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**N.KARIKALAN**,B.E(Civil),M.E(Struct.),MIE.,
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Chartered Engineer (M-1644542/19)
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# STRUCTURAL STABILITY CERTIFICATE

Site located at Plot No: 159 Part 3&4,VGN Lakshmi Nagar Devaraj Street, Mugalivakkam, Chennai, Compraised in Survey No:30/48, Mugalivakkam Village, Alandur Taluk & Survey No:14/2A2A, 14/2A2B Of Kolapakkam Village Within The Limits of Kundarthur Panchayat Union , Kundarthur Taluk ,Kanchipuram District within the limit of Greater Chennai Corporation.

It is Certified that, the Residential Building consisting of Stilt Floor + 4 Floors is Promoting & holding by **M/s BUILT TECH ASSOCIATES,** 3-Dimensional structural Analysis has been carried out for the full Building using STAAD Pro. Loading and Load combinations is as per IS:875(Relevant Parts) – 2015. The Minimum Grade of concrete is used for All Structural Elements is M25. This Building is designed and detailed as per the following Bureau of Indian Standards IS: 456:2000, IS: 1893 (Part–1)- 2016 & IS:13920 -2016 as per the Analysis and design is **sound** and **safe** for the Residential usage.

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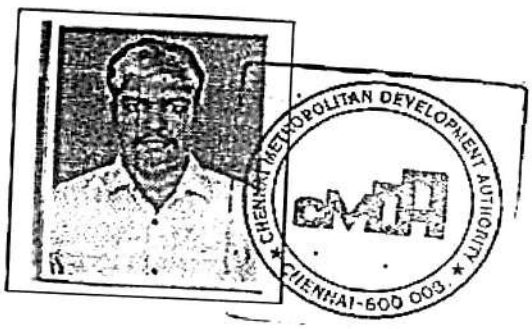
CHENNAI METROPOLITAN DEVELOPMENT AUTHORITY
'ThalamuthuNatarajan Building', No.1, Gandhi Irwin Road,
Egmore, Chennai-600 008.

# PROFESSIONAL REGISTRATION CERTIFICATE

This is to certify that the **Thiru. N. KARIKALAN** has enrolled as **Registered Structural Engineer Grade-I (SE)** with Chennai Metropolitan Development Authority (CMDA) who has the qualification of **M.E.,(Structural Engg.)** and experience in the relevant field for **10years.**

He has been given the Registration No. **SE/GR-I/2019/03/012** Renewed on **01.03.2024.** He shall be required to comply with the duties and responsibilities prescribed by the Government of Tamil Nadu in Part-V, "Registration of Professionals", Tamil Nadu Combined Development and Building Rules, 2019 approved vide G.O.(Ms) No.18 MAWS (MA1) Dept. dated 04.02.2019.

This Registration is valid upto **29.02.2029.**




1/3/24

(A. MEGANATHAN)
Superintendent

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| DATE | REV. NO. | DESCRIPTION | DESIGNED | CHECKED | APPROVED |
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| 02.08.2024 | 0 | ISSUED FOR APPROVAL | JSAN | NKK | NKK |

REVISIONS

| | |
|---|---|
| CLIENT : M/S BUILD TECH ASSOCIATES | PROJECT MANAGEMENT &CONSULTANT: |
| PROJECT : | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM |
| SUPPLIER / CONTRACTOR: | |
| JOB No. | A23015 |

| | NAME | SIGN | DATE |
|---|---|---|---|
| DSGN | JSAN | JSAN | 02.08.2024 |
| CHKD | NKK | NKK | 02.08.2024 |
| APPD | NKK | NKK | 02.08.2024 |

TOTAL NO. OF PAGES

TITLE : STRUCTURAL DESIGN DOCUMENT

DESIGN CALCULATIONS
(STILT+ 4 FLOORS ONLY)

CODE: IS

REV.: 0

Doc. No. A23015-C-RB-01-DC-0001

RELEASED FOR ☐ PRELIMINARY ☑ APPROVAL ☐ CONSTRUCTION

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## 1.INTRODUCTION

Stilt +4 story Residential building has plan dimensions as per Floor plans.The building is located in seismic Zone- III on a site with Medium soil. The design wind speed is 50 m /sec for Chennai region. Design the building for seismic and wind loads as per IS: 1893(part-1)-2016 and IS: 875 (Part-3) - 2015.

## 2.STRUCTURAL SYSTEM

Conventional (Cast in-situ) RCC Framed structural system has been considered for the building.3-D Analysis has per been carried out in STAAD Pro.

## 3.MATERIALS

The Self weight of various elements are computed based on the Unit weight of materials as given below as IS:875 (Part-1) - 1987.

**Table:1.Unit weight of materials(kN/m$^3$)**

| | |
|---|---|
| **Steel** | 78.50 |
| **Plain cement concrete/Screed** | 24.00 |
| **Reinforced cement concrete(Dry)** | 25.00 |
| **Cement concrete solid block work** | 20.00 |
| **Water** | 9.81 |
| **Brick coba** | 18.00 |

### 3.1.Concrete

Grade of Concrete for all structural items (Cast in-situ) considered as M25.

### 3.1.1.Exposure Category

As per the clause 8.2.2 of IS:456 -2000, the exposure category considered is moderate refer table-2.

**Table:2.Nominal cover to reinforcement**

**(Environmental exposure condition)**

| Structural element | Minimum(As per is456-2000) | Considered for design |
|---|---|---|
| Footing | 50 | 50 |
| Column | 40 | 40 |
| Beam | 30 | 30 |
| Slab | 20 | 20 |

### 3.2 Reinforcement

Reinforcement steel shall be of Grade Fe500 confirming to IS:1786 – 2008.

### 3.3.Structural steel

All Structural steel shall conform to IS: 2062 -2011. Pipes and tubes shall conform to IS: 1161- 2014.

## 4.LOADS:

This load comprises of self - weight of all the elements in the structure. Additional weight of the elements which are not declared in the model are calculated as below and applied.

### 4.1.Dead loads(IS875-PART1-1987)

**i)Wall load**

Main wall load:

Wall thickness = 230 mm

Height of wall = 3000 mm

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Self weight of wall = Wall thickness * Height *Unit weight of Brick

= 0.23 x 3 x 20 = 13.8 kN/m

Partition wall load:

Wall thickness = 115 mm

Height of wall = 3000 mm

Self weight of wall = Wall thickness * Height *Unit weight of Brick

= 0.115 x 3 x 20 = 6.9 kN/m

**ii)Slab load:**

Floor/Roof slab Load:

By self weight:

Thickness of slab = 125 mm

Self weight of slab = Thickness of slab * Unit weight of RCC

= 0.125 x 25 = 3.125 kN/m$^2$

By Finishing:

Thickness of finishing = 75 mm

Self weight of slab = Thickness of slab * Unit weight of PCC

= 0.075 x 24 = 1.8 kN/m$^2$

Total load = 3.125 + 1.8 = 4.925 kN/m$^2$

Sunken slab Load:

Thickness of slab = 300 mm

Self weight of slab = Thickness of slab * Unit weight of PCC

= 0.3 x 24 = 7.2 kN/m$^2$

**4.2.Live load(IS875-PART2-1987)**

Load on office/Tailoring eqip. room = 5 kN/m$^2$

Load on Bathroom/balcony/staircase = 3 kN/m$^2$

Load on roof = 1.5 kN/m$^2$

**4.3.Earthquake load(IS1893-PART1-2016)**

Length of building = 24.39 m

Width of building = 9.16 m

Slab thickness = 0.125 m

Wall thickness = 0.23 m

Zone location = Chennai

Zone = III

Total height from founding = 12 m

**Design horizontal acceleration Spectrum:**

$$A_h = \frac{Z\ I\ S_a}{2\ R\ g}$$

Zone factor Z = 0.16

Importance factor I = 1.5

Response reduction factor R = 5

$T_a$ = RC MRF building = $0.075\ h^{0.75}$ = 0.4836

RC-STEEL composite MRF building = $0.080\ h^{0.75}$ = 0.5158

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Steel MRF building = $0.085\ h^{0.75}$ = 0.548

all other buildings = $\frac{0.075\ h}{\sqrt{d}}$ = 0.2974

Type of building = RC MRF building

$\frac{T_a}{S_a}$ = 0.48 seconds

g = 0.42

**Table.3)Design Acceleration co-efficient $S_a/g$**

| | | |
|---|---|---|
| Rocky Hard soil | 1+15T<br>2.5<br>1/T<br>0.25 | T < 0.10 S<br>0.10 s < T < 0.40 s<br>0.40 s < T <4.0 s<br>T > 4.00 s |
| Medium stiff soil | 1+15T<br>2.5<br>1.36/T<br>0.34 | T < 0.10 S<br>0.10 s < T < 0.55 s<br>0.55 s < T <4.0 s<br>T > 4.00 s |
| Soft soil | 1+15T<br>2.5<br>1.67/T<br>0.42 | T < 0.10 S<br>0.10 s < T < 0.67 s<br>0.67 s < T <4.0 s<br>T > 4.00 s |

$A_h = \frac{0.16 \times 1.5 \times 0.42}{2 \times 5}$ = 0.0101

Design base shear VB will be evaluated by STAAD analysis is considering 100% Dead load and 25% of the live load .

**4.4.Wind load(IS875-PART 3-2015)**

Building location = Chennai

Basic Wind Speed $V_b$ = 50 m / sec

Greater horizontal dimension of the building l = 27.8 m

Lesser horizontal dimension of the building w = 12.7 m

Maximum height of the building z / h = 12.5 m

Design life of structure = 50 Years,

Terrain Category = I

Terrain slope q = 0 °

Type of structure = All other building

Type of building = Non Circular

Maximum Frame (Bay) spacing = 3.75 m

Roof angle = 0 °


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**Design Calculation:**

Design wind speed, $V_z = [V]_b \, k_1 \, k$ Where,

$V_z$ = Design Wind Speed at height z, m/sec

$k_1$ = Probability factor ( risk coefficient ) (Ref: Cl:6.3.1, Table-1)

$k_2$ = Terrain roughness and height factor (Ref. Cl:6.3.2)

$k_3$ = Topography factor (Ref. Cl:6.3.3)

$k_4$ = Importance factor for the cyclonic region (Ref. Cl:6.3.4)

,Shall be taken 1.15 where the buidling within 200km from the coast (Ref: Cl: 6.6)

$k_1$ = 1

$k_2$ = 1

$k_3$ = 1

$k_4$ = 1

$V_z$ = 50 x 1 x 1 x 1 = 50 m/s

**Calculate design wind pressure,**

Wind pressure, $P_z = [\![0.6\ V]\!]$ Ref: Cl:7.2

Where,

$P_z$ = Wind pressure at height, z in $N/m^2$

$V_z$ = Design wind speed at height, z in m/sec

$P_z$ = 0.6 x 50 x 50 = 1500 $N/m^2$

Design wind pressure,

$$P_d = K_d K_a K_c P_z \geq [\![$$

Where,

$P_d$ = Design wind pressure, $N/m^2$ Ref : Cl:7.2

$K_d$ = Wind directionality factor Ref : Cl:7.2.1

(For Local pressure coefficient & cyclone affected region, Kd shall be 1.0 with respect to any shape)

$K_a$ = Area averaging factor Ref : Cl7.2.2

$K_c$ = Combination factor Ref : Cl:7.3.3.13

$P_z$ = Wind pressure at height, $N/m^2$ Ref : Cl:7.2

$K_d$ = 0.9

$K_a$ = 0.8

$K_c$ = 0.9

Tributary Area, = 353.06 Sqm

$P_{d1}$ = 1500 x 0.9 x 0.8 x 0.9 = 972 $kN/m^2$

$P_{d2}$ = 0.7 x 1500 = 1050 $kN/m^2$

$P_d$ = = 1050 $kN/m^2$

**5.LOAD COMBINATIONS:**

The following load combinations are considered in scheme and detailed design stages in reference with IS 456:2000, IS 1893 (Part1): 2016 & IS 875 (Part5)

**Load combinatoons used for foundation design**

DL+SIDL+LL

DL+SIDL+LL±$WL_X$

DL+SIDL+LL±$WL_Z$

DL+SIDL+LL+EQ

DL+SIDL±$WL_X$

DL+SIDL±$WL_Z$

DL+SIDL±EQ


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**Table:4 Load combinations used for scheme and detail designs:(Limit state method)**

| Serviceability | Strength |
|---|---|
| DL+SIDL+LL+RLL | 1.5DL+1.5SIDL+1.5LL+1.5RLL |
| DL+SIDL+0.8LL±0.8$WL_x$ | 1.5DL+1.5SIDL+1.5LL±1.5$WL_x$ |
| DL+SIDL+0.8LL±0.8$WL_z$ | 1.5DL+1.5SIDL+1.5LL±1.5$WL_z$ |
| DL+SIDL+0.8LL±0.8EQ | 1.5DL+1.5SIDL+1.5LL±1.5EQ |
| DL+SIDL+±0.8$WL_x$ | 0.9DL+0.9SIDL±1.5$WL_x$ |
| DL+SIDLL±0.8$WL_z$ | 0.9DL+0.9SIDL±1.5$WL_z$ |
| DL+SIDLL±0.8EQ | 0.9DL+0.9SIDL±1.5EQ |
| | 1.2DL+1.2SIDL+1.2LL±1.2$WL_x$ |
| | 1.2DL+1.2SIDL+1.2LL±1.2$WL_z$ |
| | 1.2DL+1.2SIDL+1.2LL±1.2EQ |

**5.1.Deflection criteria:**

**Permissible deflections:** IS 456:2000 (Clause 23.2 (b) )

Max vertical deflection on beams and slab under vertical load:

Final deflection ≤ span/250 IS 456:2000 (Clause 23.2 (a) )

Final deflection after erection of all loads&finishes ≤ span/350 (or)20mm whichever is less.

**Max storey drift due to lateral load:**

Under wind load ≤ Height/500 IS 456:2000 (Clause 20.5)

Under earthquake load ≤ Height/350 IS 1893, part1 :2016 (Clause 7.11.1.1)

Long term deflections due to shrinkage and creep will be calculated as per Annexure-C of IS 456:2000.

**5.2.Crack width requirements:**

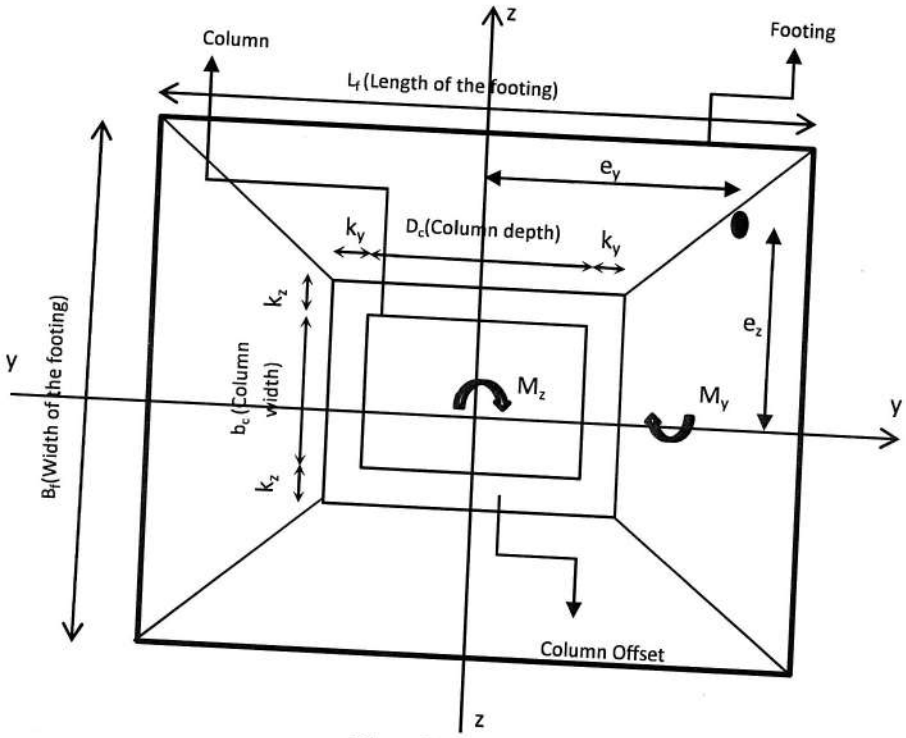
Crack width for all structural members shall be limited to 0.3 mm.


