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DIGITALLY VERIFIED RECORD

DESIGN CALCULATION FOR THE RESIDENTIAL BUILDING AT AGARAMTHEN VILLAGE. (BLOCK – A & B)	Revision	Prep by	Checked by	Approved by
	A	PRS	PRK	PRK

STRUCTURAL STABILITY CERTIFICATE

AND DESIGN REPORT

DESIGN CALCULATION FOR PROPOSED CONSTRUCTION OF GROUP HOUSING DEVELOPMENT COMPRISING 2 BLOCKS: BLOCK A – STILT FLOOR + 5 FLOORS (HEIGHT – 18.30M) RESIDENTIAL BUILDING WITH 20 DWELLING UNITS: BLOCK B – STILT FLOOR + 5 FLOORS (HEIGHT – 18.30M) RESIDENTIAL BUILDING WITH 20 DWELLING UNITS; TOTALLY 40 DWELLING UNITS FOR AFFORDABLE HOUSING AT PLOT NO.2 (CMDA APPROVED SUBDIVISION), AGARAMTHEN, CHENNAI -600126 COMPRISED IN S.NO.236/1A (DOCUMENT) AND S.NO.236/3A1 (PT) (PATTA) OF AGARAMTHEN VILLAGE WITHIN THE LIMIT OF ST.THOMAS MOUNT PANCHAYAT UNION, TAMIL NADU, INDIA.

FOR

M/s. M. C. Builders,

No 210 / 911, Velachery Main Road,

Selaiyur. Chennai – 600 073.

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	STRUCTURAL DESIGN STABILITY CERTIFICATE

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1. Scope:

The scope of this calculation covers the structural design.

2. Design Philosophy:

The Structure is modeled as 3D frame in STAAD Pro. The structure is designed to resist earthquake forces of the zonal area as per IS codes. The project site is located in a zone III seismic zone as per IS 1893.

M25 minimum Grade of concrete is considered for design and for reinforcing steel Fe415 Steel confirming to IS standards.

2.1 Standards / Codes

Recommendation and requirement of Indian codes of practice below are followed in order to ensure the global stability of the structure.

IS 875(Part 1) 1987	Code of practice for design load (other than earthquake) for building and structure – unit weights of buildings and stored materials.
IS 875(Part 2) 1987	Code of practice for design load (other than earthquake) for building and structures – Imposed Loads
IS 456 – 2000	Plain and reinforced concrete – code of practice.
IS 1786 – 1985	Specification for high strength deformed bars and wires as concrete reinforcement.
IS 13920 – 1993	Code of practice for ductile detailing of RCC structures.
IS 4326 – 1993	Earthquake resistant design and construction of buildings – Code of practice.
SP 16	Design aids for reinforced concrete to IS 456 – 1978.
SP 34	Hand book on concrete reinforcement and detailing.

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2.2 Analysis Software

The three dimensional analysis of the structures is carried out using the STAAD PRO. Appropriate loads and its combinations, as per relevant clauses in codes mentioned above, for most unfavorable effects will be chosen for design. Support at base is pinned. The excel spreadsheets are used for calculations and design.

3. Design Loads:

The various design loads considered are as follows:

- Dead Load
- Live Load
- Seismic Load

3.1 Dead Load:

The dead load comprises of Structure self weight, dead load from masonry walls, plastering, self weight of slabs, floor finishes etc, which are the permanent loads. Refer to Clause 5.0 below for detailed calculation.

3.2 Live Load:

The live is the imposed load due to the occupancy and is considered as per Indian Standard Code IS 875. Refer to Clause 5.0 below.

3.3 Seismic Load:

The loading due to earthquake shall be assessed based on the provisions of IS 1893 & Zone III is considered for design. Zone factor = 0.16 & Importance factor I = 1 for the building.

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4.0 Load Combinations:

The various loads shall be combined in accordance with the stipulations in IS 456-2000; whichever combination produces the most unfavorable effect in the building, foundation or structural member concerned will be adopted.

Combination	DL	LL	EL
DL + LL	1.5	1.5	-
DL + LL + EL	1.2	1.2	1.2
DL+EL	1.5	-	1.5
DL+EL	0.9	-	1.5

Earthquake load is considered for both x & y directions but not acting simultaneously

DL — Dead Load

LL — Live Load

EL — Earthquake Load

5.0 Load Calculations:

The load calculation for the Dead, Live and Seismic load are presented here.

5.1 Dead Load

Dead load (Selfweight) of the Structure frames will be automatically calculated by STAAD Pro.

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5.1.1 Dead Wall Load

Brick Wall Load

Load on wall for 1m high

Unit Weight of brick work	=	19 kN/m^3
Thickness of Brick work	=	230mm or 0.23m
Weight of Brick work	=	4.37 kN/m for 1m high
Finishes on both sides (0.016 +0.012) x 24)	=	0.672 kN/m for 1m high
{Considering 16 mm Outer plastering & 12 mm Inner Plastering}		
Therefore, Uniformly distributed load for 1m high	=	5.042 kN/m

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WALL LOAD

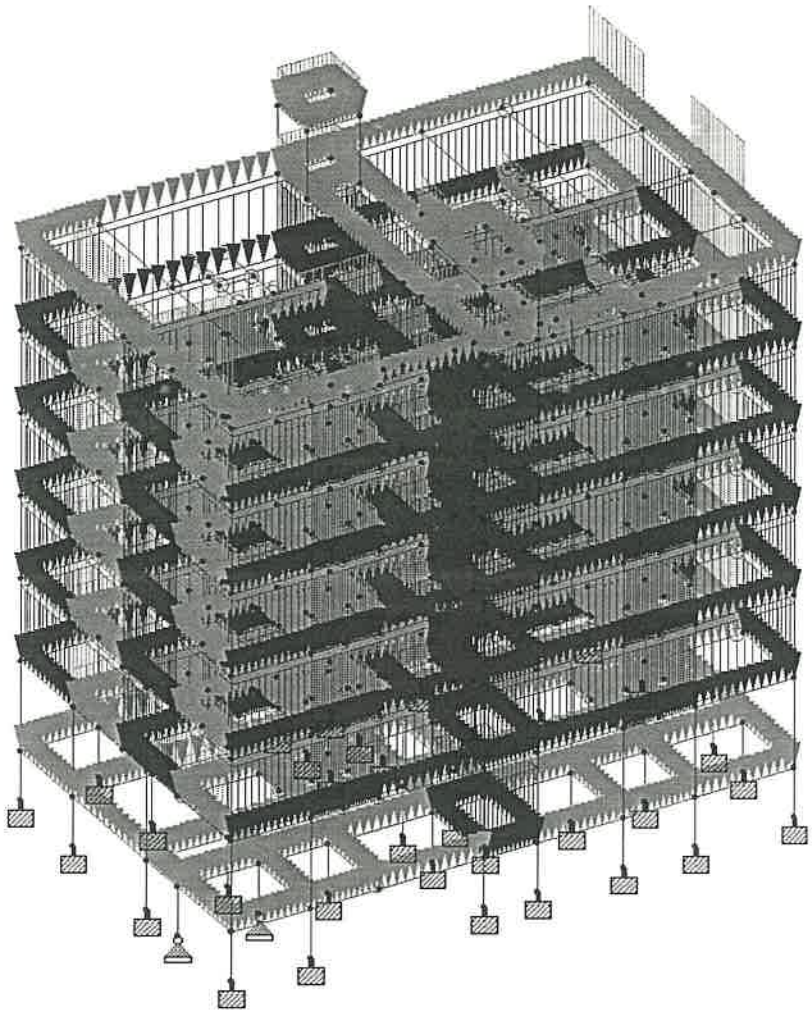


Fig 1a. Load of Brick Work (BLOCK 'A')

