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CHARTERED CIVIL ENGINEER (M-165213-8)

**02.01.2025**
**Chennai**

## STABILITY CERTIFICATE

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

The detailed engineering and structure design of the proposed building comprising of **Basements + Stilt + 11 floors** at T.S No. 125/1, Old S.F No.252/2, 253/2, Block 37, Ward B, Thally Road, Hosur, Krishnagiri District – 635109 has been done by me/us based on the report of geotechnical investigation (soil test) done by Mars Synergy Geo Tech Pvt Ltd Report No. MSGTPL/SI-5888/23-24 Dated 15.07.2023 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 M30

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 Code No. 875 and design of earthquake resistant structure as per IS Code No. 1893 (Part 1) 2016.

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

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# STRUCTURAL DESIGN STABILITY CERTIFICATE

I hereby certify that the Proposed Construction of Multi Storied Residential Apartment Building in T.S.NO:125/1, Old S.F.NO:252/2,253/2, Block 37, Ward B at Thally Road, Hosur Town, Krishnagiri District, that the building will with stand against the Earthquake, (Seismic Zone II as per IS 1893 (Part-I) - 2016) loading stress parameters are within limits of National building code and Bureau of Indian standards code of practice for concrete and loading. The R.C.C building frame of the structure is designed as per the Indian Standard code of practice for concrete and loadings. The structure will be constructed as per the structural design and detailing of reinforcements given in the drawing from foundation to roof slab and beam. For external and internal partition walls 200/100 thick Block walls are used. The structure is sound and stable.

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# DESIGN BASIS REPORT FOR

# PROPOSED RESIDENTIAL APARTMENT BUILDING FOR

# M/s.SR GROUP'S AT HOSUR.

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## 1.0 OBJECTIVE

The Design basis covers the basic requirement that will be followed for the design of Proposed Residential Apartment Building for M/s.SR GROUP AT Hosur. Considering the length and shape of the building, the same is divided into two different blocks with expansion joint wherever necessary.

The building is designed for Stilt + 11 Floors. The structure is supported on columns in turn resting on Raft foundation. The structural system comprises columns, beams and slab structure.

3-D Analysis of all the building structures will be carried out using STAAD PRO software package and analysis results shall be used for designing the various elements.

## 2.0 DESIGN LOADS

### 2.1 Dead Loads

The Dead loads that are envisaged to act permanently are considered as per IS: **875 (Part 1) – 1987 – Dead loads.** Indian Standard **"Code of Practice for Design Loads (other than earthquake) for Buildings and Structures"**

1. Slab is assumed to be 125 mm thick – 3.125 KN/m²
2. Slab is assumed to be 150 mm thick – 3.75 KN/m²
3. Floor finish – 1.25 KN/m²
4. Toilet filling load(100mm) – 2 KN/m²
5. Block work masonry walls 200 & 150 mm thick are proposed to be used (location of walls as per Architectural drawings) Unit weight is taken as 20 KN/$m^3$
6. Weathering course in Terrace finish – 3 KN/$m^2$

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## 2.2 Imposed Loads

The imposed loads that are envisaged to act permanently are considered as per IS: **875 (Part 2) – 1987**. Indian Standard **"Code of Practice for Design Loads (other than earthquake) for Buildings and Structures"**.

1. Living = 2 KN/$m^2$
2. Staircase = 4 KN/$m^2$
3. Toilet = 2 KN/$m^2$

## 2.3 Wind Load

The wind pressure shall be calculated based on the provision laid in **IS : 875 ( Part 3 ) – 2015.** The basic wind speed, terrain category, height factor and structures class etc. required for the wind pressure calculation can be furnished from this codal provisions.

| | | | | |
|---|---|---|---|---|
| Location | : | Hosur | | |
| Wind Loads | : | As per IS 875 | | |
| As per IS 875 Part 3 | : | Basic Wind speed | $V_b$ | = 39 m/Sec. |
| | | (Table 1) | K1 | = 1.0 |
| | | (Table 2) | K2 | = Terrain category -3 |
| | | Class – B | 0 to 10m – K2 = 1.05 | |
| | | | 10 to 15m – K2 = 1.09 | |
| | | | 15 to 20m – K2 = 1.12 | |
| | | | 20 to 30m – K2 = 1.15 | |
| | | | 30 to 50m – K2 = 1.20 | |
| | | (Table 3) | K3 = 1 | |
| Design Wind Speed ($V_z$) | : | $V_b$ x K1 x K2x K3 | | |
| | | 39 x 1 x 1.05 x 1 | = | 40.95 m/Sec. |
| Design Wind Pr | : | 0.6 x $Vz^2$ | | |
| Pz | : | 0.6 x $40.95^2$ | = | 1006 N /$m^2$ |
| | | | Pz = | 1.006 KN/$m^2$ |

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| | | | | |
|---|---|---|---|---|
| Design Wind Speed (Vz) | : | $V_b$ x K1 x K2x K3 | | |
| | | 39 x 1 x 1.09 x 1 | = | 42.51 m/Sec. |
| Design Wind Pr | : | 0.6 x $Vz^2$ | | |
| Pz | : | 0.6 x $42.51^2$ | = | 1084 N /$m^2$ |
| | | Pz | = | 1.084 KN/$m^2$ |

| | | | | |
|---|---|---|---|---|
| Design Wind Speed (Vz) | : | $V_b$ x K1 x K2x K3 | | |
| | | 39 x 1 x 1.12x 1 | = | 43.68 m/Sec. |
| Design Wind Pr | : | 0.6 x $Vz^2$ | | |
| Pz | : | 0.6 x $43.68^2$ | = | 1144 N /$m^2$ |
| | | Pz | = | 1.144 KN/$m^2$ |

| | | | | |
|---|---|---|---|---|
| Design Wind Speed (Vz) | : | $V_b$ x K1 x K2x K3 | | |
| | | 39 x 1 x 1.15x 1 | = | 44.85 m/Sec. |
| Design Wind Pr | : | 0.6 x $Vz^2$ | | |
| Pz | : | 0.6 x $44.85^2$ | = | 1207 N /$m^2$ |
| | | Pz | = | 1.207 KN/$m^2$ |

| | | | | |
|---|---|---|---|---|
| Design Wind Speed (Vz) | : | $V_b$ x K1 x K2x K3 | | |
| | | 39 x 1 x 1.2 x 1 | = | 46.8 m/Sec. |
| Design Wind Pr | : | 0.6 x $Vz^2$ | | |
| Pz | : | 0.6 x $46.8^2$ | = | 1314 N /$m^2$ |
| | | Pz | = | 1.314 KN/$m^2$ |

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## 2.4 Earthquake Load

The loading due to earthquake is assessed based on the provisions of **IS : 1893-2016.**

**Hosur falls under Seismic Zone II**

**Zone factor = 0.1**

**Response reduction factor = 5**

**Importance factor = 1.2**

As per **IS: 1893-2016**, percentage of imposed loads to be considered for seismic weight calculation is mentioned below:

| Imposed Uniformity Distributed Floor Load Loads ( kN/ $m^2$) | Percentage of Imposed |
|---|---|
| Up to & including 3.0 | 25 |
| Above 3.0 | 50 |

## 2.5 Load Combinations

The various loads shall be combined in accordance with the stipulations in IS: 875 (Part 5) – 1987. Whichever combinations produced the most unfavorable effect in the building, foundations or structural member concerned shall be adopted. The various load combinations considered in the analysis are as follows:

1. 1.0 (DL+LL)
2. 1.0 DL+ 1.0 SQX+1
3. 1.0 DL+ 1.0 SQX-1
4. 1.0 DL+ 1.0 SQZ+1
5. 1.0 DL+ 1.0 SQZ-1
6. 1.0 DL+ 0.8 LL + 0.8 SQX+1
7. 1.0 DL+ 0.8 LL + 0.8 SQX-1
8. 1.0 DL+ 0.8 LL + 0.8 SQZ+1
9. 1.0 DL+ 0.8 LL + 0.8 SQZ-1

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10. 1.0 DL+ 1.0 WLX+1

11. 1.0 DL+ 1.0 WLX-1

12. 1.0 DL+ 1.0 WLZ+1

13. 1.0 DL+ 1.0 WLZ-1

14. 1.0 DL+ 0.8 LL + 0.8 WLX+1

15. 1.0 DL+ 0.8 LL + 0.8 WLX-1

16. 1.0 DL+ 0.8 LL + 0.8 WLZ+1

17. 1.0 DL+ 0.8 LL + 0.8 WLZ-1

18. 1.5 (DL+LL)

19. 1.2 (DL+LL+EQX+1)

20. 1.2 (DL+LL-EQX-1)

21. 1.2 (DL+LL+EQZ+1)

22. 1.2 (DL+LL-EQZ-1)

23. 1.5 (DL+EQX+1)

24. 1.5 (DL+EQX-1)

25. 1.5 (DL+EQZ+1)

26. 1.5 (DL+EQZ-1)

27. 0.9 DL + 1.5 EQX+1

28. 0.9 DL + 1.5 EQX-1

29. 0.9 DL + 1.5 EQZ+1

30. 0.9 DL + 1.5 EQZ-1

31. 1.2 (DL+LL+WLX+1)

32. 1.2 (DL+LL+WLX-1)

33. 1.2 (DL+LL+WLZ+1)

34. 1.2 (DL+LL+WLZ-1)

35. 1.5 (DL+WLX+1)

36. 1.5 (DL-WLX-1)

37. 1.5 (DL+WLZ+1)

38. 1.5 (DL+WLZ-1)

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39. 0.9 DL + 1.5 WLX+1

40. 0.9 DL + 1.5 WLX-1

41. 0.9 DL + 1.5 WLZ+1

42. 0.9 DL + 1.5 WLZ-1

43. 1.0 DL+ 1.0 RSX+1

44. 1.0 DL+ 1.0 RSX-1

45. 1.0 DL+ 1.0 RSZ+1

46. 1.0 DL+ 1.0 RSZ-1

47. 1.0 DL+ 0.8 LL + 0.8 RSX+1

48. 1.0 DL+ 0.8 LL + 0.8 RSX-1

49. 1.0 DL+ 0.8 LL + 0.8 RSZ+1

50. 1.0 DL+ 0.8 LL + 0.8 RSZ-1

51. 1.2 (DL+LL+RSX+1)

52. 1.2 (DL+LL-RSX-1)

53. 1.2 (DL+LL+RSZ+1)

54. 1.2 (DL+LL-RSZ-1)

55. 1.5 (DL+RSX+1)

56. 1.5 (DL+RSX-1)

57. 1.5 (DL+RSZ+1)

58. 1.5 (DL+RSZ-1)

59. 0.9 DL + 1.5 RSX+1

60. 0.9 DL + 1.5 RSX-1

61. 0.9 DL + 1.5 RSZ+1

62. 0.9 DL + 1.5 RSZ-1

The above load combinations will be considered and effect of worst combinations will be taken for design of various building elements.

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## 3.0 ANALYSIS METHODS

The analysis of the structures is carried out using the STAAD PRO. The entire super-structure is modeled using frame elements as appropriate. Beams and columns are modeled as frame elements. Appropriate loads and its combination as per relevant IS code clauses are chosen for design.

## 4.0 DESIGN ASSUMPTION

4.1.1 The Base of the Foundation is assumed to be FIXED.

4.1.2 All Concrete elements shall be designed in accordance with IS 456: 2000 Limit State Design.

## 5.0 FOUNDATION DESIGN

1. Type of Foundation : Raft Foundation. (as per soil report)
2. Safe bearing Capacity

   At 2.5m depth from NGL : 200 $kN/m^2$
3. Depth of Foundation : 2.5 m from N.G.L

## 6.0 MATERIALS

The self-weight of the various elements are computed based on the unit weight of materials as given below:

| S.no | Materials | Unit weight $KN/m^3$ |
|---|---|---|
| 1 | Reinforced Cement Concrete | 25 |
| 2 | Solid Block / Brick | 20 |
| 3 | Steel | 78.50 |

Structural concrete shall be of grade M30 for Raft.

Structural concrete shall be of grade M25 for all other structural Elements.

Steel reinforcement shall be of Grade Fe500 confirming to IS: 1786-2008.

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## 7.0 NOMINAL COVER TO REINFORCEMENT

From Durability requirement, exposure condition is assumed as mild for structural elements above ground level and moderate for structural elements below ground level.

The Clear cover to reinforcement to meet durability requirement shall be as follows:

| | | |
|---|---|---|
| Column | – | 40mm |
| Raft | – | 50mm |
| Beam | – | 25mm |
| Slab | – | 20mm |

## 8.0 LIST OF CODES & REFERENCES:

- IS: 456 2000: Code of practice for Plain and Reinforced Concrete.
- IS: 875 Part 1: Code of Practice for Design of Dead Loads for buildings and structures.
- IS: 875 Part 2: Code of Practice for Design of imposed Loads for buildings.
- IS: 875 Part 3: Code of Practice for Design Loads (Wind loads) for buildings & structures (other than Earthquake).
- IS: 1893 (Part 1)-2016: Criteria for Earthquake resistant Design of structures.
- IS: 13920-2016: Ductile detailing of reinforced concrete structures subjected to seismic forces.
- IS 1786-1985: code of practice for steel.
- SP 16: Design aids for reinforced concrete to IS: 456- 1978.
- SP 34: Hand book on concrete reinforcement detailing.

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## DESIGN OF RAFT

Total Load from Building = 96874 kN

Total Load including self-weight = Total load x 1.1

= 106561 kN

SBC of Soil = 200 kN/$m^2$

Required Area = Total Load including self-weight / SBC

= 106561/200

= 532.80 $m^2$

≈ 531 $m^2$

Area provided = 662.79 $m^2$

≈ 662 $m^2$

HENCE SAFE

Pressure of Soil = Total load / Area provided

= 96874 / 662

= 146 kN/$m^2$

Depth of Raft (D) = 800 mm

Bending Moment at TOP = 146 x $5.69^2$ / 10

= 472 kNm

Factored Moment = 472 x 1.5

= 709 kNm

R = (709 x $10^6$)/(1000 x $740^2$)

= 1.29

Pt/100 =Ast/bd = fck/2fy [1-Sq.rt (1-4.598xR/fck)\

fck = 30 N/$mm^2$

fy = 500 N/$mm^2$

Pt = 0.313%

Ast required = 2316 $mm^2$

Provide 20Y @ 125 mm C/C

Ast provided = 2512 $mm^2$

Hence safe.

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Bending Moment at BOTTOM = $146 \times 5.69^2 / 10$

= 472 kNm

Factored Moment = $472 \times 1.5$

= 709 kNm

Bending moment at mid span, Mu = 709kNm

R = $(709 \times 10^6)/1000 \times 740^2)$

= 1.29

Pt = 0.313%

Ast required = 2316 $mm^2$

Provide 20Y @ 125mm C/C

Ast provided = 2512 $mm^2$

Hence Safe.

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# DESIGN OF COLUMN - (1'-0" X 3'-0")

| | | | |
|---|---|---|---|
| Length of column | D | 900 | mm |
| Breadth of column | b | 300 | mm |
| Unsupported length (longer direction) | $L_x$ | 3000 | mm |
| Unsupported length (shorter direction) | $L_y$ | 3000 | mm |
| Eff. Length (longer direction) | $L_{ex}$ | 2400 | mm |
| Eff. Length (shorter direction) | $L_{ey}$ | 2400 | mm |
| | | | |
| Factored Load | $P_u$ | 3240 | kN |
| Factored moment (longer direction) | Mux | 135 | kNm |
| Factored moment (shorter direction) | Muz | 50 | kNm |
| Charac. comp strength of concrete | $f_{ck}$ | 25 | $N/mm^2$ |
| Yield stress of steel | $f_y$ | 500 | $N/mm^2$ |
| Dia of bar used | Φ | 20 | mm |
| Clear cover | | 40 | mm |
| Effective cover | d' | 50 | mm |
| Effective depth | d | 850 | mm |
| | | | |
| **Check for slenderness** | | | |
| | | | |
| **Longer Direction** | | | |
| Slenderness ratio | $L_{ex}/D$ | 2.67 | **short** |
| Additional moment due to slenderness | $M_{ax}$ | 0 | kN-m |
| **Shorter Direction** | | | |
| Slenderness ratio | $L_{ey}/b$ | 8.00 | **short** |
| Additional moment due to slenderness | $M_{ay}$ | 0 | kN-m |
| **Calculation of $P_{uz}$** | | | |
| No of bars used | | 16 | |
| Area of reinforcement | Ast | 5024 | |
| Provided steel | | 16 nos Y20 | |
| Percentage of reinforcement | $p_t$ | 1.861 | % |
| Area of concrete | Ag | 270000 | $mm^2$ |
| Ultimate axial load (without moments) | $P_{uz}$ | 4865 | kN |
| | | | |
| **Calculation of $P_b$:** | | | |
| **Longer Direction** | | | |
| | d'/D | 0.056 | |
| Coefficient $k_1$(from TABLE 60 of SP:1980) | $k_{1x}$ | 0.218 | From Sp16 |
| Coefficient $k_2$(from TABLE 60 of SP:1980) | $k_{2x}$ | 0.532 | |
| Axial load corresponding to balanced failure | $P_{bx}$ | 1736 | kN |
| Reduction factor for additional moments | $k_x$ | 1.000 | |
| Moment due to slenderness | $M_{ax}$ | **0.00** | kN-m |
| **Shorter Direction** | | | |
| | d'/b | 0.167 | |
| Coefficient $k_1$(from TABLE 60 of SP:1980) | $k_{1y}$ | 0.191 | |
| Coefficient $k_2$(from TABLE 60 of SP:1980) | $k_{2y}$ | 0.265 | |
| Axial load corresponding to balanced failure | $P_{by}$ | 1422 | kN |
| Reduction factor for additional moments | $k_y$ | 0.472 | |
| Moment due to slenderness | $M_{ax}$ | **0.00** | kN-m |
| | | | |

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| | | | | | |
|---|---|---|---|---|---|
| **Check for moments due to min. eccentricity** | | | | | |
| | | | | | |
| **Longer Direction** | | | | | |
| Minimum eccentricity | | | $e_x$ | 36.00 | mm |
| Moment due to min. eccentricity | | | $M_x$ | 116.64 | kN-m |
| Moment in longer direction | | | $M_{ux}$ | 135.00 | kNm |
| **Shorter direction** | | | | | |
| Minimum eccentricity | | | $e_y$ | 16.00 | mm |
| Moment due to min. eccentricity | | | $M_y$ | 51.84 | kN-m |
| Moment in shorter direction | | | $M_{uy}$ | 51.84 | kNm |
| | | | | | |
| **Final design moments** | | | | | |
| | | | | | |
| Moment in longer direction | | | $M_{ux}$ | **135.00** | kNm |
| Moment in shorter direction | | | $M_{uy}$ | **51.84** | kNm |
| | | | | | |
| **Check for interaction** | | | | | |
| | | | d'/D | 0.056 | |
| | | | d'/b | 0.167 | |
| $p/f_{ck}$ | | | $p/f_{ck}$ | 0.074 | |
| $P_u/f_{ck}bD$ value | | | $P_u/f_{ck}bD$ | 0.480 | |
| $M_{ux1}/f_{ck}bD^2$ value (from SP 16:1980 charts) | | | $M_{ux1}/f_{ck}bD^2$ | 0.095 | |
| Uniaxial moment capacity (longer direction) | | | $M_{ux1}$ | **577.125** | kNm |
| $M_{uy1}/f_{ck}bD^2$ value (from SP 16:1980 charts) | | | $M_{uy1}/f_{ck}bD^2$ | 0.080 | |
| Uniaxial moment capacity (shorter direction) | | | $M_{uy1}$ | **162** | kNm |
| $P_u/P_{uz}$ ratio | | | $P_u/P$ | **0.666** | |
| Value of exponent | | | | 1.778 | |
| Interaction ratio | | | | **0.208** | |
| Percentage reinforcement satisfactory or not | | | | **safe** | |
| | | | | | |
| | | | | | |

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# Design of Roof Beam

**Client Name** : M/s. SR GROUP

**Project Name** : PROPOSED RESIDENTAIL APARTMENT AT HOSUR

| Description | | Formula / Variable | | Result | Unit |
|---|---|---|---|---|---|
| **General Input Data** | | | | | |
| Clear span | | l | = | 5330 | mm |
| Total depth of beam | | D | = | 450 | mm |
| Width of beam | | b | = | 200 | mm |
| Width of left side support | | | = | 300 | mm |
| Width of right side support | | | = | 300 | mm |
| Assumed diameter of bar | | Φ | = | 25 | mm |
| Clear cover to main reinforcement | | | = | 25 | mm |
| Effective cover to main reinforcement | | d' | = | 37.5 | mm |
| Effective depth of beam | | d | = | 412.5 | mm |
| Effective span of beam | | $L_{eff}$ | = | 5630 | mm |
| Factored bending moment | at end span1 | $M_u$ From Staad O/P | = | 125 | kNm |
| | at midspan | $M_u$ From Staad O/P | = | 65 | kNm |
| | at end span2 | $M_u$ From Staad O/P | = | 125 | kNm |
| Factored shear force | at end span1 | $V_u$ From Staad O/P | = | 110 | kN |
| | at midspan | $V_u$ From Staad O/P | = | 0 | |
| | at end span2 | $V_u$ From Staad O/P | = | 110 | |
| **Material Data** | | | | | |
| Grade of Concrete | | $f_{ck}$ M25 | = | 25 | $N/mm^2$ |
| Yield Strength of Reinforcement | | $f_y$ | = | 500 | $N/mm^2$ |
| Unit Weight of Concrete | | $w_c$ | = | 25 | $kN/m^3$ |
| Youngs modulus of steel | | $E_s$ | = | 200000 | $N/mm^2$ |
| **Check for bending moment** | | | | | |
| Ultimate limiting of bending moment | | $M_{u,lim} = 0.133 \times f_{ck} \times b \times d^2$ (From SP16, Table C, P.No:10) | = | 113.15391 | kNm |

| | | | | | | |
|---|---|---|---|---|---|---|
| **End span 1** | $M_u$ > | Mu,lim | Hence | doubly | reinforced section is required | |
| **Mid span** | $M_u$ < | Mu,lim | Hence | singly | reinforced section is required | |
| **End span 2** | $M_u$ > | Mu,lim | Hence | doubly | reinforced section is required | |

| | | | | |
|---|---|---|---|---|
| **Calculation of limiting neutral axis depth** | | | | |
| Neutral axis depth | $X_{u,lim} = 0.46 \times d$ (From IS456:2000, clause 38.1, P.No:70) | = | 189.75 | mm |

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**Calculation of tension reinforcement for end and mid span**

| | | | |
|---|---|---|---|
| Tension reinforcement | $A_{st} = A_{st1} + A_{st2}$<br>$A_{st1} = (P_{t,lim} \times b \times d) / 100$<br>$A_{st2} = (M_{u2}) / (0.87 \times f_y \times (d-d'))$<br>$P_{t,lim} = (18.87 \times f_{ck}) / (f_y)$<br>$M_{u2} = (M_u - M_{u,lim})$<br>(From SP16, Table C, P.No:10) | | |

**End span 1 (top)**

Required tension reinforcement = 851 $mm^2$

| | | Nos. | Dia.(mm) | % Rft. | | |
|---|---|---|---|---|---|---|
| Provided tension reinforcement | Main | 2 | 16 | 1.25 | = 1030 | $mm^2$ |
| | Extra | 2 | 20 | | | |

Provided area > Required area HENCE SAFE

**Mid span (bottom)**

Required tension reinforcement = 483 $mm^2$

| | | Nos. | Dia.(mm) | % Rft. | | |
|---|---|---|---|---|---|---|
| Provided tension reinforcement | Main | 2 | 16 | 0.73 | = 603 | $mm^2$ |
| | Extra | 1 | 16 | | | |

Provided area > Required area HENCE SAFE

**End span 2 (top)**

Required tension reinforcement = 851 $mm^2$

| | | Nos. | Dia.(mm) | % Rft. | | |
|---|---|---|---|---|---|---|
| Provided tension reinforcement | Main | 2 | 16 | 1.25 | = 1030 | $mm^2$ |
| | Extra | 2 | 20 | | | |

Provided area > Required area HENCE SAFE

**Calculation of compression reinforcement**

| | | | |
|---|---|---|---|
| Required compression reinforcement | $A_{sc} = [M_{u2}] / [(f_{sc} - f_{cc}) \times (d - d')]$<br>$M_{u2} = (M_u - M_{u,lim})$ | | |
| Strain at the level of centroid of compression steel | $\varepsilon_{sc} = [0.0035 \times (x_u - d')] / [x_u]$ | = 0.00281 | |
| Here value of $\varepsilon_{sc}$ is greater than $(0.696 \times f_y)/(E_s)$ | | | |
| Stress in compression steel | $f_{sc}$ is get from Interpolate $\varepsilon_{sc}$ value in Table A, Clause 1.4, SP16, P.No:6 | = 414.44005 | $N/mm^2$ |
| Stress in concrete at the level of the centroid of the compression steel | $f_{cc} = 0.447 \times f_{ck}$ | = 11.175 | $N/mm^2$ |

**End span 1 (bottom)**

Required compression reinforcement = 78.334543 $mm^2$

| | | Nos. | Dia.(mm) | % Rft. | | |
|---|---|---|---|---|---|---|
| Provided compression rft. | Main | 2 | 16 | 0.49 | = 402 | $mm^2$ |
| | Extra | 0 | 0 | | | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| Provided area | > | Required area | | HENCE SAFE | | |
| **Mid span (top)** | | | | | | |
| Required compression reinforcement | | | | | = -318.4268 | $mm^2$ |
| | | Nos. | Dia.(mm) | % Rft. | | |
| Provided compression rft. | Main | 2 | 16 | 0.49 | = 402 | $mm^2$ |
| | Extra | 0 | 0 | | | |
| Provided area | > | Required area | | HENCE SAFE | | |
| **End span 2 (bottom)** | | | | | | |
| Required compression reinforcement | | | | | = 78.334543 | $mm^2$ |
| | | Nos. | Dia.(mm) | % Rft. | | |
| Provided compression rft. | Main | 2 | 16 | 0.49 | = 402 | $mm^2$ |
| | Extra | 0 | 0 | | | |
| