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STRUCTURALDESIGNCALCULATIONREPORT

- ☐ Design Information and criteria
- ☐ Design of Foundation
- ☐ Design of Column
- ☐ Design of Slab
- ☐ Design of Beam

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DESIGN INFORMATION AND CRITERIA

1. INTRODUCTION

(Proposed 152 Dwelling units) at TS.No 65/2 , Old TS.No 315/1, 315/2, 315/3, & 316/2 Kottapattu Majara Ward -AV , Block No - 11, Raja Nagar Ext -II , Ponmalai Zone, Trichy City Corporation is designed to resist all possible Gravity, Seismic loads, Wind loads and other Combination of loads as per the relevant IS Codes and other Codes in vogue which the structure is intended to with stand

2. CODES OF PRACTICE

In the analysis ,design and detailing of the building, the following Indian Standard codes will be used.

Design Loads (Other Than Earthquake Loads)

IS Code	Description
IS875(Part1):1987	Dead Loads(Unit Weight of Building Material and Stored Material)
IS875(Part2):1987	Imposed Load
IS875(Part3): 2015	Wind Load
IS875(Part5):1987	Special Load sand Combinations

Design for Earth quake Resistance

IS Code	Description
IS1893(Part-1):2016	Criteria for Earthquake Resistance design of structures.
IS4326:1993	Earth quake Resistant Design and Construction of Buildings -Code of Practice
IS13920:2016	Ductile Detailing of Reinforced Concrete Structures subject to Seismic Forces - Code of Practice.
IS16700:2017	Criteria for Structural Safety of Tall Concrete Buildings

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Design of Concrete Elements

IS Code	Description
IS456:2000	Plain and Reinforced Concrete-Code of practice
IS6403-1981	Code of practice for determination of bearing capacities of shallow foundations.
IS 8009-1976 (Part I):	Code of practice for calculation of settlement of foundations -Shallow foundation
IS1904	Indian Standard Code of practice for design & construction foundations in Soil: General Requirements
IS2950(Part1):1981 (Reaff.Nov2013)	Code of practice for design and construction of raft foundations : Part 1 Design (second revision).
IS2974	Code of practice for design &construction of machine foundation
SP16	Structural use of concrete, Design charts for singly reinforced beams, doubly reinforced beams and columns.
SP34	Hand book on Concrete Reinforcement &Detailing
SP7(Part IV)-2015	National Building code of India
IS1786-2007	Specification for high strength deformed bars and wires for concrete Reinforcement.
IS432 (Part2) 1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete reinforcement-Hard Drawn Steel Wire
IS3370 (partI)	Code of practice for concrete structure for the storage of liquids

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3. DESIGN PARAMETERS

Materials of Construction

The building is predominantly Shear wall connected with slab/beam. The lateral load resisting system of Shear walls/ Columns are well connected in orthogonal direction along with the centrally located Lift Core wall which are connected by floor slab is act as diaphragm in distribution of lateral forces.

3.1. Concrete Grade

Concrete grade shall be M20 for Basement wall, Basement slab ,etc. whereas Shear wall, RC Column, RC beam &RC slab shall be M20 with minimum 28-day strength of 20 MPa respectively.

Concrete Mix Ml0 has been used infilling, plum concrete, leveling courses (PCC) and other non-structural items.

Density of reinforced concrete is assumed as -25kN/cu.m.
Minimum cement content, water cement ratio etc. shall conform to IS 456:2000 code provisions for durability and strength criteria. The approved design mix shall be used for producing concrete.

Cement

Ordinary Portland cement of grade 43 or higher confirming to IS 8112 and IS 12269 is specified for concrete M20 for Basement wall & Slab whereas the grade is to be M20 for RC shear wall, column, Beam, RC Slab etc. with cement content appropriate to the desirable compressive strength and slump. The design mix using the intended brand of cement together with material test report including tests on coarse aggregate, fine aggregate etc. shall be submitted to the consultant's review and approval.

Aggregates

The sizes of coarse aggregates confirm to IS 383. Nominal maximum size of coarse aggregate to be 20 mm, suitably graded as per the requirement of mix design. The fine aggregates confirm to the specifications of IS 383.

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Water

Waterusedforconstructionshallcompliedwithstipulationsgiveninis456:2000.

Reinforcement

High yield strength deformed bars conforming to IS1786 with fy=500*N*Isq.mm has been used with elongation not less than 14.5 %.

Structural Steel

MS steel with yield strength fy = 250*N*I sq.mm shall be used for Structural steel work wherever necessary which shall conform to IS226 and IS2062 for Indian steel sections.

Concrete Cover

Cover to reinforcement considered for various elements with Fire rating considered- 2hrs. are as follows.

a. Raft =60mm
b. Column = 40mm
c. Beam =30mm (Bottom and sides)
d. Slab =25mm(Top and Bottom)

Table Structural Configuration and Floor heights:

Building Floor Height Details	**Stilt + 4**
Stilt floor height (Car Park)	3.00m
1st Floor to 4th Floor height(Residential)	3.00m
Head Room	2.50m
Type of Foundation	**Raft**
Grade of concrete for Raft	M20
Grade of concrete for Columns (Podium)	M20

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Material	Density
Plain Cement Concrete	25.00 kN/Cu.m
Brick Work	20.00 kN/Cu.m
Mortar Finishing	20.00 kN/Cu.m
Dry soil	18.00kN/Cu.m
Saturated soil	10.00kN/Cu.m
Glass	28.00kN/Cu.m
water	09.81kN/Cu.m

R.C Design

The structures are analyzed for the various load combinations as per IS: 456-2000.The design of structural elements are carried out by **Staad pro** for all structural elements for the worst forces extracted from the staad pro analysis output whereas the slab design is being done using in house spread sheet. For the design of R.C.C structural elements carried out, the recommendations stipulated in IS:456-2000 is followed. Limit State method of design is adopted with appropriate load factors with the various load combinations for the different structural elements appropriately.