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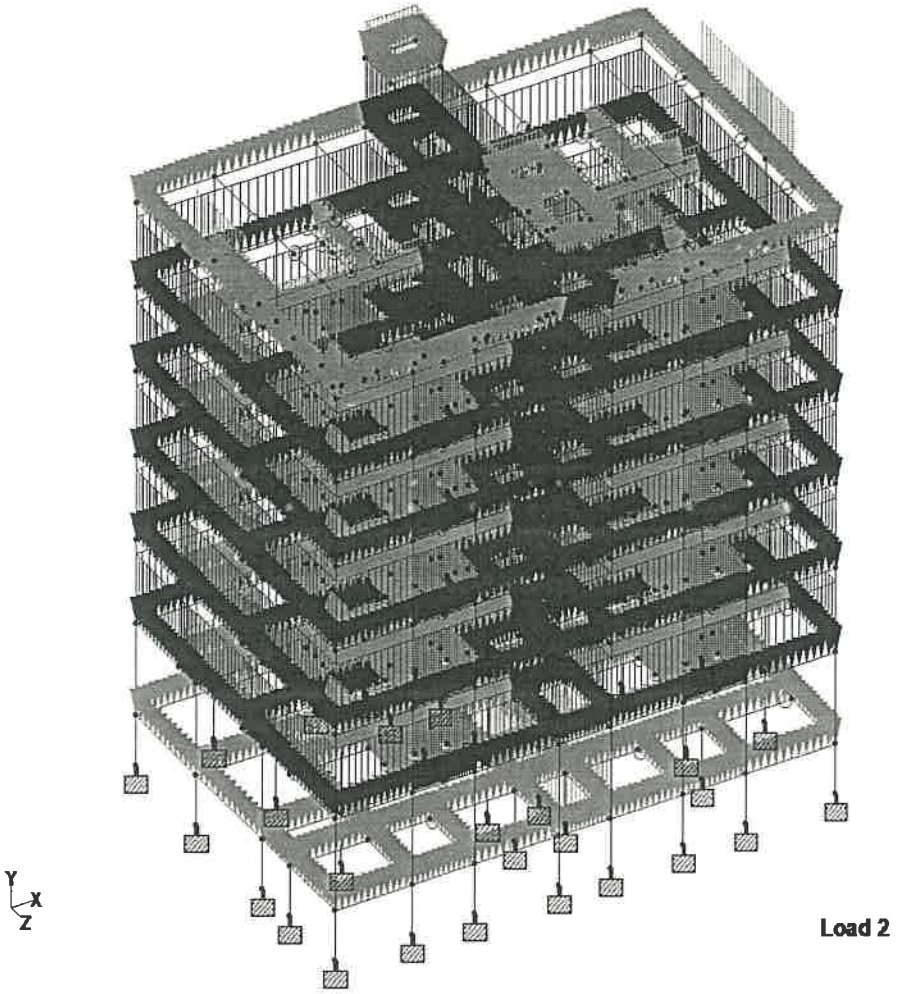


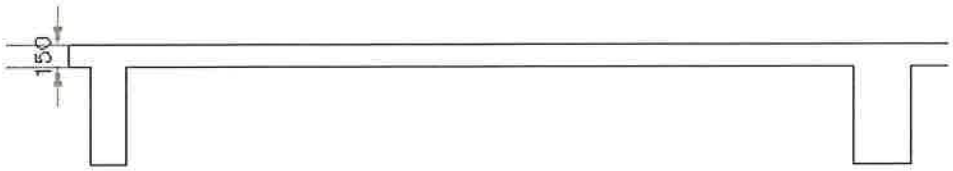
Fig 1b. Load of Brick Work (BLOCK 'B')

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5.1.2 Dead Floor Load (slab load)

Floor Slab load is given as 'Floor Load

Slab Thickness considered = 150 mm



Dead load of the slab (0.15m x 25 kN/m^3)	=	3.75 kN/m^2
Floor finishes	=	1.25 kN/m^2
Ceiling Plastering (12mm) (0.012m x 21 kN/m^3)	=	0.252 kN/m^2
Total dead load on floor slab	=	5.25 kN/m^2

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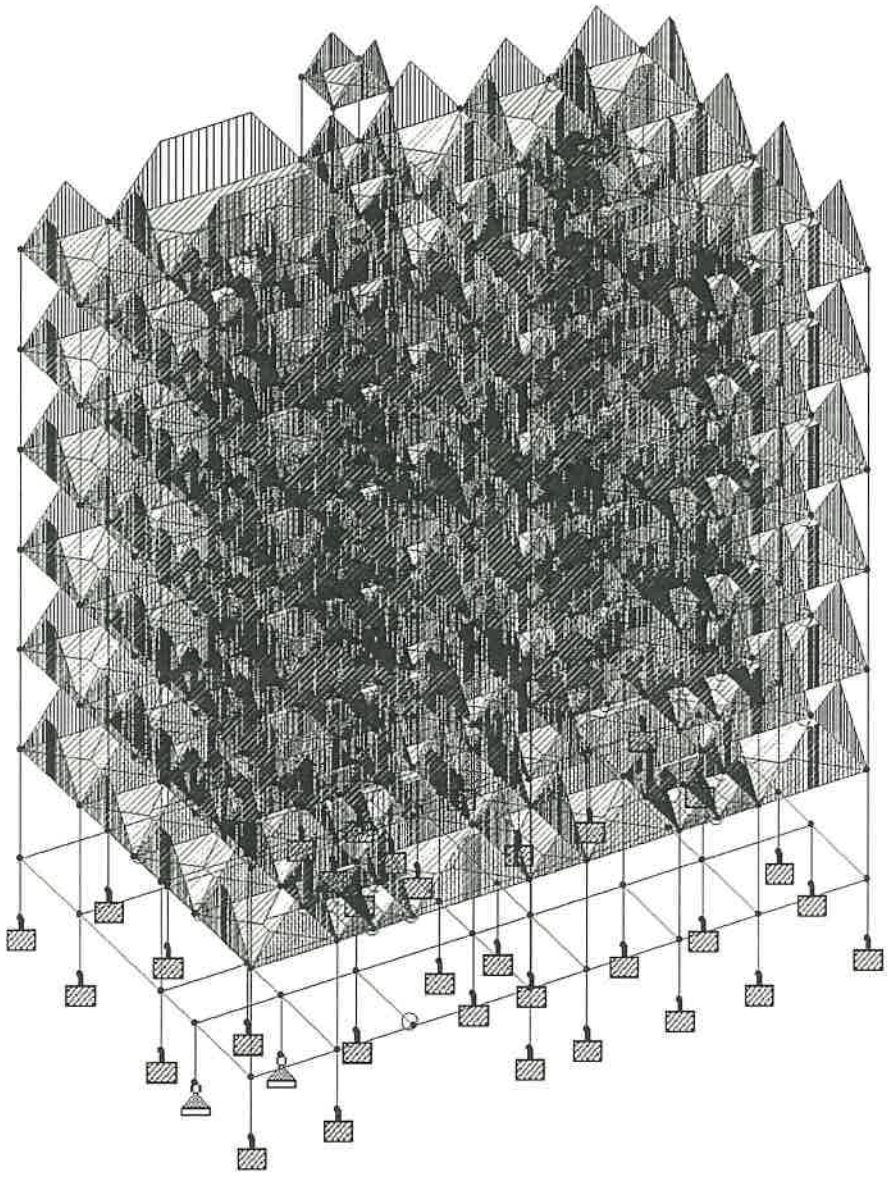


Fig 2a Self Weight of Floor Slab (BLOCK 'A')

