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KRITI
Structural Engineering Consultants

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STRUCTURAL STABILITY CERTIFICATE

PLAN SHOWING THE PROPOSED CONSTRUCTION OF BANK CUM RESIDENTIAL BUILDING AT PLOT NO - 17, CRESENT PARK ROAD AND 4th MAIN ROAD, GANDHI NAGAR, CHENNAI. COMPRISEDIN T.S NO-49/2, BLOCK No-34 OF KOTTUR VILLAGE, ADYAR, GUINDY TALUK, GREATER CHENNAI CORPORATION, ZONE-XIII, DIVISION-175.

The Proposed Building referred to above is a framed structure with Stilt (car parking) + 4 Upper Floors .The Structural Design and Drawing for the building are being prepared by us conforming to the relevant Bureau of Indian Standard viz. IS 456:2000 for Plain and Reinforced Concrete, IS 875(Part II)—1987 for Imposed Loads and IS 1893:2002(part 1) for Seismic Force. We certify that the building when constructed according to our Structural Designs and Drawings will be structurally safe and fit for occupation.

1. The least dimension of the column is 300mm.
2. The minimum grade of concrete is M30.

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DESIGN OF PROPOSED BUILDING AT PLOT NO - 17, CRESENT PARK ROAD, AND 4th MAIN ROAD, GANDHI NAGAR, CHENNAI. COMPRISEDIN T.S NO-49/2, BLOCK No-34 OF KOTTUR VILLAGE, ADYAR, GUINDY TALUK, GREATER CHENNAI CORPORATION, ZONE-XIII, DIVISION-175.

STRUCTURAL DESIGN CALCULATION

Structural Consultant

Kriti Structural Consultant

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PLAN SHOWING THE PROPOSED CONSTRUCTION OF BANK CUM RESIDENTIAL BUILDING AT PLOT NO - 17, CRESENT PARK ROAD AND 4th MAIN ROAD, GANDHI NAGAR, CHENNAI. COMPRISEDIN T.S NO-49/2, BLOCK No-34 OF KOTTUR VILLAGE, ADYAR, GUINDY TALUK, GREATER CHENNAI CORPORATION, ZONE-XIII, DIVISION-175.

1. General:

The Proposed building is a Framed Structure with Stilt (car park) +4 Upper floors.

2. Design Basis:

Latest design codes of BIS-456,875 and 1893 are followed with SP-16 design aid book .A typical 3 D Wire Frame was made for analysis to arrive Moment and Axial force for Column. Wind load is taken into account. Isolated Footing is proposed as per Soil report. Fe415 Steel is used for main reinforcement and a minimum grade of Concrete is M25.

3. Wind Load:

$Vz=VbxK_1xK_2xK_3.$
Vb=50m/sec in Chennai.

Check for direct stress (shear)

Critical section for shear is at a distance d=800mm from the face of the column.

Max. Shear force at critical section = 131x2.75x (1.26-0.8/2)=310KN.

$$Tv=\frac{310x10^3}{2520x790}=0.155.$$

Check for nominal shear stress<Design nominal shear stress
Tv(0.155)<Ts(0.36).

Check for punching shear.

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Tv=Vp/d x Perimeter of critical section.

$$=\frac{1.5x1244x1000}{1360x800}$$

Tv=2.4N/sqmm.

Tv=1.71<Tc=2.8 (Hence safe).

K_1 = Probability factor = 1

K_2 = Terrain, Height Factor = 1

K_3 = Topography factor = 1

p= 0.6xVzxVb

=0.6x50x50

=15000N/sqmm.

3. Earthquake Consideration:

For Better Stability during Earthquake condition, the columns are braced in both direction with beams and slab. Continuous lintels are specified for outer walls and column ties are closely spaced for better ductility. For Building on stilt, min size is taken as 300mm for Column.

Zone Factor, Z for Chennai seismic Zone III : 0.16 (table 2,Clause 6.4.2)

I, Importance Factor :4,(From table 6)

R, Response Reduction Factor : 3 for OMRF(Ordinary Moment resisting Frame, Table 7)

Fundamental Natural Period along X direction $Tx = 0.09xh/(dx)^{½}$

$=0.09x15.25/(7.7)^{½} = 0.49$(clause 7.6.2)

The Soil at the site is medium Sa/g = 2.5 as $0.1 \leq T \leq 0.55$

Fundamental Natural Period along Z direction $Tz = 0.09xh/(dz)^{½}$

$=0.09x15.25/(21.45)^{½} = 0.296$(clause 7.6.2)

The Soil at the site is medium Sa/g = 2.5 as $0.1 \leq T \leq 0.5$

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Design Horizontal Seismic Coefficient

Ah = ZISa/2Rg (Clause 6.4.2)

= 0.16x1x2.5/2x3=0.0667

Seismic Weight of the Building : Total Gravity Load + 0.25 Super imposed Load

W = 12729 KN

Design Seismic Base Shear

Vb = AhW

= 0.0667 x 12729 = 849 KN

Shear Per Column = 849/12 = 70.75 KN

Seismic Moment per Column = 70.75x3.05/2=107.89Nm.