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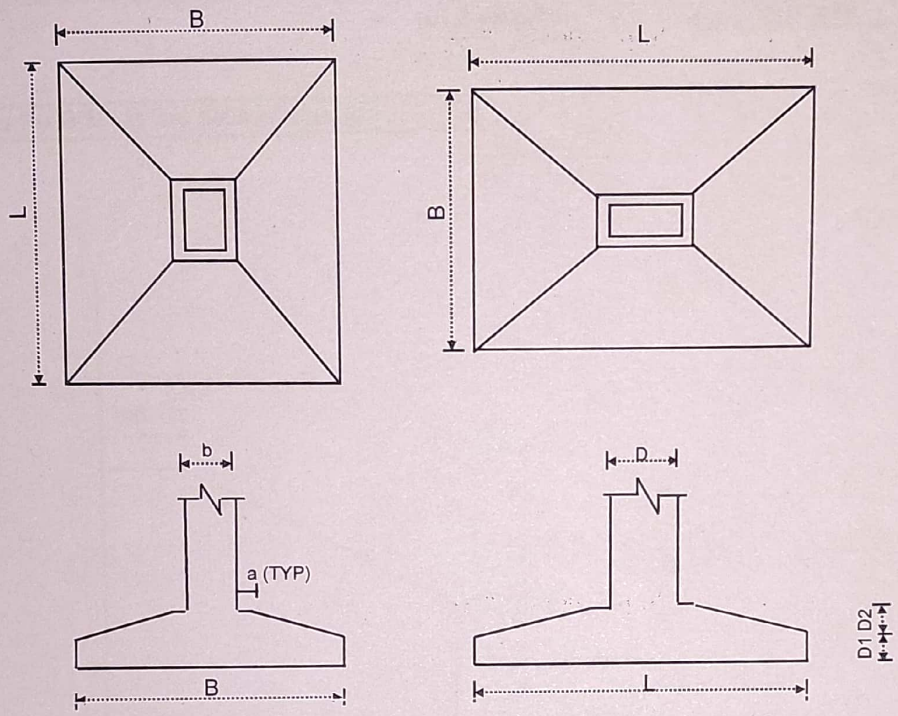
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DESIGN OF FOUNDATION

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DESIGN OF FOOTINGS (SAMPLE CALCULATION)

Footing Mkd. :	**F6**
Node Mkd. :	**1**



Design data

Grade of concrete	=	M 20
Grade of steel	=	Fe 500
Net safe bearing capacity of soil	=	220 kN/m^2
Clear cover to reinforcement	=	50 mm
Depth of foundation	=	1.85 m
Axial load on footing [1.5*(DL+LL)]	=	**600 kN**

Design dimensions

Length of footing (L)	=	1.65 m
Breadth of footing (B)	=	1.65 m
Shorter column dimension (b)	=	300 mm
Longer column dimension (D)	=	450 mm
Depth of footing at the tip (D1)	=	300 mm
Depth of footing at the column face (D2)	=	300 mm
Horizontal dimension around column (a)	=	100 mm
Diameter of bar along length	=	16 mm
Diameter of bar along breadth	=	12 mm
Cantilever along length	=	600 mm
Cantilever along breadth	=	675 mm

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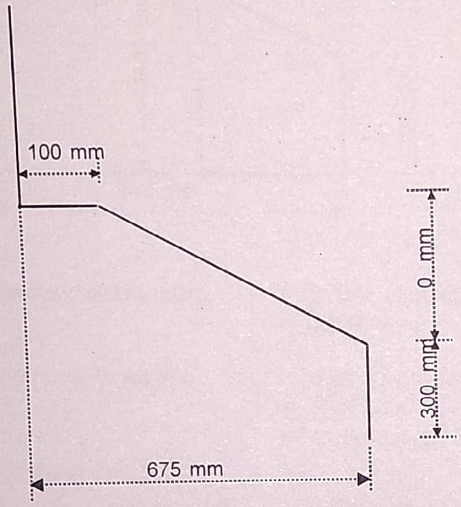
Check for bearing pressure

Total design load at the bottom of footing = (600* 1.1)/1.5 kN
= 440 kN

Design pressure at the bottom of footing = (440/(1.65*1.65)) kN/sqm
= 161.6 kN/m^2

Hence ok

Design for B.M. at the face of column



Cantilever moment at the face of the col. = (1.5*161.6* 0.5*0.675^2) kN-m
= 55.23 kN-m

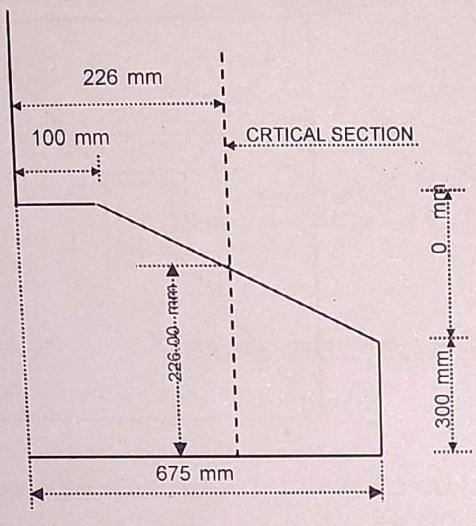
Effective depth at the face of the column = (300-50-16-8) mm
= 226 mm