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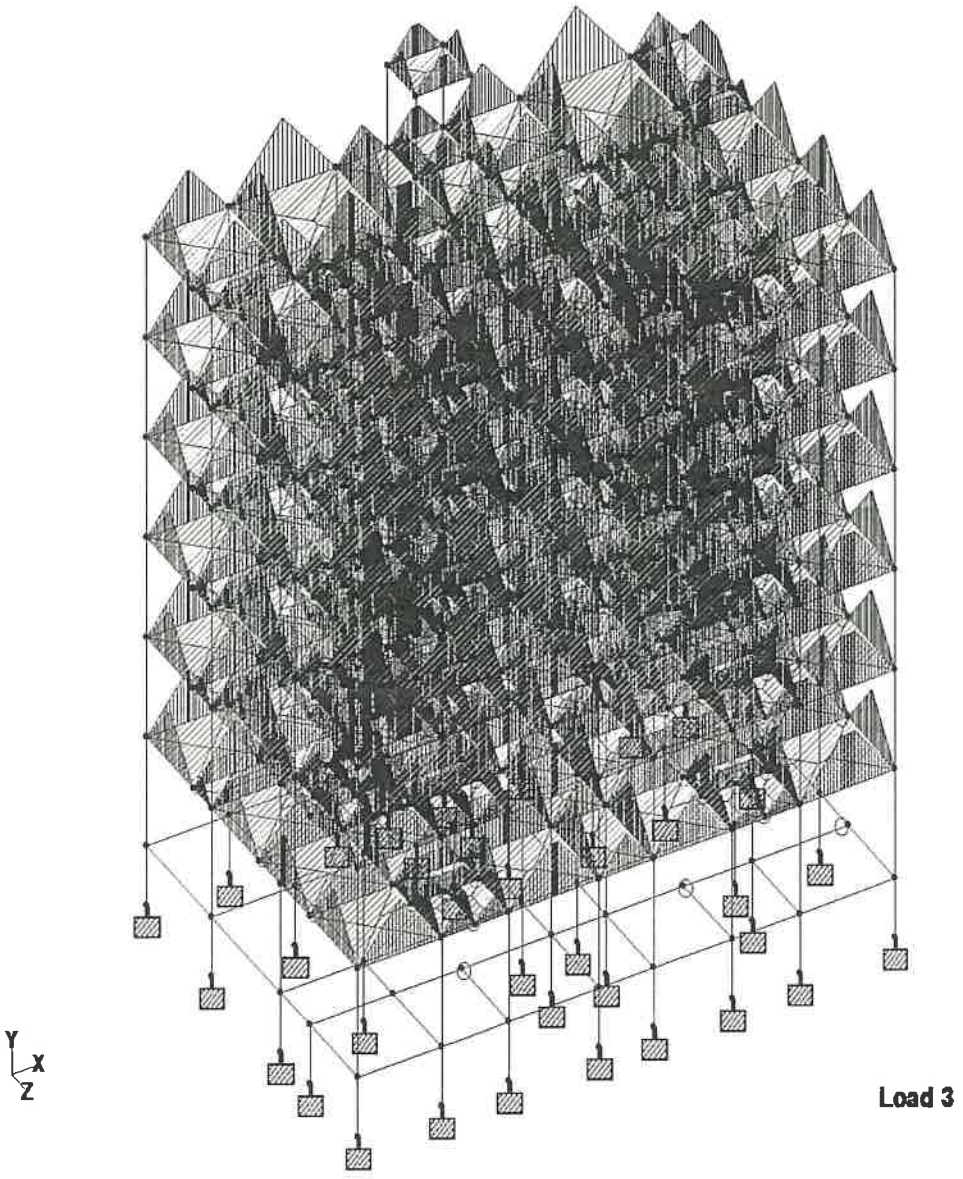


Fig 2b Self Weight of Floor Slab (BLOCK 'B')

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5.2 Live Load for Floor Slab & Stairs:

Live load on flat roof as per IS 875 = 2.0 kN/m^2

Reduction for live load of 25 % is considered as per IS 1893 (Part 1): 2002 for seismic Weight calculation.

LIVE LOAD ON FLOOR SLAB

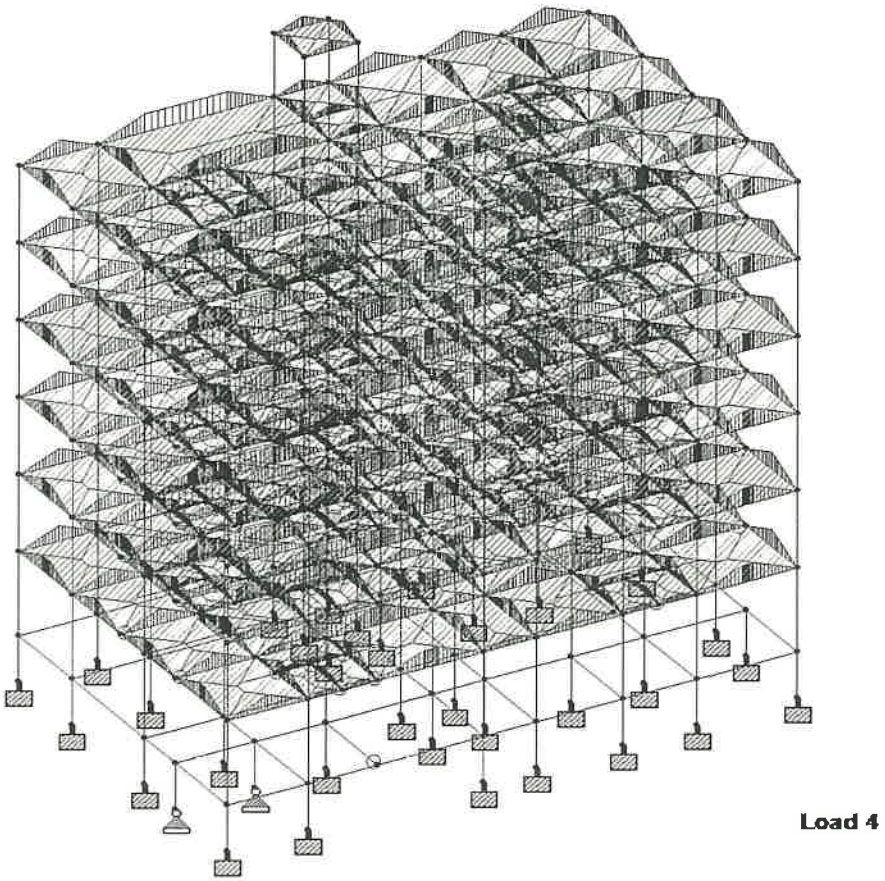


Fig 3a Live Load on Roof and Terrace (BLOCK 'A')

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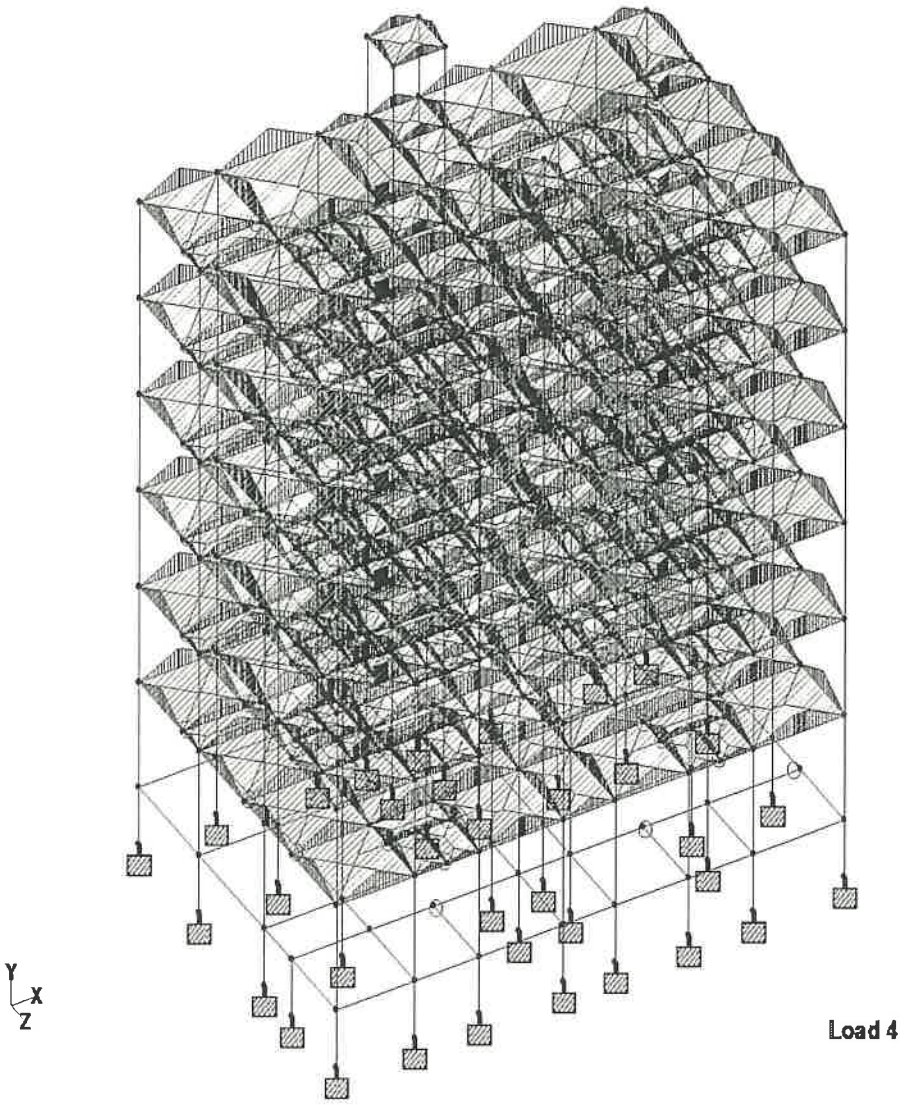