LOAD CALCULATION FOR MAXIMUM LOADED COLUMN

Loading Area for the column = 4.32x6.76 = 29.2 sqm

Gravity Load Reaction from the roof = 6.125x29.2 = 178.87 KN

Self Weight of the beams = 0.3x0.475x25x11.08 = 27.04 KN

Weight of the Parapet wall = 1x0.23x20x11.08 = 50.97 KN

Total Gravity Load = 256.87 KN

Super impose Load Reaction from roof = 1.5x29.2 = 43.8 KN

Super impose Load Reaction from Floor = 2x 29.2 = 58.41 KN

Gravity Load Reaction from the floor = 4.125x29.2 = 120.46 KN

Self weight of the beams = 0.3x0.475x25x11.08 = 27.04 KN

Reaction from water tank = 141.37 KN

Weight from Head room = 80 KN

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Total Gravity Load = 269.38 KN

Self weight of Column = 0.23x0.6x20.05x25 = 69.17 KN

Total Gravity Load at the Foundation Level KN = 256.87+269.38x4+69.17 +141.37+80 = 1624.93 KN

Total Super imposed Load at the Foundation Level KN = (43.8+(58.41x4))x0.6 166.46 KN

Total Load =1624.93+166.46= 1791.39KN

The loads of other column calculated in similar way.

5. Design Loads:

Slab 125 mm thick	= 3.125 KN/sqm.
Live load (Residence)	=2.00 KN/sqm.
Live load (Commercial)	=6.00 KN/sqm.
Floor finishes	=2.00 KN/sqm.

This Value is also taken for frame analysis.

Brick work 230mm thick for exterior walls

0.23x2.5x20 = 11.5 KN/m/floor.

Brick work 115mm thick for exterior walls

0.115x2.5x20 = 5.75 KN/m/floor.

Beams 0.3x0.45x25 = 3.375 KN/m/floor.

Column 0.3x0.6x25 = 4.5K N/m/floor.

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Foundation details

Type of Foundation	Pile Foundation
Depth of Pile	15 mt.
Safe bearing capacity of soil	450 KN/sqm.

Slab details

Type of Slab	Two way Slab.
Thickness of Slab Provided	125mm.
Cover to reinforcement	20mm.
Diameter of bar used	10mm,12mm.

Beam details

Size of Beam Provided	230x450,230x600,
Cover to Reinforcement	30mm.
Diameter of main bar	25mm 20mm,16mm,12mm.
Stirrups	2/4 legged stirrups of 8mm/10mm dia.

Column details

Size of Column Provided	380x600,300x600,300x380, 230x450 , 375x750
Cover to reinforcement	for 12mm bar 25mm For 16mm or greater 40mm.
Diameter of main bar	25mm,20mm,16mm,12mm
Lateral ties	8mm.

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Design of Column

Column size = 300mmx600mm.

Cover = 40mm.

Ground Floor Ht = 2.75mt.

First Floor Ht = 3.05 mt.

Fy = 415 & Fck = 25

Effective Length ratio 0.65 as per IS456:2000

Leff1 = 0.65 x L

Leff2 = 0.65 L

Check for Slenderness

Leff1/D = 3.30 Leff1/b = 8.62.

Leff2/D = 3.30 Leff2/b = 8.62.

All Columns are short about both axis

Size of Column and check e_{min}

e_{min} = Leff/500+D/30 = 23.97

Find Mmin = 0.02397x1210.00 =29.0KNm

Design Axial Load Pu = 1210.00 KN

Design Moment Mx = Mmin = 29.00KNm

Designing the column as an axially loaded column with uniaxial moment

Calculation of Area of Steel.

Cover = 40mm

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Design Axial Load Pu 1210.00KN.

Design Moment Mx = Pux e_{min} 29.00KNm

D = 600mm,b=300mm Cover 40mm.

d' = 40+25/2 = 52.5mm

d'/D = 52.5/600 = 0.875

$M_u/f_{ck}bD^2$ = 29.00x1.5x10^6/25x300x600x600)=0.016

$Pu/f_{ck}bD$ = 1210x1.5x10^3 /25x300x600=0.403

From SP 16 Chart 44,

p/Fck = 0.08

Ast = 0.08x25x300x600/100 = 3600sqmm (

However 8 Nos of 25 tor rod are Provided.

Also Lateral ties 8 tor rod @ 150c/c are Provided.

Check for Column steel for earthquake load.

As per Clause 7.10.3 the partial safety factor for limit state design of reinforced concrete is given by 1.2 (DL+IL+EL)

The Load coming on the column Pu = 1.2(1210.00+70.75)=1536.9KN

Moment on Column Mu = Mu = 1.2(29.00+107.89)=164.27KNm

Pu/FckxbxD = 1536.9x10^3/25x300x600 = 0.341

$Mu/Fckbd^2$ = 164.27x10^6/25x300x600x600 = 0.060

From Chart 44 of SP 16 P/Fck = 0.08

Ast = 0.08x25x230x600/100 = 2760sqmm

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However 8 nos of 25 tor rods are provided which is found to be safe for the requirement of steel, Others Column are also designed in similar way.

Hence the design satisfies the requirement of extra steel for earthquake loads.