Area of steel required = 601.8 mm^2
Percentage of steel required = 0.266 %

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Design for one-way shear



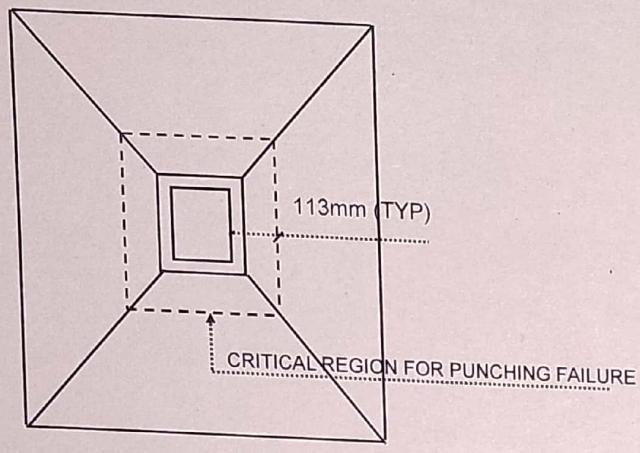
Effective depth at the critical section	= (226-0*(226-100)/(675-100)) mm	
	= 226.00 mm	
Design shear at the critical section	= (1.5*161.6*0.449) kN	
	= 108.8 kN	
Shear stress (τ_v)	= 0.482 N/mm^2	
Percentage of reinforcement (p_t) reqd.	= 0.2 %	
Allowable shear stress for the section(τ_c)	= 0.326 N/mm^2	Hence check
Area of steel reqd.(A_{st})	= 452 mm^2	

Hence required reinforcement = 16T @333mm c/c
Reinforcement provided = 12T @200mm c/c

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Check for punching shear



Effective depth at the critical region = (226-0*13/575) mm
= 226 mm

Total shear force at the section = (440*1.5-1.5*0.526*0.676*161.6) kN
= 573.8 kN

Shear stress (τ_v) = 1.06 N/mm^2

Allowable shear stress for the section(τ_c) = $0.25\sqrt{f_{ck}}$
= 1.12 N/mm^2

β_c = 1

k_s = $(0.5+\beta_c)$
= 1.5 >1

Hence k_s = 1.00

Allowable shear stress for the section(τ'_c) = $k_s \tau_c$
= 1.12 N/mm^2 **Hence ok**

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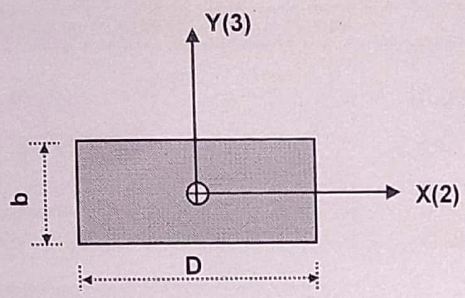
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DESIGN OF COLUMN

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DESIGN OF COLUMNS

Column Mkd. :	C6
Node Mkd. :	1



Design data

Grade of concrete	=	M 20
Grade of steel	=	Fe 500
Clear cover to reinforcement	=	40 mm
P_u [1.5*(DL+LL)]	=	**600 kN**
M_x [1.5*(DL+LL)]	=	**28.70 kN-m**
M_y [1.5*(DL+LL)]	=	**0.657 kN-m**

Design dimensions

Effective length of column (l_{ex}) (About x - axis)	=	3.00 m
Effective length of column (l_{ey}) (About y - axis)	=	3.00 m
Dimension of column perpendicular to x-axis (b)	=	300 mm
Dimension of column perpendicular to y-axis (D)	=	450 mm
Diameter of the corner longitudinal reinforcement	=	16 mm
Diameter of the additional longitudinal reinforcement	=	12 mm
Diameter of the lateral ties	=	8 mm

Calculation of moment due to minimum eccentricities

Minimum eccentricity (e_x) in y-direction	=	20 mm
Minimum eccentricity (e_y) in x-direction	=	21 mm

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Moment due to minimum eccentricity about x-axis ($P_u e_x$)	=	12 kN-m
Moment due to minimum eccentricity about y-axis ($P_u e_y$)	=	12.6 kN-m

Additional moment due to slenderness

About x-axis (lex/b)	=	10.00	Short column about x-axis
About y-axis (ley/D)	=	6.67	Short column about y-axis
Additional moment about x-axis	=	0.00 kN-m	
Additional moment about y-axis	=	0.00 kN-m	

Design of reinforcement

Design axial load on column (P_u)	=	600.00 kN	
Design moment about x-axis on column (M_{ux})	=	28.70 kN-m	
Design moment about y-axis on column (M_{uy})	=	12.60 kN-m	
d'/D	=	0.124	
Let the percentage of long. reinf. (p_t)	=	0.76 %	
p/f_{ck}	=	0.038	
$P_u/(f_{ck}bD)$	=	0.22	
$M_{ux1}/(f_{ck}b^2D) = M_{uy1}/(f_{ck}bD^2)$	=	0.06	(from Chart-45 of SP 16)
M_{ux1}	=	48.6 kN-m	
M_{uy1}	=	72.9 kN-m	
P_{uz}	=	$0.45 f_{ck} A_c + 0.75 f_y A_{sc}$	
	=	1590.52 kN	
P_u/P_{uz}	=	0.377	
α_n	=	1.295	
$\left(\frac{M_{ux}}{M_{ux1}}\right)^{\alpha_n} + \left(\frac{M_{uy}}{M_{uy1}}\right)^{\alpha_n}$	=	0.6083	<=1,hence ok
Required area of longitudinal steel (A_{st})	=	1026 mm^2	
No. of bars at each corner	=	1	

Required longitudinal reinforcement is 4 nos 16T at corners + 2 nos 12T on faces
Provide longitudinal reinforcement of 4nos 16T at corners and 2nos 12T at faces