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|---|---|---|---|---|---|---|---|
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| CLIENT | M/S BUILD TECH ASSOCIATES | DESIGNED | | CHECKED | | APPROVED | |
| | | JSAN | | NKK | | NKK | |
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**INPUT:**

| | | | |
|---|---|---|---|
| Founding Depth | = | 2 | m |
| Safe bearing capacity of soil(SBC) | = | 207 | kN/m² |
| Unit weight of soil | = | 18 | kN/m² |
| Unit weight of concrete | = | 25 | kN/m² |
| Bearing capacity factor(BCF) | = | 1 | |
| Cover to reniforcement | = | 50 | mm |
| Eccentricity along z-z direction($e_z$) | = | 0 | mm |
| Eccentricity along y-y direction($e_y$) | = | 0 | mm |
| Offset along z-z direction($k_z$) | = | 50 | mm |
| Offset along y-y direction($k_y$) | = | 50 | mm |
| Type of footing | = | Rectangular/Sloped | |




**Plan of Footing**

**Column Numeration Details:-**

| Depth of column (Dc)mm | Width of coulum(bc)mm |
|---|---|
| 450 | 230 |

**Grade of Concrete /Rft**

| Concrete ($F_{ck}$) N/mm² | Steel ($F_y$) N/mm² |
|---|---|
| 25 | 500 |

**Footing Numeration Details:-(Units in mm)**

| Length ($L_f$) | Width ($B_f$) | Depth @ column face (D) | Depth @ toe (d) | Effective depth ($d_{eff}$) mm |
|---|---|---|---|---|
| 2250 | 2250 | 600 | 300 | 545 |

**Size of Reinforcement**

| Location | Along y-y(longer bar) | Along z-z(shorter bar) |
|---|---|---|
| Bottom | 10 | 10 |
| Top | 8 | 8 |


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Stadd-Pro Output

IS 456-2000

**ANALYSIS RESULT:**

| | | | | |
|---|---|---|---|---|
| Moment about z-z $M_z$ | = | 5 | kNm | Clockwise |
| Moment about y-y $M_y$ | = | 5 | kNm | Clockwise |
| Axial Load (P) | = | 850 | kN | Compression |
| Load Factor | = | 1.5 | | |

**Moment due to Eccentricity:**

About z-z = Axial load x Eccentricity along y-y
= 850 x 0 = 0 kNm

About y-y = Axial load x Eccentricity along z-z
= 850 x 0 = 0 kNm

**TOTAL MOMEMT:**

| | | | | |
|---|---|---|---|---|
| About z-z($M_z$) | = | 5 | kNm | Clockwise |
| About y-y($M_y$) | = | 5 | kNm | Clockwise |

**Gross Bearing Capacity:**

GSBC = SBC x BCF+Founding depth x Unit weight of soil
= 207 x 1 + 2 x 18

$$P = \frac{P}{A} \pm \frac{M_z}{Z_z} \pm \frac{M_y}{Z_y} \leq SBC = 243 \text{ kN/m}^2$$

$$P1 = \frac{P}{A} + \frac{M_z}{Z_z} + \frac{M_y}{Z_y} = \frac{850}{2.25 \times 2.25} + \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} + \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} = 173 \text{ kN/m}^2$$

$$P2 = \frac{P}{A} + \frac{M_z}{Z_z} - \frac{M_y}{Z_y} = \frac{850}{2.25 \times 2.25} + \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} - \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} = 168 \text{ kN/m}^2$$

$$P3 = \frac{P}{A} - \frac{M_z}{Z_z} - \frac{M_y}{Z_y} = \frac{850}{2.25 \times 2.25} - \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} - \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} = 163 \text{ kN/m}^2$$

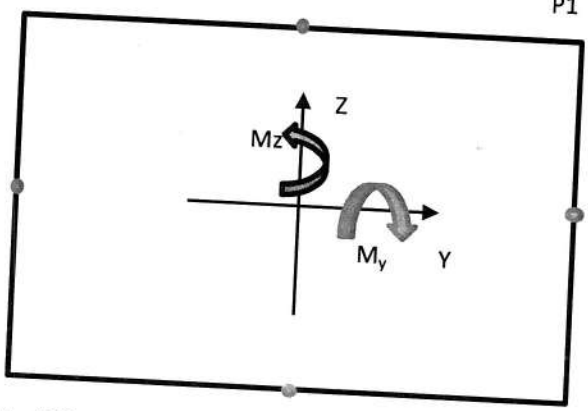
$$P4 = \frac{P}{A} - \frac{M_z}{Z_z} + \frac{M_y}{Z_y} = \frac{850}{2.25 \times 2.25} - \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} + \frac{5 \times 6}{2.25 \times 2.25 \times 2.25} = 168 \text{ kN/m}^2$$

Safe

P5 168 kN/m²

P3 163 kN/m²

P1 173.17 kN/m²




P7 165 kN/m²

P8 171 kN/m²

P4 168 kN/m² P6 168 kN/m² P2 168 kN/m²

**Base Pressure Below the Footing**

**FLEXURAL REINFORCEMENT**

**Bottom Reinforcement**

**Reinforcement along Longer Direction (Along y-y)**

i)Factored moment @ longer direction per "m" width(to the centre of column)

Factored Moment due to P3,P5,P1 Mz

$$= \frac{[MAX(P3+P5),(P5+P1)]}{2} \times \frac{((L_f-D_c)*0.5)^2)}{2} \times 1.5$$

$$= \frac{167.92+173.18}{2} \times \frac{((2250-450)*0.5)\text{^}2}{2} \times 1.5 = 103.62 \text{ kNm}$$


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| TITLE: | DESIGN OF FOOTING | A23015-C-RB-01-DC-0002 | | | | | |
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| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

Factored moment due to P4,P6,P2 Mz $= \frac{[MAX(P4+P6),(P6+P2)]}{2} \times \frac{((L_f-D_c)*0.5)^2)}{2} \times 1.5$

$= \frac{167.92+167.92}{2} \times \frac{((2250-450)*0.5)^2}{2} \times 1.5 = 102.02$ kNm

Check the footing depth for BM

$d = \sqrt{\frac{\text{Max moment}}{0.133 Fck\ b}}$

$= \sqrt{\frac{103.62 \times 10^6}{0.133 \times 25 \times 1000}} = 176.533$ mm

$< 545$ mm

Safe

$A_{st.req} = \frac{bd*f_{ck}}{2f_y}[1-\sqrt{1-\frac{4.598M_u}{F_{ck}\,bd^2}}]$

$= \frac{2250 \times 25 \times 545}{2 \times 500}[1-\sqrt{1-\frac{4.598 \times 176.6 \times 10^6}{25 \times 2250 \times 545^2}}] = 440.27$ mm²

$A_{st.min}$ = 0.12% of bD $= \frac{0.12}{100} \times 1000 \times 600 = 720$ mm²

$P_{t.required} = \frac{Max(A_{st.req}, A_{st.min})}{bd_{eff}} \times 100 = \frac{720}{1000 \times 545} \times 100 = 0.13\%$

Spacing Required $= \frac{\pi \times 10^2}{4 \times 720} \times 1000 = 109$ mm

Spacing Provided = 105 mm

Safe

$P_{t.\ Provided} = \frac{\pi \times 10^2}{4 \times 105 \times 545} \times 100 = 0.14\%$ > 0.13%

Safe

**Provide T10 mm dia of reinforcement @ 105 mm c/c**

**Reinforcement along shorter Direction (Along z-z)**

i)Factored moment@shorter direction per "m" width(to the centre of column)

Factored Moment due to P4,P3,P7 My $= \frac{[MAX(P3+P7),(P7+P4)]}{2} \times \frac{((B_f-b_c)*0.5)^2)}{2} \times 1.5$

$= \frac{165.28+167.92}{2} \times \frac{((2250-230)*0.5)^2}{2} \times 1.5 = 127.46$ kNm

Factored Moment due to P2,P1,P8 My $= \frac{[MAX(P2+P8),(P8+P1)]}{2} \times \frac{((B_f-b_c)*0.5)^2)}{2} \times 1.5$

$= \frac{173.18+170.54}{2} \times \frac{((2250-230)*0.5)^2}{2} \times 1.5 = 132$ kNm

Checking of footing depth for Factored BM

$d = \sqrt{\frac{\text{Max moment}}{0.133 Fck\ b}}$

$= \sqrt{\frac{131.5 \times 10^6}{0.133 \times 25 \times 1000}} = 198.869$ mm

Safe

Ast.req $= \frac{2250 \times 545 \times 25}{2 \times 500}[1-\sqrt{1-\frac{4.598 \times 131.6 \times 10^6}{25 \times 2250 \times 545^2}}] = 559.83$ mm²

$A_{st.min}$ = 0.12% of bD $= \frac{0.12}{100} \times 1000 \times 600 = 720$ mm²

$P_{t.required} = \frac{Max(A_{st.req}, A_{st.min})}{bd_{eff}} \times 100 = \frac{720}{1000 \times 545} \times 100 = 0.13\%$

Spacing Required $= \frac{\pi \times 10^2}{4 \times 720} \times 1000 = 109$ mm

Spacing Provided = 105 mm

Safe

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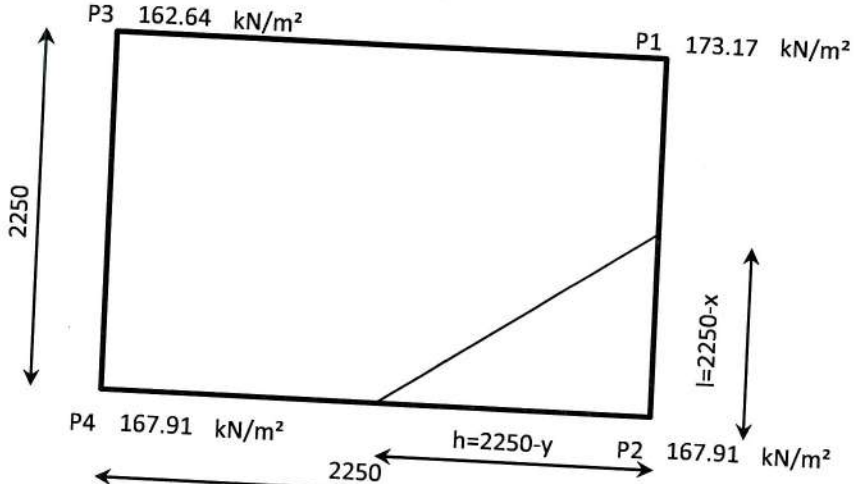
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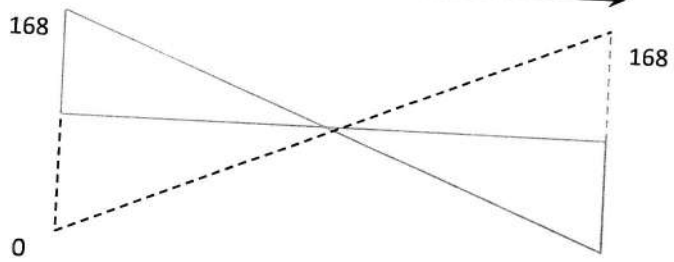
$$P_{t.\ Provided} = \frac{\pi \times 10^{\wedge}2}{4 \times 105 \times 545} \times 100 = 0.14\% > 0.13\%$$ Safe

**Provide T10 mm dia bars @105 mm Spacing along shorter direction**

**Top Reinforcement**

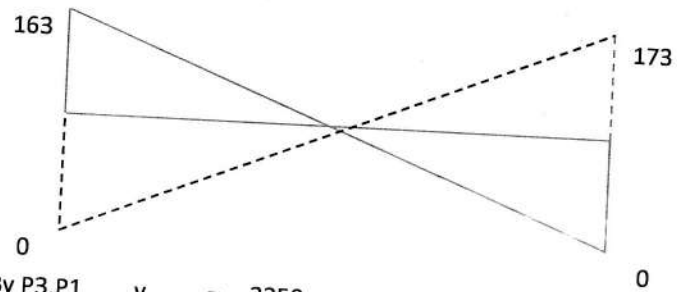
Total area of footing($A_f$) = 5.06 $m^2$



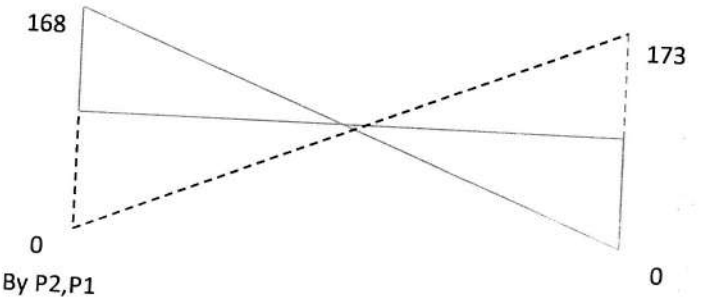




By P4,P2 $\frac{y}{167.91} = \frac{2250-y}{0}$

$y = 2250$ $h = L_f - y = 0$ mm




By P3,P1 $y = 2250$ $l = L_f - y = 0$ mm

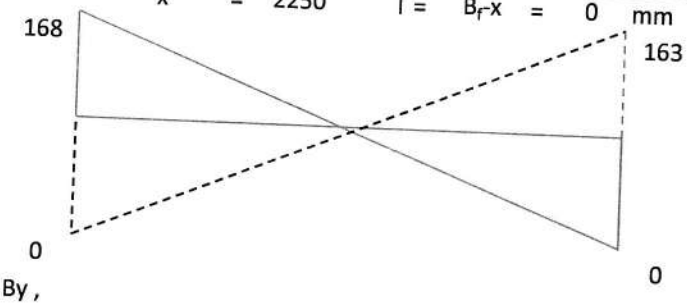



By P2,P1

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x = 2250 l = $B_f$-x = 0 mm




By ,

x = 2250 l = $B_f$-x = 0 mm

Area of tension zone (Loss of area) $= \frac{1}{2} \times lh$

$= \frac{1}{2}(0x0 + 0x0)$ = 0.00 $m^2$

Area of compression zone = Total area-loss of area = 5.06

Loss of contact $= \frac{\text{Loss area}}{\text{Total area}} \times 100 = \frac{0.00}{5.06} \times 100$ = 0 %

< 10 %

**Size of footing is safe**

**Reinforcement along y-y** (Applicable When the Negative pressure is generated)

**i)Factored Moment @ longer direction per "m" width(to the centre of column)**

Factored Moment due to P3,P5,P1 Mz $= \frac{\text{No (-ve) Pressure}}{2} \times \frac{((L_f-D_c)*0.5)^{\wedge}2 \times 1.5}{2}$

$= \frac{\text{Not applicable}}{2} \times \frac{((2250-450)*0.5)^{\wedge}2}{2} \times 1.5$ = 0 kNm