PILE DESIGN

500 diameter circular Pile

As the Pile has the carrying capacity of 1178KN the pile is designed for the same load.

Ultimate load = 1.5x1178 = 1767 KN Length of Pile = app 28m

fck = 30N/sqmm.
fy = 500 N/sqmm.

Longitudinal Reinforcement

Pu = 0.4fckAg+(0.67fy-0.4fck)Asc.

1767x1000 = 0.4 x 30 x 3.14/4x500x500 + (0.67 x 500 – 0.4 x 30)Asc.

1767000 = 3391200 + 323 Asc.

Asc = 1820 sqmm. Use 8nos of 20 Tor with cover of 40mm.(2512 sqmm)

PILE CAP DESIGN

DESIGN OF FOUR PILE GROUP

A column 375mmx750mm has to carry a Axial load of 3810 KN to be supported on 4 Piles each of 600 mm diameter and spaced at 1800 mm centers. fck =30N/sqmm and fy=500N/sqmm.

Pile diameter = 600mm Spacing of Pile = 1800mm

Column size = 375mm x 750mm

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Service Load = 3810KN Factored Load 3810 x 1.5 = 5715KN

Pile Carrying capacity = 1650 KN

Arrangement of pile cap

With extension of the pile cap equal to 150mm on all sides from the outer side of piles

Size of pile cap = 1800+600+300 = 2700mm

Depth of pile cap

Empirical formula = 1/3(8xdia of pile +600) = 1800mm (too high)

Adopting over all depth as 1200mm.

Effective depth of pile cap d = 1200-75-10 = 1115mm

Pile cap size 2700mmx2700mmx1200mm.

Self wt of Pile cap = 1.5(2.7 x2.7 x 1.2 x 25) = 328 KN

Check for truss action

Shear span = av

av = 535mm from data

av/d=0.47(only)

Truss action exists (av/d<2).

Total Factored Load = 5715 + 328 = 6043KN

Tension steel in X direction:

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Tx = p/24Ld x (3LxL-axa)

= [6043/(24x1800x1115)] (3x1800x1800-375x375) = 1201 KN

As = 1201x1000/0.87x500 = 2760sqmm.

Percentage of steel p = 2760 x100/2700x1115 = 0.09% <0.2%

Tension steel in Y direction:

Ty = p/24Ld x (3LxL-bxb)

= [6043/(24x1800x1115)] (3x1800x1800-750x750)

= 1148 KN.

As = 1086x1000/0.87x500 = 2640sqmm.

Percentage of steel p = 2640 x100/2700x1115 = 0.087% <0.2%.

In both axis % of steel is less than 0.2% as per IS.

Providing 0.2% of Steel for Pile cap @ Bottom

As = 0.2 x 1115 x 2700 / 100 = 6021sqmm.

Provide 20nos of 20 Tor rod 6280sqmm. Use 20 Tor @ 125 c/c Bothways.

Providing 0.12% of steel for Pile cap @ Top

As = 0.12 x 1115 x 2700 / 100 = 3612 sqmm.

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Provide 20nos of 16 Tor rod 4019sqmm. Use 16 Tor @ 125 c/c Bothways.

Check for shear (fck = 30) using enhanced shear theory,

Spacing of piles 600 = 3 times of pile size = 3x600 =1800mm

Hence enhanced shear is allowed in the section

=0.36x2x1115/535 = 1.5 N/sqmm but < 3.1N/sqmm (Enhanced shear).

Shear = 6043x1000/2(2700x1115) = 1. N/sqmm < 1.5 N/sqmm .

DESIGN OF TWO PILE GROUP

A column 375mmx750mm has to carry a Axial load of 1890 KN to be supported on 2 Piles each of 600 mm diameter and spaced at 1800 mm centers. fck =30N/sqmm and fy=500N/sqmm.

Pile diameter = 600mm Spacing of Pile = 1800mm

Column size = 375mm x 750mm

Service Load = 1890KN Factored Load = 2835KN Safe Load on Single Pile = 1650 KN

Concrete Grade = M30 Steel Grade = Fe500

Pile cap dimension

Length of Pile cap = 1800+600+300 = 2700

Width of Pile cap = 600+300 = 900

Depth of pile cap

Empirical formula = 1/3(8xdia of pile +600) = 1800mm (too high)

Adopting over all depth as 1000mm.

Effective depth of pile cap = 1000-10-75 = 915mm

Pile cap size 2700mmx900mmx1000mm.

Self wt of Pile cap = 1.5(2.7 x 0.9 x 1 x 25) = 92KN

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Check for truss action

av = 345 , d = 915mm

ratio of av/d = 0.37 < 2

Truss action exists.

Total Factored Load = 2835 + 92 = 2927 KN

Tension steel:

Tx = P/12Ld x (3LxL – axa)

= [2927/(12 x 1800 x 915)] (3 x 1800x 1800 – 750x750)

=1356KN

As = 1356 x 1000/0.87x500 = 3117 sqmm

Percentage of steel p = 3117 x 100 /900 x 1115 = 0.31% > 0.2%

Provide 10nos of 20 Tor rod 3140sqmm. @ TOP & BOTTOM.

