	4.0	-	1.80kN/m2 for office/commercial floors (75mm floor finish).
6	Staircase	1.20	-	4.0	1.80 Step Wt.	
7	Toilet	4.0	0.5	2.0	-	
8	Pump/plant Room	1.80	0.5	-	7.5	

9	Electrical room	1.80	0.5	-	7.50	
10	Terrace	3.60	0.5	3.0	-	Average 150mm thick water proofing
11	LMR	2.40	-	-	10.0	(Actual wt. of machine to be ensured)
12	Over Head Tank	2.40	-	-	-	Water depth x 10kN/Cu.m

Permissible reduction in imposed load on each floor is considered for design of columns and footings as per IS 875 Part(2).

a) The Solid Block Masonry (S.B.M) wall loads in different thickness is mention below.

1) 200mm thick S.B.M wall load per meter height = 4.4 KN/m
2) 150mm thick S.B.M wall load per meter height = 3.3 KN/m
3) 100mm thick S.B.M wall load per meter height = 2.2 KN/m
4) 14mm thick Glazing load per meter height = 0.4 KN/m

b) SEISMIC LOADS

The lateral load resisting system of the buildings is flat slab with periphery beams structural wall system.

1) As per IS 1893:2016 code, Chennai lies in Zone III with Zone factor Z = 0.16
2) The Design Base Shear is given by $V_b = Z / 2 \times I / R \times S_a / g \times W$

   I = 1.20 Importance Factor (1) Table 6

   Soil Type 1 (Rock or Dense soil)

   R (Response reduction factor) = 4

   Sa/g = Average Response acceleration coefficient

   Time period formula used $T = (0.075\ h^{0.75}) / (\sqrt{Aw})$ (Refer IS 1893 - 2016 clause 7.6.2b)

Where,

T is Fundamental natural period

h = Height of the structure from Ground

d = Width of the building along the direction of lateral force

Aw = Total effective area in square meter

3) Time period and Horizontal seismic coefficient shall be calculated as per IS 1893: 2016.
4) Response spectrum method is used as per IS 1893: 2016.
5) Modal combination –CQC and Directional combination - SRSS
6) Cut off frequency in case response spectrum method of analysis - 33hz.

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7) Mass participation is 90% as per our analysis
8) Damping 5%is used for seismic analysis
9) Dynamic analysis of building is carried out. The members are designed accordingly.
10) Horizontal Projections

All horizontal projections like balconies/cantilever slabs are designed and checked for stability for the five times the design vertical coefficient (Av).

c) **WIND LOADS**

The wind pressure shall be calculated based on the basic wind speed and other provisions laid in IS 875 Part (3) - 2015

Design Wind speed $V_Z = V_b x k_1 x\ k_2 x\ k_3$

V_b ⟶ Basic Wind velocity for Chennai = 50m/s

k_1 ⟶ Risk coefficient for all general buildings = 1.00

k_2 ⟶ Terrain category 2, = To suit the height of the structure for terrain

k_3 ⟶ Topography factor = 1.00

k_4 ⟶ Importance factor for cyclonic region = 1.00

Based on the above,
Max. design wind speed (V_Z) = K1 x K2 x K3 x K4
Max. design wind pressure (Pz) = 0.6 x Vz^2

SELF WEIGHTS

The Self weights are calculated on the basis of unit weights of materials given in IS 875 (Part 1) the data provided by consultant and other service consultants will be used for the specific materials.

Unit weight of concrete	-	25.0 KN / Cum.
Unit weight of steel	-	78.5 KN / Cum.
Screed concrete	-	24.0 KN / Cum.
Unit weight of dry soil	-	18.0 KN / Cum.
Unit weight of saturated soil	-	20.0 KN / Cum
Unit weight of block wall	-	22.0 KN / Cum.
Unit weight of Glass	-	27.2 KN / Cum.
Unit weight of water	-	9.81 KN / Cum.
Aerated block masonry	-	8.65 KN / Cum.(865kg/m3)
Light weight concrete filling	-	10.0 KN / Cum.
Aluminium Composite panel (6mm thick)		-0.03 kN/sq.m

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DEAD LOAD (DL)

These are permanent loads due to self-weight of RCC/PT Slabs, Beam and Columns, Walls, Infill walls.

LOADS ON M&E SERVICES AREA

Loads arising due to HVAC/ electrical, DG, Chiller Load and other equipment's are considered as per the relevant integrated M&E consultant input.

TEMPERATURE LOAD

The building is completely covered with facade/block work on the sides and with over deck insulation at top of terrace. So there will be no appreciable differential temperature during the service life of building. In addition to this, Temperature difference during construction stage is taken care by providing shrinkage strips in form of pour strips.

The roof slab of building is analysed for average temperature variation of +15°C.

4.0 LOAD COMBINATIONS

The various loads combinations used for design in accordance with IS 1893-2016 are as follows

1. 1.5(DL+IL)
2. 1.2(DL+IL ±SPECX-D)
3. 1.2(DL+IL ±SPECY-D)
4. 1.2(DL+IL ±WLX)
5. 1.2(DL+IL ±WLY)
6. 1.5(DL ±SPECX-D)
7. 1.5(DL ±SPECY-D)
8. 1.5(DL ±WLX)
9. 1.5(DL ±WLY)
10. 0.9DL ±1.5SPECX-D
11. 0.9DL ±1.5SPECY-D
12. 0.9DL ±1.5WLX
13. 0.9DL ±1.5WLY
14. 1.5(DL+IL)+TL
15. 1.2(DL+IL ±SPECX-D)+1.2TL
16. 1.2(DL+IL ±SPECY-D)+1.2TL
17. 1.2(DL+IL ±WLX)+1.2TL
18. 1.2(DL+IL ±WLY)+1.2TL
19. 1.5(DL ±SPECX-D)+1.2TL
20. 1.5(DL ±SPECY-D)+1.2TL
21. 1.5(DL ±WLX)+1.2TL
22. 1.5(DL ±WLY)+1.2TL
23. 0.9DL ±1.5SPECX-D+1.2TL
24. 0.9DL ±1.5SPECY-D+1.2TL
25. 0.9DL ±1.5WLX+1.2TL
26. 0.9DL ±1.5WLY+1.2TL

The various service loads combinations of structure as per IS 456 are as follows

27. (DL+IL)
28. (DL ±SPECX)
29. (DL ±SPECY)
30. (DL ±WLX)

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31. (DL ±WLY)
32. DL+IL+TL
33. 1.0DL+0.8IL ±0.8SPECX+0.8TL
34. 1.0DL+0.8IL ±0.8SPECY+0.8TL
35. 1.0DL+0.8IL ±0.8WLX+0.8TL
36. 1.0DL+0.8IL ±0.8WLY+0.8TL

Where SPEC - for Serviceability
SPEC - D-for Design
SPEC W-for wall Design

5.0 MATERIAL GRADES

Keeping the durability and structural requirement, the proposed strength of various elements of structure will be as follows:

Durability provisions for structures shall be as per "Mild" conditions of environment in accordance with IS 456: 2000. Keeping the durability and structural requirement, the proposed strength of various elements of structure will be as follows:

Structural concrete for columns/Shear wall/Core wall shall have characteristic compressive strength as mentioned below:

- Foundation to Roof - M35 Grade
- Plain cement concrete shall have a grade of M20.
- Minimum grade of concrete should be M30, as per IS 16700-2017.

i) CONCRETE Grade for foundation, beam and slabs

The concrete shall be in grades designated as per Table 2 IS 456-2000.Recommended grades for the different members is as follows:

Foundation with connecting slab	M30
Basements slab & Beam	M30
R.C.C. Beams / Slabs	M35
PT Beams / Slabs	M35
Water Tanks	M30
Basement Wall	M30
Grade slab (Only for non-suspended slab)	M25

ii) REINFORCEMENT

HYSD-TMT bars of grade 500 conforming to IS: 1786.
Young's Modulus: Es= 200,000 N/Sq mm
Yield Stress: fy = 500 N/Sq mm
Diameters [in mm]: 8, 10, 12, 16, 20, 25 & 32

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Density :78.5 kN/cum

Young's Modulus (E) : 200,000 N/ mm^2

Density : 78.5 kN/m^3,

Poisson's Ratio : 0.30

Thermal Expansion Coefficient : ε = 1.2x10-5 /°C

iii) PT STRAND

Prestressing systems

The pre-stressing system is incorporating strands with 12.70 mm dia strand /15.20 mm dia strand. Prestressing strands shall be of class-3, confirming to IS 14268-1995

Materials

Strands	0.5"	0.6"
Nominal Diameter	12.7mm	15.2mm
Nominal Area	98.7mm	141mm^2
Nominal weight	0.775 kg/m	1.101 kg/m
Tensile strength	1860 N/mm^2	1860 N/mm^2
Modulus of elasticity	195 N/mm^2	195 N/mm^2
Min breaking load of strand	184kN	263kN
Strand quality in accordance with	IS 14268	IS 14268

GENERAL ASSUMPTIONS FOR PT SLAB AND BEAM DESIGN

1) Strength design of prestressed member for flexure and axial loads shall be based on assumptions given in IS1343/ Clause 18.3 (Chapter 18) ACI-318

2) Design moment strength of flexural members shall be computed by the strength design method of the code IS1343/ACI-318

3) Prestressed flexural members shall be classified as class U, Class T or Class C based on extreme fiber stress (Ft) in tension in pre compressed tensile zone calculated at service loads.