Fig 3b Live Load on Roof and Terrace (BLOCK 'B')

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5.3 Seismic Load

Seismic load shall be in accordance with IS 1893 (Part 1): 2002

Seismic Zone	=	II (Annex E, pg. no.: 35 of IS 1893 (Part 1): 2002
Seismic Zone	=	0.16 (Annex E, pg. no.: 35 of IS 1893 (Part 1): 2002
Response Reduction Factor (RF)	=	3 (Table 7, Cl 6.4.2, pg. no.:23 of IS 1893 (Part 1): 2002
Importance Factor (I)	=	1.0 (Table 6, Cl 6.4.2, pg. no.:18 of IS 1893 (Part 1): 2002
Damping Ratio (DM)	=	0.05
Period in X Direction (PX) T_a	=	$0.09/\sqrt{d}$
	=	$0.09/\sqrt{8.9}$
	=	0.030 Seconds
Period in Z Direction (PZ) T_a	=	$0.09/\sqrt{d}$
	=	$0.09/\sqrt{14.95}$
	=	0.023 Seconds

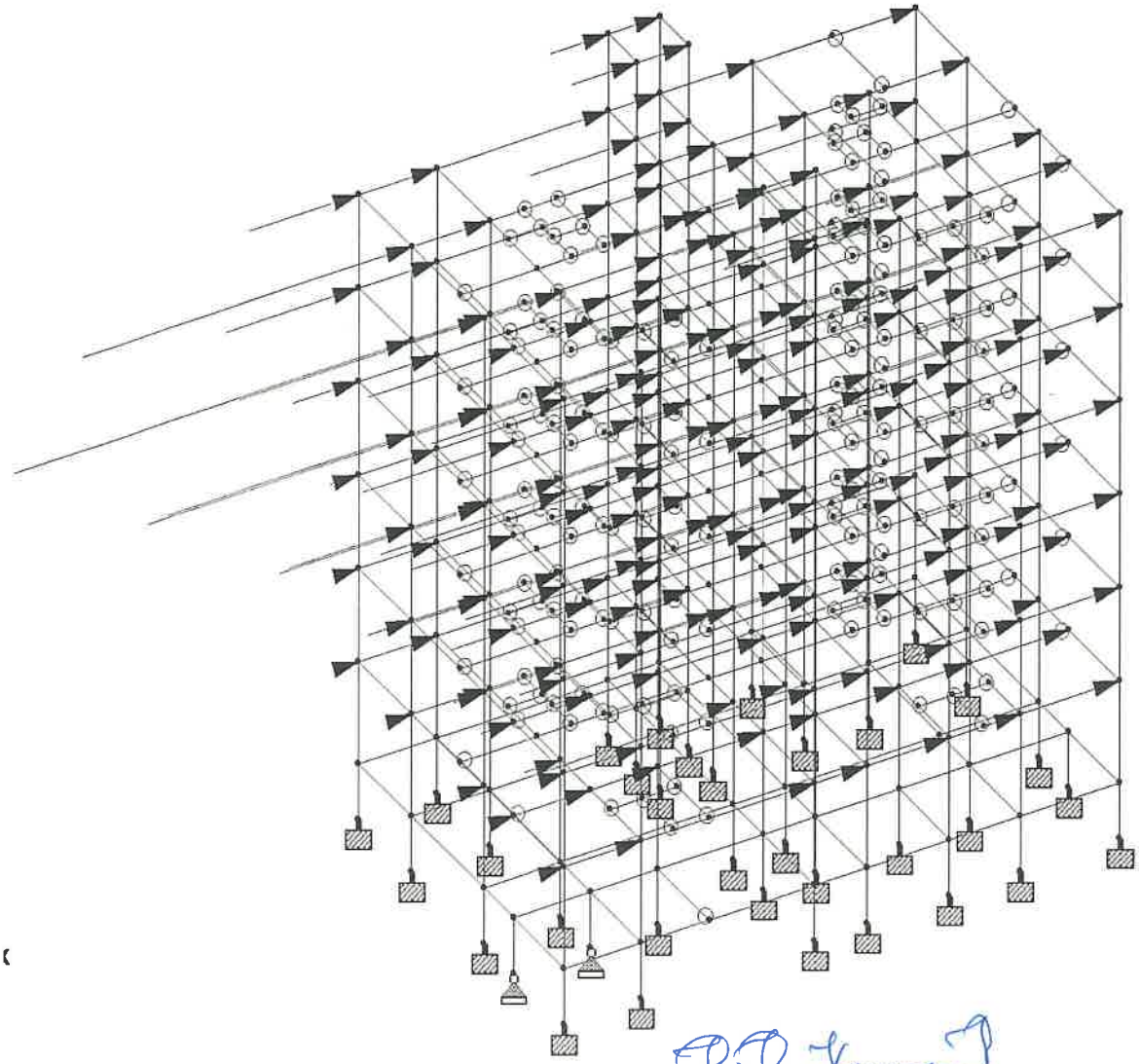
Nodal Mass for the structure is computed using STAAD by DEFINE seismic load method for the Full dead Load + appropriate % of Live Load combination the Seismic weight is computed.

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SEISMIC LOAD IN X DIRECTION

(BLOCK – 'A')

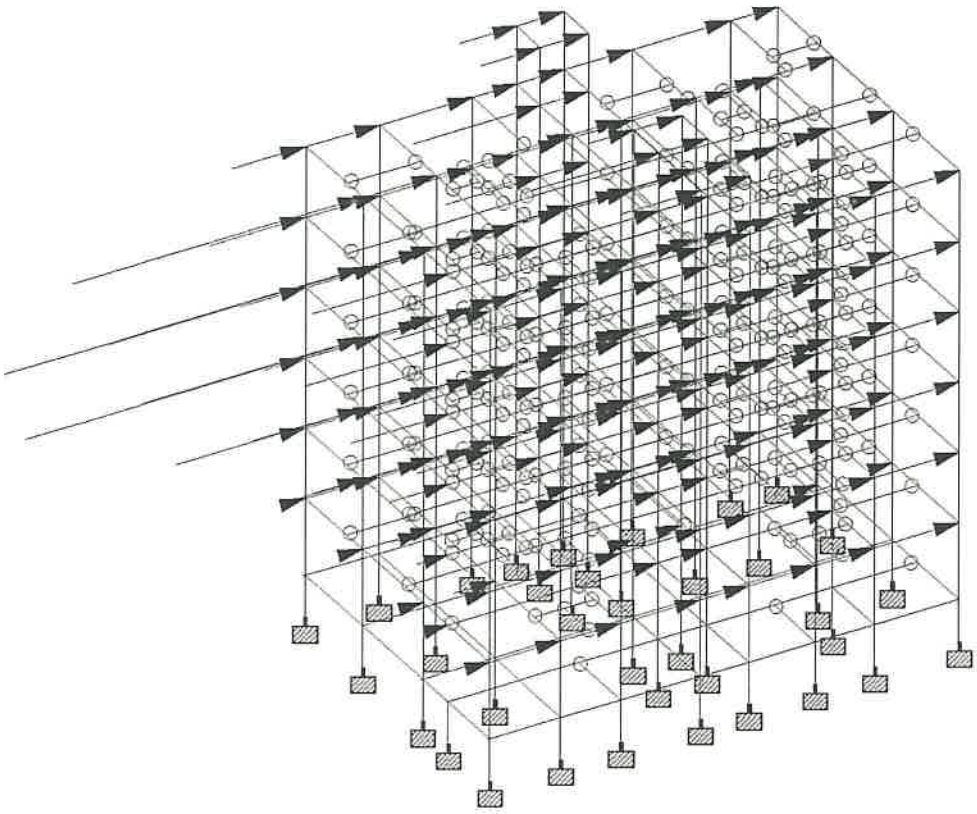


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SEISMIC LOAD IN X DIRECTION

(BLOCK – 'B')