Required lateral tie is 8T @ 192mm c/c
Provide lateral ties of 8T @ 150mm c/c

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DESIGN OF BEAM

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BEAM CALCULATION SHEET - B1

MAX MOMENT =	110.55	KN.m
MAX SHEAR =	79.32	KN
FACTORED MOMENT =	110.55	KN.m
FACTORED SHEAR =	79.32	KN.m
EFFECTIVE SPAN =	4500	mm

SPAN DEPTH RATIO =

CONTINOUS BEAM =	26	mm	R IS CODE REFER
d =	173.08	mm	
ASSUME WIDTH =	300	mm	
Mu/bd²	3.45		AS PER IS CODE TABLE G
d =	326.82	mm	
Mu/bd² =	2.19		

SAY D = 450 mm
DIA = 20 mm
CLEAR COVE 30 mm

d = 410 mm

d = 41 cm

AREA OF STEEL CALCULATION

Pt = Ast/bd *100

Pt =	0.35		REFER SP16 TABLE 2
Ast =	434.19	mm²	

Pc = Asc/bd *100

Pc =	0.45		REFER SP16 TABLE 2
Asc =	553.5	mm²	

PROVIDE AT 2 # 16 + 1# 20 Ast = (515 mm^2) (TOP) , 3# 16 (BOTTOM)

CHECK FOR SHEAR

SHEAR TAKEN BY

1. CONCRETE
2. NOMINAL STIRRUPS

CONCRETE : $\tau c * b * d / 1000$ 0.72 N/mm AS PER IS CODE TABLE 19

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88.56 KN

NOMINAL STIRRUPS

Vus/d = balance shear / c KN/cm

BALANCE SHEAR -9.24 KN

Vus/d = -0.23 REFER SP16 TABLE 63

PROVIDE AT Y8 2- LEGGED @150 C/C STIRRUPS

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DESIGN OF SLAB

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DESIGN OF FLOOR SLAB : S4

Assumed slab thickness = 125 mm

Total load intensity (w) = 10.6 kN/m^2

Design Parameters :

Grade of concrete : M 20
Grade of steel : Fe 500
Clear cover to the reinforcement = 25 mm
Bar diameter for main reinforcement = 10 mm

Design Calculations :

Edge condition of the slab: Adjacent edges discontinuous

Length along shorter direction (l_x) = 3.10 m
Length along longer direction (l_y) = 3.30 m
Ratio of longer and shorter lengths(l_y/l_x) = 1.06

$-\alpha_x$ = 0.075
$-\alpha_y$ = 0.047
α_x = 0.056
α_y = 0.035

$-M_{ux}/(bd^2)$ = 1.27 $(-)p_{tx}$ = 0.317
$-M_{uy}/(bd^2)$ = 0.80 $(-)p_{ty}$ = 0.192
$M_{ux}/(bd^2)$ = 0.95 $(+)p_{tx}$ = 0.231
$M_{uy}/(bd^2)$ = 0.59 $(+)p_{ty}$ = 0.141

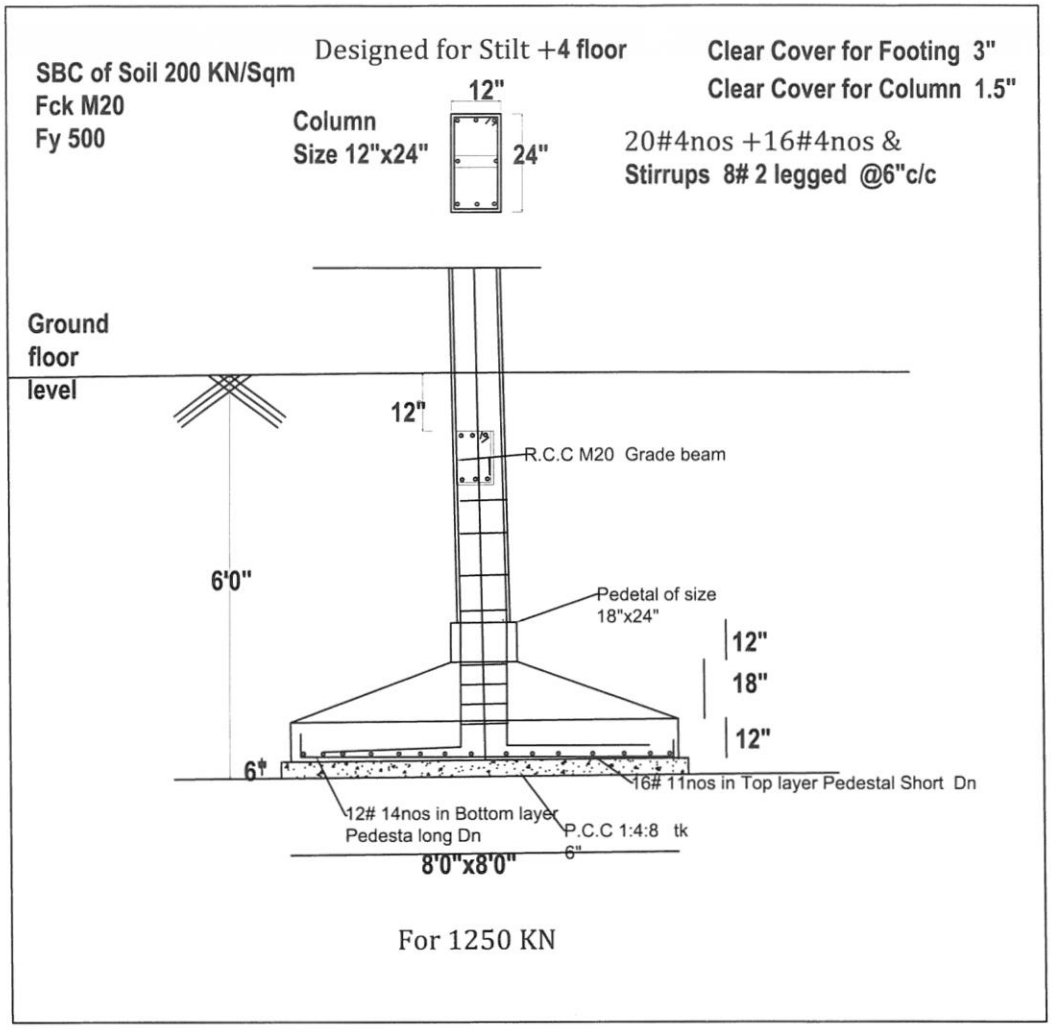
$-A_{tx}$ (mm^2) = 301.18	Required 10T @ 261 c/c	Provided spacing 10T @ 150 c/c
$-A_{ty}$ (mm^2) = 182.55	Required 10T @ 431 c/c	Provided spacing 10T @ 150 c/c
A_{tx} (mm^2) = 219.77	Required 10T @ 358 c/c	Provided spacing 8T @ 150 c/c
A_{ty} (mm^2) = 134.15	Required 10T @ 586 c/c	Provided spacing 8T @ 150 c/c