4) Serviceability Design Requirements are as per clause 18.3 ACI-318/ IS1343

5) Deflection of prestressed flexural members shall be calculated in accordance with Clause 18.3.5- ACI-318 / IS1343

6) Permissible tensile stresses in flexural member are as per Class-B (Table 18.3.3- ACI-318) / IS1343

7) Permissible stresses in prestressing steel shall not exceed the following

a) Due to prestressing steel jacking force---0.94 Fpy (specified yield strength of prestressing steel in psi) but not greater than the lesser of 0.80(Fpu specified tensile strength of Prestressing steel)and the maximum value recommended by the manufacturer of prestressing steel or anchorage devices.

b) Immediate after prestress transfer -----0.82Fpy but not greater than 0.74 Fpu (specified tensile strength of prestressing steel)

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8) Minimum Bonded reinforcement shall be provided in all prestressed flexural members is as per Clause 18.9-ACI-318 / IS1343.

9) Minimum average effective prestress of 125 psi on the slab section tributary to the tendon or tendon group.

10) Required elongation shall be determined from average load-elongation curves for the prestressing steel used. Generally 7% tolerance in prestressing steel force determined by gauge pressure and elongation measurements for post tension construction.

CONSTRUCTION JOINT

Construction joints and shrinkage strips will be planned with the contractor and only be used in locations pre-approved by consultants.

1) No construction joint is allowed in the sunken portion

2) Preferred at l/3 from support.

3) Construction joint shall be placed at accessible location for maintenance purpose.

4) Joints are common source of weakness; therefore, it is desirable to avoid or at least minimize them.

6.0 COVER AND FIRE RATING

Fire rating considered - 2hrs.

Cover to reinforcement considered for various elements

Footings	50 mm
Columns	40 mm
Tank walls	40 mm
Shear Walls	30 mm
Beams (simply supported)	40 mm
Beams (continuous)	30 mm
Slabs (simply supported)	35 mm
Slabs (continuous)	25 mm

7.0 DEFLECTION CRITERIA

7.1 Lateral Deflection (Wind)

Overall Deflection	<	Height/500
Storey Deflection	<	Storey height/500

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7.2 Lateral Deflection (Seismic)

Overall Drift	<	H / 250
Storey Drift	<	0.004 times storey height

7.3 Vertical Deflection of Beams and Slabs due to Gravity Loads

Total Deflection (DL + LL)	<	Span/250 up to 20 maximum

Deflection including the effects of

Temperature, Creep and Shrinkage
Occurring after erection of partitions
and the application of finishes < Span/350 or 20mm whichever is greater

8.0 STRUCTURAL SYSTEM

Super Structure (Above ground Floors)

The super structure (including terrace) is two way PT slab system. In center core RCC Beam and slab system is to be proposed.

9.0 STRUCTURAL ANALYSIS

Idealisation

The 3-dimensional structural analysis will be carried out using Etabs, beams and columns in the structure are model as line members. Shear walls, retaining wall and floor slabs are model as shell elements.

Member Properties

As per IS456 code of practice the plain and reinforced concrete member stiffness can be based on cracked section properties and for the calculation of deflection reduced moment of inertia of section shall be used based on cracked section. The section modifiers used from IS 16700: 2017

The following property modifiers are considered in the analysis unfactored loads

Moment of Inertia

Beams	0.70Ig
Column & Shear wall	0.90Ig
Slabs	0.35Ig

For factored loads,

Moment of Inertia

Beams	0.35Ig
Column & Shear wall	0.70Ig
Slabs	0.25Ig

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Design Procedure

Structural member are designed based on the results of ETABS analysis and the design (Foundation, columns and beams) is carried out using RCDC software. The design of Flat slabs based on the results of SAFE analysis and the design is carried out using RCDCFE/RAPT.

10.0 FOUNDATION SYSTEM

For Structures with Part basement we have considered the foundation system as pile foundation with reference to soil investigation report.

11.0 STRUCTURAL ANALYSIS - METHOD STATEMENT

a) ETABS MODEL

Modulus of Elasticity of Concrete -5000√fck

Consideration of Diaphragm - Rigid Diaphragm

Slab element considered as Shell element

The structural will be checked for the following

a) Storey Drift

b) Soft Storey Effect

c) Deflection

12.0 COMPUTER PROGRAMS

The following Software / spreadsheet to be used to carry out Structural analysis and design.

1. PROKON Ver 2.3 - Beam design
2. ETABS Ver 16.0 - Three Dimensional Program for analysis
3. SAFE Ver 16.0 - Raft Analysis / Strip Analysis
4. In-House Spreadsheet - one way/ two way slab design
5. Rapt-6 - Post Tensioning Analysis & Design
6. RCDC - Beam Design, Isolated footing design, Column design and Wall design
7. STAAD PRO & ETABS - Structural Steel Design.

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PILECAP DESIGN CALCULATIONS

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Pilecap No	:	PC15	
Column No	:	C15	(600mm x 600mm)
Member Ref. No	:	C15	
Concrete Grade	:	M30	
Steel Grade	:	Fe500	
Clear Cover	:	75	mm
Top of pile-cap below ground	:	2.5	m
Density of Soil	=	18	kN/cum
Founding Depth	=	4	m
Pile Capacity in Compression	=	2000	kN
Pile Capacity in Tension	=	800	kN
Pile Capacity in Shear	=	200	kN
Pile Capacity Reduction	=	0	%
Pile Overloading	=	10	%
Pile Group Overloading	=	10	%
Pile Capacity Increase for EQ	=	25	%
Pile Capacity Increase for Wind	=	25	%
Live Load Reduction	=	20	%
Consider Capacity Design	:	No	
Consider Overburden Pressure	:	No	
No. of Piles	=	3	
Pile Diameter	=	750	mm
Pilecap Offset	=	100	mm
Pile Spacing	=	2.5	x Ø
Pilecap Size	=	2423	mm (edge)
Pilecap Depth	=	1500	mm
Pile-cap Wt.	=	186.591	kN

Check for Maximum Compressive Load on One Pile:

Critical Load Combination	:	[3] : (Dead) +(SDL) +(WALL) -(SPEC-XMax) +(Live)	
Pcomb	=	5299.86	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	5486.45	kN
Mx	=	-80.7	kNm
My	=	-78.91	kNm
P	=	Ptotal/ No. of Piles	
	=	1828.82	kN



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	=	49.697	kN
Pmy	=	0	kN
Maximum Compressive load on pile	=	1878.52	kN
Allowable Compressive load on pile	=	2000 x 1.25 x 1.1	
	=	2750	kN

Check for Maximum Compressive Load on Pile Group:

Critical Load Combination	:	[1] : (Dead) +(SDL) +(WALL) +(Live)	
Pcomb	=	5010.72	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	5197.31	kN
Mx	=	48.82	kNm
My	=	13.62	kNm
Maximum Compressive load on pile group	=	5197.31	kN
Allowable Compressive load on pile group	=	3 x 2000 x 1.1	
	=	6600	kN

Check for Maximum shear on Pile Group:

Critical Load Combination	:	[2] : (Dead) +(SDL) +(WALL) +(SPEC-XMax) +(Live)	
Pcomb	=	4721.57	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	4908.16	kN
Mx	=	178.34	kNm
My	=	106.16	kNm
Vx	=	40.63	kNm
Vy	=	68.18	kNm
Maximum shear on pile group	=	$\text{sqrt}(40.63^2 + 68.18^2)$	
	=	79.37	kN
Shear capacity of pile group	=	3 x 200 x 1 x 1.25	
	=	750	kN

Check for Tensile Load on One Pile:

No Tensile load in pile group.