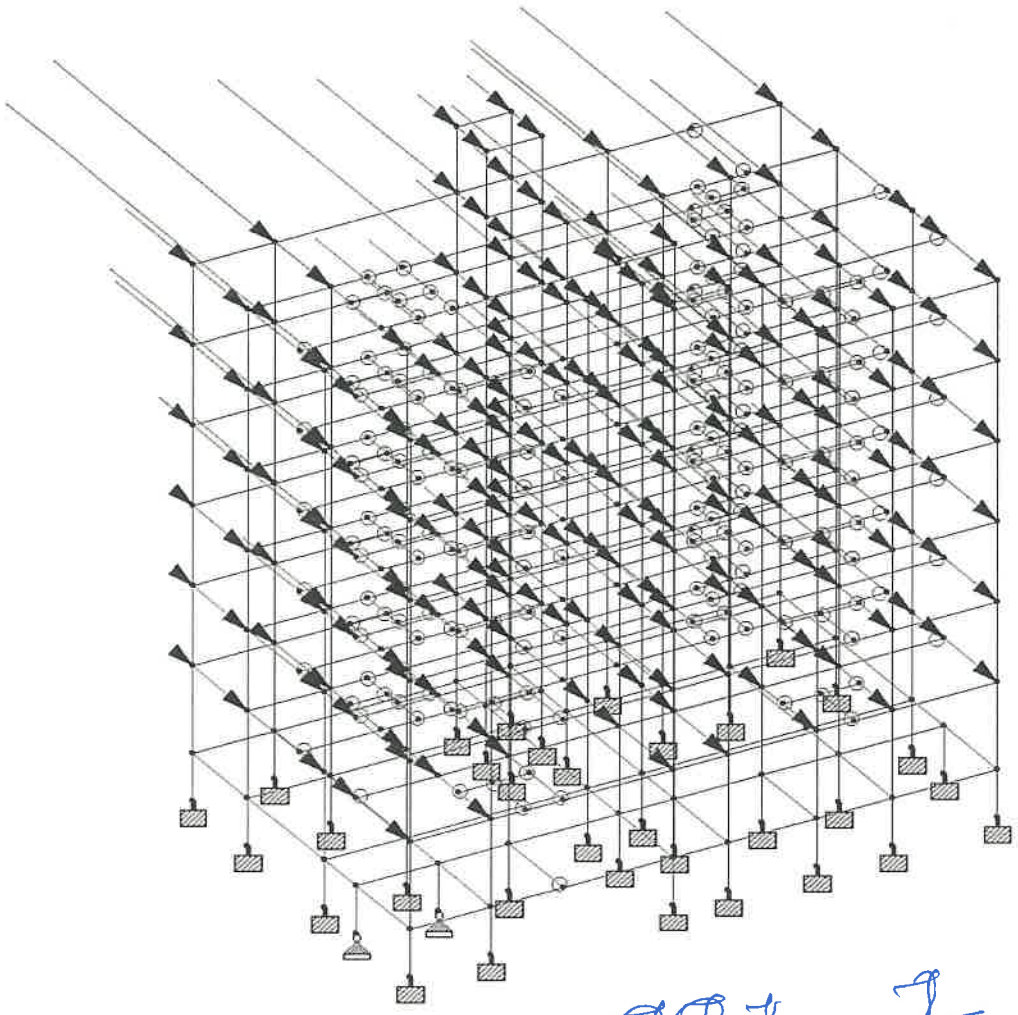


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SEISMIC LOAD IN Z DIRECTION

(BLOCK – 'A')

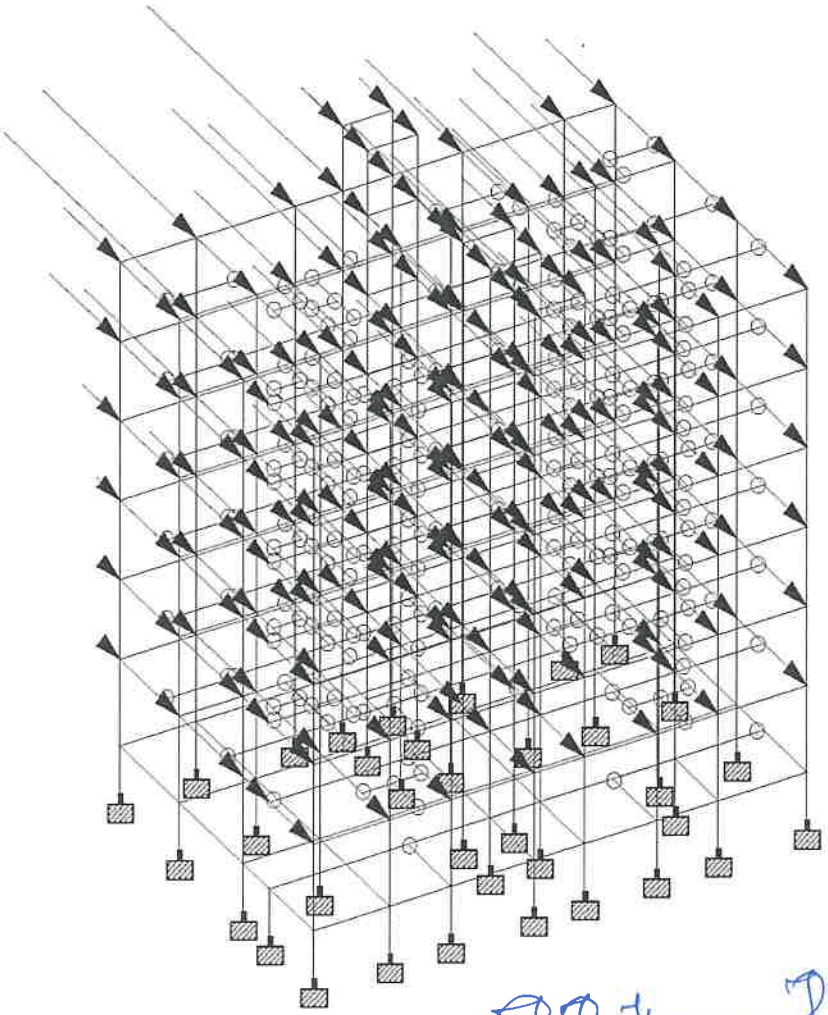


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SEISMIC LOAD IN Z DIRECTION

(BLOCK – 'B')