Check for shear (fck = 30) using enhanced shear theory,

Spacing of Pile 600 = 300 times of pile size = 3 x 600 = 1800mm

Hence enhanced shear is allowed in the section

= 0.36 x 2 x 915/345 = 1.9N/sqmm but < 3.1N/sqmm(Enhanced shear)

Shear = 2927 x 1000/2(900x915) = 1.77 N/sqmm < 1.9 N/sqmm.

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Design of Plinth Beam

Assuming a plinth beam of size = 230mmx450mm

Self weight of the Plinth beam = 0.23x0.450x25=2.587KN/m

Weight of the 230mm wall = 0.23x2.45x20 = 11.27KN/m

Total Load on the Plinth beam = 2.587+11.27 = 13.857KN/m

Maxium Moment for a span of 5 mt = 13.857x1.5x5x5/8 = 31.54KNm

Mu/bd^2 = $31.54x10^6/230x330x330$ = 1.26

From Table 3 of SP16 Pt = 0.3722

Ast = 0.3622x230x420/100=380sqmm

Top and Bottom steel of 2Nos of 16 Tor is provided.

Area of steel provided = 401 sqmm.

Design of Floor Beam

Beam size	=	230mmx450mm
Effective depth	=	415mm
Span	=	4.76m
Self wt of slab	=	0.125x24x4.34 = 14.28KN/m
Self wt of beam	=	0.23x0.45x25=2.5KN/m
Wall Load	=	0.23x2.8x20=14KN/m
Live load	=	2x4.34=8.68KN/m
Floor finish	=	2x4.34=8.68KN/m

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Total = 49KN/m

Factored Load = 65KN/m

$M_u = \frac{wl^2}{12} = \frac{65 \times 4.76^2}{12}$

= 116KN.m.

$M_u/bxd^2 = 11.6X\ 10^7 / 230\ X\ 600^2 = 1.4$

From table 2 Sp-16

$P_t = 0.65\%$

$A_{st} = 0.65x200x600/100 = 780mm^2$

Provide tor steel Rod

Bottom rod – 4 nos – 16 tor

Top rod – 4 nos – 16 tor

Check for Shear

Shear Stress $Vu = \frac{W1}{2}$

$= \frac{74.2x4.34}{2}$

Vu = 161. KN

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From table 61, Page 178, Sp-16

For 0.369 % Steel shear is resisted by concrete section.

(0.45x200x415)/1000 = 37KN

Balance shear =161-37

Vus=124KN

Vus/d = 124/41.5 = 2.98KN/cm

Required 8 Tor @ 160mmc/c

Provide 8 Tor @ 150mmc/c

Design of Floor Slab

Self weight of the slab 125mm thk = 3.125KN/sqm

Floor Finish =21KN/sqm

Live Load = 2KN/sqm Total Load = 7.125KN/sqm

The slab has one short edge discontinuous as a two way slab

Ly/lx = 4.38/3 = 1.46<2.The slab is designed as a two way slab

From Table 26 of IS456:2000 for ly/lx = 1.46 Alpha x = 0.0562 and Alpha y = 0.037

Negative moment at continuous edge for shorter side

$$Mx = alphax \times w \times lx \times lx$$

$$Mx = 0.0562x7.125x3x3x1.5 = 4.65KNm$$

Effective depth = $(4.65x10^6 / 0.138x25x1000)^{1/2}$

= 106.71 mm

A slab depth of 125 mm provided.

$Mu/bd^2 = 4.65x10^6 / 1000x100x100 = 0.465$

From Table 3 of SP16 Pt =0.1315

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Ast required = 0.1315x1000x125/100 = 131.55 sqmm