Check for Maximum Tensile Load on Pile Group:

No Tensile load in pile group.

Design for Bending:



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Bottom Reinforcement Along Parallel Edge

Critical Load Combination	:	[6] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Pcomb	=	7516.08	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	7795.967	kN
Mx	=	73.23	kNm
My	=	20.44	kNm
Ppile	=	Max Load on pile	
	=	2632.1	kN
Deff	=	1395	mm
Beff	=	950	mm
DfCol	=	0.64	m
BMux	=	Ppile x DfCol	
	=	1677.97	kNm
PtReq	=	0.22	%
AstReq (BM)	=	3020.22	sqmm/m
AstPrv	=	T25 @ 125 C/C	
	=	3926.96	sqmm/m

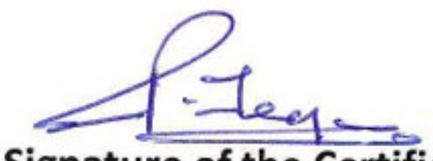
Top Reinforcement Along Parallel Edge

There is no Tensile Force, hence Minimum Percentage of steel will be provided.

D	=	1500	mm
AstReq (BM)	=	Min Pt for Top Reinforcement x D x 1000/100	
	=	0.06 x 1500 x 1000/100	
	=	360	sqmm/m
AstPrv	=	T10 @ 200 C/C	
	=	392.7	sqmm/m

Bottom Reinforcement Along Perpendicular Edge

Critical Load Combination	:	[6] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Pcomb	=	7516.08	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	7795.967	kN
Mx	=	73.23	kNm
My	=	20.44	kNm
Ppile	=	Max Load on pile	
	=	2553.55	kN
Deff	=	1415	mm
Beff	=	950	mm
DfCol	=	0.78	m



Signature of the Certified Engineer

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ADYAR, CHENNAI - 600 020.

BMuy	=	Ppile x DfCol	
	=	1998.24	kNm
PtReq	=	0.25	%
AstReq (BM)	=	3567.95	sqmm/m
AstPrv	=	T25 @ 125 C/C	
	=	3926.96	sqmm/m

Top Reinforcement Along Perpendicular Edge

There is no Tensile Force, hence Minimum Percentage of steel will be provided.

D	=	1500	mm
AstReq (BM)	=	Min Pt for Top Reinforcement x D x 1000/100	
	=	0.06 x 1500 x 1000/100	
	=	360	sqmm/m
AstPrv	=	T10 @ 200 C/C	
	=	392.7	sqmm/m

Design for One Way Shear:

Along Parallel Edge (Compression Case)

Critical Load Combination	:	[6] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Pcomb	=	7516.08	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	7795.97	kN
Mx	=	73.23	kNm
My	=	20.44	kNm
Ppile	=	Max Load on pile	
	=	2632.103	kN

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

Section Location from column center	=	997.5	mm

Data for Piles

Pile No	Load (kN)	% covered	Shear (kN)
P1	2553.55	0	0
P2	2610.31	58	1096.33
P3	2632.1	58	1105.48

Design Shear Force (Vu)	=	Max. of (Shear due to P2, P3)	
	=	1105.48	kN
Deff	=	1395	mm
Beff	=	1321.08	mm



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Tv	=	Vu/(Beff x Deff)	
	=	0.6	N/sqmm
Tc	=	0.346	N/sqmm
Av	=	60	mm
Shear enhancement factor	=	2 x Deff / Av	
	=	46.5	
Enhanced shear strength (Tce)	=	3.5	N/sqmm
Tv	<	Tce, Hence Shear Reinforcement is not required	

Along Parallel Edge (Tension Case)

All Load Combination having Compressive Force. Thus, One way Shear is not applicable for Tensile Force.

Along Perpendicular Edge (Compression Case)

Critical Load Combination	:	[6] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Pcomb	=	7516.08	kN
Ptotal	=	Pcomb + Pilecap Wt.	
	=	7795.97	kN
Mx	=	73.23	kNm
My	=	20.44	kNm
Ppile	=	Max Load on pile	
	=	2632.103	kN

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

Section Location from column center	=	1007.5	mm

Data for Piles

Pile No	Load (kN)	% covered	Shear (kN)
P1	2553.55	40	1532.24
P2	2610.31	0	0
P3	2632.1	0	0

Design Shear Force (Vu)	=	Max. of (Shear due to P1, P2+P3)	
	=	1532.24	kN
Deff	=	1415	mm
Beff	=	1183.6	mm
Tv	=	Vu/(Beff x Deff)	
	=	0.91	N/sqmm
Tc	=	0.37	N/sqmm
Av	=	75.03	mm
Shear enhancement factor	=	2 x Deff / Av	
	=	37.72	



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Enhanced shear strength (Tce)	=	3.5	N/sqmm
Tv	<	Tce, Hence Shear Reinforcement is not required	

Along Perpendicular Edge (Tension Case)

All Load Combination having Compressive Force. Thus, One way Shear is not applicable for Tensile Force.

Design of Face Reinforcement:

Asfr Req	=	SFR % x D x Beffsfr	
	=	0.05 x 1500 x 500 / 100	
	=	375	sqmm
Asfr Prv	=	5-T10	
	=	393	sqmm

Check for Load Transfer from Column to PileCap

Critical Analysis Load Combination	=		
Critical Load Combination	:	[6] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
P	=	7516.08	kN
A2	=	0.36	sqm
A1	=	4.98	sqm
Base Area	=	4.98	sqm
A1	<	Base Area	
Modification Factor	=	SquareRoot(A1/A2) < = 2	
SquareRoot(A1/A2)	=	3.72	
Thus, Modification Factor	=	2	
Concrete Bearing Capacity	=	0.45 x Fck x Modication Factor x Column Area	
	=	9720	kN
Concrete Bearing Capacity	>	P, Hence Safe.	

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COLUMN DESIGN CALCULATIONS

Signature of the Certified Engineer

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Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe550	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Cover	=	40	mm
Clear Floor Height @ B	=	1850	mm
Clear Floor Height @ D	=	2150	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	1 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C6	
Load Combination	=	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Critical Location	=	Top Joint	
Pu	=	7357.35	kN
Mux	=	448.67	kNm
Muy	=	-33.23	kNm
Vux	=	11.63	kN
Vuy	=	-425.9	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	482.216	No Beam	No Beam	-	-	1
Top	482.216	11200 x 1000 x 500	No Beam	117.644	-	0.87

Sway Condition (as per Stability Index)	=	Non Sway
Effective Length Factor along Major Axis	=	0.95

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Calculation Along Minor Axis Of Column

	Column	Beam Sizes		Beam Stiffness		
		Beam 1	Beam 2			

Joint	Stiffness	(Length x Width x Depth)	(Length x Width x Depth)	Beam 1	Beam 2	Beta
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	482.216	No Beam	No Beam	-	-	1
Top	482.216	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.653

User Defined Effective Length Factor = 0.88

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	23.7	mm
Minimum Eccentricity	>	20	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	174.37	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	3.08	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	0.95	
Slenderness Ratio	=	Effective Length / D	
	=	3.4, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	0.88	
Slenderness Ratio	=	Effective Length / B	
	=	2.71, Column Not Slender Along B	

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	448.67	---	448.67	0	448.67
Minor Axis - Muy	-33.23	174.37	-174.37	0	-174.37

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E



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ADYAR, CHENNAI - 600 020.

