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# STABILITY CERTIFICATE

(To be furnished while filing application for registration of building)

The detailed engineering and structure design of the proposed building comprising of S+5 floors at **R.S.F.NO. 517/1B, SUB-DIVISION R.S.F. NO. 517/1B2, SITE NO. 10, 11, 12, 13, 14, OLD WARD NO. 46, NEW WARD NO. 49, ERODE " C " VILLAGE (KASIPALAYAM), AT BLUE LEAF GARDEN (PHASE-II), IRANIYAN 2nd STREET (ANNA NAGAR), ERODE CITY MUNICIPAL CORPORATION, ERODE TALUK & DISTRICT** has been done by me/us based on the report of geotechnical investigation (soil test) done by **V R GEOTECHNICAL ENGINEERS** Report No. **Ref: 751/Soil-2022-23** Dated **27.07.2022** and considering the functional requirement of the building.

2. It is certified that among other factors, the proposed building has been designed to resist earthquake. I/We have checked various parameters and found that the proposed building would be safe.

3. I/We further certify that:

(i) The minimum grade of concrete is **M25**

(ii) The design and analysis has been done using the code of practice for plain and reinforced concrete as per IS 456, design loads as per IS Codes No **875 Pt.1 & Pt.2** and design of earthquake resistant structure as per IS Code No.1893.2002.

4. The building will be safe and sound when used for the purpose for which it is designed.

Encl.: Structural Design Calculation

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# BLUE LEAF GRANGE APARTMENT
# ERODE.
# DESIGN CALCULATIONS

## INTRODUCTION:

The structure is a **"Six– Storied Building" consisting of Silt + 5 upper floors proposed to be constructed for "BLUE LEAF" in R.S.F.NO. 517/1B, SUB-DIVISION R.S.F. NO. 517/1B2, SITE NO. 10, 11, 12, 13, 14, OLD WARD NO. 46, NEW WARD NO. 49, ERODE " C " VILLAGE (KASIPALAYAM), AT BLUE LEAF GARDEN (PHASE-II), IRANIYAN 2nd STREET (ANNA NAGAR), ERODE CITY MUNICIPAL CORPORATION, ERODE TALUK & DISTRICT.**

It is designed as Reinforced concrete framed structure supported on footings and columns. Footings are placed at 10'-0" depth below ground level and the **SBC of the soil is taken 310 kN/Sq.m**

## MATERIALS USED

Following material are generally used in the design of the various components of the structure.

1. M25 & M30 grade concrete for all concrete parts of the structure.
2. Fe 500 & Fe550D grade Reinforcement steel for all Reinforced concrete members.

## CODES FOLLOWED:

Following codes and specifications has been used in the design of the members of the structure.

1. IS:456 - 2000 Plain and Reinforced Concrete
2. SP: 16 Design Aids for Reinforced Concrete to IS: 456
3. IS: 875 Part1,2,4,5(1987) and Part 3(2015) Design Loads
4. IS: 1893 – 2016 Criteria for Earthquake Resistant Design of Structures
5. IS: 13920 – 2016 Ductile Detailing for Reinforced Concrete Structures Subjected to Seismic forces.

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**DESIGN DATA:**

| | | | |
|---|---|---|---|
| 1. | No. of floors | = | Stilt + 5 upper floors |
| 2. | Height of floors | = | 3.05 m |
| 3. | SBC of soil @ 10'-0" | = | 310.0 kN/m² |
| 4. | D.L. of 150 thk slab | = | 3.75 kN/m² |
| 5. | D.L. of 140 thk slab | = | 3.5 kN/m² |
| 6. | D.L. due to flooring | = | 1.00 kN/m² |
| 7. | D.L. of 230 thk walls per metre length | = | 13.50 kN/m |
| 8. | D.L. of 115 thk walls per metre length | = | 6.00 kN/m |
| 9. | L.L on rooms | = | 2.00 kN/m² |
| 10. | Design mix of Columns, Footings, Slabs, Beams | = | M25 & M30 |

**ANALYSIS OF STRUCTURE:**

The structure is analyzed by using Etabs. All members are Manually designed as Reinforced Concrete members.

Shear Walls are designed by using Etabs.

Independent Footing has been provided for columns.

**DESIGN OF COLUMNS:**

**Material – M25; Fe550D**

**LOAD ON COLUMNS:**

| | | |
|---|---|---|
| R1 | = | 3500 KN |
| R2 | = | 2690 KN |
| R3 | = | 2130 KN |
| R4 | = | 2002 KN |
| R5 | = | 1440 KN |
| R6 | = | 1000 KN |
| R7 | = | 800 KN |

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## COLUMN DESIGN:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DESIGN OF COLUMN | | | | | | | | |
| LOAD(P) | = | 3550 | KN | | | | | |
| Fact. Laod | = | 5325 | | | | | | |
| fck | = | 25 | N/Sq .mm | | | | | |
| fy | = | 550 | N/Sq .mm | | | | | |
| Unsupported length of colum | = | 3.5 | m | | | | | |
| Column end conditions | = | Effectively held in position and restrained against rotation | | | | | | |
| Recommended value of effective lenth | = | 0.65L | = | 2.275 | m | | | |
| Assumed area of steel | = | 0.80% | = | 0.08Ag | | | | |
| Size of column Assumed | = | **300** | x | **760** | | | | |
| Provided Area of concrete | = | 228000 | | | | | | |
| **Check for Slenderness ratio** | | | | | | | | |
| Effective length of colum | = | 2.275 | m | | | | | |
| Slenderness ratio | = | l/b | = | **7.58** | < | **12** | | |
| | | l/d | = | **2.99** | < | **12** | | |
| **So the column will be designed as short column** | | | | | | | | |
| **Check for eccenricity** | | | | | | | | |
| Min. Eccenricity | = | (L/500)+((b/30) | | | = | 17.00 | mm | |
| | = | | | | = | 32.33 | mm | |
| | = | 20 | mm | | (As per IS 456-2000 cl 25.4) | | | |
| Eccenricity taken as ( e ) | = | 32.33 | mm | | | | | |
| **Moment calculations** | | | | | | | | |
| Moment due to eccentricity vs As per Analysis | = | (P*e) | = | 114783333.3 | N.mm | = | 230 | KN .M |
| **Reinforcement calculations** | | | | | | | | |
| **Longitudinal reinforement** | | | | | | | | |
| P/(fck.b.d) | = | 0.9342 | | | | | | |
| M/(fck.b.d^2) - (Max of M3-3 & M2-2) | = | 0.053 | | | | | | |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| d' | = | 56.000 | mm | (Assumed as | 32 | mm | dia bars to be used) | |
| d'/d | = | 0.2 | | | | | | |
| For these values p/fck from the chart 38 of IS hand book SP-16 - As | = | 0.14 | fck | = | 3.5 | % | | |
| Min. Reinforcement for column | = | 0.8 | % | | | | | |
| Area of steel taken as | = | 3.5 | % | | | | | |
| Area of steel reqd. | = | **7980** | Sq.mm | | 8493.724 | | | |
| Provide | 32 | mm dia bars | 6 | | | | | |
| and | 32 | mm dia bars | 6 | | | | | |
| | | | | | | | | |
| Ast. Provided | = | **9646.08** | Sq.mm | > | **8493.724** | **HENCEOK** | | |
| | | | | | | | | |
| **Transverrse reinforcement** | | | | | | | | |
| Max. Length of the Longituditional reinforcement direction = | | | | | 760 | | | |
| No. of rods placing in one side = | | | | | 2 | | | |
| Spacing of Longituditional bars other than corner = | | | | | 226.6667 | >75 | | |
| Provide | 8 | mm dia double stirrups @ | | | 150 | mm C/C | | |
| Check for Min spacing | | | | | | | | |
| 150 | < | 300 | mm | (Least lateral dimension) | | | | |
| 150 | < | 512 | mm | (16 times to the smallest dia of long. bar) | | | | |
| 150 | < | 300 | mm | | | **Hence O.K** | | |
| | | | | | | | | |
| **Column Design Result** | | | | | | | | |
| **Size of Column** | = | **300** | x | **760** | | | | |
| **Longituditional Reinforcement** | **32** | mm dia bars | **6** | nos. and | | | | |
| | **32** | mm dia bars | **6** | nos. | | | | |
| **Transvers reinforcement** | **8** | mm dia double stirrups @ | | | **150** | mm C/C | | |

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## COLUMN SCHEDULE:

| COLUMN NAME | AXIAL LOAD(KN) | COLUMN SIZE | REINFORCEMENT | STIRRUPS |
|---|---|---|---|---|
| R1 | 3550 | 300 x 760 | 6Y32 + 6Y32 | Y8 @ 150mm c/c |
| R2 | 2690 | 230 x 760 | 14Y25 | Y8 @ 150mm c/c |
| R3 | 2130 | 230 x 680 | 10Y25 | Y8 @ 150mm c/c |
| R4 | 2002 | 230 x 600 | 10Y20 | Y8 @ 150mm c/c |
| R5 | 1440 | 230 x 460 | 4Y25 + 8Y20 | Y8 @ 150mm c/c |
| R6 | 1000 | 230 x 610 | 10Y20 | Y8 @ 150mm c/c |
| R7 | 800 | 230 x 460 | 4Y20 + 4Y16 | Y8 @ 150mm c/c |

## SHEAR WALL SCHEDULE:

| SHEAR WALL NAME | AXIAL LOAD(KN) | SHEAR WALL SIZE | REINFORCEMENT | STIRRUPS |
|---|---|---|---|---|
| SW1 | 2860 | 230 x 1220 | 8Y25 + 16Y20 | Y8 @ 150mm c/c |

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## FOOTING DESIGN:

| Design of Footing | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **(A) INPUT DATA** | | | | | | | | |
| Safe Bearing Capacity of Soil, SBC | | | 310.00 | $KN/m^2$ | Concrete, $F_{ck}$ | 25.00 | MPa | |
| Cross- sectional width of column, b | | | 300.00 | mm | Steel, $F_y$ | 550.00 | MPa | |
| Cross- sectional depth of column, D | | | 760.00 | mm | Clear Cover, CC | 50.00 | mm | |
| Axial Load (Service), P | | | **3550.00** | KN | Dia. of Steel, $d_b$ | 12.00 | mm | |
| Footing wieght by (%) P | **5.00** | % | 177.50 | KN | Gross Load, | **3727.50** | KN | |

| **(B) FOOTING SIZE** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Area of Footing Required, $A_f$ | 12.02 | $m^2$ | Provided, $A_f$ | 12.08 | $m^2$ | | |
| Length of footing required, $L_f$ | 3.71 | m | Provided, $L_f$ | 3.96 | m | $C_{LL}$ | 1.601 |
| Width of footing required, $B_f$ | 3.25 | m | Provided, $B_f$ | 3.05 | m | $C_{BB}$ | 1.374 |
| Top projection from column face, K | 801 | mm | Depth at edge of footing, $E_d$ | | | 914 | mm |
| Upword soil pressure, | 308.63 | $m^2$ | **Upword Soil Pressure < SBC , Hence OK** | | | | |

| **(C) Depth Required For Flexure** | | | | | |
|---|---|---|---|---|---|
| Moment along L-L axis, $M_{uL}$ | 1808.89 | KN-m | Moment along B-B axis, $M_{uB}$ | 1731.56 | KN-m |
| Resisting width in concern | 1901.20 | | Resisting width in concern | 2361.20 | mm |
| Depth required along length, $d_{req}$ | 598.07 | mm | Depth required along width,$d_{req}$ | 525.06 | mm |
| **Provide the depth of footing, D** | **914** | mm | **Available effective depth, $d_{avai}$** | **858.40** | mm |
| Actual Self weight of footing, | **276.09** | KN | Weight by % of loading (P), | **7.78** | % |