However 8 tor @ 150mm c/c (335sqmm) is provided along the Shorter span

Postive moment at mid span for the longer side

My = Alphay x w x lx x lx

My = 0.037x7.125x3x3x1.5 = 3KNm

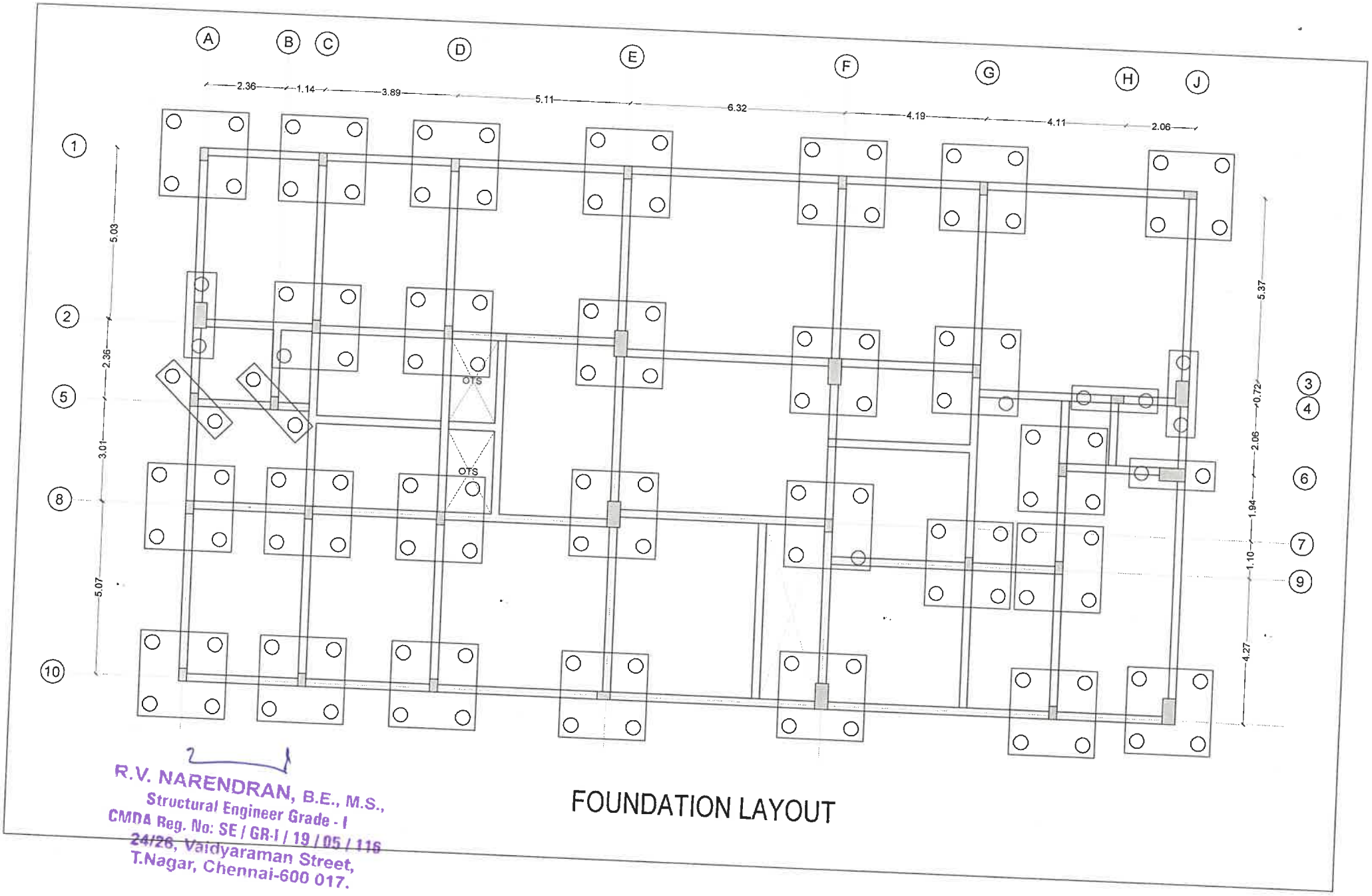
$Mu/bd^2 = 3x10^6 / 1000x100x100 = 0.3$

From Table 3 of SP16 Pt = 0.084

Ast required = 0.084x1000x100/100 = 84 sqmm

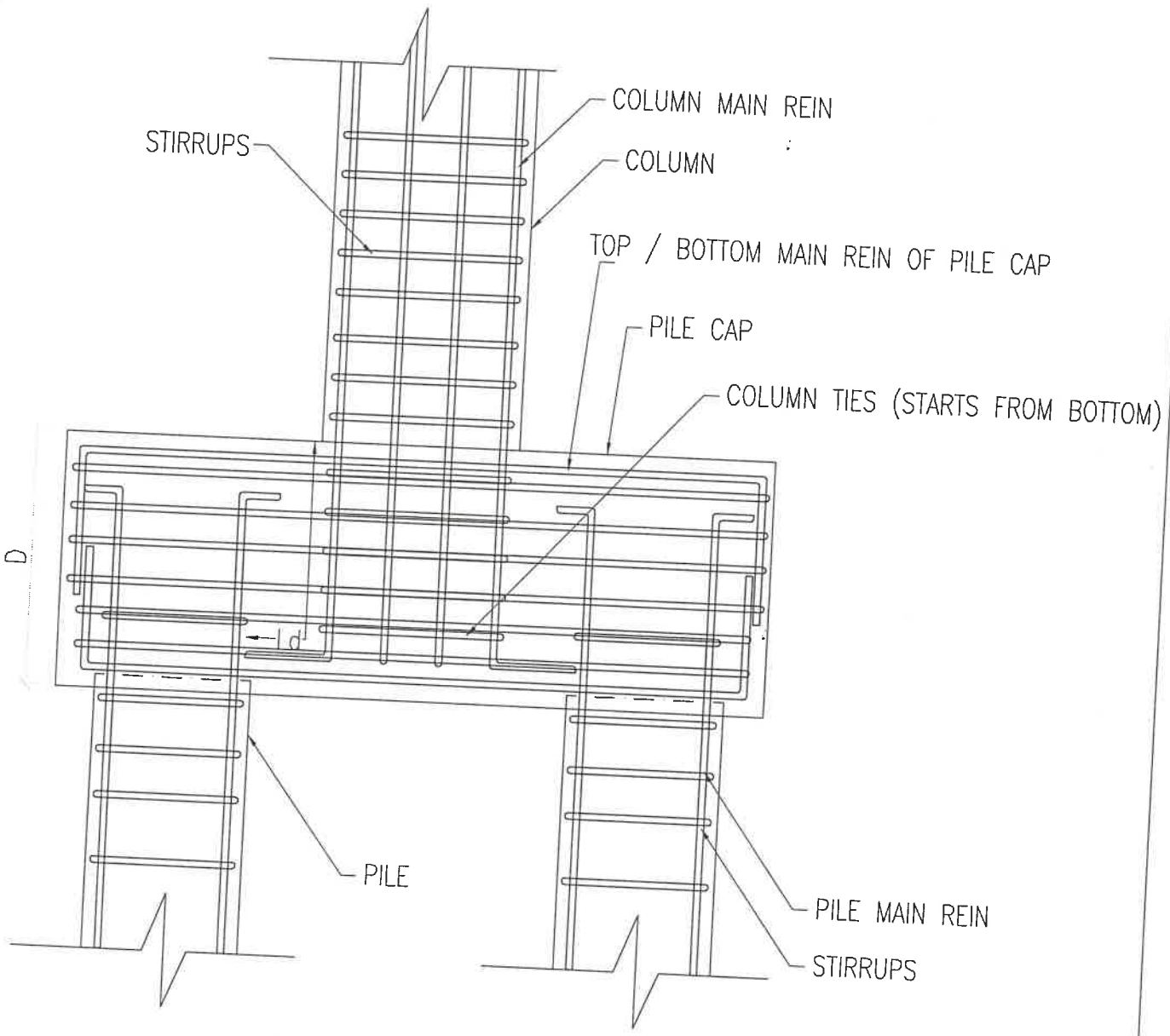
However 8 tor @ 150mm c/c (335sqmm) is provided along the longer span

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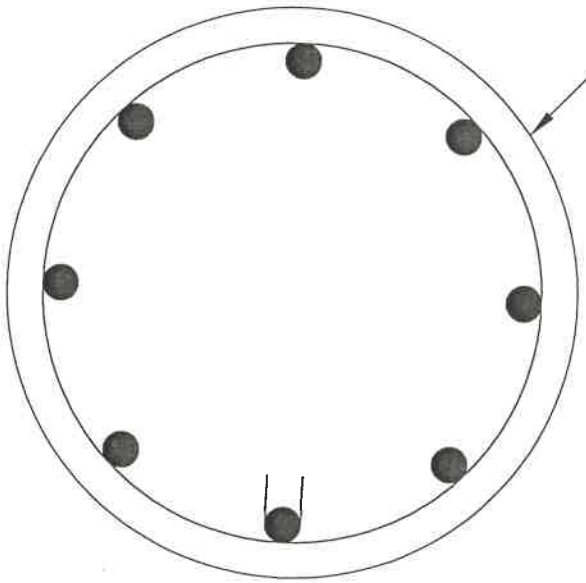
FOUNDATION LAYOUT

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TYP COLUMN REINFORCEMENT DETAILS @ PILE CAP JUNCTION

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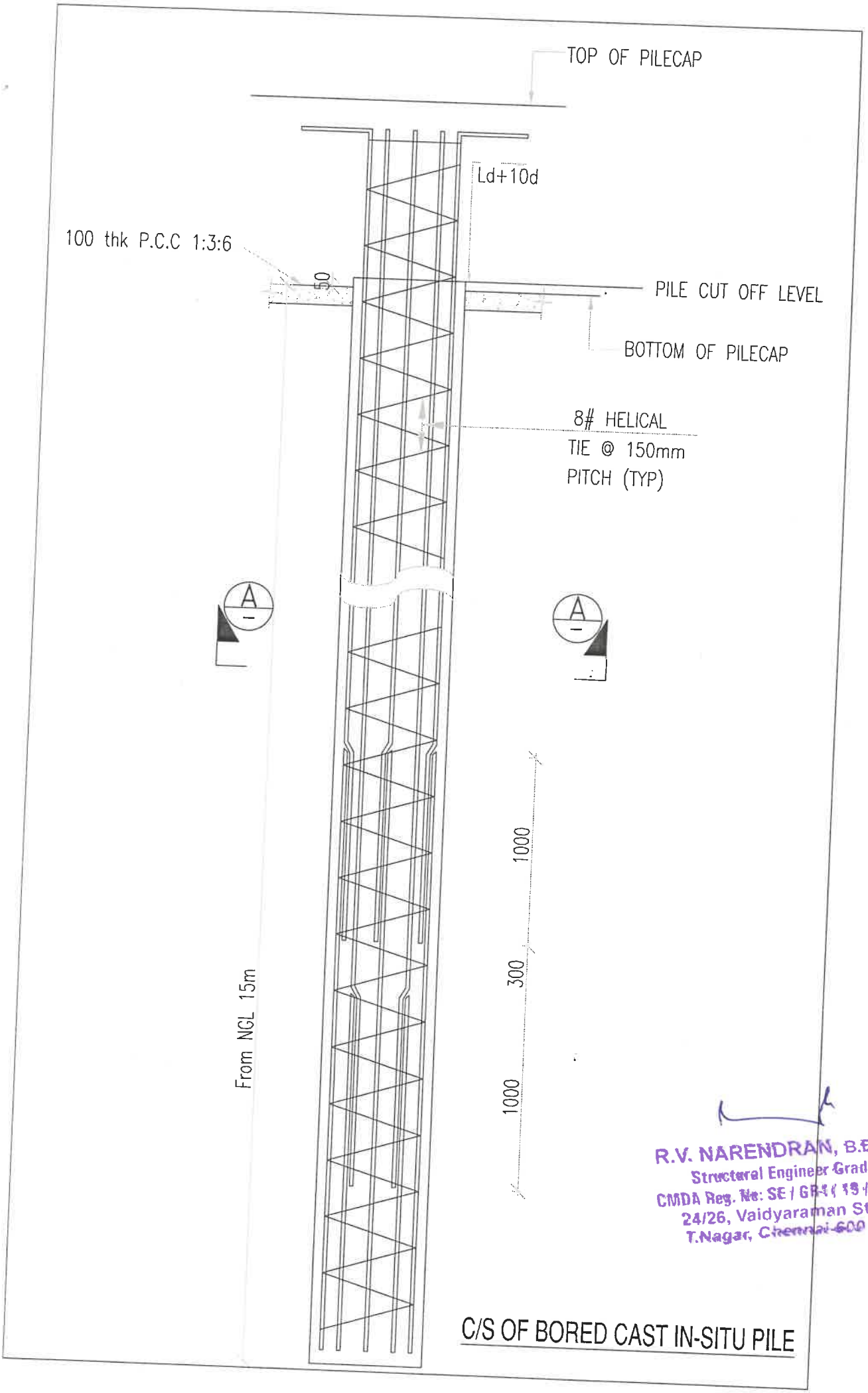
Ø500 BORED
CAST-IN-SUITE PILE

• 8-20#

8# Stirrups @150mm pitch

CROSS SECTION OF PILE - 500Ø

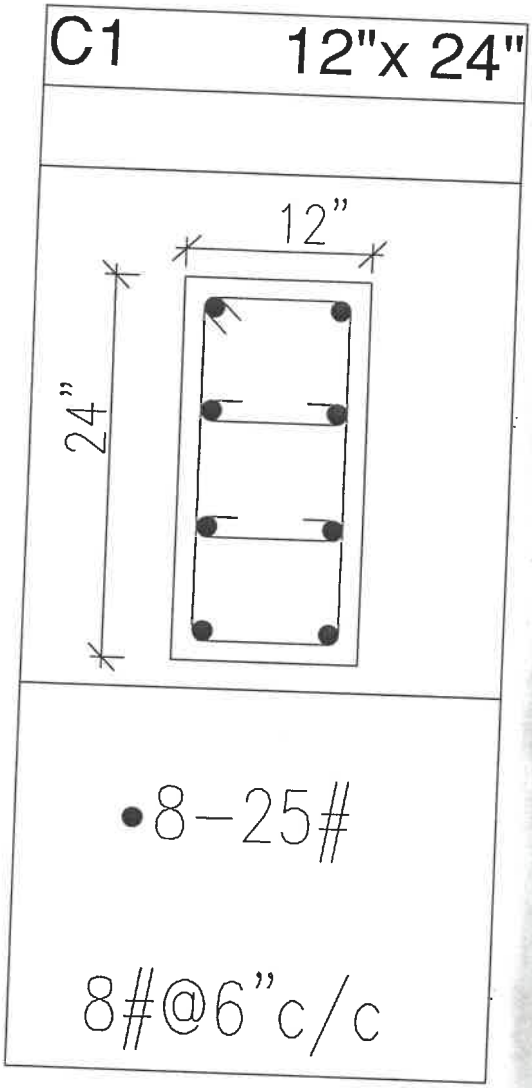
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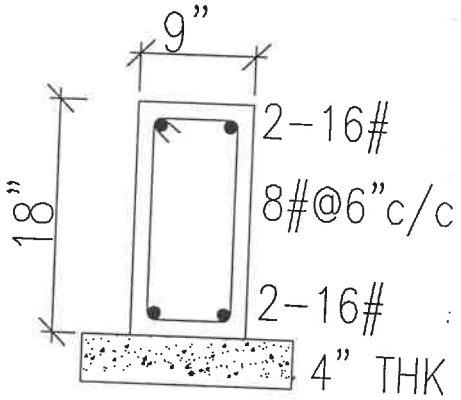
C/S OF BORED CAST IN-SITU PILE

R.V. NARENDRAN, B.E., M.S.,
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COLUMN SIZE : 12" x 24"