Final Critical Design Forces

Pu	=	7357.35	kN
Mux	=	448.67	kNm
Muy	=	-174.37	kNm

Interaction Principle (Discrete Action)

Moment Capacity Check

Pt Calculated	=	3.23	
Reinforcement Provided	=	12-T32 + 4-T25	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	21.24	deg
Corresponding NA angle (β)	=	21.89	deg
MRes	=	481.36	kNm
MCap	=	632.32	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.76 <= 1	

Shear Calculation	Along D	Along B
Critical Load Combination	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	[9] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-YMax)
Design shear force, Vu (kN)	-425.8962	-67.742
Pu (kN)	7357.35	5733.98
Deff , Beff (mm)	544	544
Aeff (sqmm)	326400	326400
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	1.3048	0.2075
Pt (%)	1.613	1.613
Design shear strength, Tc (N/sqmm)	0.7996	0.7996
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.9321	2.5058
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	1.1995	1.1995
Design shear check	Tv > Tc x Enhancement factor	Tv < Tc x Enhancement factor

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ADYAR, CHENNAI - 600 020.

Shear Links Design	Shear Links Required	Shear Links Not Required
Pt %	1.613	-
Shear resisted by concrete Vc (kN)	(Tc-e) x (B x Deff)	-
	391.5	-
Shear to be resisted by shear reinforcement = Vus (kN)	Vu - Vc	
	34.39	-
Area of shear reinforcement required, Asv (sqmm)	(Vus x 1000) / (Deff x 0.87 x Fy)	(Vus x 1000) / (Beff x 0.87 x Fy)
	175.11	-
Master Link Rebar (mm)	8	-
Number of legs provided	5	-
Spacing of links reqd (mm)	1435	-
Spacing of links prvd, Sv (mm)	300	-
Asv Provided (sqmm)	837.76	-

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	8	mm

Criterion for spacing of normal links

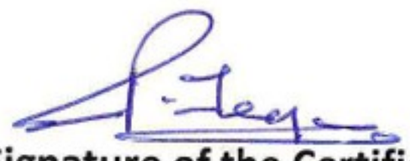
Min. Longitudinal Bar dia X 16	=	400	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Provided spacing	=	300	mm

Table For Links

	Required			Provided	
	Normal Design	Shear Design	Ductile Design	Normal Zone	Ductile Zone
Link Dia.	8	---	---	8	---
Spacing	300	---	---	300	---

General Data

Column No.	:	C4
Level	:	STILT To 1ST
Frame Type	=	Non-Ductile



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Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M35	N/sqmm
Grade Of Steel (Main)	=	Fe550	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe550	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Cover	=	40	mm
Clear Floor Height @ B	=	3400	mm
Clear Floor Height @ D	=	3700	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	1 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C6	
Load Combination	=	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Critical Location	=	Bottom Joint	
Pu	=	6147.78	kN
Mux	=	-750.09	kNm
Muy	=	9.4	kNm
Vux	=	8.04	kN
Vuy	=	-361.7	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	304.256	11200 x 1000 x 500	No Beam	117.644	-	0.87
Top	304.256	11200 x 1000 x 500	No Beam	117.644	-	0.838

User Defined Effective Length Factor = 1

Calculation Along Minor Axis Of Column

Signature of the Certified Engineer

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Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	304.256	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.653
Top	304.256	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.593

User Defined Effective Length Factor = 1

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	26.8	mm
Minimum Eccentricity	>	20	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	164.76	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	5.67	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.17, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	5.67, Column Not Slender Along B	

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	-750.09	---	-750.09	0	-750.09
Minor Axis - Muy	9.4	164.76	164.76	0	164.76

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)



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E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

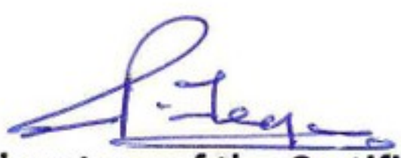
Pu	=	6147.78	kN
Mux	=	-750.09	kNm
Muy	=	164.76	kNm

Interaction Principle (Discrete Action)

Moment Capacity Check

Pt Calculated	=	3.23	
Reinforcement Provided	=	12-T32 + 4-T25	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	12.39	deg
Corresponding NA angle (β)	=	14.05	deg
MRes	=	767.98	kNm
MCap	=	828.99	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.93 <= 1	

Shear Calculation	Along D	Along B
Critical Load Combination	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	[9] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) - 1.5 (SPEC-YMax)
Design shear force, Vu (kN)	-361.6967	-63.6228
Pu (kN)	6101.89	4762.46
Deff , Beff (mm)	544	544
Aeff (sqmm)	326400	326400
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	1.1081	0.1949
Pt (%)	1.613	1.613
Design shear strength, Tc (N/sqmm)	0.7996	0.7996
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.6024	2.2506
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear	1.1995	1.1995



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strength, Tc-e (N/sqmm)		
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	8	mm

Criterion for spacing of normal links

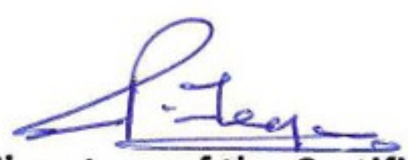
Min. Longitudinal Bar dia X 16	=	400	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Provided spacing	=	300	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	300	---	---	300	---

General Data

Column No.	:	C4	
Level	:	1ST To 2ND	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M35	N/sqmm
Grade Of Steel (Main)	=	Fe550	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe550	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Cover	=	40	mm
Clear Floor Height @ B	=	3400	mm
Clear Floor Height @ D	=	3700	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	



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Column Type	:	UnBraced
Minimum eccentricity check	:	One Axis at a Time
Code defined D/B ratio	:	4
D/B Ratio	:	1 <= 4 Hence, Design as Column

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C6	
Load Combination	=	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Critical Location	=	Bottom Joint	
Pu	=	4905.37	kN
Mux	=	-741.59	kNm
Muy	=	-7.23	kNm
Vux	=	-0.52	kN
Vuy	=	-355.54	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	304.256	11200 x 1000 x 500	No Beam	117.644	-	0.838
Top	304.256	11200 x 1000 x 500	No Beam	117.644	-	0.838

User Defined Effective Length Factor = 1

Calculation Along Minor Axis Of Column

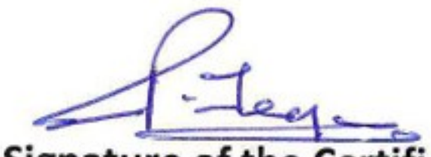
Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	304.256	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.593
Top	304.256	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.593

User Defined Effective Length Factor = 1

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction



Signature of the Certified Engineer

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ADYAR, CHENNAI - 600 020.

Minimum Eccentricity Along B :

Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	26.8	mm
Minimum Eccentricity	>	20	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	131.46	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	5.67	
	<	60	(Hence Ok)

Column Is Unbraced Along D

Slenderness Check Along D:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	
	=	6.17, Column not Slender Along D	

Column Is Unbraced Along B

Slenderness Check Along B:

Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	5.67, Column Not Slender Along B	

Calculation of Design Moment

Direction	Manalysis	Mmin (Abs)	Mdesign	Mslndx (Abs)	Mdesign-final
	A	B	C	E	F
Major Axis - Mux	-741.59	---	-741.59	0	-741.59
Minor Axis - Muy	-7.23	131.46	-131.46	0	-131.46

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

Pu	=	4905.37	kN
Mux	=	-741.59	kNm
Muy	=	-131.46	kNm

Interaction Principle (Discrete Action)

Moment Capacity Check

Pt Calculated	=	2.53	

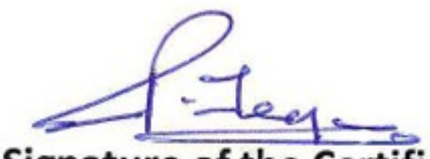


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Reinforcement Provided	=	4-T32 + 12-T25	
Load Angle	=	Tan^{-1}(Muy/Mux)	
	=	10.05	deg
Corresponding NA angle (β)	=	12.08	deg
MRes	=	753.16	kNm
MCap	=	832.91	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.9 <= 1	

Shear Calculation	**Along D**	**Along B**
Critical Load Combination	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	[9] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) -1.5 (SPEC-YMax)
Design shear force, Vu (kN)	-355.5413	-96.8199
Pu (kN)	4859.48	3796.28
Deff , Beff (mm)	544	544
Aeff (sqmm)	326400	326400
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	1.0893	0.2966
Pt (%)	1.265	1.265
Design shear strength, Tc (N/sqmm)	0.7305	0.7305
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	2.2761	1.9969
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.5
Enhanced shear strength, Tc-e (N/sqmm)	1.0958	1.0958
Design shear check	Tv < Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Not Required**	**Shear Links Not Required**



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Design Of Links

Links in the zone where special confining links are not required

Normal Links

Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	8	mm

Criterion for spacing of normal links

Min. Longitudinal Bar dia X 16	=	400	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Provided spacing	=	300	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	300	---	---	300	---

General Data

Column No.	:	C4	
Level	:	2ND To 3RD	
Frame Type	=	Non-Ductile	
Response Reduction Factor	=	3	
Design Code	=	IS 456 : 2000 + IS 13920 : 2016	
Grade Of Concrete	=	M35	N/sqmm
Grade Of Steel (Main)	=	Fe550	N/sqmm
Grade Of Steel (Shear)	=	Fe415	N/sqmm
Grade Of Steel - Flexural Design	=	Fe550	N/sqmm
Grade Of Steel - Shear Design	=	Fe415	N/sqmm
Column B	=	600	mm
Column D	=	600	mm
Clear Cover	=	40	mm
Clear Floor Height @ B	=	3400	mm
Clear Floor Height @ D	=	3700	mm
No Of Floors	=	1	
No Of Columns In Group	=	1	
Column Type	:	UnBraced	
Minimum eccentricity check	:	One Axis at a Time	
Code defined D/B ratio	:	4	
D/B Ratio	:	1 <= 4 Hence, Design as Column	

Flexural Design (Analysis Forces)

Analysis Reference No.	=	C6	
Load Combination	=	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	
Critical Location	=	Bottom Joint	
Pu	=	3672.87	kN
Mux	=	-745.02	kNm



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Muy	=	-15	kNm
Vux	=	-5.22	kN
Vuy	=	-360.98	kN

Effective Length Calculation

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	304.256	11200 x 1000 x 500	No Beam	117.644	-	0.838
Top	304.256	11200 x 1000 x 500	No Beam	117.644	-	0.838

User Defined Effective Length Factor = 1

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		Beta
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	304.256	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.593
Top	304.256	8100 x 300 x 800	7430 x 300 x 800	199.887	217.912	0.593

User Defined Effective Length Factor = 1

Minimum Eccentricity Check

Since Axial Force is compressive, Min. Eccentricity check to be performed

Most critical case is with Min. Eccentricity check in Y-direction

Minimum Eccentricity Along B :			
Minimum Eccentricity	=	Unsupported Length / 500 + B / 30	
	=	26.8	mm
Minimum Eccentricity	>	20	mm
Mminy	=	Pu x Minimum Eccentricity	
	=	98.43	kNm

Slenderness Check

Max Slenderness Ratio(L/B)	=	5.67	
	<	60	(Hence Ok)
Column Is Unbraced Along D			
Slenderness Check Along D:			
Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / D	



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	=	6.17, Column not Slender Along D	
Column Is Unbraced Along B			
Slenderness Check Along B:			
Effective Length Factor	=	1	
Slenderness Ratio	=	Effective Length / B	
	=	5.67, Column Not Slender Along B	

Calculation of Design Moment

Direction	**Manalysis**	**Mmin** (Abs)	**Mdesign**	**Mslndx** (Abs)	**Mdesign-final**
	A	B	C	E	F
Major Axis - Mux	-745.02	---	-745.02	0	-745.02
Minor Axis - Muy	-15	98.43	-98.43	0	-98.43

Where

A = Moments directly from analysis

B = Moments due to minimum eccentricity

C = Maximum of analysis moment and min. eccentricity = Max (A,B)

E = Moment due to slenderness effect

F = Final design Moment = Max(C- Top Bottom , D- Top Bottom) + E

Final Critical Design Forces

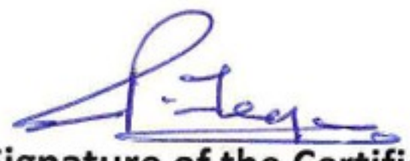
Pu	=	3672.87	kN
Mux	=	-745.02	kNm
Muy	=	-98.43	kNm

Interaction Principle (Discrete Action)

Moment Capacity Check

Pt Calculated	=	1.99	
Reinforcement Provided	=	12-T25 + 4-T20	
Load Angle	=	$Tan^{-1}(Muy/Mux)$	
	=	7.53	deg
Corresponding NA angle (β)	=	9.24	deg
MRes	=	751.5	kNm
MCap	=	829.94	kNm
Capacity Ratio	=	MRes/ MCap	
	=	0.91 <= 1	

Shear Calculation	**Along D**	**Along B**
Critical Load Combination	[1] : 1.5 (Dead) +1.5 (SDL) +1.5 (WALL) +1.5 (Live)	[13] : 0.9 (Dead) +0.9 (SDL) +0.9 (WALL) -1.5 (SPEC-YMax)
Design shear force, Vu	-360.9832	-104.6891



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(kN)		
Pu (kN)	3626.99	1719.17
Deff , Beff (mm)	547.5	547.5
Aeff (sqmm)	328500	328500
Design shear stress, Tv	Vu / (B x Deff)	Vu / (D x Beff)
Tv (N/sqmm)	1.0989	0.3187
Pt (%)	0.993	0.993
Design shear strength, Tc (N/sqmm)	0.6653	0.6653
Shear Strength Enhancement Factor (Compressive Force)	1 + 3 x Pu / (B x D x Fck)	
	1.9464	1.4486
Shear Strength Enhancement Factor (Tensile Force)	-	-
Shear Strength Enhancement Factor (max)	1.5	1.5
Shear Strength Enhancement Factor	1.5	1.4486
Enhanced shear strength, Tc-e (N/sqmm)	0.998	0.9638
Design shear check	Tv > Tc x Enhancement factor	Tv < Tc x Enhancement factor
Shear Links Design	**Shear Links Required**	**Shear Links Not Required**
Pt %	0.993	-
Shear resisted by concrete Vc (kN)	(Tc-e) x (B x Deff)	-
	327.84	-
Shear to be resisted by shear reinforcement = Vus (kN)	Vu - Vc	
	33.14	-
Area of shear reinforcement required, Asv (sqmm)	(Vus x 1000) / (Deff x 0.87 x Fy)	(Vus x 1000) / (Beff x 0.87 x Fy)
	167.67	-
Master Link Rebar (mm)	8	-
Number of legs provided	5	-
Spacing of links reqd (mm)	1498	-
Spacing of links prvd, Sv (mm)	300	-
Asv Provided (sqmm)	837.76	-

Design Of Links

Links in the zone where special confining links are not required

Normal Links

Signature of the Certified Engineer

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Diameter of link	=	8	mm
	>	Max. longitudinal bar dia / 4	
	=	6.25	mm
Criterion for spacing of normal links			
Min. Longitudinal Bar dia X 16	=	320	mm
Min. dimension of column	=	600	mm
Max. 300 mm	=	300	mm
Provided spacing	=	300	mm

Table For Links

	Required			Provided	
	Normal Design	**Shear Design**	**Ductile Design**	**Normal Zone**	**Ductile Zone**
Link Dia.	8	---	---	8	---
Spacing	300	---	---	300	---

Signature of the Certified Engineer

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NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.