**(D) Design for Flexural Reinforcement**

| Direction | $A_{st}$ Required ($mm^2$) | $A_{st}$ Minimun ($mm^2$) | Dia. of Bar (mm) | Sapcing (mm) | | Rebar Provided |
|---|---|---|---|---|---|---|
| | | | | Required | Provided | |
| Along $L_f$ | 4704.48 | 3344.51 | **20** | **203.54** | **150.00** | T20 @ 150 mm |
| Along $B_f$ | 4430.87 | 4347.86 | **20** | **280.94** | **150.00** | T20 @ 150 mm |

| | | | | | |
|---|---|---|---|---|---|
| $A_{st}$ finally provided along $L_f$ - $L_f$ | 6383.73 | $mm^2$ | Pt (%) | 0.367 | **1-way shear is needed to check along L-L** |
| $A_{st}$ finally provided along $B_f$ - $B_f$ | 8298.85 | $mm^2$ | Pt (%) | 0.384 | |

**(E) Check for 1-Way Shear** **Note: Critical Section is at d = 858.4 mm from column face**

| *Check along Length ($L_f$) of Footing* | *Check along Width ($B_f$) of Footing* |
|---|---|

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Where, β = (0.8 fck ) / (6.89 Pt ) or 1 whichever is greater, $\tau_c = 0.85\sqrt{(0.8\,fck)}\,(\sqrt{1+5\beta}-1)/$ | | | | | | | |
| (%) R/F available | Pt = | 0.35 | % | (%) R/F available | Pt = | 0.37 | % |
| Therefore, | β = | 8.39 | - | Therefore, | β = | 7.92 | - |
| Critical Shear Capacity, | Tcc= | 0.48 | MPa | Critical Shear Capacity, | Tc = | 0.43 | MPa |
| Shear Force along length, | $V_u$ = | 1048.15 | KN | Shear Force along width, | $V_u$ = | 945.82 | KN |
| Critical Section Moment, | $M_u$ = | 389.28 | KN-m | Critical Section Moment, | $M_u$ = | 243.83 | KN-m |
| At critical section, b' | 2016.80 | 858.40 | mm | Critical section b' & d' | 2476.80 | 858.40 | mm |
| Nominal Shear, $\tau_v$ = | | 0.42 | MPa | Nominal Shear, $\tau_v$ | | 0.39 | MPa |
| **Provided Depth is Safe For One Way Shear** | | | | **Provided Depth is Safe For One Way Shear** | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **(F) Check for 2-Way Shear** | | | | **Note: Critical Section is at d/2 = 429.2 mm** | | | |
| Effective depth at proposed section, d/2 from the face of column, d' | | | | 858.40 | | mm | |
| Shear Force on Shaded Area, $V_u$ = | 4723.33 | KN | | Perimeter length of Shear Area,= | 5553.60 | mm | |
| $\tau_v = \frac{V_u}{(Perimeter\ length\ x\ Effective\ depth)}$ | | | | = | 0.991 | MPa | |
| IS 456-2000, Pg.No.58, Cl.31.6.3, Shear Stress @ Critical Section, | | | | = | $\tau_c$ x $K_S$ | | |
| $K_S = 0.5 + \beta c$ | Where, βc = | 0.39 | Therefore, $K_S$ | = | 0.89 | or | 1.00 |
| $\tau_c = K_S$ x 0.25 x $\sqrt{f_{ck}}$ | 1.118 | MPa | **Provided Depth is Safe For Two Way Shear** | | | | |