Factored Moment due to P4,P6,P2 Mz $= \frac{\text{No (-ve) Pressure}}{2} \times \frac{((L_f-D_c)*0.5)^{\wedge}2 \times 1.5}{2}$

$= \frac{\text{Not applicable}}{2} \times \frac{((2250-450)*0.5)^{\wedge}2}{2} \times 1.5$ = 0 kNm

$A_{st.req} = \frac{1000x545x25}{2 \times 500}\left[1-\sqrt{1-\frac{4.598 \times 0 \times 10^{\wedge}6}{25 \times 1000 \times 545^{\wedge}2}}\right]$ = 0 $mm^2$

$A_{st.min}$ = 0.06% of bD $= \frac{0.06}{100} \times 1000 \times 600$ = 360 $mm^2$

$P_{t.required} = \frac{Max(A_{st.req} x A_{st.min})}{bd_{eff}} \times 100 = \frac{0}{1000 \times 545} \times 100$ = 0.00%

Spacing Required $= \frac{\pi \times 8^{\wedge}2}{4 \times 360} \times 1000$ = 125 mm

Spacing Provided = 125 mm Safe

$P_{t.\ Provided} = \frac{\pi \times 8^{\wedge}2}{4 \times 125(600-50)} \times 100$ = 0.08% > 0.06%

**Top reinfocrement is not required in longer direction** Safe


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**Reinforcement along z-z**

**i)Factored moment @ Shorter direction per "m" width(to the centre of column)**

Factored Moment due to P4,P3,P7 My $= \frac{\text{No (-ve) Pressure}}{2} \times \frac{((B_f-b_c)*0.5)^2 \times 1.5}{2}$

$= \frac{\text{Not applicable}}{2} \times \frac{((2250-230)*0.5)^2}{2} = 0$ kNm

Factored Moment due to P2,P1,P8 My $= \frac{\text{No (-ve) Pressure}}{2} \times \frac{((B_f-b_c)*0.5)^2 \times 1.5}{2} =$

$= \frac{\text{Not applicable}}{2} \times \frac{((2250-230)*0.5)^2}{2} = 0$ kNm

$A_{st.req} = \frac{1000 \times 545 \times 25}{2 \times 500}\left[1-\sqrt{1-\frac{4.598 \times 0 \times 10^6}{25 \times 1000 \times 545^2}}\right] = 0$ mm²

$A_{st.min}$ = 0.06% of bD $= \frac{0.06}{100} \times 1000 \times 600 = 360$ mm²

$P_{t.required} = \frac{Max(A_{st.req}, A_{st.min})}{bd_{eff}} \times 100 = \frac{0}{1000 \times 545} \times 100 = 0.00\%$

Spacing Required $= \frac{\pi \times 8^2}{4 \times 360} \times 1000 = 125$ mm

Spacing Provided = 125 mm — Safe

$P_{t.\ Provided} = \frac{\pi \times 8^2}{4 \times 125 \times 545} \times 100 = 0.08\%$ > 0.06% — Safe

**Top reinfocrement is not required in shorter direction**

**SHEAR CALCULATION**

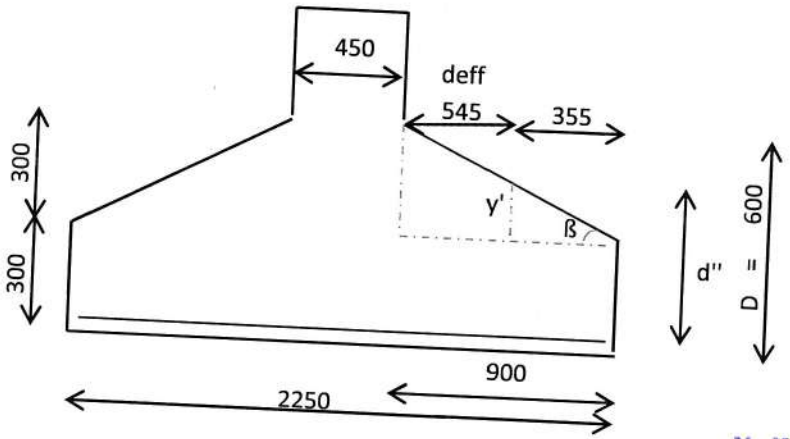
**One way shear :**

**In Z direction**

**Shear force along Z direction by P5 , P6**

$V_{uy}$ = Max(P5 , P6)*Bf*(0.5*(Lf-Dc-2deff) )*1.5

= 167.91 x 2250 ( 2250 - 450 - 2 x 545) x 0.5 x 1.5 = 202 kN




y' = 119 mm

d'' = 300 + 119 - 50 - 5 = 364 mm

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IS456-2000 P.NO.72

**One way shear resistance :**

$$\tau_v = \frac{V_{uy} - \frac{M_{uy} \tan ß}{d''}}{B_f * d''} \qquad \tan ß = \frac{300}{900} = 0.334$$

$$= \frac{202 \times 1000 - \frac{103.62 \times 10^6 \times 0.334}{364}}{2250 \times 364} = 0.13 \ N/mm^2$$

**Design shear strength:**

SP 16 CLAUSE 4.1

$$\tau_c = \frac{0.85\sqrt{(0.8\ Fck)} * (\sqrt{(1+5\beta)}-1)}{6\beta}$$

$$pt = 100Ast/bd$$

(P.NO. 175)

$$\beta = 0.8Fck/6.89pt = \frac{0.8 \times 25}{6.89 \times 0.14} = 21.15$$

$$\tau_c = \frac{0.85 \times \sqrt{(0.8 \times 25)}(\sqrt{(1+5 \times 21.15)}-1))}{6 \times 21.15} = 0.28 \ N/mm^2$$

**In Y direction** $\tau v < \tau_c$ Safe

**Shear force along Y direction by P7 , P8**

$V_{uz}$ = Max(P7 , P8)*Lf*(0.5*(Bf-bc-2deff)) *1.5

= 170.54 x 2250 ( 2250 - 230 - 2 x 545 ) x 0.5 x 1.5 = 268 kN

y' = 139 mm

d'' = 300 + 139 - 50 - 5 = 384 mm

**One way shear resistance:**

IS456-2000 P.NO.72

$$\tau_v = \frac{V_{uz} - \frac{M_{uz} \tan ß}{d''}}{L_f * d''} \qquad \tan ß = \frac{300}{1010} = 0.298$$

$$= \frac{268 \times 1000 - \frac{131.5 \times 10^6 \times 0.298}{384}}{2250 \times 384} = 0.19 \ N/mm^2$$

**Design shear strength :**

$$\tau c = \frac{0.85\sqrt{(0.8\ Fck)} * (\sqrt{(1+5\beta)}-1)}{6\beta}, \quad pt = 100Ast/bd$$

(P.NO. 175)

$$\beta = 0.8F_{ck}/6.89p_t = \frac{0.8 \times 25}{6.89 \times 0.138} = 21.15$$

$$\tau c = \frac{0.85 \times \sqrt{(0.8x)}(\sqrt{(1+5 \times 21.15)}-1))}{6 \times 21.15} = 0.28 \ N/mm^2$$

**Two way shear** $\tau v < \tau_c$ Safe

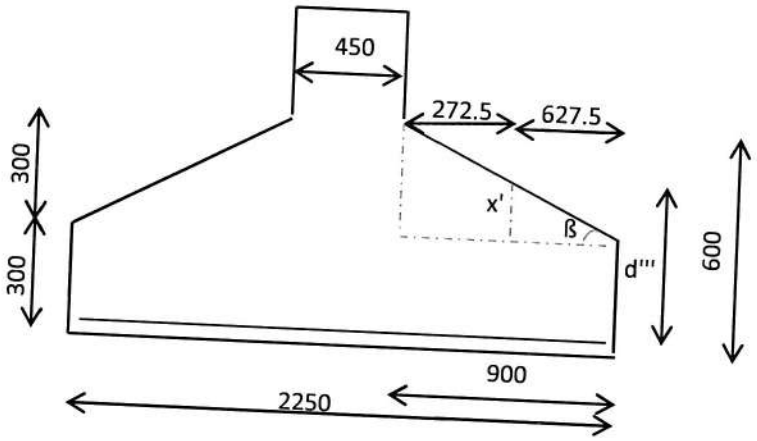
The critical section is located d/2 from the periphery of the column

Factored shear force $V_{uz}$ = 1.5 x Pu

= 1.5 x 850 = 1275 kN

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x' = 210 mm

d''' = 300 + 210 - 50 - 5 = 455 mm

Two way

IS 456-2000

shear resistance $V_c$ = Ks x Tc2 x d''' x 2 x [($D_c$+deff)+($b_c$+deff)] = 2013.4 kN

$T_{c2}$ = 0.25√fck = 0.25 x √25 = 1.25 N/mm²

$K_s$ = 0.5+$\beta_c$ < 1

$$\beta_c = \frac{\text{Short side of column}}{\text{Long side of column}} = \frac{230}{450} = 0.51$$

$K_s$ = 0.5 + 0.52 < 1

= 1.01 > 1

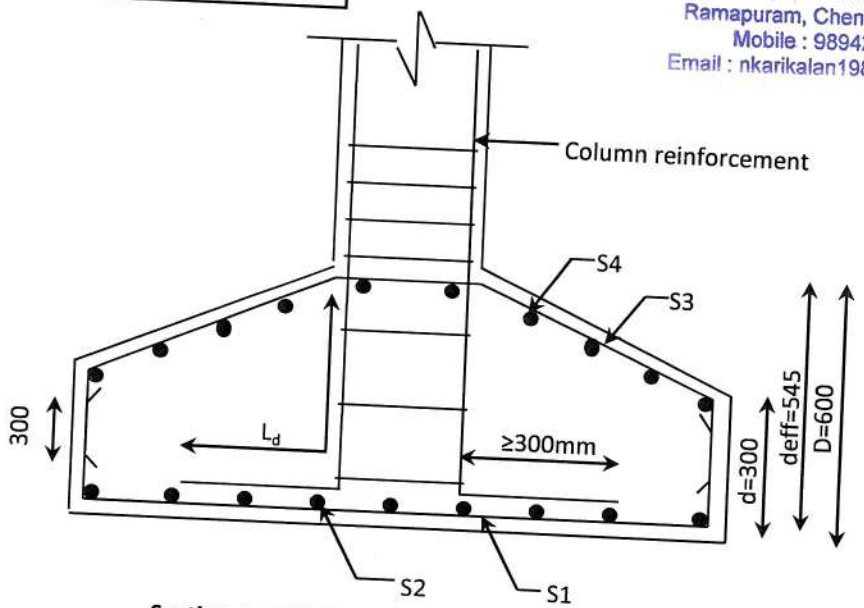
Take Ks as 1

$V_{uz}$ < $V_c$ SAFE

**Schedule of RC Details:-**

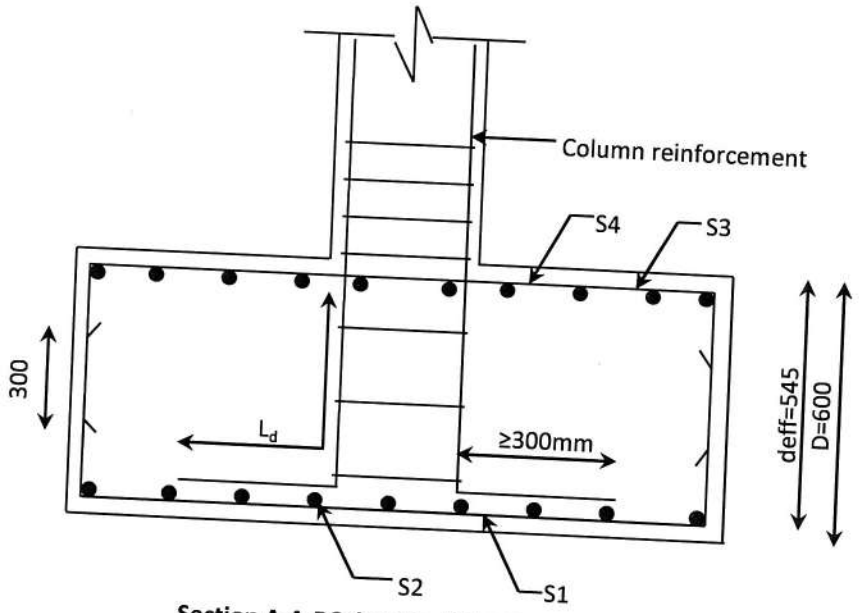
| | |
|---|---|
| S1 | T10 at 105 mm C/C |
| S2 | T10 at 105 mm C/C |
| S3 | Nil |
| S4 | Nil |

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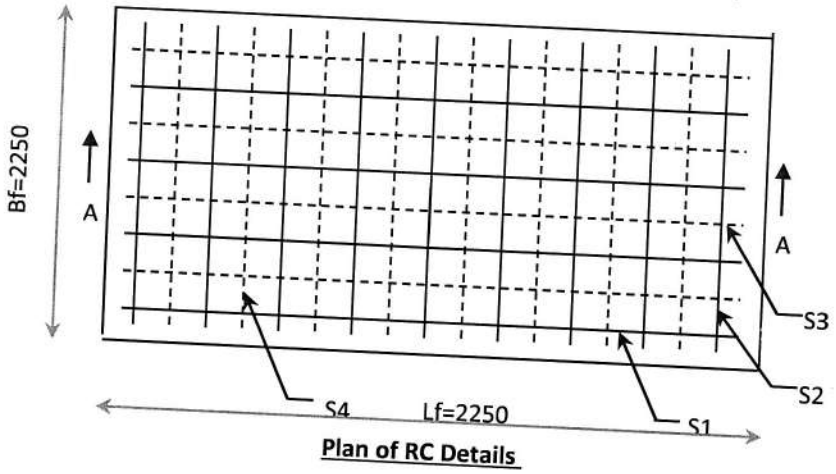



**Section A-A-RC details of Trapezoidal Footing**

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**Section A-A-RC details of Flat Footing**




**Plan of RC Details**


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**Input:**

| | | | | |
|---|---|---|---|---|
| Depth of column D) | | = | 380 | mm |
| Width of column ($D_z$) | | = | 230 | mm |
| Unsupported length ($L_y$) | | = | 3000 | mm |
| $L_z$ | | | 3000 | mm |
| Column condition against sidesway | | = | Restrained | |
| Multiplication factor of ($k_y$,$k_z$) | $k_{y1}$ | = | 1.2 | |
| | $k_{z1}$ | = | 1.2 | |
| Effective length ($L_{ey}$) | | = | 3600 | |
| Effective length ($L_{ez}$) | | = | 3600 | |
| Clear cover(cc) | | = | 50 | mm |

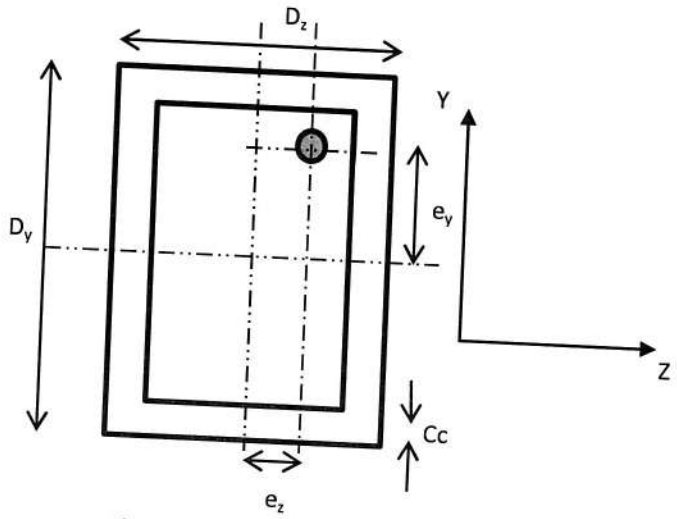



**Fig:1 Cross section of column**

Stadd.Pro

**Analysis Result**

| Axial load (kN) $P_u$ | | | 1798 | Compression |
|---|---|---|---|---|
| Moment (kNm) | $M_{uy}$ | Bottom | 39 | Clock-wise |
| | $M_{uz}$ | Bottom | -23 | Anti-clockwise |