Beam: (Code of Practice : IS:456 - 2000)

Input Tables

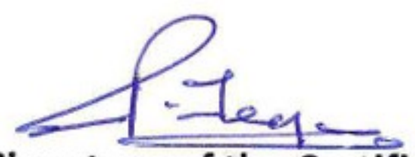
fcu (MPa)		25
fy	(MPa)	550
fyv	(MPa)	415
% Redistribution		0
(O)ptimised or (D)ownward redistribution		D
Top Cover :Reinforcement centre	(mm)	40
Bottom Cover :Reinforcement centre	(mm)	40
Dead load factor		1.5
Live load factor		1.5
Concrete density	(kN/m3)	25
% of live load considered as permament		25
Ø (Creep coefficient)		2
Ecs (Shrinkage strain)		300E-6

Section number	Bw (mm)	D (mm)	Bf-top (mm)	Hf-top (mm)	Bf-bottom (mm)	Hf-bottom (mm)	Y-offset (mm)	Web offset	Flange offset
1	450	600							

Span number	Section length (m)	Section number left	Section number right
1	6	1	

Support number	Code C,F	Column below			Code F,P	Column above			Code F,P
		D (mm)	B (mm)	H (mm)		D (mm)	B (mm)	H (mm)	

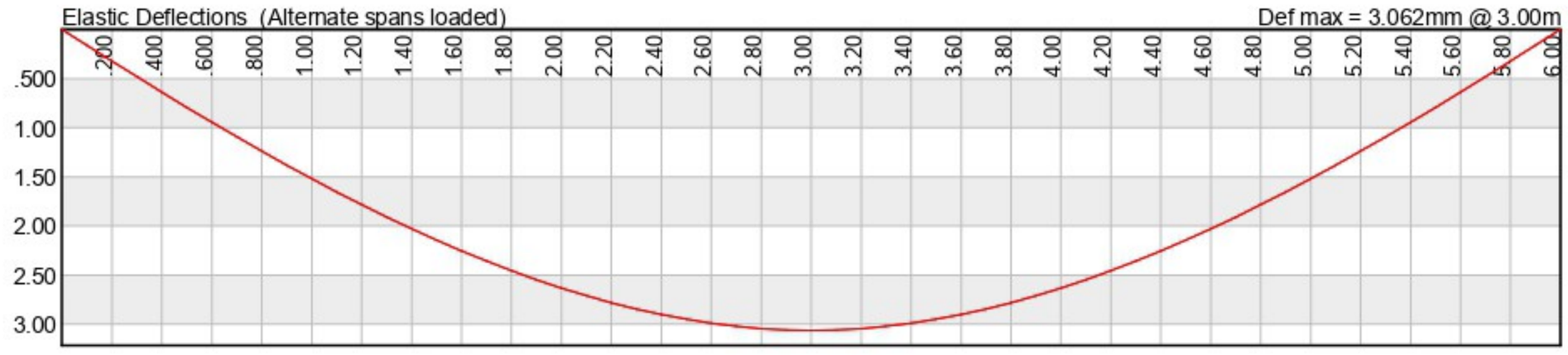
Load Case	Span	W-left (kN/m)	W-right (kN/m)	a (m)	b (m)	P (kN)	a (m)	M (kNm)	a (m)	Load Description
D	1	30								

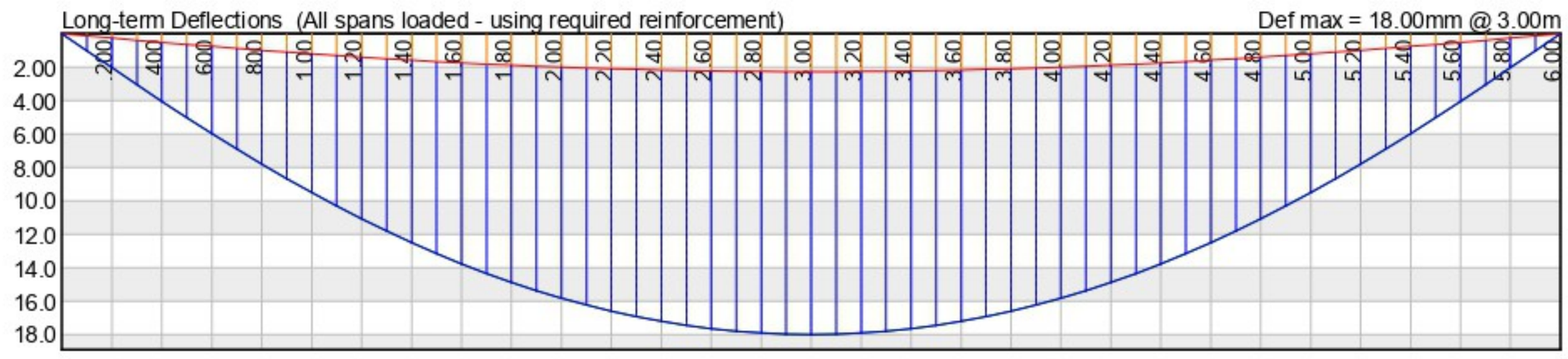


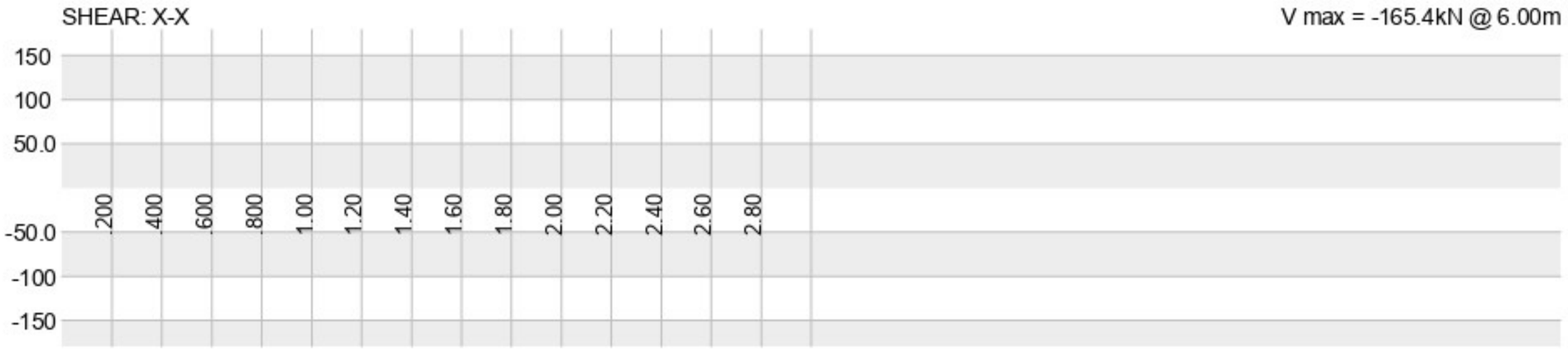
Signature of the Certified Engineer

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Deflection, Shear, Moment and Steel diagrams. Span 1



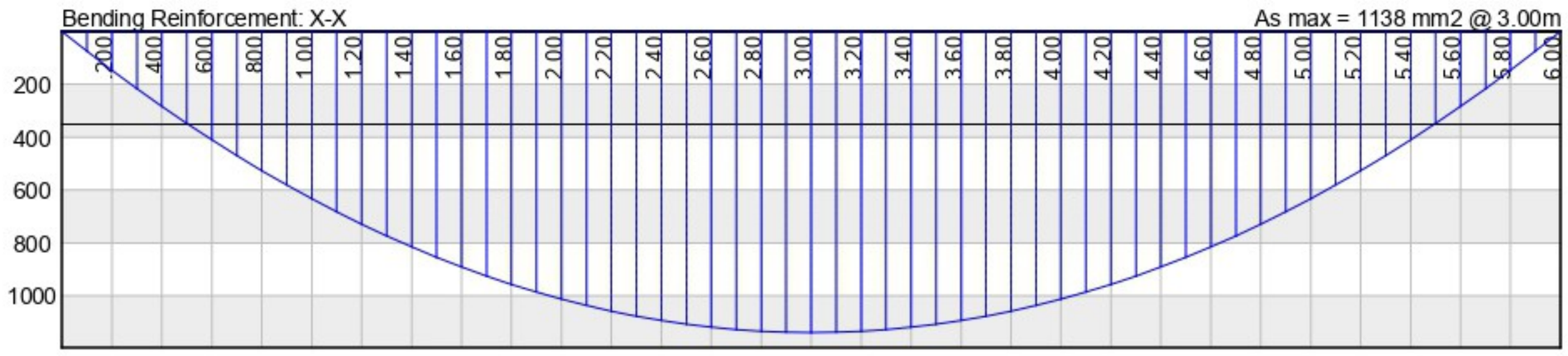




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Job Number	Beam design	Sheet
Job Title	Proposed commercial office building	
Client		
Calcs by	Checked by	Date



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ADYAR, CHENNAI - 600 020.