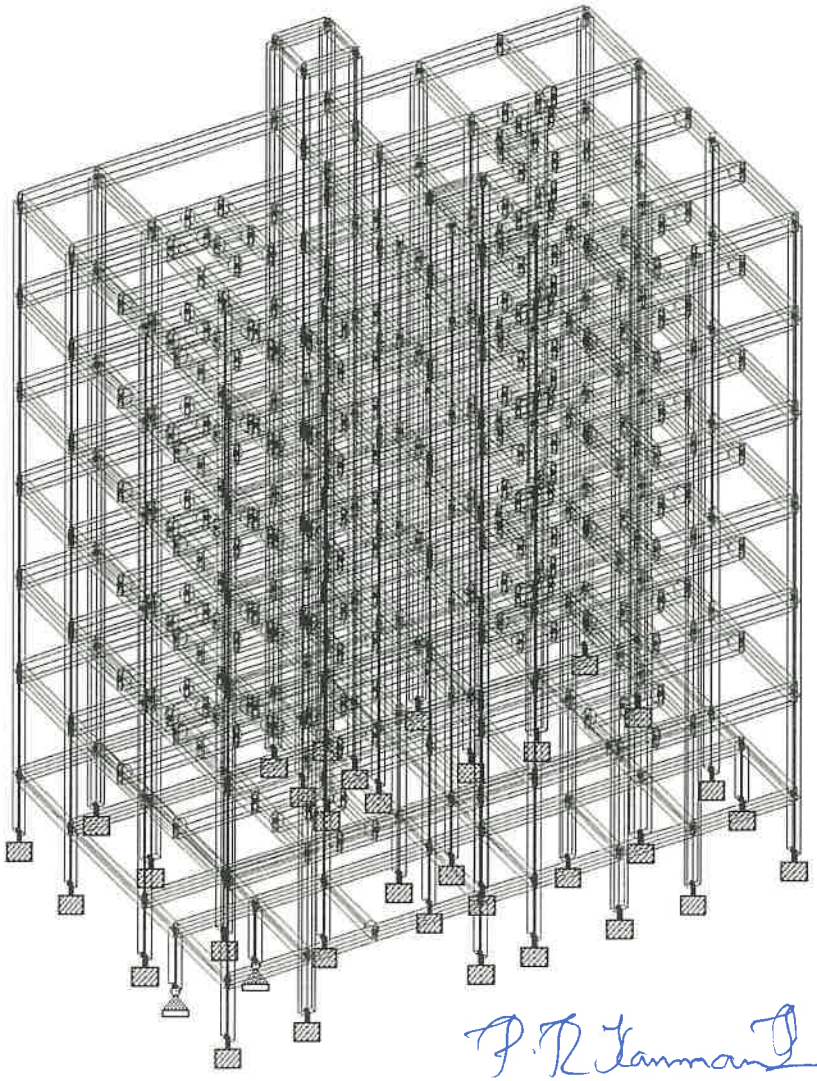


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3D View of Structure Modeled in STAAD.Pro.

(BLOCK – 'A')

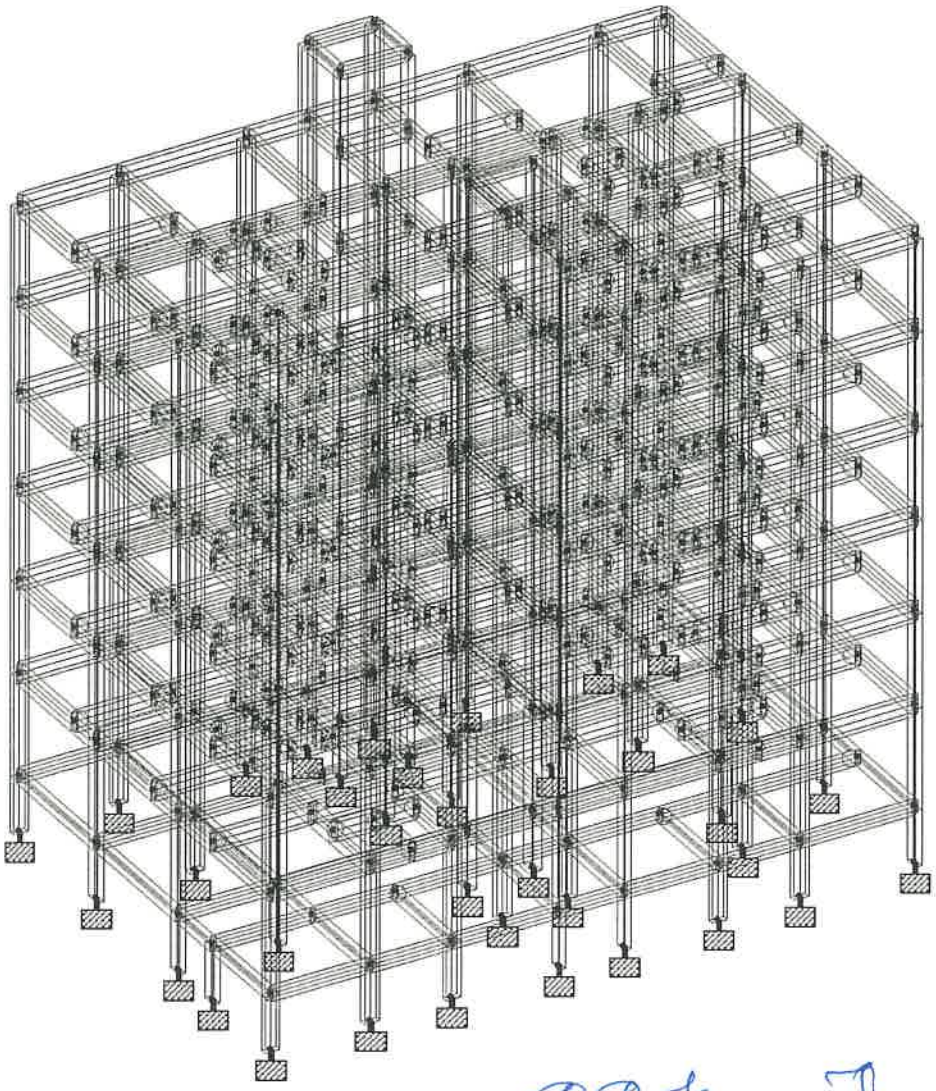


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3D View of Structure Modeled in STAAD.Pro.

(BLOCK – 'B')



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6.0 STRUCTURAL DESIGN:

The structure is modeled as 3D model in STAAD Pro and the analysis is performed using the STAAD Pro option 'PERFORM ANALYSIS PRINT STATIC CHECK'.

The analysis results are obtained from STAAD in the form of Support Reactions, member end forces etc. and the design is performed using the Spreadsheets developed for the design and such as for slab, beam , column & foundations.

The design is summarized in the following appendices of this document.

Appendix A	=	Slab design for all the levels using the spread sheet. For Slab type refer the Structural drawings.
Appendix B	=	Beam design is carried out from the Bending moments & shear forces extracted from STAAD and the design is done using spread sheet. The typical beam designs for the critical members are represented in this Appendix.
Appendix C	=	Column design is carried out from the Bending moments & shear forces extracted from STAAD. The typical Column design for the critical members is represented in this Appendix.
Appendix D	=	Foundation design is carried out from the Support reactions extracted from STAAD. The Support type is kept as pinned as per the soil condition. The typical foundation design for the critical members is represented in this Appendix and check for one-way shear & two-way shear is also carried out.

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7 CONSTRUCTION MATERIAL SPECIFICATIONS

7.1 Concrete

Concrete shall comply with IS456-2000 with a minimum grade of M25 using a cement content of 320 kg/m^3 with Ordinary Portland Cement.

7.2 Reinforcement

Steel reinforcement bar should confirm to Fe500D as per IS1786-2008. All rebar steel should be epoxy coated to avoid corrosion.

7.3 Soil

Soil test conducted by The Mars Synergy Geotech Pvt Ltd, Chennai has completed the geotechnical engineering services for the above referred project as directed by Mr. Ramesh Architect. They have conducted one bore hole in the proposed construction area. The bore holes were drilled upto 7m below the existing ground level. With reference to the bore hole – Upto 0.00 to 2.00m Very Desne Brownish and Light Greyish Clayey SAND, 2 – 4.5 m Very Dense Brownish Moorum, 4.5 – 7 m Fractured Hard Rock.

7.4 FOUNDATION SYSTEM

From field investigations, fter thorough compaction, adopt open shallow foundation in the form of isolated/strip raft at a depth of 2.0m below the Existing Ground Level (E.G.L). The ISOLATED FOOTING is recommended for this site. Rest the Foundation at The Safe bearing capacity of soil is 25T/Sq.m. at 2.0m below E.G.L in BORE HOLE NO-2 @ Foundation Level.

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Total Load on the Critical Column – 1286.85 kN

SBC of soil – 250 kN/m^2

Area Required – 1286.85 / 250 = 5.14m^2.

Area Provided = 6.72m^2.