Deflection Check :

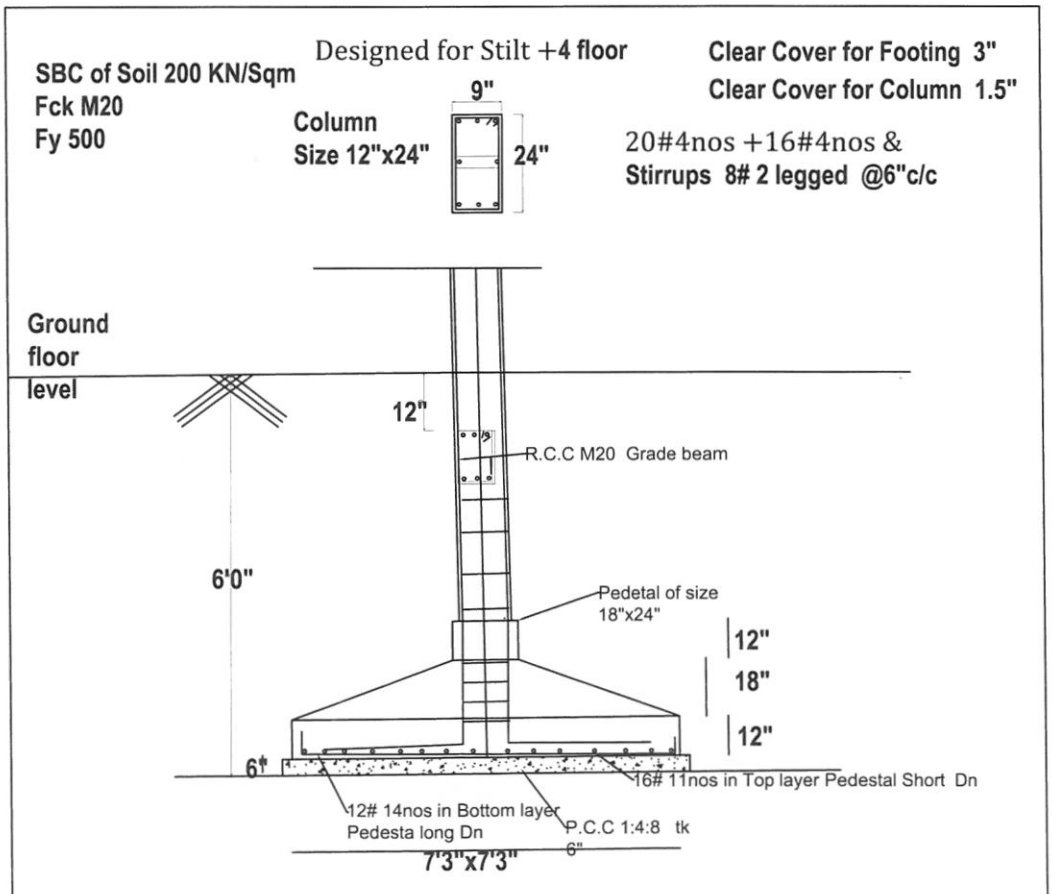
Effective span of the slab	=	3.10 m	
Span to depth ratio	=	24.8	(Clause 23.2.1, IS 456 : 2000)
Percentage of reinforcement required	=	0.23	
Percentage of reinforcement provided	=	0.23	
Steel stress of service loads (f_s)	=	292 N/mm^2	
Modification factor	=	2	{Clause 23.2.1(c), IS 456 : 2000}
Effective depth of the slab required	=	62.5	**< Effective depth provided, hence safe in deflection.**