Job Number	Slab Design	Sheet
Job Title	Commercial Office building	
Client		
Calcs by	Checked by	Date

Slab Design :

C04

Input Data

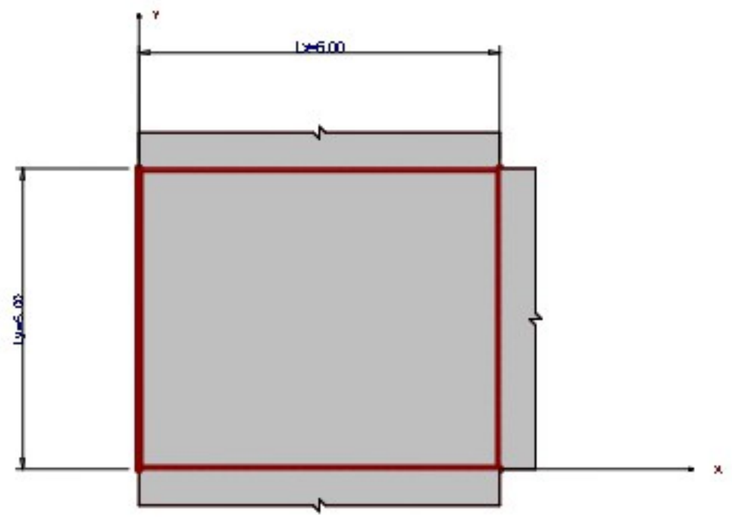
Lx	(m)	6
Ly	(m)	5
Slab depth	(mm)	200
deff X-direction	(mm)	170
deff Y-direction	(mm)	160
Poisson's ratio		0.2
fck (MPa)		35
fy (MPa)		550
Density	(kN/m^3)	25
Self weight load factor		1.5
ϕcr - creep factor		1.2
(ACI318 :9.5.2.5)		

Load Cases

Unfactored Loads			Unfactored Point Loads			Unfactored Line Loads				
Load case Number	Load Factor	UDL kN/m^2	P kN	x m	y m	L kN/m	x1 m	y1 m	x2 m	y2 m
1	1.5	7.4								

Sketch of slab

IS:456 - 2000



Total UDL=

18.600 kN/m^2

(Incl self Wt)

Load Case 1 (factored)

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	Job Number	Slab Design	Sheet
	Job Title	Commercial Office building	
	Client		
	Calcs by	Checked by	Date

Output

Wood-Armer Moments and reinforcement for each load case:
Wood-Armer moments were calculated using the 'Wood & Armer' theory.

LOAD CASE 1

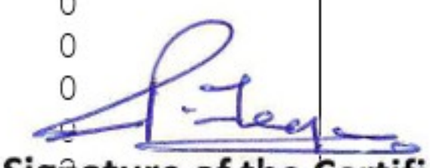
Position		Wood-Armer Moments (kNm/m)				Reinforcement (mm^2/m)			
		Top		Bottom		Top		Bottom	
X(m)	Y(m)	X	Y	X	Y	X	Y	X	Y
0.00	0.00	2.1	2.3	1.8	1.6	32	37	27	26
0.50	0.00	3.9	12.5	0.0	0.0	59	200	0	0
1.00	0.00	5.5	22.5	0.0	0.0	84	361	0	0
1.50	0.00	6.1	26.7	0.0	0.0	92	429	0	0
2.00	0.00	6.7	31.0	0.0	0.0	101	498	0	0
2.50	0.00	6.5	31.2	0.0	0.0	98	501	0	0
3.00	0.00	6.7	31.8	0.0	0.0	102	511	0	0
3.50	0.00	6.3	29.0	0.0	0.0	96	465	0	0
4.00	0.00	5.9	26.1	0.0	0.0	89	420	0	0
4.50	0.00	4.7	19.3	0.0	0.0	72	310	0	0
5.00	0.00	3.3	12.0	0.0	0.0	50	193	0	0
5.50	0.00	1.6	5.9	0.0	0.0	25	94	0	0
6.00	0.00	0.2	0.0	1.1	1.2	3	1	17	20
0.00	0.42	5.2	5.6	5.5	5.1	79	91	84	82
1.00	0.42	4.5	13.9	0.4	0.0	68	223	7	0
2.00	0.42	3.7	17.3	0.0	0.0	55	278	0	0
3.00	0.42	3.3	17.5	0.0	0.0	50	281	0	0
4.00	0.42	4.3	15.5	0.0	0.0	66	248	0	0
5.00	0.42	4.5	9.2	1.9	0.0	68	148	29	0
6.00	0.42	4.6	1.3	0.0	0.1	69	20	0	2
0.00	0.83	8.1	8.7	9.3	8.7	122	139	141	141
0.50	0.83	5.7	7.4	9.3	7.6	86	118	140	122
1.00	0.83	3.4	6.0	8.9	6.3	51	96	134	101
1.50	0.83	2.0	4.9	6.2	3.3	30	79	94	52
2.00	0.83	0.6	4.0	3.8	0.5	9	64	58	8
2.50	0.83	0.0	2.2	1.6	0.0	0	35	24	0
3.00	0.83	0.0	3.1	1.9	0.0	0	50	29	0
3.50	0.83	1.3	4.3	4.2	1.1	19	70	63	17
4.00	0.83	2.8	5.4	5.9	3.3	42	87	89	53
4.50	0.83	4.3	6.0	6.2	4.6	65	96	94	74
5.00	0.83	5.8	6.5	6.8	6.1	88	105	103	99
5.50	0.83	7.6	4.7	0.3	3.3	115	75	5	53
6.00	0.83	9.4	2.8	0.0	0.0	141	45	0	0
0.00	1.25	6.4	7.0	8.1	7.6	97	112	122	122
1.00	1.25	0.1	1.5	10.5	9.1	1	25	159	146
2.00	1.25	0.0	0.0	6.8	6.9	0	0	102	112
3.00	1.25	0.0	0.0	5.4	5.9	0	0	81	95
4.00	1.25	0.0	0.0	7.9	7.8	0	0	119	125
5.00	1.25	4.5	3.8	6.5	7.2	68	61	98	115
6.00	1.25	15.4	4.2	0.0	0.0	233	67	0	0
0.00	1.67	5.0	5.5	6.8	6.2	75	89	103	100
0.50	1.67	0.7	1.0	9.7	9.4	10	16	147	151
1.00	1.67	0.0	0.0	12.2	12.5	0	0	184	201
1.50	1.67	0.0	0.0	10.7	12.9	0	0	161	207
2.00	1.67	0.0	0.0	9.6	13.4	0	0	144	215
2.50	1.67	0.0	0.0	7.9	12.2	0	0	119	196
3.00	1.67	0.0	0.0	8.1	12.8	0	0	123	206
3.50	1.67	0.0	0.0	8.8	12.7	0	0	134	205
4.00	1.67	0.0	0.0	9.8	12.7	0	0	148	204
4.50	1.67	0.0	0.0	7.5	10.4	0	0	114	167
5.00	1.67	3.0	0.9	6.2	8.2	46	15	93	132
5.50	1.67	11.6	3.1	0.0	0.6	175	50	0	9
6.00	1.67	21.1	5.2	0.0	0.0	318	83	0	0
0.00	2.08	1.9	2.6	4.0	3.3	29	41	60	53
1.00	2.08	0.0	0.0	10.8	11.3	0	0	163	182
2.00	2.08	0.0	0.0	9.8	14.3	0	0	148	230
3.00	2.08	0.0	0.0	8.8	14.4	0	0	133	231
4.00	2.08	0.0	0.0	9.0	12.5	0	0	136	201



Signature of the Certified Engineer

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.