Axial load - [ +ve= Compression , -ve=Tension]

Moment -[ +ve = Clock-wise, -ve = Anti-clockwise ]

**Grade of Materials**

| Concrete ($F_{ck}$) N/mm$^2$ | Steel ($F_y$) N/mm$^2$ |
|---|---|
| 25 | 500 |

**Reinforcement Details**

| | |
|---|---|
| Longitudinal bar(mm) | 20 |
| Tie bar(mm) | 8 |
| Reinforcement % | 3 |

**Slenderness Ratio:**

$$\text{About y-y} = \frac{L_{ey}}{Dy} = \frac{3600}{380} = 9.4737 < 12$$

$$\text{About z-z} = \frac{L_{ez}}{Dz} = \frac{3600}{230} = 15.652 > 12$$

Column is slender about z-z axis — Long-Column

$$\text{Effective cover } d' = cc + \frac{\text{Dia of bar}}{2} = 50 + \frac{20}{2} = 60 \text{ mm}$$

$$\frac{d'}{D} = \frac{60}{380} = 0.16$$

$$\frac{d'}{B} = \frac{60}{230} = 0.26$$

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**Minimum eccentricity:**

**e_min =Max of (((Unsupported length)/500+(Late**

$$e_{min.y} = \frac{3000}{500} + \frac{380}{30} = 18.67 < 20 = 20 \text{ mm}$$

$$e_{min.z} = \frac{3000}{500} + \frac{230}{30} = 13.67 < 20 = 20 \text{ mm}$$

**Additional Moment Calculation:**

**M_a = P_(u) e_(y) k_y**

$M_a$ = Additional moment along major and minor axis

$e_a$ = Additional eccentricity along major and minor axis

ky = Reduction factor

**e_a = D_y/2000 x (L_ey/l**

$$e_{ay} = \frac{230}{2000} \times \left(\frac{3600}{230}\right)^{\wedge 2} = 28.174 \text{ mm}$$

$$e_{az} = \frac{380}{2000} \times \left(\frac{3600}{380}\right)^{\wedge 2} = 17.053 \text{ mm}$$

**k = Min of( (P_uz/P_uz - P_u/P**

Here,

$P_{uz}$ = Maximum pure compression strength of the column

$P_b$ = Axial strength corresponding to balance failure about the axis

$P_u$ = Axial load

$P_{uz} = 0.45 f_{ck} \times D \times b + (0.75 \times f_y - 0.45_{fck}) A_s$

$= (0.45 \times 380 \times 230) + (0.75 \times 500 - 0.45 \times 25)(0.03 \times 380 \times 230)$

IS456 1978 Table 6

**P_b= (k_1+k_2 p/f_ck)f_ckBD** = 1937.01 mm

$k_{y1}$ = 0.194

$k_{y2}$ = 0.222

$P_{by}$ = ( 0.194 + 0.222 x 0.03 ) 25 x 380 x 230 = 438.44 kN

$$k_y = \frac{1937.01}{1937.01} - \frac{1798}{438.44}, \quad 1 = 0.0928$$

$k_{z1}$ = 0.17

$k_{z2}$ = -0.116

$P_{by}$ = ( 0.17 + -0.116 x 0.03 ) 25 x 380 x 230 = 363.85 kN

$$k_z = \frac{1937.01}{1937.01} - \frac{1798}{363.85}, \quad 1 = 0.0884$$

$M_{ay}$ = 1798 x 28.1739130434783 x 0.0928 = 4.7 kNm

$M_{az}$ = 1798 x 17.0526315789474 x 0.0884 = 2.71 kNm

**Moment Due to Eccentricity:**

**$M_e$ = $P_u$ x $e_{min}$**

$$M_{ey} = \frac{1798 \times 20}{1000} = 35.96 \text{ kNm}$$

$$M_{ez} = \frac{1798 \times 20}{1000} = 35.96 \text{ kNm}$$

**Design moment:**

**$M_d$ = Max($M_e$,$M_u$) + $M_a$**

$M_{dy}$ = Max(39,35.96) + 4.7 = 43.7 kNm

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$M_{dy}$ = Max(23,35.96) + 2.71 = 38.67 kNm

**Uniaxial moment capacity about y-y axis:**

$\frac{P_u}{F_{ck} * BD} = \frac{1798 \times 10^3}{25 \times 230 \times 380}$ = 0.82

$\frac{M_{uy}}{F_{ck} * bD^2}$ = 0.10095

$M_uy1 = M_uy/(f_ck$

= 0.10095 x 25 x 230 x 380^2 = 84 kNm

**Uniaxial moment capacity abouz-z axis:**

$\frac{P_u}{F_{ck} * BD} = \frac{1798 \times 10^3}{25 \times 230 \times 380}$ = 0.82

$\frac{M_{uz}}{F_{ck} * DB^2}$ = 0.087

$M_uz1 = M_uz/(f_ck$

= 0.08675 x 25 x 380 x 230^2 = 43.596 kNm

**Calculation of $P_{uz}$**

$p_t$ = 3 %

$\frac{P_u}{P_{uz}} = \frac{1798}{1937}$ = 0.9282

| $(P_u/P_{uz})$ | $\alpha^n$ |
|---|---|
| 0.2 | 1 |
| 0.8 | 2 |
| Other values | Interpolate |

$\alpha^n$ = 2.22

$\frac{M_{dy}}{M_{uy1}} = \frac{43.7}{84}$ = 0.53

$\frac{M_{dz}}{M_{uz1}} = \frac{38.67}{43.5962}$ = 0.89

**Criteria for Biaxial Bending (Bresler's Formulation)**

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$[Mdy/Muy1\ ]\alpha\hat{}n+[Mdz/$

(0.53) ^ 2.22 + (0.89) ^ 2.22 = 1.02 ≥ 1

**Check for Maximum and Minimum Reinforcement**

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Maximum reinforcement = 4% of cross sectional area

$= \frac{4}{100} \times 380 \times 230$ = 3496 $mm^2$

Minimum reinforcement = 0.8% of cross sectional area

$= \frac{0.8}{100} \times 380 \times 230$ = 699.2 $mm^2$

Provided reinforcement = 3% of cross sectional area

$= \frac{3}{100} \times 380 \times 230$ = 2622 $mm^2$

**Codal provisions are satisfied**

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**Transverse reinforcement:**

**Lateral Ties**

1) Dia of tie bar sholuld be

$$> \frac{\text{Maximum longitudinal dia of bar}}{4} = \frac{20}{4} = 5 \text{ mm}$$

> 6mm = 6 mm

Take high value 8 mm

2) Pitch

= Least dimesnion fo compression member = 230 mm

(or)

= 16*smallest dia of longitudinal bar = 320 mm

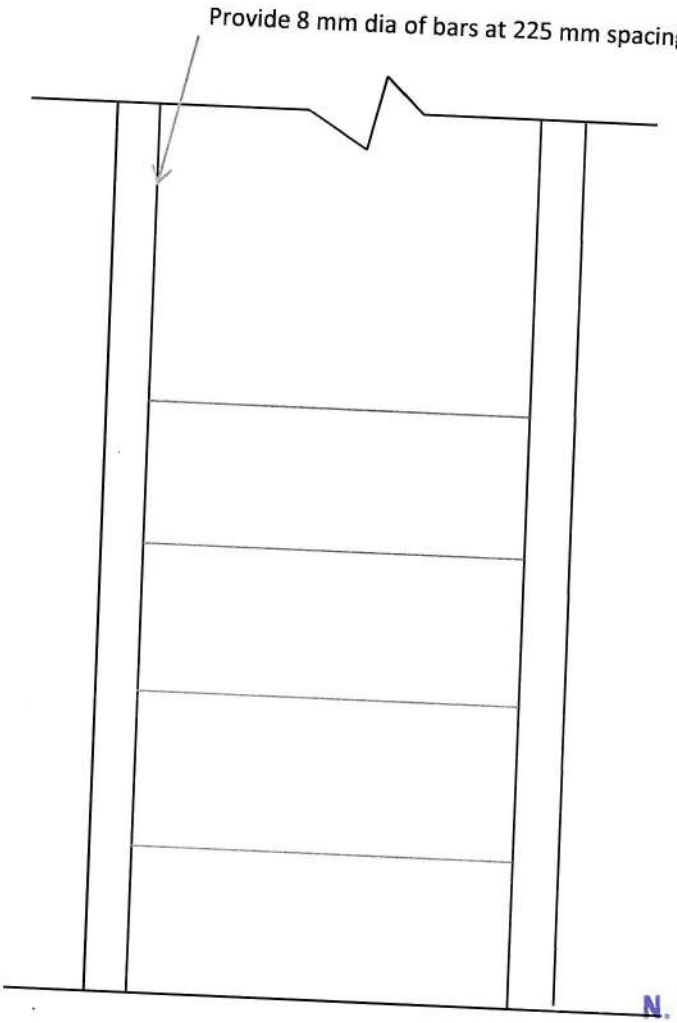
(or)

= 300mm = 300 mm

Take low value 225 mm

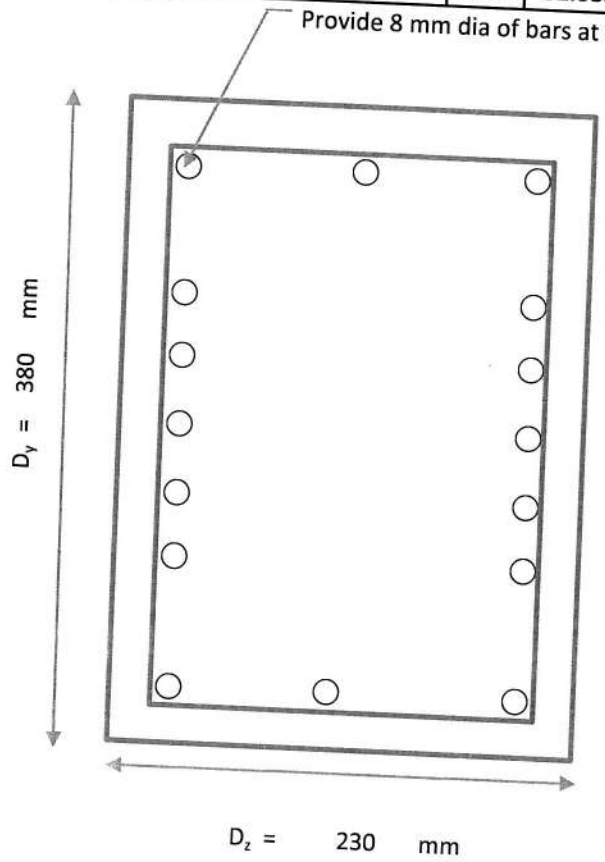
Provide 8 mm dia of bars at 225 mm spacing

Provide closer spacing on either side of the column above and below beam / slab.




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Span(L) = 3.1 m

Clear cover($C_c$) = 30 mm

Modulus of elasticity of concrete (Ec ) = $5000\sqrt{f_{ck}}$ ($N/mm^2$) = 25000

Modulus of elasticity of steel($E_s$) ($N/mm^2$) = 200000

Type of beam = Fixed

Environment condition = Not Aggressive

**Beam Numeration Details:-**

| Depth of Beam (D)mm | Width of Beam(b)mm |
|---|---|
| 380 | 230 |

**Grade of Concrete /Rft**

| Concrete($F_{ck}$) $N/mm^2$ | Steel ($F_y$) $N/mm^2$ |
|---|---|
| 25 | 500 |

**Longitudinal Reinforcement Details:**

| Location | Left Support | | Mid | | Right Support | |
|---|---|---|---|---|---|---|
| | Dia(mm) | No | Dia(mm) | No | Dia(mm) | No |
| Top | 20 | 3 | 20 | 3 | 20 | 3 |
| Bottom | 20 | 3 | 20 | 3 | 20 | 2 |

**Transverse Reinforcement Details:**

| Location | Left Support | Mid | Right Support |
|---|---|---|---|
| Bar dia | 8 | 8 | 8 |
| No of Leg | 2 | 2 | 2 |

**ANALYSIS RESULT:**

Stadd.pro

| Location | Left Support | Mid | Right Support |
|---|---|---|---|
| BM at Top (kNm) | 192 | 0 | 198 |
| BM at Bottom (kNm) | 0 | 180 | 0 |
| SF (kN) | 200 | 15 | 215 |
| Torsion (kNm) | 0 | 0 | 0 |

**DESIGN CALCULATIONS:(For Top BM at Left support)**

**Equiavelent Bending moment:-**

$M_e = M_u + M_t$

$M_1 = T_u \frac{(1+D/b)}{1.7} = 0\left(\frac{1+ 380/230}{1.7}\right)$ = 0 kN.m

$M_e = 192 + 0$ = 192 kN.m

**Limiting Moment:**

$M_u$ limit = 0.133*Fck*b*d*d

eff.depth = D-dia of bar x 0.5-cover = 340 mm

$M_u$ limit = 0.133 x 25 x 23088.41 x 340 = 88.41 kNm

The section is doubly reinforced

$M_u > M_u$limit

**Reinforcement At Tension Zone:**

**Singly Reinforced Beam:**

IS456-2000
Annex-G

$$A_{st.required} = (bdf_{ck})/[2f]$$

$$= \frac{1000 \times 380 \times 25}{2 \times 500}\left[1-\left[1-\frac{4.598 \times 192 \times 10^6}{25 \times 1000 \times 340^2}\right]^{1/2}\right] = 0 \text{ mm}^2$$

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**Doubly Reinforced Beam:**

SP.16 P.NO 10

$A_{st\ Req} = A_{st.limit} + \Delta A_{st}$

$A_{st.limit} = \frac{p_t\ limit}{100} \times bd$

$P_{t.limit} = \frac{0.36\ F_{ck} * b * X_{umax}}{0.87 F_y * b * d} \times 100$

$\frac{Xu_{max}}{d} = \frac{0.0035}{0.0055 + \frac{0.87 * f_y}{E_s}} = 0.456$

$Pt_{limit} = \frac{0.36 \times 25 \times 230 \times 0.456 \times 340}{0.87 \times 500 \times 230 \times 340} \times 100 = 0.94\ \%$

$A_{st.limit} = \frac{0.94}{100} \times 230*340 = 735.1\ mm^2$

$\Delta A_{st} = \frac{M_u - M_u limit}{0.87 \times f_y \times (D-d')}$

$d' = 40\ mm$

$\Delta A_{st} = \frac{192 - 88.41}{0.87 \times 500 \times (340 - 40)} = 794\ mm^2$

$A_{st\ Req} = 735.08 + 794 = 1529\ mm^2$

Minimum reinforcement

IS456-2000

IS13920 Cl.6.2.1

$= \frac{0.85 \times bd}{Fy} = 132.94\ mm^2$

$= \frac{0.24 \times \sqrt{Fck} * bd}{Fy} = 187.68\ mm^2$

$A_{st\ pro} = 1530\ mm^2$

Maximum reinforcement:

IS456-2000 IS13920 Cl.6.2.2

$A_{st\ max} = 0.04bD = 3496\ mm^2$

$A_{st\ max} = 0.025bD = 2185\ mm^2$

$> A_{st\ pro}$ SAFE

Provide3No's of 20mm Dia bars

**Reinforcement At Compression Zone:**

$A_{sc} = \frac{0.87 \times f_y \times \Delta A_{st}}{F_{sc} - 0.447 \times f_{ck}}$

SP.16 P.NO 6

$E_{sc} = \frac{0.0035 x (X_{umax} - d')}{X_{umax}}$

$X_{umax} = 0.456 \times d = 155.04$

$E_{sc} = \frac{0.0035 \times (155.04 - 40)}{155.04}$

$= 0.002597007$

$F_{sc} = 405.63\ N/mm^2$

$A_{sc} = \frac{0.87 \times 500 \times 794}{405.63 - 0.447 \times 30} = 880.6\ mm^2$

Min $A_{sc}$ $= 187.68\ mm^2$

$A_{sc\ provided} = 881\ mm^2$

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Provide 3 No's of 20mm dia bars

**Longitudinal reinforcement Details:**

**Top face:-**

| Zone | $M_{eq}$ | $M_{ulim}$ | Section | $A_{streq}$ | $A_{st.pro}$ | $A_{screq}$ | $A_{st.pro}$ | Status |
|---|---|---|---|---|---|---|---|---|
| Left | 192 | 88.41 | Doubly | 1529 | 1529 | 875.4 | 875.4 | SAFE |
| Mid | 0 | 88.41 | Singly | 0 | 187.7 | 0 | 187.7 | SAFE |
| Right | 198 | 88.41 | Doubly | 1575 | 1575 | 926.1 | 926.1 | SAFE |

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**Bottom face:-**

| Zone | $M_{eq}$ | $M_{ulim}$ | Section | $A_{streq}$ | $A_{st.pro}$ | $A_{screq}$ | $A_{st.pro}$ | Status |
|---|---|---|---|---|---|---|---|---|
| Left | 0 | 88.41 | Singly | 0 | 187.7 | 0 | 187.7 | SAFE |
| Mid | 180 | 88.41 | Doubly | 1437 | 1437 | 774 | 774 | SAFE |
| Right | 0 | 88.41 | Singly | 0 | 187.7 | 0 | 187.7 | SAFE |

**SHEAR STRESS CALCULATION**

**Equiavelent Shear force:-**

$$V_e = V_u + \frac{1.6T_u}{b} = 200 + \frac{1.6 \times 0}{0.23} = 200 \text{ kN}$$

$$\text{Shear Stress } \tau_v = \frac{V_e}{bd} = \frac{200 \times 1000}{230 \times 340} = 2.558 \text{ N/mm}^2$$

$$\text{Design Shear Stress } \tau_c = \frac{0.85\sqrt{(0.8\ Fck)}*(\sqrt{(1+5\beta)}-1)}{6\beta}$$

$$pt = \frac{100Ast}{bD} = \frac{100 \times 1530}{380 \times 230} = 1.75057\ \%$$

(P.NO. 175)

$$\beta = 0.8f_{ck}/6.89pt = \frac{0.8 \times 30}{6.89 \times 1.76} = 1.99$$

IS456-2000 TABLE NO 20

$$\tau_c = \frac{0.85 \times \sqrt{(0.8 \times 25)}(\sqrt{(1+5 \times 1.99)}-1))}{6 \times 1.99} = 0.735 \text{ N/mm}^2$$

$\tau_{cmax}$ = 3.1 /mm²

$\tau_c < \tau_v < \tau_{cmax}$

Provide shear reinforcement

$V_{us} = Vu - \tau c * bd$ = 142.52 kN

$A_{sv}$ = 101 mm²

$$S_v = \frac{0.87 F_y A_{sv} d}{V_{us}} = \frac{0.87 \times 500 \times 101 \times 340}{142.52 \times 1000} = 104.813 \text{ mm}$$

**Minimumm and maximum spacing of striuups:**

**As per IS13920-2016:**

**At support:**

IS13920-2016 CL.6.3.5

Maximum Spacing is minimum of

i) $\frac{d}{4} = \frac{340}{4}$ = 85 mm

ii) $8\Phi = 8 \times 20$ = 160 mm

(Take diametre of smallest bar)

iii) 100mm = 100 mm

Take spacing as per IS3920 = 85 mm

**At Mid:**

Maximum Spacing is minimum of

i) $\frac{d}{2} = \frac{340}{2}$ = 170 mm

**As per IS456-2000:**

**Maximum:**

IS456-2000 CL.26.5.1.5

i) Max spacing of stirrups = 0.75d = 255 mm

ii) 300mm = 300 mm

**Minimum:**

$$A_{svmin} = \frac{0.4\ b\ S_v}{0.87\ F_y}$$

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$$S_v = \frac{(0.87 \times 500 \times 101)}{0.4 \times 230} = 477.6 \text{ mm}$$

$S_{vprc}$ = 85 mm

SAFE

Provide T8 mm 2 Legged stirrups at 85 mm C/C

**Transverse Reinforcement Details:**

| Zone | $V_{eq}$ | $\tau_v$ | $\tau_c$ | $\tau_{cmax}$ | $V_{us}$ | $A_{sv}$ | $S_v$ | Status |
|---|---|---|---|---|---|---|---|---|
| Left | 200 | 2.5575 | 0.71914 | 3.1 | 143.8 | 101 | 85 | SAFE |
| Mid | 15 | 0.19182 | 0.71914 | 3.1 | 41.24 | 101 | 170 | SAFE |
| Right | 215 | 2.74936 | 0.74259 | 3.1 | 156.9 | 101 | 85 | SAFE |

**DEVELOPMENT LENGTH:**

$$L_d = \frac{\phi \sigma_s}{\tau_{bd}} = \frac{20 \times 0.87 \times 500}{3} = 2900 \text{ mm}$$

Bar diametre $\phi$ = 20 mm

Bond stress $\tau_{bd}$ = 3 N/mm²

**DEFLECTION :**

$$\delta_L = \frac{1}{384} \times \frac{wl^4}{EI_{eff}}$$

$$w_{service} = \frac{12M_{eq}}{l^{2 \times 1.5}} = \frac{12 \times 192}{3.1 \times 3.1 \times 1.5} = 159.834 \text{ kN}$$

$$I_{eff} = \frac{I_r}{1.2 - \frac{M_r}{M} \times \frac{Z}{d}\left(1-\frac{a}{d}\right) \times \frac{b_w}{b}}$$

$I_r \le I_{eff} \le I_{gr}$

Cracking moment $M_r = \frac{F_{cr} \times I_{gr}}{y_t} = \frac{3.5 \times 1051713334}{190} = 19.37$ kNm

$y_t$ = 190 mm

$I_{gr}$ = 1051713334 $mm^4$

Moduulus of rupture $F_{cr} = 0.7\sqrt{F_{ck}}$ = 3.5 N/mm²

Modular ratio m = 8

$$\frac{b\,a^2}{2} = m\,Ast\,(d-a)$$

$$a^2 = \frac{2m\,Ast\,d - 2m\,Ast\,a}{b}$$

$$= \frac{8323200}{230} - \frac{24480}{230} * a$$

$a^2$ = 36188 - 106.434783 a

Neutral axis a = 145 mm

Lever arm

$$Z = d - \frac{a}{3} = 340 - \frac{145}{3} = 331.7 \text{ mm}$$

Moment at service load = 128 kNm

$$I_r = \frac{ba^3}{12} + m A_{st.pro}(D-a)^2 + (m-1)\,Asc.pro\,(a-d')^2$$

$$I_r = \frac{230x145x145x145}{3} + 8 \times 1530 \times (380-145)^{\wedge}2$$

$$+ (8-1) \times 881 \times (145-40)^{\wedge}2$$

Critical moment of inertia $I_r$ ($mm^4$) = 802377154

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$$I_{eff} = \frac{802377154.2}{1.2 - \frac{19.37}{128} \times \frac{331.7}{340}\left(1-\frac{145}{340}\right) \times \frac{230}{230}} = 719414248 \text{ mm}^4$$

Ir ≤ Ieff ≤ Igr

$I_{eff}$ ($mm^4$) = 802377155

**i)Deflection due to load**

$$\delta_L = \frac{159.833506763788 \times 3.1 \times 3.1 \times 3.1 \times}{384 \times 25000 \times 802377155} = 1.92 \text{ mm}$$

**ii)Deflection due to shrinkage:**

$$\delta_s = k_3 \times \Psi_{es} \times L^2$$

Shrinkage curvature $\Psi_{es} = k_4 \frac{\varepsilon_{cs}}{D} = 0.322 \frac{0.0003}{380} = 0.255 \times 10^{\wedge -6}$

$\varepsilon_{cs} = 0.0003$

if, $0.25 \le P_t - P_c < 1.0$ $\quad k_4 = \frac{0.72(P_t-P_c)}{\sqrt{p_t}} = \frac{0.72 \times 0.2}{0.4472136} \le 1 = 0.322$

if, $P_t - P_c \ge 1.0$ $\quad k_4 = \frac{0.65(P_t-P_c)}{\sqrt{p_t}} = \frac{0.65 \times 0.2}{0.4472136} \le 1 = 0.098$

$P_t - P_c = 1.76 - 1.01 = 0.2$ %

$k_4$

$k_3 = 0.322$

$\delta_s = 0.125 \times 0.255 \times 10\text{^-}6 \times 3.1 \times 3.1 \times 10\text{^}6 = 0.125 = 0.30632$ mm

**iii)Deflection due to creep:**

$$\delta_c = \delta_{1c} - \delta_1$$

$$= \frac{5}{384} \times \frac{wl^4}{E_{cc} I_{eff}} - \frac{5}{384} \times \frac{wl^4}{E_c I_{eff}}$$

$$= \frac{5}{384} \times \frac{wl^4}{I_{eff}} \left(\frac{1}{Ecc} - \frac{1}{Ec}\right), \quad Ecc = \frac{Ec}{1+\theta}$$

$$= \frac{5}{384} \times \frac{wl^4}{I_{eff}} \theta \qquad \theta = 1.5$$

$$= \frac{159.833506763788 \times 3.1 \times 3.1 \times 3.1 \times}{384 \times 25000 \times 802377155} \times 1.5 = 2.88 \text{ mm}$$

$\delta = \delta_l + \delta_s + \delta c = 5.106$ mm

**Limiting Deflection:**

IS 456-2000
CL 23.2

$$\delta_{max} = \frac{\text{Span}}{350}, \ 20$$

$= 8.857, \ 20$

$= 8.857$ mm

$\delta_{max} > \delta$ = SAFE

**CRACK WIDTH CALCULATION**

$$W_{cr} = \frac{3a_{cr} \times \varepsilon_m}{1 + \frac{2(a_{cr}-C_{min})}{h-x}}$$

$a_{cr} = [[0.5S]_2 + C^2_{min}]^{1/2}$

Cover to rft $C_{min} = 30$ mm

Spacing of bars $S = 100$ mm

$a_{cr} = 59$

$$\varepsilon_m = \varepsilon_1 - \frac{b(h-a)(g-a)}{3E_s A_s (d-a)}$$

$$\varepsilon_1 = \frac{Fs}{Es} \times \frac{(h-a)}{(g-a)}$$

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| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | | | REV | 0 |
|---|---|---|---|---|---|---|---|
| TITLE: | DESIGN OF BEAM | A23015-C-RB-01-DC-0002 | | | | | |
| CLIENT: | M/S BUILD TECH ASSOCIATES | DESIGNED | | CHECKED | | APPROVED | |
| | | JSAN | | NKK | | NKK | |
| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

$$F_s = \frac{m*\text{Service moment}*(d-a)}{I_r}$$

$$= \frac{8x128x10^{\wedge}6\ (340-145)}{802377154.2} = 248.9 \quad N/mm^2$$

D = h = 380 mm

Crack width calculating distance from combression edje = g = 20 mm

$$\varepsilon_1 = \frac{248.9}{200000} \times \frac{(380-145)}{(20-145)} = -0.00234$$

$$\varepsilon_m = -0 - \frac{230(380-145)(20-145)}{3 \times 200000 \times 1530(340-145)} = -0.0023$$

$$W_{cr} = \frac{3 \times 59 \times -0.0023}{1 + \frac{2(59-30)}{(380-145)}} = -0.32651 \text{ mm}$$

IS456-2000

Limiting crack width = 0.3 mm

SAFE

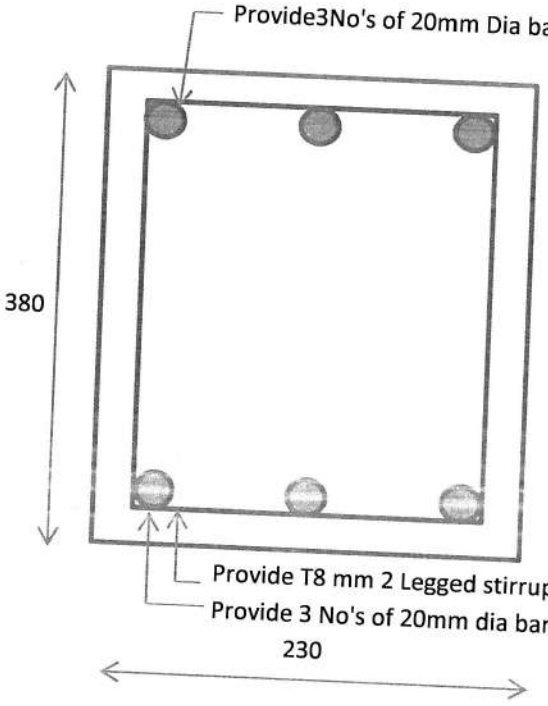



Fig.1 Cross section details

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| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | | | REV | 0 |
|---|---|---|---|---|---|---|---|
| TITLE: | DESIGN OF SLAB | A23003-C-CB-01-DC-0001 | | | | | |
| CLIENT | M/S BUILD TECH ASSOCIATES | DESIGNED | | CHECKED | | APPROVED | |
| | | JSAN | | NKK | | NKK | |
| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

**INPUT DETAILS:-**

| | | | | |
|---|---|---|---|---|
| Grade of Concrete | $F_{CK}$ | = | M25 | |
| Grade of Steel | $F_y$ | = | Fe500 | |
| Cover to Main Reinforcement | | = | 20 | mm |
| Thickness of the Slab | | = | 125 | mm |
| Floor finishing thickness | | = | 20 | |
| Assumed Dia of main Reinforcement | | = | 8 | mm |
| Modulus of Elasticity OF steel | $E_s$ | = | 200000 | $N/mm^2$ |
| Support Condition | | = | Fixed | |
| Creep Coefficient | θ | = | 1.6 | |
| crack width Distance | g | = | 50 | mm |
| Environment Condition | | = | Not Aggressive | |

**SIZES OF PANEL:-**

| | | | | | |
|---|---|---|---|---|---|
| Clear Span | $L_y$ | = | 3.564 | m | (Longer Span) |
| | $L_x$ | = | 3.072 | m | (Shorter Span) |
| Effective depth | dx | = | 101 | mm | = (125-20-(0.5x8) |
| | dy | = | 93 | mm | = (101-8) |
| Effective Span (As per IS456:2000 Cl 22.2 Pg34) | $L_y$ | = | 3.657 | m | = (3.564+93) |
| | $L_x$ | = | 3.173 | m | = (3.072+101) |