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For 1250 KN



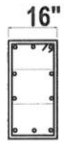
For 1150 KN

SBC of Soil 200 KN/Sqm
Fck M20
Fy 500

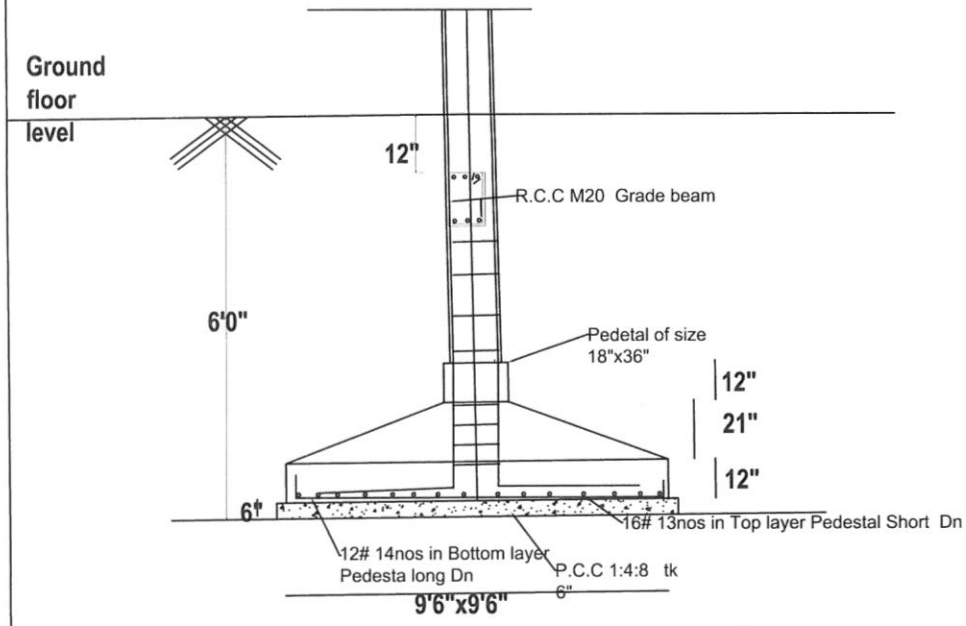
Designed for Stilt +4 floor

Clear Cover for Footing 3"
Clear Cover for Column 1.5"

Column
Size 12"x30"



20#10nos & Stirrups 8# 2 legged @6"c/c



For 1800 KN

SBC of Soil 200 KN/Sqm
Fck M20
Fy 500

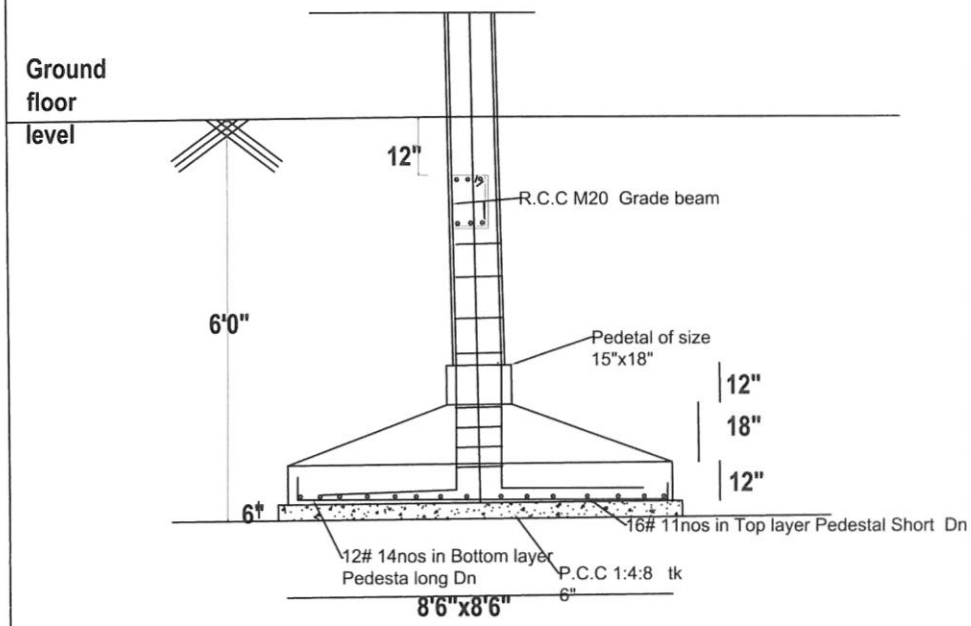
Designed for Stilt +4 floor

Clear Cover for Footing 3"
Clear Cover for Column 1.5"

Column
Size 12"x24"



20#6nos +16#4nos & Stirrups 8# 2 legged @6"c/c

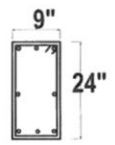


For 1400 KN

SBC of Soil 200 KN/Sqm
Fck M20
Fy 500

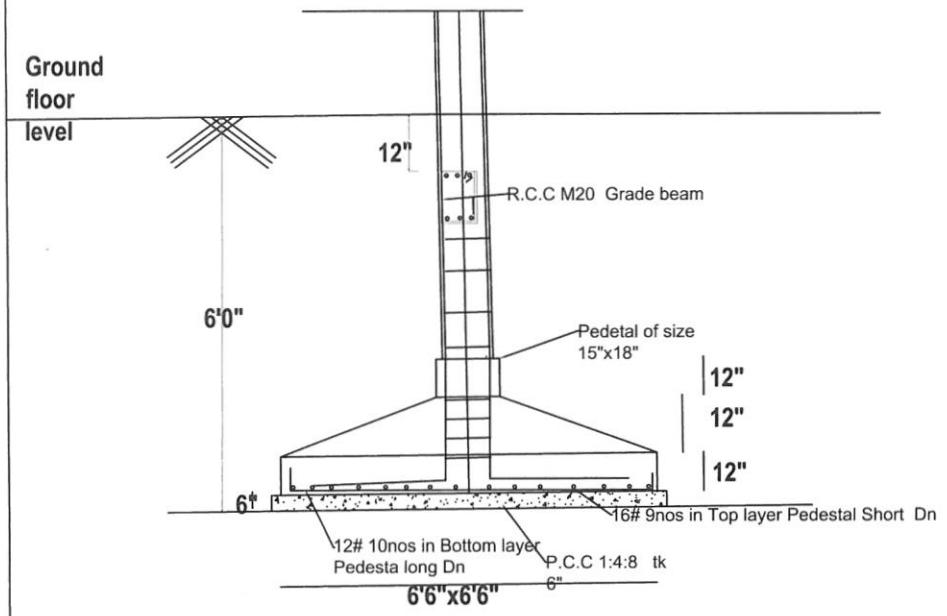
Designed for Stilt +4 floor

Column
Size 12"x24"