## FOOTING SCHEDULE:

| F.No | FOOTING SIZE | | | | | | Bottom Mat | |
|---|---|---|---|---|---|---|---|---|
| | Step-1 | Depth(D1) | Step-2 | Depth(D2) | Step-3 | Depth(D3) | Rebar(X) | Rebar(Y) |
| F1 | 3.96 x 3.05 | 910 | Refer section on F1-F1 | | | | Y20 @ 150 C/C | Y20 @ 150 C/C |
| F2 | 3.35 x 2.74 | 835 | Refer section on F2-F2 | | | | Y16 @ 125 C/C | Y16 @ 125 C/C |
| F3 | 2.89 x 2.89 | 460 | 2.14 x 2.14 | 460 | 1.37 x 1.37 | 460 | Y16 @ 150 C/C | Y16 @ 150 C/C |
| F4 | 2.36 x 2.36 | 300 | 1.75 x 1.75 | 300 | 1.00 x 1.00 | 300 | Y12 @ 125 C/C | Y12 @ 125 C/C |
| F5 | 2.21 x 2.21 | 460 | 1.52 x 1.52 | 460 | --- | --- | Y12 @ 150 C/C | Y12 @ 150 C/C |
| F6 | 1.98 x 1.98 | 460 | 1.06 x 1.06 | 460 | --- | --- | Y12 @ 150 C/C | Y12 @ 150 C/C |
| F7 | 1.68 x 1.68 | 380 | 0.91 x 0.91 | 380 | --- | --- | Y12 @ 150 C/C | Y12 @ 150 C/C |

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## MAXIMUM MOMENT ON BEAMS:

End of the span = 239 kNm

Middle of the span = 387 kNm

## MAXIMUM SHEAR ON BEAM:

End of the span = 210 kN

Middle of the span = 15 kN

## BEAM DESIGN:

| Beam Design | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Properties of Beam | | | | | | Forces | | | | | |
| Fck | = | 30 | N/mm$^2$ | | | | at top LHS | at bottom Mid Span | at top RHS | Units |
| Fy | = | 550 | N/mm$^2$ | | | | | | | |
| Length | = | 8.2296 | m | | | Moment | 239 | 387 | 100 | Kn.m |
| Size | = | 228.6 | X | 685.8 | mm | Shear | 210 | 1 | 166 | Kn |

| DESIGN CALCULATIONS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FACT. | at top LHS | at bottom Mid Span | at top RHS | Units | Mu Lim for Balanced section | | | |
| MOMENT | 358.5 | 580.5 | 150 | Kn.m | Mu Lim = (0.36*Xu max/d)*(1-(0.42*Xu max/d))*b*d$^{2*fck}$ | | | |
| SHEAR | 315 | 1.5 | 249 | Kn | ML | = | 355.88 | Kn.m |
| Xu max/d | 0.48 | 0.48 | 0.48 | | | | | |

**MF>Mu limit, so the beam is designed as Doubly reinforced beam**

| MF - ML | at top LHS | at bottom Mid Span | at top RHS | Units | Dia. Of Bars to be used | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | at top LHS | | at bottom Mid Span | | at top RHS | |
| | 2.62 | 224.62 | 0.00 | Kn.m | I Layer | II layer | I Layer | II layer | I Layer | II layer |
| Effective depth d= | 613.3 | 613.3 | 613.3 | mm | Tensile zone reinforcement | | | | | |
| | | | | | 25 | 25 | 25 | 25 | 25 | 25 |
| d'= | 47.5 | 47.5 | 47.5 | mm | Comp. zone reinforcement | | | | | |
| d' / d | 0.0774 | 0.07745 | 0.07745 | | 25 | | 25 | | 25 | |
| | | | | | at top LHS | | at bottom Mid Span | | at top RHS | |
| Design stress in compression reinforcement (fsc) | | | | | 700*(1-(d'/Xu) = | | (Xu limited to Xumax) | | | |