**SPAN RATIO:-**

$$r = \frac{Ly}{Lx} = 1 < 2$$

Hence The Slab is Two Way Slab

**LOADS ON SLAB:-**

| | | | | |
|---|---|---|---|---|
| Self weight of Slab | = | (0.125x25) | = | 3.125 $N/m^2$ |
| Floor Finish | = | (0.02x24) | = | 0.48 $N/m^2$ |
| Super imposed dead load | = | | = | 2 |
| Live Load | | | = | 5 $N/m^2$ |
| Factored total load | | | w = | 15.908 $N/m^2$ |

Boundary Condition: Two adjacent edges discontinuous

**REINFORCEMENT CALCULATION:**

| Moment Cofficient | | | | Bending Moment in kN-m | | | |
|---|---|---|---|---|---|---|---|
| Short Span | | Long Span | | Short Span | | Long Span | |
| $\alpha_x$ | | $\alpha_y$ | | $M_x = \alpha_x w l_x^2$ | | $My = \alpha_y w l_y^2$ | |
| Support | Span | Support | Span | Support | Span | Support | Span |
| 0.0567 | 0.0426 | 0.047 | 0.035 | 9.08 | 6.83 | 10 | 7.4459 |

**CHECK FOR DEPTH:-**

Mumax = 0.133Fck*bd^2 = 0.133 x 25 x 1000 x 101^2

dreq = 54.850 mm < $d_{provided}$

b = 1000 mm

d = 101 mm

**% of Reinforcement**

**% of steel ,** $P_t = f_ck/(2f_y)\,[1-\sqrt{((1-4.598M}$

| Short Span | |
|---|---|
| Support | Span |
| $\frac{25}{2x500}\left(1-\sqrt{\frac{1-4.598x9.08}{25x1000x101^2}}\right)$ = 0.2138 | $\frac{M25}{2x500}\left(1-\sqrt{\frac{1-4.598x6.83}{25x1000x101^2}}\right)$ = 0.159 |

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| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | | | REV | 0 |
|---|---|---|---|---|---|---|---|
| TITLE: | DESIGN OF SLAB | A23003-C-CB-01-DC-0001 | | | | | |
| | | DESIGNED | | CHECKED | | APPROVED | |
| CLIENT | M/S BUILD TECH ASSOCIATES | JSAN | | NKK | | NKK | |
| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

**Long Span**

| Support | Span |
|---|---|
| 25 / 2x500 $\left(1-\sqrt{\frac{1-4.598\times10}{25\times1000\times93^2}}\right)$ = 0.2817 | M25 / 2x500 $\left(1-\sqrt{\frac{1-4.598\times7.4459462513625}{25\times1000\times93^2}}\right)$ = 0.20645 |

**Ast required**

| Short Span | | Long Span | |
|---|---|---|---|
| Support | Span | Support | Span |
| 0.21/100x1000x101 | 0.159/100x1000x101 | 0.28/100x1000x93 | 0.206/100x1000x93 |
| = 215.91 | = 160.59 | = 261.9621913 | = 191.994262 |

**Design Required**

| Design Result along short Span | | | | | |
|---|---|---|---|---|---|
| At support | Provide | Y- | 8 | 230 | mm c/c |
| At span | Provide | Y- | 8 | 310 | mm c/c |

| Design Result along long Span | | | | | |
|---|---|---|---|---|---|
| At support | Provide | Y- | 8 | 190 | mm c/c |
| At span | Provide | Y- | 8 | 260 | mm c/c |

**Design Provided**

| Design Result along short Span | | | | | |
|---|---|---|---|---|---|
| At support | Provide | Y- | 8 | 100 | mm c/c |
| At span | Provide | Y- | 8 | 100 | mm c/c |

| Design Result along long Span | | | | | |
|---|---|---|---|---|---|
| At support | Provide | Y- | 8 | 100 | mm c/c |
| At span | Provide | Y- | 8 | 100 | mm c/c |

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**CHECK FOR DEFLECTION CONTROL:-**

$A_{stprovided}$ = Spacing/3.14$d^2$

| Short Span | | Long Span | |
|---|---|---|---|
| Support | Span | Support | Span |
| 230/ 3.14 x 8 x 8 | 310/ 3.14 x 8 x 8 | 190/ 3.14 x 8 x 8 | 260/ 3.14 x 8 x 8 |
| = 502.65 | = 502.66 | = 502.65 | = 502.655 |

**Short Term Deflection**

as per cl. C-2 p.no. 88 $l_{eff}$ = $\frac{l_f}{(1.2-M_r/M\ z/d\ (1-x/d)\ b_w/b)}$

Reinforcement ratio p = Ast/bd = 502.66 / 1000 x 101 = 0.005

Modulus of elasticity Ec = 5000 √fck = 5000 x √25 = 25000 KN/mm$^2$

Modulur ratio m = Es/Ec = 200000 / 25000 = 8

Neutral axis factor k = √(2pm+(pm)$^2$)-pm = √((2x0.005x8) + (0.005x8)^2) - (0.005x8) = 0.246

Lever arm factor j = 1-(k/3) = 1-(0.246/3) = 0.92

Lever arm z = j d = 0.918x101 = 93

Neutral axis depth x = k d = 0.246x101 = 24.9

| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | | | REV | 0 |
|---|---|---|---|---|---|---|---|
| TITLE: | DESIGN OF SLAB | A23003-C-CB-01-DC-0001 | | | | | |
| CLIENT | M/S BUILD TECH ASSOCIATES | DESIGNED | | CHECKED | | APPROVED | |
| | | JSAN | | NKK | | NKK | |
| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

Second moment of the area of the cracked section

$I_{cr}$ = $(b\,(kd)^3/3) + (m\,Ast\,(d-kd)^2)$

$= \frac{1000 \times 0.246 \times 101^3}{3} + 8 \times 502.66 \times (101-0.246\times101)^2 = 28433814$ $mm^4$

Gross Moment of Inertia $I_{gr} = bD^3/12$

$= 1000 \times 101^3/12 = 85858416.67$ $mm^4$

factor $\eta = z/d\,(1 - x/d)\,(bw/b) = 0.692$

Modulus of Rupture $f_{cr} = 0.7\sqrt{fck}$

$= 0.7 \times SQRT25 = 3.5$ $N/mm^2$

Distance from centroidal axis of gross section $y_t = D/2 = 62.5$ mm

Cracking Moment $Mcr = f_{cr} I_{gr}/y_t = 1$

$= \frac{3.5 \times 85858416.67}{62.5} = 4.81$ kNm/m

Effective second moment of area $I_{eff} = Icr/(1.2-(Mcr/M)\eta)$

$= \frac{28433813.79}{1/10\times0.692))} = 32790035$ $mm^4$

Icr < Ieff < Igr The section is safe

28433813.79 < 32790035 < 85858416.67

Short term deflection due to total load

$\delta_{D+L} = \frac{1\,M\,L^2}{384\,Ec\,Ieff}$

$= \frac{1 \times 17.728443455625 \times 3.564^2}{48 \times 25000 \times 32790035} = 0.8$ mm

Short term deflection due to dead load alone

$\delta_D = \frac{5\,M_D\,L^2}{48\,Ec\,Ieff}$

$= \frac{1\times 6.25 \times 3.56^2}{384\times25000 \times 32790035} = 0.38$ mm

Short term deflection due to live load alone $\delta_L = \delta_{D+L} - \delta_D = 0.37$ mm

**Deflection due to shrinkage:**

Ultimate shrinkage strain in cor Ecs — as per cl. C-3 p.no. 88, from cl. 6.2.4 p.n 16 = 0.0003

Shrinkage constant $k_4$ — from cl. C-3.1 p.n 88 = 0.051

Shrinkage constant $k_3$ = 0.125

Deflection due to shrinkage $\delta sh = k_3\,k_4\,Ecs\,L^2/D$

$= \frac{0.125\times0.05 \times 0.0003\times(3.657\times1000)^2}{125.0} = 0.2$ mm

**Deflection due to creep:**

as per cl. C-4 p.no. 88

Modulus of elasticity due to creep, Ece $= Ec/(1+\theta) = 25000/(1+1.6) = 9615.4$ $N/mm^2$

modulur ratio $m = Es/Ece = 200000/9615.38 = 20.8$

Neutral axis factor $k = \sqrt{(2pm+(pm)^2)}-pm$

$= \sqrt{2\times0.005\times20.8)+(0.005\times20.8)^2}-(0.005\times20.8) = 0.364$

Lever arm factor $j = 1-(k/3) = 1-(0.364/3) = 0.879$

Lever arm $= j\,d = 88.78$ mm

Neutral axis depth $z = k\,d = 36.76$ mm

Second moment of the area of the cracked section x

$I_{cr} = (b\,(kd)^3/3) + (m\,Ast\,(d-kd)^2)$

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$= \frac{(1000x(0.364x101)^3}{3} + 20.8x10x(101-0.364x101)^2 = 59704746$ mm$^4$

$\eta_{factor} = z/d(1-x/d)(bw/b)$

$= (88.78/101) \times (1-36.76/101) = 0.559$

Effective second moment of area, $I_{eff\ D+L} = Icr/(1.2-(Mcr/M)\eta)$

$= \frac{59704746}{(1.2-(4.81/10X0.559)} = 49753961$ mm$^4$

Icr and Ieff are less than Igr, Hence it is ok

Initial plus creep deflection due to permenent loads

$a_{i,cc} = (1/384)(M_D L^2/(EceI_{effD+L}))$

$= \frac{1}{384} \times \frac{6.24660855375x10^6x3.657}{(3.564x1000)^2/(9615.38x49753961.34)} = 0.68$ mm

Short term deflection due to permanent loading

$a_i = (W_{DL}/W)\delta_{(D+L)}$

$= (3.605 / 15.9075) \times 0.37 = 0.3964$ mm

Deflection due to creep

$= a_{cc} = a_{i,cc} - a_i = 0.29$ mm

$= L/250 = 14.63$ mm

Permissible final deflection due to all loads

Permissible deflection that occurs after construction

L/350 or 20mm which ever is less = 10.45 mm

Actual deflection due to all loads $= \delta_{D+L}+\delta_{sh}+a_{cc} = 1.24$ mm

Actual deflection is less than Permissible deflection hence safe

Actual deflection that occurs after constructi $= \delta_L+\delta_{sh}+a_{cc} = 0.86$ mm

Actual deflection is less than Permissible deflection hence safe

**CHECK FOR CRACK WIDTH:-**

$W_{cr} = \frac{3a_{cr} \times \varepsilon_m}{1 + \frac{2(a_{cr}-C_{min})}{h-a}}$

$a_{cr} = [[0.5S]^2 + C^2_{min}]^{1/2}$

Spacing of Ba = 20

$a_{cr} = 23$

$\varepsilon_m = \varepsilon_1 - \frac{b(h-a)(g-a)}{3E_s A_s (d-a)}$

$\varepsilon_1 = \frac{Fs}{Es} \times \frac{(h-a)}{(g-a)}$

$F_s = \frac{m \times Moment\ (d-a)}{I_r}$

$\frac{b\,a^2}{2} = m\,Ast\,(d-a)$

$a^2 = \frac{2m\,Ast\,d - 2m\,Ast\,a}{b}$

$= \frac{2 \times 20.8 \times 502.66 \times 101 - 220.8 \times 502.66a}{1000}$

$= \frac{418213.12 - 10898\,a}{1000}$

$a = 1$

$F_s = \frac{20.8 \times 10 \times (101-1)}{59704746} = 281.36$ N/mm$^2$

$\varepsilon_1 = \frac{281.36}{2.00E+05} \times \frac{(125-1)}{(50-1)} = 0.0036$


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$$\varepsilon_m = 0.0036 - \frac{1000 \times (125 - 1) \times (50 - 1)}{3 \times 200000 \times 502.66 \times (101-1)} = 0.00339$$

$$W_{cr} = \frac{3 \times 23 \times 0.00339}{1 + \frac{2 \times (23 - 20)}{125 - 1}} = 0.1726$$

Limiting Crack width = 0.300

safe

**CHECK FOR SHEAR:-**

Average effective depth = 97 mm

$V_U = W_U(0.5 \times L_x - d_{avg})$

= 15.91 x (0.5 x 3.173 - (97 / 1000))

= 24 kN

$\tau_v = V_u/bd = 0.24$

$(Pt)_{Provided} = 0.28$

Sp-24-126

$\beta = 0.8f_{ck}/6.89p_t$ ( but Sould not less than 1)

$\beta = \frac{0.8 \times 25}{6.89 \times 0.28}$

$\beta = 10$

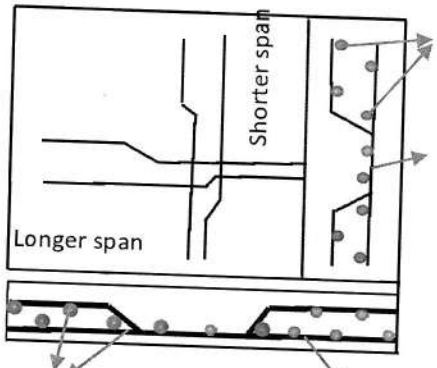
$\tau_c$ = 0.85*sqrt(0.8*fck)*(sqrt(1+5β)-1)/6β

= 0.85 x SQRT(0.8x25 )x (SQRT(1+5x)-1)/6x10.37

= 1.21 Safe

**REINFORCEMENT DETAILS:-**

**Two way slab**



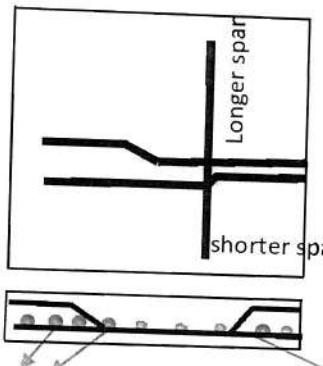

Provide 8 mm ϕ 230 mm c/c

Provide 8 mm ϕ 310 mm c/c

Provide 8 mm ϕ 190 mm c/c

Provide 8 mm ϕ 260 mm c/c

**One way slab**




Provide 8 mm ϕ 230 mm c/c

Provide 8 mm ϕ 190 mm c/c


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| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | REVISION | 0 |
|---|---|---|---|---|---|
| TITLE: | DESIGN OF STAIRCASE | A23015-C-RB-01-DC-0002 | | | |
| CLIENT | M/S BUILD TECH ASSOCIATES | DESIGNED | CHECKED | APPROVED | |
| | | JSAN | NKK | NKK | |
| | | DATE 02.08.2024 | DATE 02.08.2024 | DATE | 02.08.2024 |

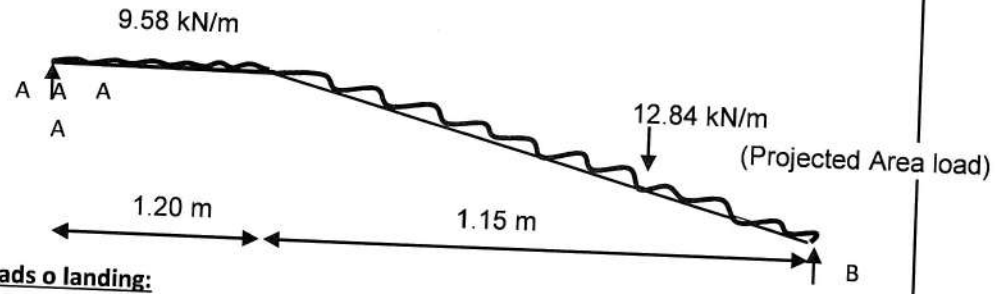
**Input:**

| | | | | |
|---|---|---|---|---|
| Unit Weight of concrete(RCC) | | = | 25 | $KN/m^3$ |
| Unit Weight of concrete(PCC) | | = | 24 | $KN/m^3$ |
| Unit Weight of Masonary work | | = | 20 | $KN/m^3$ |
| Tensile strength of steel | | = | 500 | $N/mm^2$ |
| Compressive strength of concrete | | = | 20 | $N/mm^2$ |
| Main bar Dia | | = | 12 | mm |
| Distribution bar Dia | | = | 8 | mm |

**Stair Case Details:**

| | | | | |
|---|---|---|---|---|
| Tread | | = | 0.30 | m |
| Riser | | = | 0.18 | m |
| Thickness of slab | | = | 0.175 | m |
| Efeective depth of slab | = 0.175 - 0.025 - 0.006 | = | 0.144 | m |
| Thickness of finishing | | = | 0.05 | |
| Clear cover | | = | 25 | mm |
| $X_{umax}/d$ | | = | 0.460 | |

A **Flight 1 Design:**




**Loads o landing:**

**i)Dead load:**

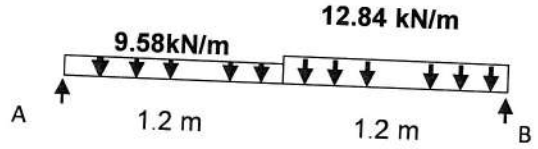
| | | | | |
|---|---|---|---|---|
| Self weight | | | | |
| **Finishing load** | | = | 4.38 | $kN/m^2$ |
| Total load per m run | | = | 1.20 | $kN/m^2$ |
| **ii)Live load:** | 4.375 + 1.2 | = | 5.58 | $kN/m^2$ |
| Railway building class | | | | |
| IS 875 Part 2 Table 2 (Corridors, passages, lobbies, staircases) | | = | 4 | $kN/m^2$ |
| UnFactored Loads on Landing slab | | = | **9.58** | $kN/m^2$ |

**Loads on Going (or) Horizontal portion on Projected Plan Area**

**i)Dead load:**

| | | | | |
|---|---|---|---|---|
| **Self weight** | | | | |
| **Finishing load** | | = | 5.065 | $kN/m^2$ |
| Load due to Steps | | = | 1.583 | $kN/m^2$ |
| Total load per m run | | = | 2.188 | $kN/m^2$ |
| **ii)Live load:** | | = | **8.836** | $kN/m^2$ |
| **Railway building class** | | | | |
| Unactored Loads on Going on Projected Plan Area | | = | 4 | $kN/m^2$ |
| | | = | **12.84** | $kN/m^2$ |


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Email : nkarikalan1985@gmail.com

| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | | | REVISION | 0 |
|---|---|---|---|---|---|---|---|
| TITLE: | DESIGN OF STAIRCASE | A23015-C-RB-01-DC-0002 | | | | | |
| CLIENT | M/S BUILD TECH ASSOCIATES | DESIGNED | | CHECKED | | APPROVED | |
| | | JSAN | | NKK | | NKK | |
| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

As per Clause 33.1 (b) of IS : 456 -2000 , the effective span of stair is taken as = 2.35 m

Reaction at Support B = $\frac{9.575x1.2^2/2)+12.84x1.15x(0.575+1.2)}{2.35}$ = 14.08 kN

Reaction at Support B = 12.17 kN

Shear Force is zero at = 14.08-12.84X = 0

X = 1.10 From B

Maximum B.M = (14.08x1.1) -12.84x(1.1)^2/2 = 7.73 kN-m

Design Bending Moment = 40.55 kN-m

**Check For Depth**

$d_{lim}$ = 123.2 mm

$d_{provided}$ = 144.0 mm

= **SAFE**

**Reinforcement Details**

$R=M_u/bd^2$ = 1.956

**$(Pt)_{Required}$** = **0.516** %

Area of steel required ( $A_{st)\ Required}$= = 743 $mm^2$

$a_{st}$ = 113 $mm^2$

Spacing req = 152.214 mm

Spacing $_{pro}$ = 150 mm

**Provide12mm bar at 150mm C/C**

**$(Pt)_{Provided}$ =** = **0.524**

Min steel required = **210** $mm^2$

**SAFE**

**Provide8mm bar at 225mm C/C**

**Check For Shear**

24-126

**$(Pt)_{Provided}$ =** = 0.524

$\beta=0.8f_{ck}/6.89p_t$( but Sould not less than 1) $\beta$ = 4.435

Tc=0.85*sqrt(0.8*fck)*(sqrt(1+5β)-1)/6β Tc = 0.487 $Nmm^2$

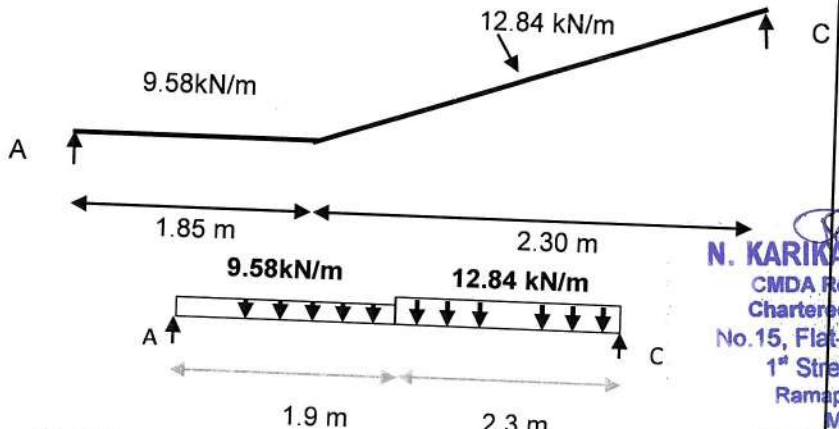
Design Shear Force ($V_u$) = **18.35** kN

$T_v$ = 0.127 $Nmm^2$

**Tv < Tc**

**SAFE**

**Design of 2nd flight**




As per Clause 33.1 (b) of IS : 456 -2000 , the effective span of stair is taken as

= 1.85+2.3 = 4.15 m

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Email : nkarikalan1985@gmail.com

| PROJECT: | PROPOSED RESIDENTIAL BUILDING AT VGN LAKSHMI NAGAR, KOLAPAKKAM | DOCUMENT NO | | | | REVISION | 0 |
|---|---|---|---|---|---|---|---|
| TITLE: | DESIGN OF STAIRCASE | A23015-C-RB-01-DC-0002 | | | | | |
| CLIENT | M/S BUILD TECH ASSOCIATES | DESIGNED | | CHECKED | | APPROVED | |
| | | JSAN | | NKK | | NKK | |
| | | DATE | 02.08.2024 | DATE | 02.08.2024 | DATE | 02.08.2024 |

Reaction at Support C = $\frac{(9.575 \times 1.85^2/2)+12.84 \times 2.3 \times (1.15+1.85)}{4.15}$ = **25.29** kN

**Reaction at Support A =** = **21.95** kN

Shear Force is zero at = 25.29-12.84X = 0 X = 1.97 From B

Maximum B.M = (25.29x1.97) -12.84x(1.97)^2/2 = 24.91 kN-m

Design Bending Moment = **41.00**

**Check For Depth**

d lim= = 123.87 mm

d provided = 144.00 mm **SAFE**

**Reinforcement Details**

$R=M_u/bd^2$ = 1.977

**(Pt) Required** = **0.523** %

Area of steel required ( $A_{st)\ Required}$ = = 753 $mm^2$

$a_{st}$ = 113 $mm^2$

Spacing req = 150 mm

Spacing $_{pro}$ = 150 mm

**Provide12mm bar at 150mm C/C**

**(Pt) Provided =** = **0.524**

**SAFE**

**Distribution steel**

Min steel required = **210** $mm^2$

**Provide8mm bar at 225mm C/C**

**Check For Shear**

24-126

**(Pt) Provided =** = 0.524

$\beta=0.8f_{ck}/6.89p_t$( but Sould not less than 1) $\beta$ = 1.000

Tc=0.85*sqrt(0.8*fck)*(sqrt(1+5β)-1)/6β Tc = 0.821 $Nmm^2$

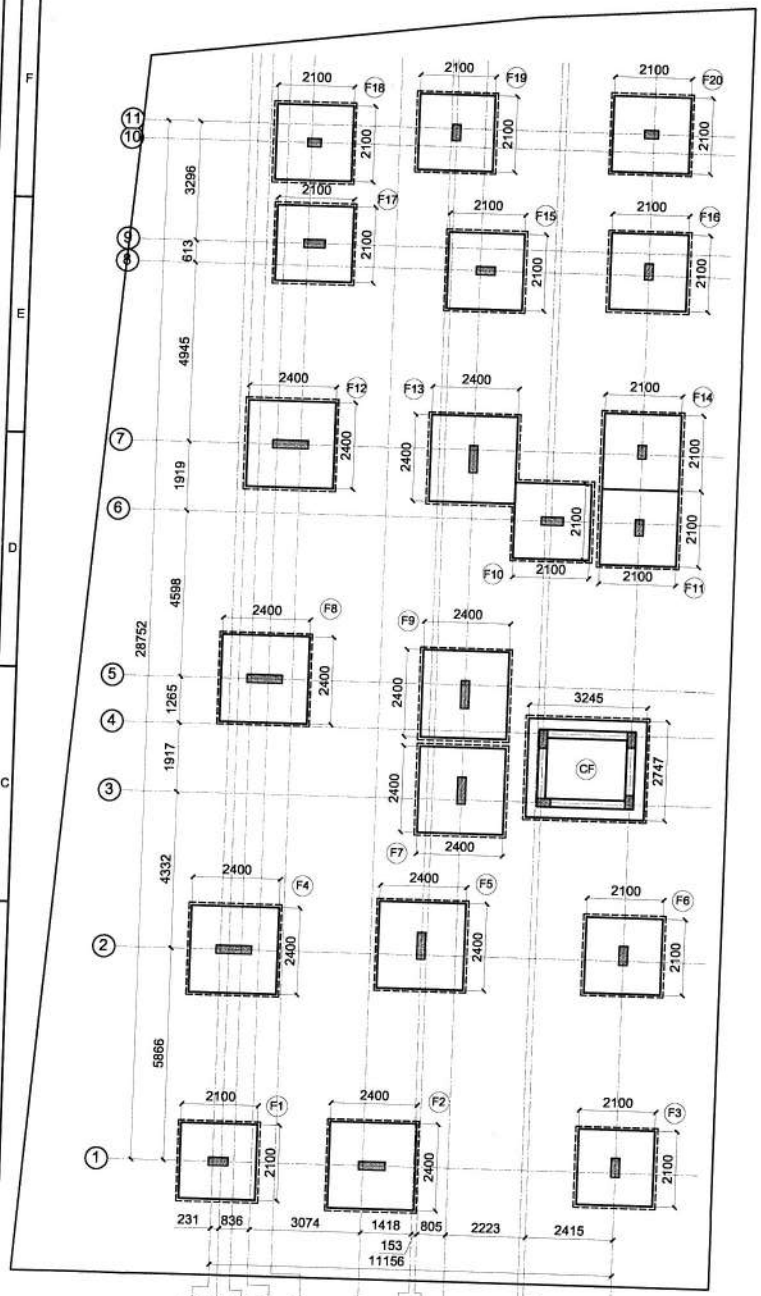
Design Shear Force ($V_u$) = **35.16** kN

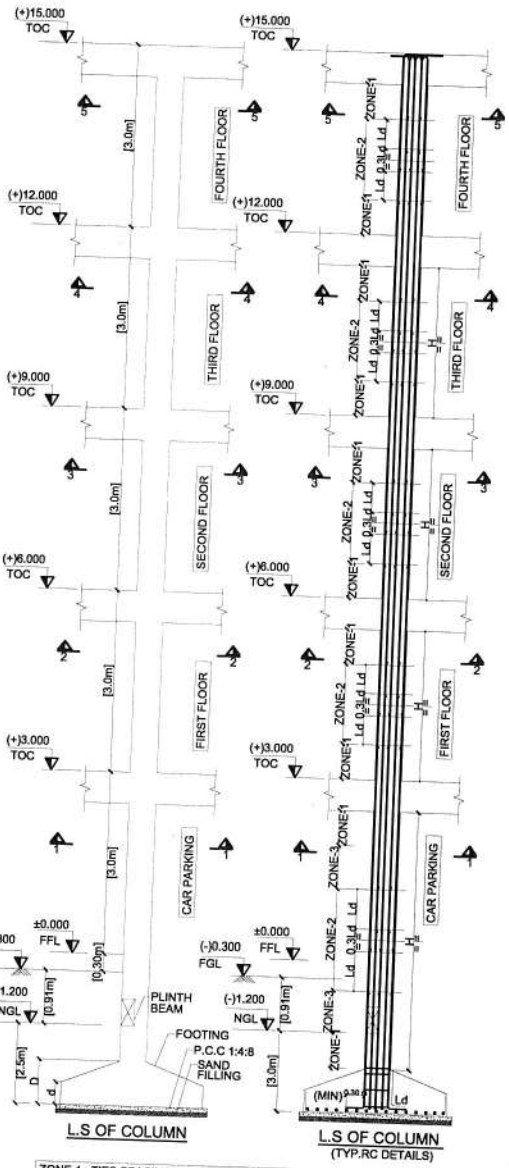
$T_v$ = 0.244 $Nmm^2$

**Tv < Tc** **SAFE**

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ZONE-1, TIES SPACING IS CONSIDERED AS 100MM C/C
ZONE-2, TIES SPACING IS CONSIDERED AS 150MM C/C
ZONE-3, TIES SPACING IS CONSIDERED AS 200MM C/C

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| GRADE \ Ø(mm) | Ld - DEVELOPMENT LENGTH 8 | 10 | 12 | 16 | 20 |
|---|---|---|---|---|---|
| M20 | 1'4.5" | 1'9" | 2'0" | 2'7.5" | 3'4.5" |
| M25 | 1'3" | 1'6" | 1'9" | 2'4.5" | 2'10.5" |

REINFORCED CEMENT CONCRETE(RCC):-

| GRADE OF CONCRETE | MINIMUM CEMENT CONTENT (kg/m3) | WATER CEMENT RATIO |
|---|---|---|
| M20 | 300 | 0.55 |
| M25 | 300 | 0.50 |
| M30 | 320 | 0.45 |

PLAIN CEMENT CONCRETE(PCC):-

| | MINIMUM CEMENT CONTENT (kg/m3) | WATER CEMENT RATIO |
|---|---|---|
| PCC | 240 | 0.60 |

THE MINIMUM NET S.B.C AT 2.5m BELOW NGL IS 24 T/SQ.M AS PER SOIL REPORT DONE BY CHENNAI SOIL LAB

BUILDING CO-ORDINATES TO BE DECIDED BY ARCHITECT / CLIENT

IN CASE OF ANY OTHER SERVICE LINE FOULING WITH FOUNDATION, THEN SAME TO BE REPORTED TO STRUCTURAL DESIGNER IMMEDIATELY.

THE STRUCTURE IS DESIGNED FOR STILT +4 FLOORS ONLY

NOTES:-

1. ALL DIMENSIONS ARE IN FEET AND INCHES & LEVELS ARE IN METRES.
2. "T" DENOTES HYSD BARS (Fe 500 / Fe 500 D) CONFORMING TO IS :- 1786: 2008
3. UOS MINIMUM CLEAR COVER TO ANY REINFT. SHALL BE AS FOLLOWS :

| MEMBER MKD. | CLEAR COVER |
|---|---|
| FOOTING | 50 mm |
| COLUMN | 40 mm |
| BEAMS | 30 mm OR BAR DIA WHICHEVER IS GREATER |
| SLAB | 25 mm OR BAR DIA WHICHEVER IS GREATER |

4. GRADE OF CONCRETE FOR FOOTIING,COLUMN,BEAM & SLAB SHALL BE M20 (MIN.). GRADE OF CONCRETE FOR LINTEL & SUNSHADE SHALL BE M20 (MIN.).
5. LAPS SHALL BE STAGGERED SUCH THAT NOT MORE THEN 50% OF REINFORCEMENT IS LAPPED AT ANY LOCATION.
6. TOP BARS IN BEAMS & SLABS SHALL BE LAPPED AT MID SPAN AND NOT AT SUPPORT ZONE.
7. BOTTOM BARS IN BEAMS & SLABS SHALL BE LAPPED AT END ONE THIRD SPAN.
8. COL. REINFT. LAPS SHALL BE STAGGERED & DONE JUST ABOVE BEAM COL. INTERSECTIONS UOS.
9. ALL HOOKS, BENDS AND LAPS SHALL BE AS PER IS :- 2502:1963 & IS13920-1993 UNLESS OTHERWISE INDICATED.

| REV.NO. | DESCRIPTION | DESIGNED | DRAWN | CHECKED | APPROVED |
|---|---|---|---|---|---|
| A | ISSUED FOR APPROVAL | JSAN 02.08.24 | JSAN 02.08.24 | NKK 02.08.24 | NKK 02.08.24 |

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E-MAIL ID: sivasankarl.structural@gmail.com

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|---|---|
| CLIENT : M/S BUILD TECH ASSOCIATES | CONSULTANT : SIVASANKARI STRUCTURAL CONSULTANT |
| PROJECT : (S+4)PROPOSED RESIDENTIAL BUILDING AT KOLAPAKKAM | CONCEPT ARCHITECT : SNS ASSOCIATES |
| SUPPLIER/ CONTRACTOR : M/S BUILD TECH ASSOCIATES | |

JOB No : A23015

| | NAME | SIGN | DATE |
|---|---|---|---|
| DSGN | JSAN | | 02.08.24 |
| DRWN | JSAN | | 02.08.24 |
| CHKD | NKK | | 02.08.24 |
| APPD | NKK | | 02.08.24 |

TITLE:
RESIDENTIAL BUILDING
LAYOUT &NUM.RC DET. OF FOOTING COLUMN

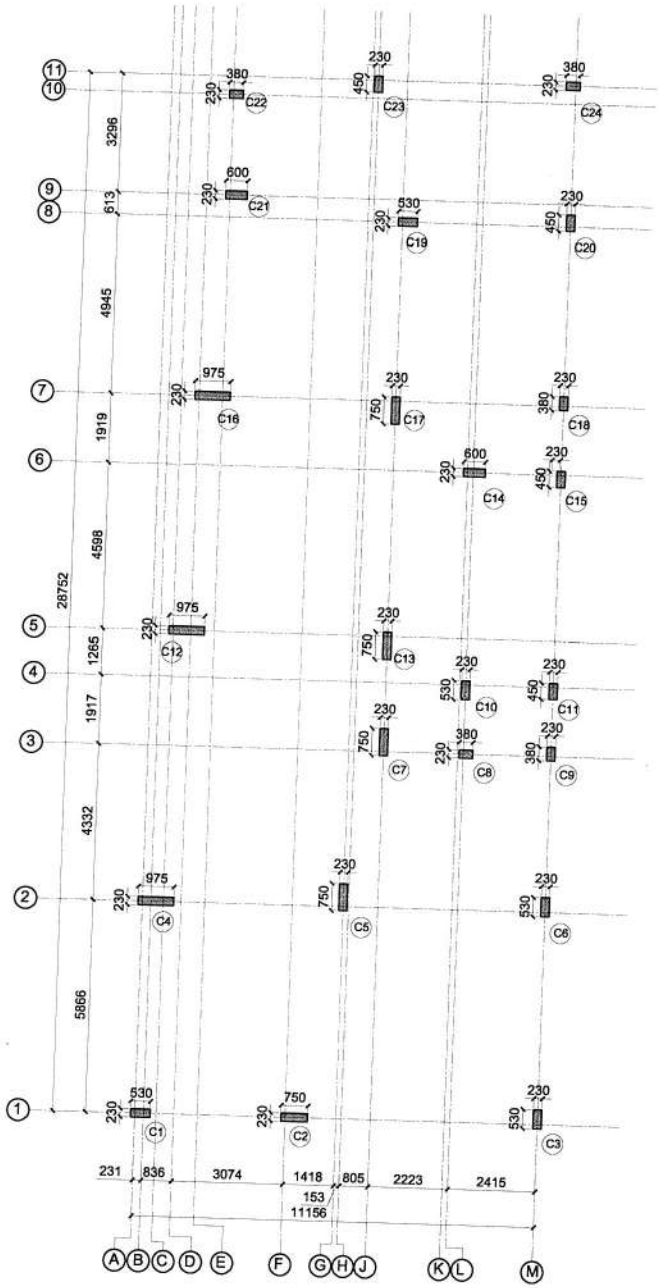
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DRAWING NUMBER
SCALE 1:100

DRAWING No. A23015 - C -RB - 04 - 0001
PROJECTION
SIZE A3
REV A

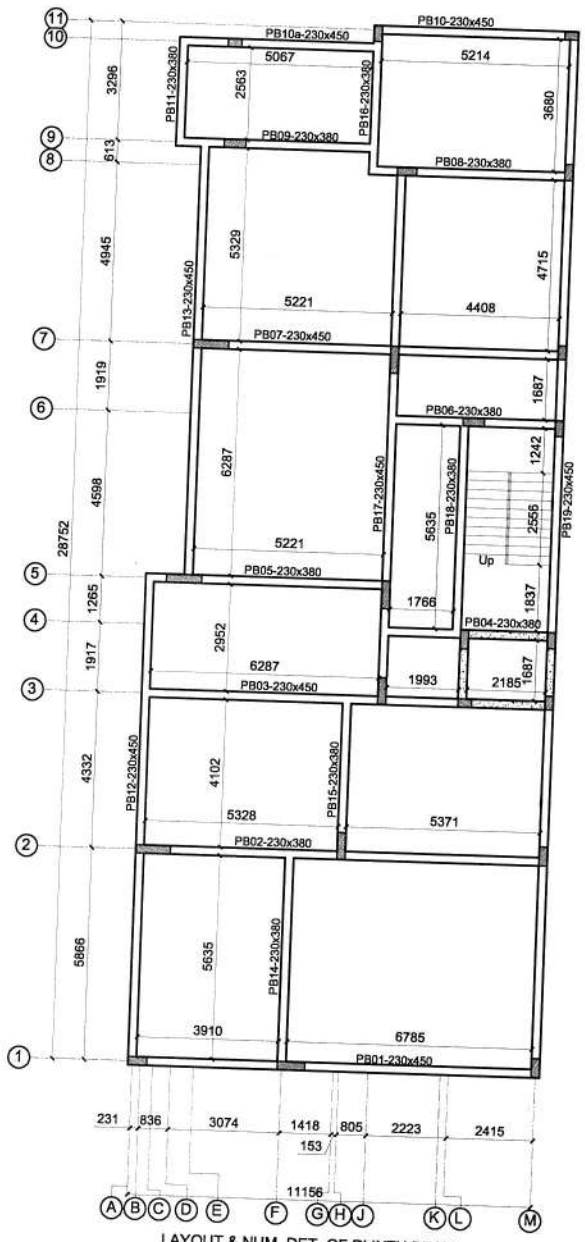
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SIVASANKARI STRUCTURAL CONSULTANT

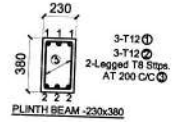
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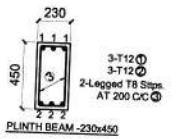

LAYOUT & NUM. DET. OF COLUMN




LAYOUT & NUM. DET. OF PLINTH BEAM




PLINTH BEAM -230x380




PLINTH BEAM -230x450

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| A | ISSUED FOR APPROVAL | JSAN 02.08.24 | JSAN 02.08.24 | NKK 02.08.24 | NKK 02.08.24 |

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| PROJECT : (S+4)PROPOSED RESIDENTIAL BUILDING AT KOLAPAKKAM | CONCEPT ARCHITECT : SNS ASSOCIATES |
| SUPPLIER/ CONTRACTOR : M/S BUILD TECH ASSOCIATES | |

JOB No : A23015

| | NAME | SIGN | DATE |
|---|---|---|---|
| DSGN | JSAN | | 02.08.24 |
| DRWN | JSAN | | 02.08.24 |
| CHKD | NKK | | 02.08.24 |
| APPD | NKK | | 02.08.24 |

TITLE:
RESIDENTIAL BUILDING
LAYOUT & NUM.R.C DET. OF COLUMN & PLINTH BEAM

SECTION / ELEVATION MARKING
DRAWING NUMBER
SCALE 1:100

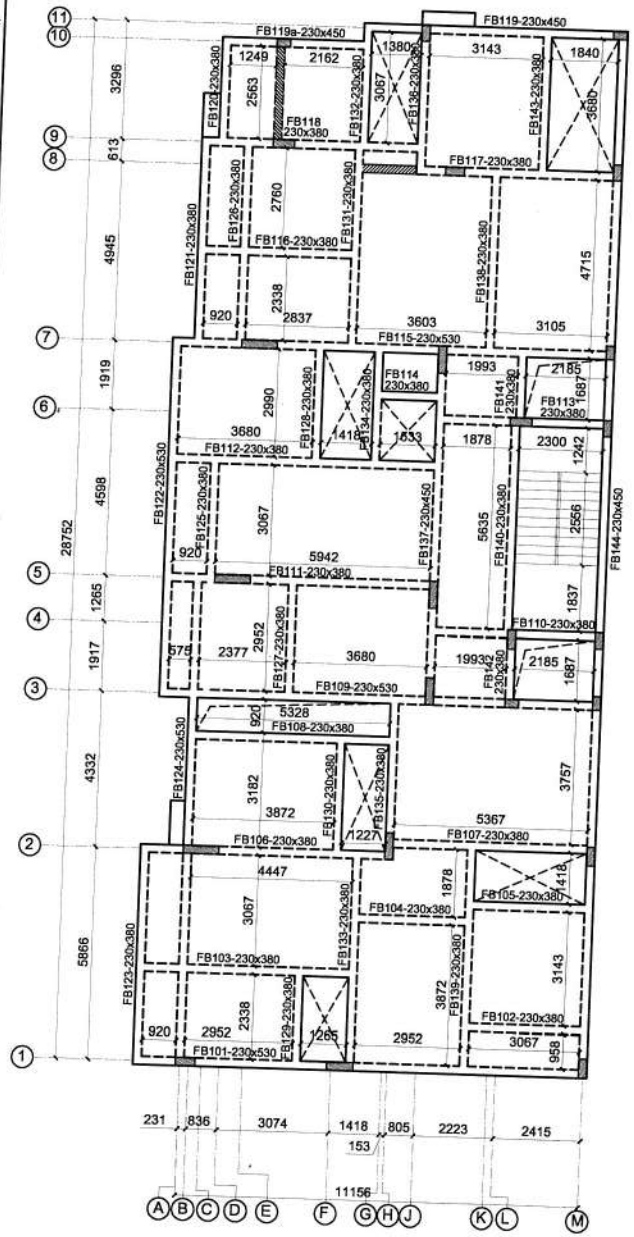
DRAWING No. A23015 - C -RB - 04 - 0002

PROJECTION | SIZE A3 | REV A

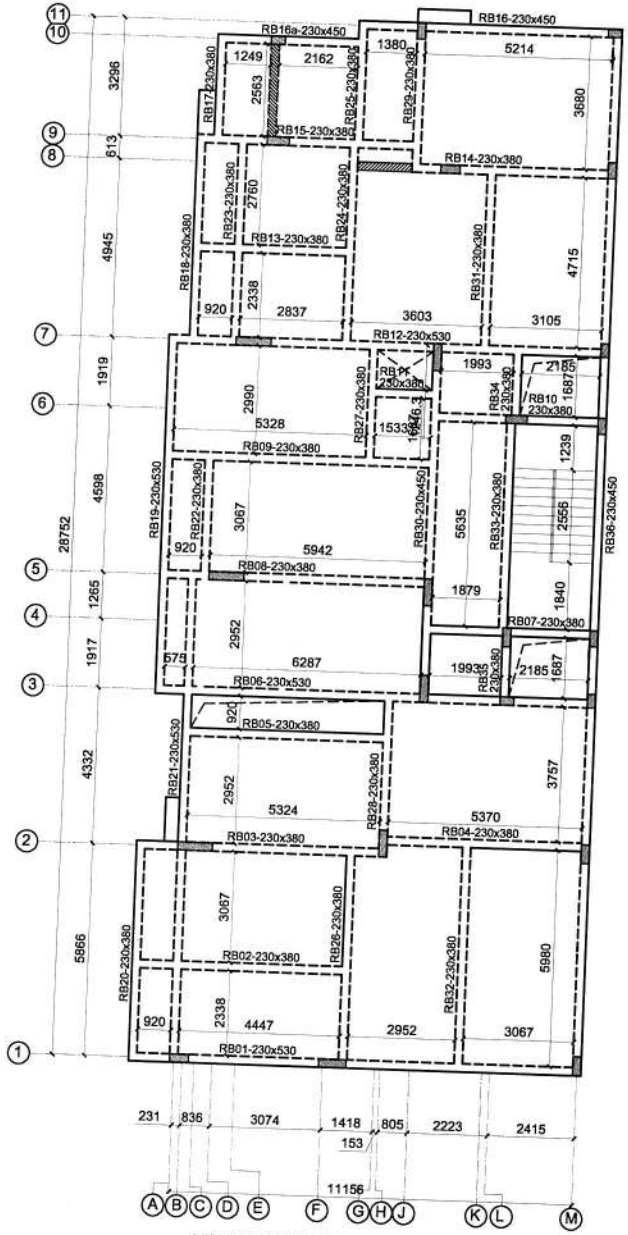
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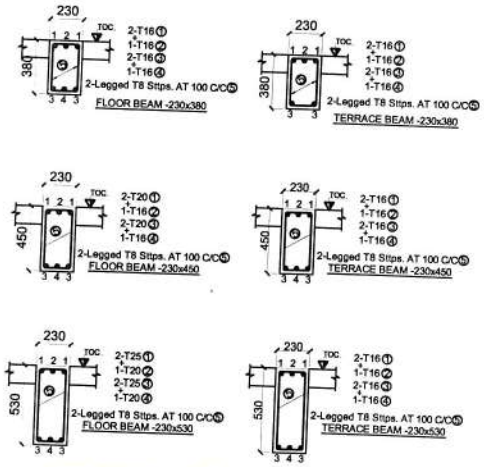
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LAYOUT & NUM. DET. OF FLOOR BEAM
(SLAB THICKNESS 125mm)




LAYOUT & NUM. DET. OF TERRACE BEAM
(SLAB THICKNESS 125mm)




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JOB No : A23015

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| DRWN | JSAN | | 02.08.24 |
| CHKD | NKK | | 02.08.24 |
| APPD | NKK | | 02.08.24 |

TITLE:
RESIDENTIAL BUILDING
LAYOUT,NUM & RC DET. OF FLOOR BEAM & TERRACE BEAM

SECTION / ELEVATION MARKING
DRAWING NUMBER
SCALE 1:100

DRAWING No. A23015 - C -RB - 04 - 0003
PROJECTION
SIZE A3
REV A

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