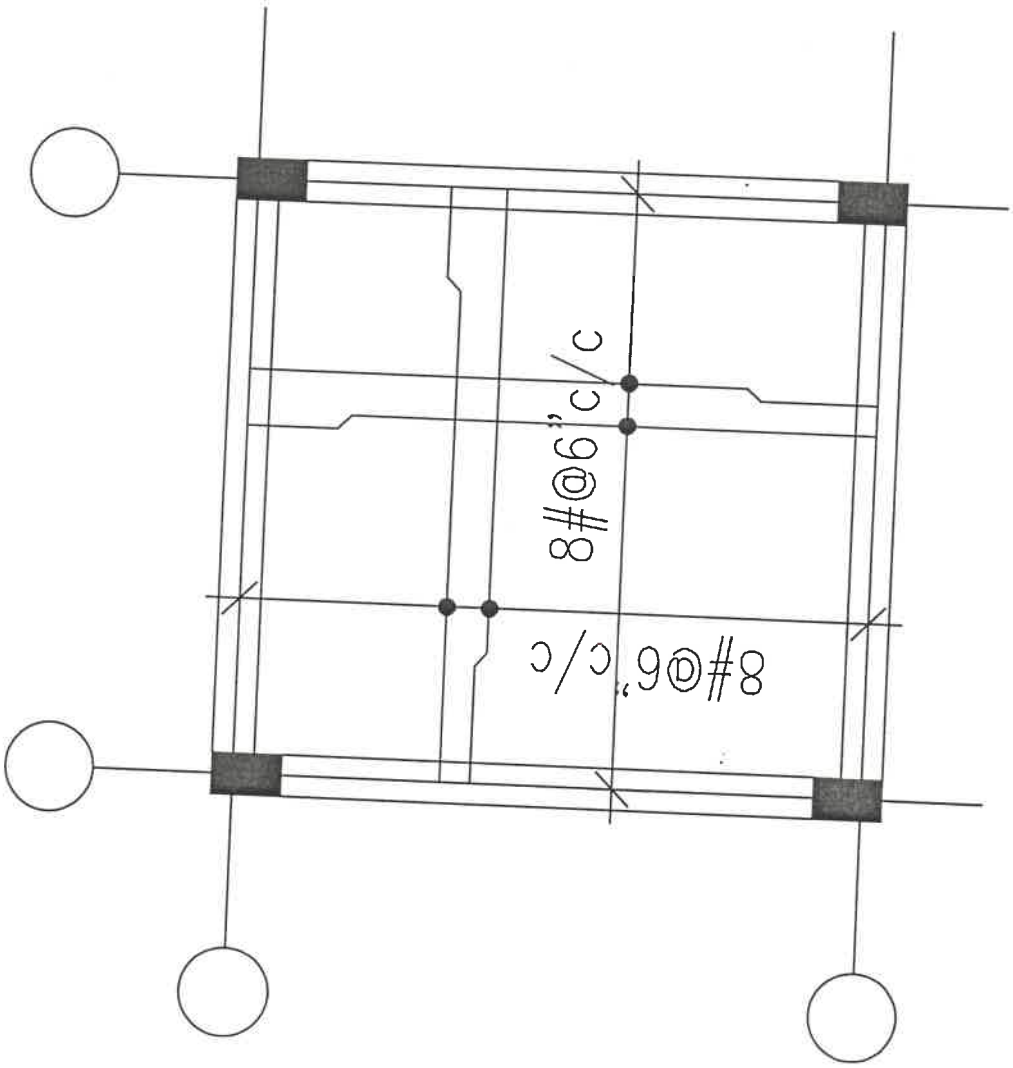


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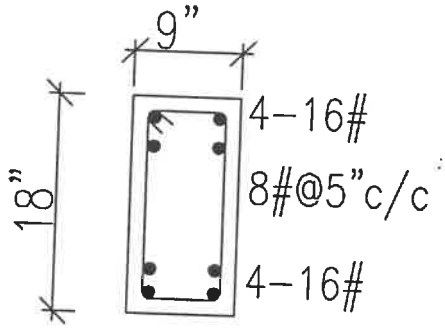


C/S OF PLINTH BEAM

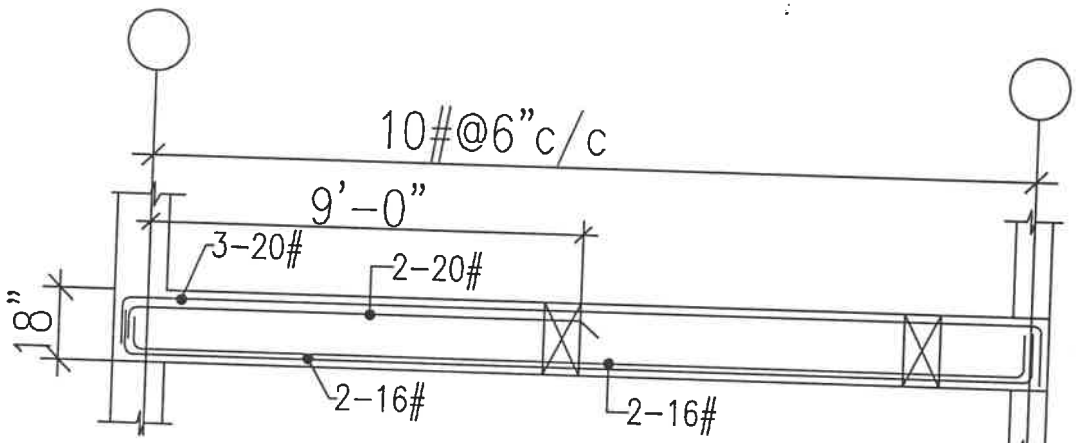
9"x18"



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C/S OF FLOOR BEAM
9"x18"



L.S. OF FLOOR BEAM 9"x18"

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