Clear Cover for Footing 3"
Clear Cover for Column 1.5"

20#4nos +16#4nos &
Stirrups 8# 2 legged @6"c/c

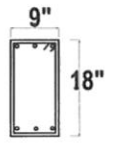


For 900 KN

SBC of Soil 200 KN/Sqm
Fck M20
Fy 500

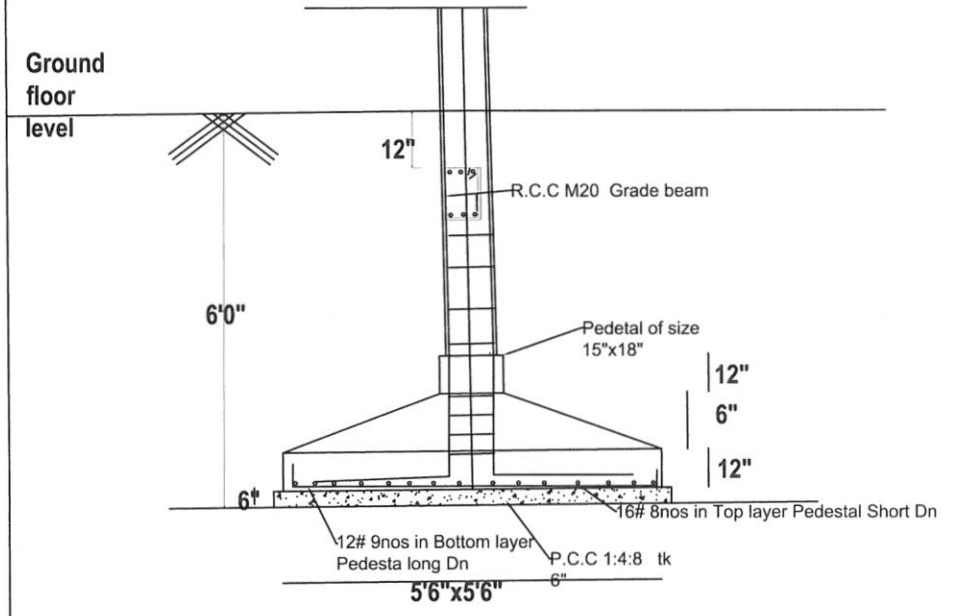
Designed for Stilt +4 floor

Column
Size 12"x24"