7.5 SUPERSTRUCTURE

The entire structure is designed a reinforced concrete frame without brick partition wall in the Ground floor and upper floors with 230mm brick wall in Cement Mortar 1:6 for all outer walls 115mm wide partition wall in cement mortar 1:4, reinforced with two 8mm diameter rod for each 3 coarse interval for all inner wall. For RCC frame work i.e columns, beam and slab the material of construction should be M25 grade concrete (As per IS 456-2000) and Fe500D Steel (As per IS1786-2008).

COLUMN

Column Grid: C1

Cross sectional Area	=	230 x 600 = 138000 mm^2
Total Load	=	1286.85 kN
Compressive Strength of Concrete	=	25 N/mm^2
Bending in Compression (0.446 fck)	=	11.15 N/mm^2
Actual Stress (Load/Area)	=	9.32 N/mm^2
		< 11.15 N/mm^2
		Hence Safe

BEAM

Along Grid: C10-C12

Length	=	4.25 m
Breadth	=	230mm

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Depth	=	600mm
Effective Depth	=	540mm
Support Moment	=	186 kNm
Compressive Strength of Concrete (M25)	=	25 N/mm^2
Allowable Flexural Stress (0.7 x sqrt fck)	=	3.5 N/mm^2
Actual Flexural Stress (M_u/bd^2)	=	2.77 N/mm^2
		< 3.5 N/mm^2

Hence Safe and it is designed as Double Reinforced Beam

SLAB

Ground Floor Slab

Breadth per metre	=	1000mm
Overall depth	=	150mm
Effective Depth	=	126 mm
Load	=	7.25 kN/m^2
Maximum Bending Moment	=	9.71 kNm
Compressive Strength of Concrete (M25)	=	25 N/mm^2
Allowable Flexural Stress (0.7 x sqrt fck)	=	3.5 N/mm^2
Actual Flexural Stress (M_u/bd^2)	=	0.61 N/mm^2
		< 3.5 N/mm^2
		Hence Safe.

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8 DEFLECTION SHOULD BE WITHIN THE LIMIT

Deflection of individual members as well as total structure checked based on serviceability criteria recommended in IS 456-2000 and IS 1893-2016 is

1. 1.0 DL + 1.0 LL

2. 1.0 DL + 0.8 LL + 0.8 EL

Earthquake load is considered for both x & y directions but not acting simultaneously

DL — Dead Load

LL — Live Load

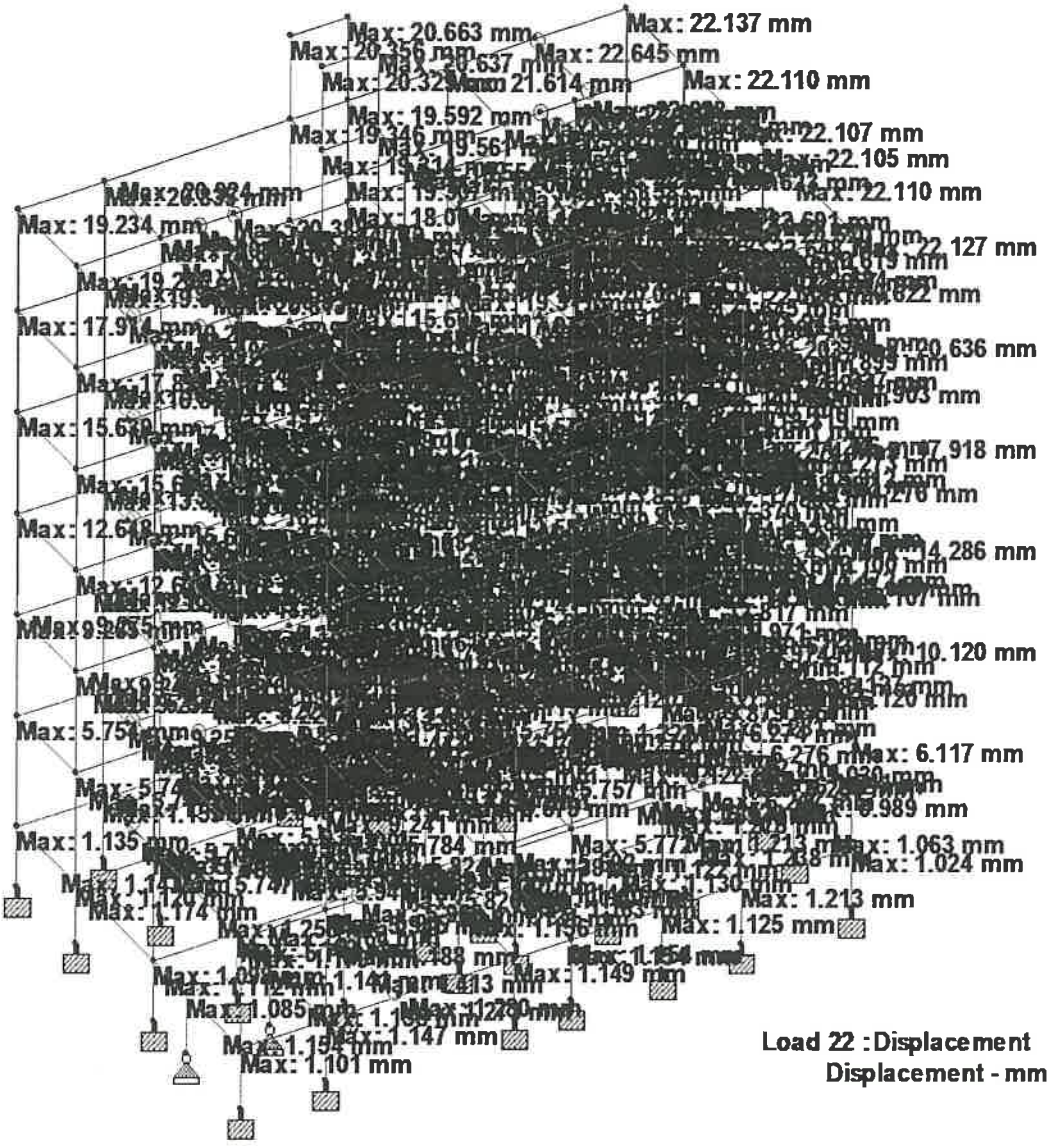
EL — Earthquake Load

IS 456 insists that deflection should be under certain control for structural members to satisfy serviceability requirements. In this structure the deflection for all individual structural members were checked and calculated locally and globally and ensured that they were within the limit.

Also all lateral deflections of frames for gravitational and lateral loads (Seismic Loads) were checked for storey drift as well as lateral deflection which were all within the limit. A portal frame from this structure is attached for reference.

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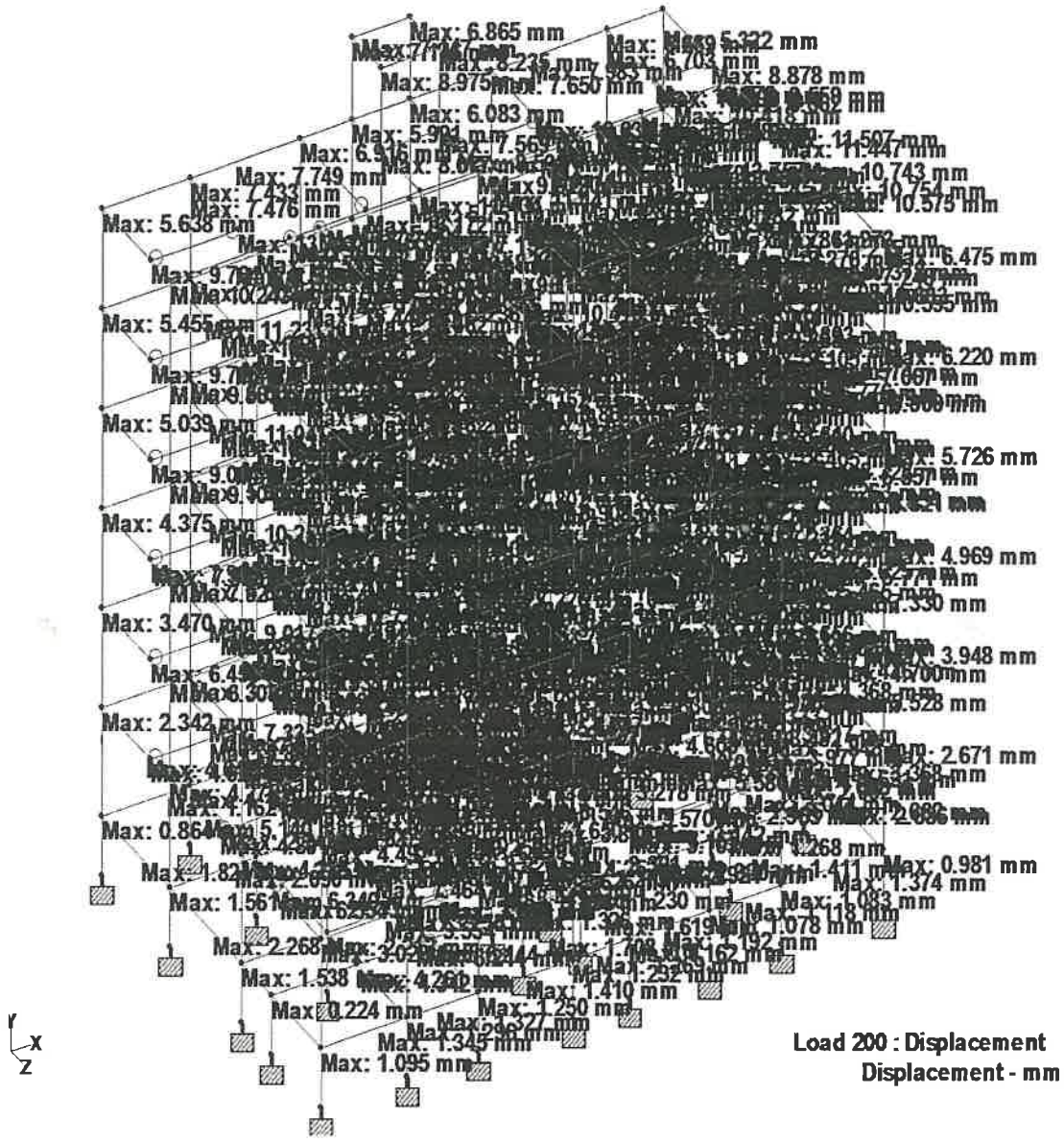
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Deflection of One Frame from STAAD Pro
(1.5 DL + 1.5 LL)
(BLOCK – 'A')

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Deflection of One Frame from STAAD Pro
(1.5 DL + 1.5 LL)
(BLOCK – 'B')

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Deflection diagram from STAAD Pro of Critical Frame with maximum deflection

Deflection value taken from STAAD

Total Height	=	18.3 m
The actual drift at top	=	32.93 mm
The allowable drift at top (Height / 300)	=	18300 / 300 = 61 mm
		> 24.93 mm
		Hence Safe
Storey to Storey Height (h)	=	3000 mm
Difference of Drift between each storey	=	32.930 – 28.425
	=	4.502 mm
Total Allowable drift between each floor	=	0.004 h
	=	0.004 x 3000
		12mm
		> 4.502 mm
		Hence Safe

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APPENDIX A

SLAB DESIGN

Design of Two way Slab The values are Displayed in Blue color are the Input values

1 Design Datas

1. Length of slab along shorter span, Lx	=	3.64	m
2. Length of slab along longer span, Ly	=	5.85	m
3. Compressive strength of Concrete, Fck	=	25	N/mm^2
4. Yield Strength of steel, Fy	=	500	N/mm^2
5.Diameter of Reinforcement, (Shoter span)	=	10	mm
6.Diameter of Reinforcement, (Longer span)	=	10	mm
7. Clear cover to the reinforcement, C	=	20	mm

2 Assume trial depth of slab

Span/depth, ratio l/d (Basic value)	=	26		(As per IS:456;2000, Clause 23.2.1)
Assume modification factor, M.F	=	1.5		
depth of slab	=	(Span/B.V x M.F)		
	=	(3.64 x 1000) / (26 x 1.5)		
	=	93.33	mm	
Overall depth required, D	=	(d+cc+1/2 dia of bars)		
	=	93.33 + 20+ 10 /2		
	=	118.3	mm	
	=	125	mm	
Eff. Depth,d	=	100	mm	

3 Load Calculations

Unit weight of Concrete	=	25	KN/m^3
Dead load of Slab	=	3.13	KN/m^2
Floor finishes	=	1	KN/m^2
Partitions	=	1.12	KN/m^2
Extra loads due to filling, surki , etc., if any	=	0	KN/m^2
Live Load	=	2	KN/m^2
Total Load	=	7.25	KN/m^2
Design Load	=	10.88	KN/m^2

4 Calculation of Bending Moment

Edge condition of Slab	=	4 4.Two Adjacent edges discontineous
Ly/Lx, ratio	=	5.85 / 3.64
	=	1.607
	=	The slab is Two way Slab

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S.No	Direction & Sign	Moment Co-efficients	Moment KN.m		
1	X - Negative	0.091	12.68	(alpha x * wu *lx^2)	(Annex D, clause D.1.1, IS:456:2000)
2	X - Positive	0.068	9.48	(alpha x * wu *lx^2)	
3	Y- Negative	0.045	6.27	(alpha y * wu *lx^2)	
4	Y- Positive	0.034	4.74	(alpha y * wu *lx^2)	

M,max = 12.68 KN/m

5 Effective depth required

Mu.lim = (0.36 x Fck x (xu.max/d) x (1-0.42(xu.max/d)) x bd^2 (IS:456:2000, Annex G, clause G.1.1.c)

xu.max/d = 0.48

Mu.lim = 3.45 bd^2

d,reqd = (Mu.lim/Qb)$^{1/2}$

= (12680000 / (3.45 x 1000)) $^{1/2}$

= 60.62 mm

60.62 < 100

O.K

6 Reinforcement Calculations

S. N	Dn & Sign	Mu/bd^2	pt from SP16	pt, min	pt,provided	Ast, mm^2
1	x -ve	1.27	0.311	0.12	0.311	311
2	x +ve	0.95	0.228	0.12	0.228	228
3	y -ve	0.63	0.149	0.12	0.149	149
4	y +ve	0.47	0.11	0.12	0.12	120

pt = 100Ast/bd

Ast = (pt/100)xbd

7 Spacing of reinforcement

Spacing, mm		Spacing provided, mm	Ast provided, mm^2
Actual	Minimum		
252.4	300	100	785
344.3	300	100	785
526.8	300	150	523.33
654.2	300	150	523.33

Spacing = (ast x 1000)/Ast

where,

ast= C/s area of bar

Ast=Area of reinforcement provided

3d or 300mm which ever is less IS:456:2000, Clause 26.3.3.b

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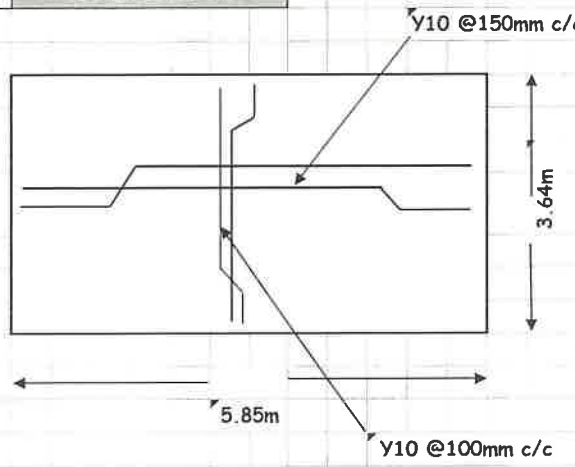
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8 Check for deflection

lx/d, Actual	=	36.4
l/d, Max	=	B.V x M.F
pt,	=	100Ast/bd
	=	0.785
fs	=	0.58x fyx(Ast required/Ast provided)
fs	=	78.69 N/mm^2
Modification Factor	=	2.42
l/d, Max	=	2.42 X 26
	=	62.92
		62.92>36.4
		O.K

9 Reinforcement Details

Direction	Reinforcement
X	Y10 @100mm c/c
Y	Y10 @150mm c/c



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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.
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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
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