			Job Number Slab Design						Sheet
			Job Title Commercial Office building						
			Client						
			Calcs by			Checked by			Date
5.00	2.08	0.0	0.0	3.9	6.4	0	0	59	103
6.00	2.08	22.8	5.3	0.0	0.0	345	86	0	0
0.00	2.50	0.0	0.0	1.1	0.4	0	0	17	6
0.50	2.50	0.0	0.0	5.4	5.3	0	0	82	85
1.00	2.50	0.0	0.0	9.4	10.2	0	0	142	164
1.50	2.50	0.0	0.0	9.6	12.8	0	0	144	206
2.00	2.50	0.0	0.0	10.0	15.4	0	0	151	248
2.50	2.50	0.0	0.0	9.6	15.7	0	0	145	253
3.00	2.50	0.0	0.0	9.5	16.1	0	0	143	258
3.50	2.50	0.0	0.0	8.7	14.3	0	0	132	229
4.00	2.50	0.0	0.0	8.2	12.5	0	0	124	200
4.50	2.50	0.0	0.0	4.7	8.6	0	0	70	138
5.00	2.50	0.0	0.0	1.6	4.5	0	0	25	73
5.50	2.50	11.1	0.5	0.0	0.0	167	7	0	0
6.00	2.50	24.5	5.3	0.0	0.0	370	86	0	0
0.00	2.92	1.9	2.6	4.0	3.3	29	41	60	53
1.00	2.92	0.0	0.0	10.8	11.3	0	0	163	182
2.00	2.92	0.0	0.0	9.8	14.3	0	0	148	230
3.00	2.92	0.0	0.0	8.8	14.4	0	0	133	231
4.00	2.92	0.0	0.0	9.0	12.5	0	0	136	201
5.00	2.92	0.0	0.0	3.9	6.4	0	0	59	103
6.00	2.92	22.8	5.3	0.0	0.0	345	86	0	0
0.00	3.33	5.0	5.5	6.8	6.2	75	89	103	100
0.50	3.33	0.7	1.0	9.7	9.4	10	16	147	151
1.00	3.33	0.0	0.0	12.2	12.5	0	0	184	201
1.50	3.33	0.0	0.0	10.7	12.9	0	0	161	207
2.00	3.33	0.0	0.0	9.6	13.4	0	0	144	215
2.50	3.33	0.0	0.0	7.9	12.2	0	0	119	196
3.00	3.33	0.0	0.0	8.1	12.8	0	0	123	206
3.50	3.33	0.0	0.0	8.8	12.7	0	0	134	205
4.00	3.33	0.0	0.0	9.8	12.7	0	0	148	204
4.50	3.33	0.0	0.0	7.5	10.4	0	0	114	167
5.00	3.33	3.0	0.9	6.2	8.2	46	15	93	132
5.50	3.33	11.6	3.1	0.0	0.6	175	50	0	9
6.00	3.33	21.1	5.2	0.0	0.0	318	83	0	0
0.00	3.75	6.4	7.0	8.1	7.6	97	112	122	122
1.00	3.75	0.1	1.5	10.5	9.1	1	25	159	146
2.00	3.75	0.0	0.0	6.8	6.9	0	0	102	112
3.00	3.75	0.0	0.0	5.4	5.9	0	0	81	95
4.00	3.75	0.0	0.0	7.9	7.8	0	0	119	125
5.00	3.75	4.5	3.8	6.5	7.2	68	61	98	115
6.00	3.75	15.4	4.2	0.0	0.0	233	67	0	0
0.00	4.17	8.1	8.7	9.3	8.7	122	139	141	141
0.50	4.17	5.7	7.4	9.3	7.6	86	118	140	122
1.00	4.17	3.4	6.0	8.9	6.3	51	96	134	101
1.50	4.17	2.0	4.9	6.2	3.3	30	79	94	52
2.00	4.17	0.6	4.0	3.8	0.5	9	64	58	8
2.50	4.17	0.0	2.2	1.6	0.0	0	35	24	0
3.00	4.17	0.0	3.1	1.9	0.0	0	50	29	0
3.50	4.17	1.3	4.3	4.2	1.1	19	70	63	17
4.00	4.17	2.8	5.4	5.9	3.3	42	87	89	53
4.50	4.17	4.3	6.0	6.2	4.6	65	96	94	74
5.00	4.17	5.8	6.5	6.8	6.1	88	105	103	99
5.50	4.17	7.6	4.7	0.3	3.3	115	75	5	53
6.00	4.17	9.4	2.8	0.0	0.0	141	45	0	0
0.00	4.58	5.2	5.6	5.5	5.1	79	91	84	82
1.00	4.58	4.5	13.9	0.4	0.0	68	223	7	0
2.00	4.58	3.7	17.3	0.0	0.0	55	278	0	0
3.00	4.58	3.3	17.5	0.0	0.0	50	281	0	0
4.00	4.58	4.3	15.5	0.0	0.0	66	248	0	0
5.00	4.58	4.5	9.2	1.9	0.0	68	148	29	0
6.00	4.58	4.6	1.3	0.0	0.1	69	20	0	0
0.00	5.00	2.1	2.3	1.8	1.6	32	37	27	26
0.50	5.00	3.9	12.5	0.0	0.0	59	200	0	0
1.00	5.00	5.5	22.5	0.0	0.0	84	361	0	0
1.50	5.00	6.1	26.7	0.0	0.0	92	429	0	0
2.00	5.00	6.7	31.0	0.0	0.0	101	498	0	0
2.50	5.00	6.5	31.2	0.0	0.0	98	501	0	0
3.00	5.00	6.7	31.8	0.0	0.0	102	511	0	0

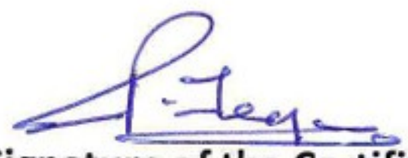


Signature of the Certified Engineer

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
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Job Number Slab Design		*Sheet*
Job Title Commercial Office building		
Client		
Calcs by	*Checked by*	*Date*

3.50	5.00	6.3	29.0	0.0	0.0	96	465	0	0
4.00	5.00	5.9	26.1	0.0	0.0	89	420	0	0
4.50	5.00	4.7	19.3	0.0	0.0	72	310	0	0
5.00	5.00	3.3	12.0	0.0	0.0	50	193	0	0
5.50	5.00	1.6	5.9	0.0	0.0	25	94	0	0
6.00	5.00	0.2	0.0	1.1	1.2	3	1	17	20



Signature of the Certified Engineer

P. JEGATHEESAN, M.E., (Struct.)
REGISTERED STRUCTURAL ENGINEER
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
REGISTRATION No.SE/GR-I/19/03/027
NEW No.31 (OLD No.14), BESANT AVENUE,
ADYAR, CHENNAI - 600 020.

THE LANDLENS SUITE

Eight ways to know a piece of land before you pay for it.

This report covers one part of the picture. These cover the rest, drawn from the same government records, for any property in Tamil Nadu.

LandLens One
Ask anything about a property and get an answer grounded in live government records, with the sources shown.
/landlens/one

Verify My Land
Every record check run on one property and returned as a single report.
/landlens/verify-my-land

Legal Opinion
An advocate's written opinion on the title, built on the records we pull for it.
/landlens

One Map
Every layer on one map: the parcel, its boundary, zoning, water bodies and what sits around it.
/landlens/one/map

PriceMap
What land actually changed hands for around this plot, taken from the registered deeds.
/landlens/pricemap

Build Scope
What you are allowed to build here: floor space, height, coverage and setbacks.
/landlens/build-scope

Property Tracker
Watch a property and hear about it when something new is registered against it.
/landlens/property-tracker

Deal Room
Run the transaction in one place: documents, stamping, signatures and the parties.
/landlens/deal-room

FREE TOOLS · NO ACCOUNT NEEDED

Twenty-four checks you can run yourself, at no cost.

Records and verification

The registers themselves, read for you.

- Encumbrance Certificate
- Patta and Chitta
- Field Measurement Sketch
- EC Analyzer
- Bank charge check
- Court case search
- Seller background check
- Approval check by survey

Value and duty

What it is worth and what it costs to register.

- Guideline value by street
- Guideline value by survey
- Stamp duty and registration fees
- Capital gains
- Floor space index
- Area unit converter

Zoning and land use

What the plan says can happen on this land.

- Land use zone finder
- CMDA land use check
- Coastal regulation zone
- Master plan check
- Water bodies finder
- Airport height clearance

Registers and directories

Who holds it, and which office keeps the record.

- Find your registering office
- Temple property check
- Waqf property check
- RERA register

Every free tool
/tools

Services we run for you
/services

The LandLens suite
/landlens/one

Verified RealEstate™

Every claim in this document traces back to a government record.

- Legal opinions, due diligence and title verification
- Building plan, layout and sub-division approvals
- Completion and occupancy certificates, regularisation
- Escrow, negotiation and NRI property management
- Land survey, soil testing, architecture and construction

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Prepared from the registers named on the page each finding sits on. Where a register could not be read, this document says so in its place rather than leaving the gap to be read as a clean result.