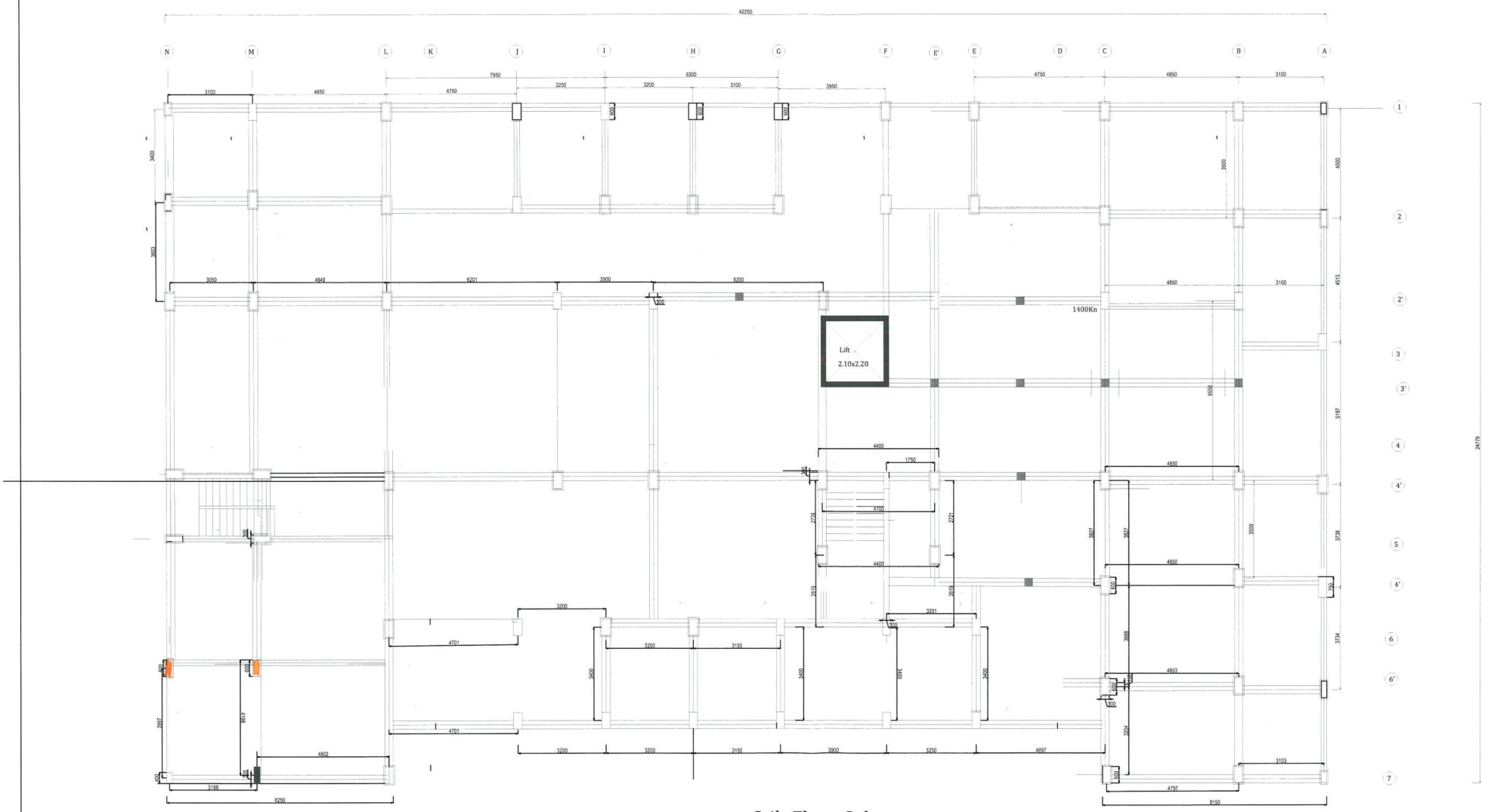


Clear Cover for Footing 3"
Clear Cover for Column 1.5"

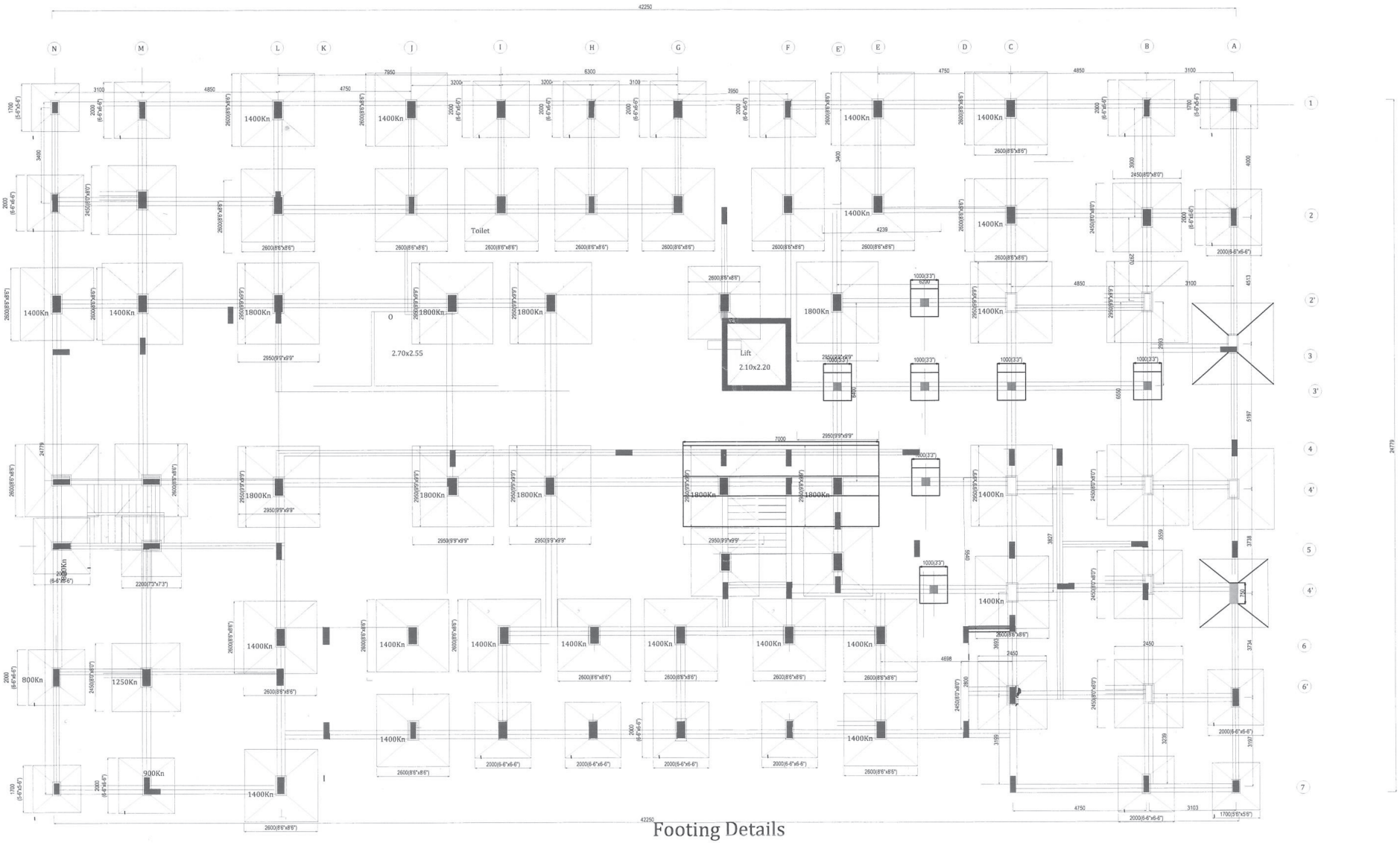
16#4nos +12#2nos &
Stirrups 8# 2 legged @6"c/c



For 600 KN



Stilt Floor Columns



Footing Details



our services doesn't just end there

Buying & Selling Services

Property Buying Assistance, Property Selling Support, Market Price Analysis, Owner Outreach and Negotiation.

Legal & Documentation Services

Certified EC, Patta, legal opinions, property verification, due diligence, litigation solutions, and legal heir certificates.

Property Development & Approvals

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

NRI & Investment Services

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

Compliance & Special Services

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



empowering your real estate decisions with smart tools

Property Valuation & Cost Estimation

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

Ownership, Compliance & Legal Verification

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

Zoning & Land Use Analysis

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

Property Documentation & Workflow Tools

Forms & Templates, Document Generator, Document Translation, Dictionary

Vastu & Property Management Tools

Home Vastu Shastra, Plot Vastu Shastra, Property Management

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We're honored to be part of your real estate journey

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