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| | | | | | |
|---|---|---|---|---|---|
| | 587.05 | | 587.05 | 587.05 | N/mm$^2$ |
| Allowable stress in compression steel (0.8*0.87fy) | 382.8 | | 382.8 | 382.8 | N/mm$^2$ |
| Design stress in comp. reinforcement taken (fsc) | 382.8 | | 382.8 | 382.8 | N/mm$^2$ |
| Strain in compression steel | 0.0029 | | 0.0029 | 0.0029 | Max. strain |
| **Tensile Steel Calculations** | | | | | |
| Ast for singlly reinforced beam ( Ast1 ) | (Mu=0.87*fy*Ast*d - 0.87* fy$^2$ * Ast$^2$ / b*fck) | | | | |
| | **at top LHS** | **at bottom Mid Span** | **at top RHS** | | |
| ( from the eqn. IS 456 Annex.G 1.01 b ) | **1511.42** | **1511.42** | **550.809** | mm$^2$ | |
| **Compreesion Steel Calculations** | | | | | |
| **Area of comp steel (Asc)** | (Mu-Mulim) / (fsc*(d-d')) | | | | |
| ( from the eqn. IS 456 Annex.G 1.2 ) | 12.08119 | 1037.067593 | 0 | mm$^2$ | |
| Area of comp steel (Asc) for max. stress | 12.55002 | 1077.312007 | 0 | mm$^2$ | |
| Ast 2 = (Asc*fsc) / (0.87fy) | **at bottom LHS** | **at Top Mid Span** | **at bottom RHS** | | |
| | 10.04001 | 861.8496052 | 0 | mm$^2$ | |
| **Shear Calculations** | | | | | |
| | **LHS** | **MIDSPAN** | **RHS** | | |
| Percentage of tensile steel= | 1.56 | 1.56 | 1.56 | % | |
| Tc from Table 19 of IS 456 : 2000 | 0.770 | 0.791 | 0.770 | N/mm$^2$ | |
| Tv= | 2.246784 | 0.010698972 | 1.776029 | N/mm$^2$ | |
| Maximum Allowed Shear stress Tc max = | | 3.4 | | | |
| Shear strength of concrete (Tc*b*d) | 108.00 | 110.9099618 | 108.0048 | KN | |
| Strength of shear reinfocement reqd. (Vus) | 207.00 | -109.41 | 141.00 | KN | |
| Dia. Of shear reinforcement | **10** | **10** | **10** | | |
| Shear reinforcement = Sv= (0.87*fy*Asv*d) / Vus | 222.5842 | 300 | 326.7762 | mm C/C | |
| Min. shear reinforcement | 821.5715 | 821.5715223 | 821.5715 | mm C/C | |
| Max spacing (0.75*d ) | 459.975 | 459.975 | 459.975 | mm C/C | |
| | 300 | 300 | 300 | mm C/C | |
| **Check for development length** | | | | | |

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.3 * M1/V+ | L0 | >=Ld | L0= | 613.3 |
| Ld=( 0.87*fy / (4*tbd))* Dia. Of Bar= | | | | | | | **1246.09375** | mm | < | 2082.025 | mm |

**RESULTS**

| Fck | = | 30 | Fy | = | 550 | Beam Size | = | 228.6 | x | 685.8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|

| SUP P. | Steel Provided | | | | | | Min.Reqd spacing for stirrups | Tensile steel | | Comp. steel | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Straight | | Curtail | | Stirrups | | | Prov. | Reqd. | Prov. | Reqd. |
| | Dia. | Nos. | Dia. | Nos. | Dia. | Spacing | | | | | |
| LHS | **25** | **3** | **25** | **2** | 10 | **150** | **223** | **2453** | **1521** | **1472** | **13** |
| MID SPA | **25** | **3** | **25** | **2** | 10 | **150** | **300** | **2453** | **2373** | **1472** | **1077** |
| RHS | **25** | **3** | **25** | **2** | 10 | **150** | **300** | **2453** | **551** | **1472** | **0** |

**Check for Deflection**

| | | | |
|---|---|---|---|
| Stress Developed in Steel, $F_s$ | = | 308.62 | N/Sq.mm |
| Maximum Provided % of reinforcements, $P_t$ | = | 1.56 | % |
| Modification Factor, $K_t$ (M/F) | = | 0.75 | - |
| Maximum Allowed Deflection Ratio, $\delta R_{Allowed}$ | = | 19.40 | - |
| Actual Deflection Ratio, $\delta R_{Actual}$ | = | 13.42 | - |

**DESIGN IS SAFE IN DEFLECTION**

## ROOF BEAM SCHEDULE:

| BEAM No | BEAM SIZE | REINFORCEMENT | | | STIRRUPS |
|---|---|---|---|---|---|
| | | Bottom | Top | Extra | |
| RB1 | 230 X 685 | 3-Y25 + 2-Y25 | 3-Y25 | 2-Y25 | Y10 @ 150 C/C |
| RB2 | 230 X 609 | 3-Y25 + 2-Y25 | 3-Y25 | 2-Y25 | Y10 @ 150 C/C |
| RB3 | 230 X 609 | 2-Y25 + 2-Y25 | 2-Y25 | 2-Y25 | Y10 @ 150 C/C |
| RB4 | 230 x 530 | 3-Y25 + 2-Y25 | 3-Y25 | 2-Y25 | Y10 @ 150 C/C |
| RB5 | 230 X 609 | 2-Y25 + 2-Y25 | 2-Y25 | 2-Y25 | Y10 @ 150 C/C |
| RB6 | 230 X 609 | 2-Y20 + 2-Y20 | 3-Y20 | 2-Y20 | Y10 @ 150 C/C |
| RB7 | 230 X 609 | 2-Y20 + 2-Y20 | 2-Y20 | 2-Y20 | Y10 @ 150 C/C |
| RB8 | 230 x 530 | 2-Y20 + 2-Y20 | 2-Y20 | 2-Y20 | Y10 @ 150 C/C |
| RB10 | 230 x 460 | 2-Y20 + 2-Y20 | 2-Y20 | 2-Y20 | Y8 @ 150 C/C |
| CB1 | 230 x Slab Tk | 3-Y12 | 3-Y12 | --- | Y8 @ 150 C/C |

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## ROOF SLAB DESIGN:

| Slab Design | | | | | | | |
|---|---|---|---|---|---|---|---|
| Size of the slab in 'm' | = | 5.03 | x | 5.03 | | | |
| Support width | = | 0.23 | m | | | | |
| Slab tk.(Span/25) | = | 201.168 | mm | | | | |
| Adopt eff. Depth | = | 125 | mm | | | | |
| Overall Depth | = | 150 | mm | | | | |
| Grade of concrete | = | M | 20 | | 20 | N/sq.mm | |
| Grade of steel | = | Fe | 500 | | 500 | N/sq.mm | |

**Loads**

| Dead | | | | Live | Fact. Load(1.5D.l+1.5l.l) | |
|---|---|---|---|---|---|---|
| Dead | Floor finish | Total | | | | |
| Kn/Sq.m | Kn/Sq.m | Kn/Sq.m | | Kn/Sq.m | (w) Kn/Sq.m | |
| 3.75 | 1.5 | 5.25 | | 2 | 10.875 | |

**Design Calculations**

From IS 456:2000, Anx.D2.1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shorter span Bending Moment | | | Mx= | ax*w*lx² | ax,ay are co efficeients | | |
| Shorter span Bending Moment | | | My= | ay*w*lx² | | | |
| Effective Shorter span | | | Lx= | 5.26 | m | | |
| Effective Longer span | | | Ly= | 5.26 | m | | |
| | | Ly/Lx= | 1.00 | < | 2 | | |

**So the Slab is designed as Two way slab**

| Edge Condition = | | 1 | Interior panels | | | | |
|---|---|---|---|---|---|---|---|
| (-)ax= | 0.032 | | (-)ay= | 0.032 | Refer IS 456:2000 Table 26 | | |
| ax= | 0.024 | | ay= | 0.024 | | | |
| Midspan moments | | | Support Moments | | | | |
| Mx= | 7.22 | Kn.m | (-)Mx | 9.63 | | Mx max= | **9.63** |
| My= | 7.22 | Kn.m | (-)My | 9.63 | | My max= | **9.63** |

**Check for Depth :**

| | | | | | | |
|---|---|---|---|---|---|---|
| | Mmax= | 0.138*fck*bd² | | | | |
| | d= | Sqrt(M/(0.138*fck*b) | | | | |
| | d reqd= | 59.0547408 | mm | < | 125 | |

**Area of steel Calculations**

| Ast for Slab | (Mu=0.87*fy*Ast*d - 0.87* fy² * Ast² / b*fck) | | | |
|---|---|---|---|---|
| | **Shorter span** | | **Longer Span** | |
| | **Reqd** | **Provided** | **Reqd** | **Provided** |
| ( from the eqn. IS 456 Annex.G 1.01 b ) | **171.159656** | **523.333333** | **171.159656** | **523.333333** |
| | **At Support** | | **At mid span** | |

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| | Dia of rod | Spacing | % of ast | Dia of rod | Spacing | % of ast |
|---|---|---|---|---|---|---|
| **Shorter span** | **10** | **150** | **0.42** | **10** | **150** | **0.42** |
| **Longer span** | **10** | **150** | **0.42** | **10** | **150** | **0.42** |

| **Torsion reinforcement** | | | |
|---|---|---|---|
| **Area of steel** | **Dia of rod** | **Spacing** | Length in mm | To be Provide @ corners of the slab in both directions & both faces |
| **346** | 10 | 150 | 1051.84 | |

| **Check for shear** | | | | | | |
|---|---|---|---|---|---|---|
| | % of Ast= | 0.42 | | $\zeta c$ max= | 1.4 | $N/mm^2$ |
| | $\zeta v$= | V/b*d | 0.18 | $N/mm^2$ | Refer IS 456 cl 40.1 | |
| | $\zeta c$= | | **0.44** | $N/mm^2$ | Refer IS 456 Table 19 | |
| | $\zeta v$ | < | $\zeta c$ | < $\zeta c$ max | **DESIGN IS SAFE** | |

| **Check for Crack width** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **$\varepsilon 1$ =Strain@lvl considered** | | **$\varepsilon 2$ = 1.5b(D-x)(a-x)/3AsEs(d-x)** | | | **Wcr={3*acr*$\varepsilon$m}/{1+[2(acr-cmin)/(D-x)]}** | | |
| | **acr** | **X** | **fsb** | **$\varepsilon_1$ =fsb/Es** | **$\varepsilon_2$** | **$\varepsilon$m( $\varepsilon$1-$\varepsilon$2)** | **Wcrb** |
| **S span** | **85.1388** | **56.96** | **96.16** | **0.00048** | **0.00061** | **0.0000** | **0.000** |
| **L Span** | **45.0000** | **68.16** | **67.14** | **0.00034** | **0.00061** | **0.0000** | **0.000** |

| **Check for Deflection** | | | |
|---|---|---|---|
| Stress Developed in Steel, $F_s$ | = | 94.85 | N/Sq.mm |
| Maximum Provided % of reinforcements, $P_t$ | = | 0.42 | % |
| Modification Factor, $K_t$ (M/F) | = | 3.40 | - |
| Maximum Allowed Deflection Ratio, $\delta R_{Allowed}$ | = | 88.37 | - |
| Actual Deflection Ratio, $\delta R_{Actual}$ | = | 42.07 | - |
| **DESIGN IS SAFE IN DEFLECTION** | | | |

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**ROOF SLAB SCHEDULE:**

| Slab No. | Tk | Type of slab | Main Reinforcement | Distributor | Shorter Span | Longer Span |
|---|---|---|---|---|---|---|
| S1 | 150 | Two Way | --- | --- | Y10 @ 150 C/C | Y10 @ 150 C/C |
| S2 | 150 | Two Way | --- | --- | Y8 @ 150 C/C | Y8 @ 150 C/C |
| S3 | 150 | One Way | Y10 @ 150 C/C | Y8 @ 150 C/C | --- | --- |
| S4 | 150 | One Way | Y8 @ 150 C/C | Y8 @ 150 C/C | --- | --- |

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**Note:**

Adequate Plinth beams, Continuous Lintels are provided for the earthquake resistance. Columns are designed for horizontal shear forces. The detailing of Reinforcement is done according to provisions of IS:13920 – Indian Standard Code of Practice for ductile detailing of R.C. Structures subjected to Seismic forces.

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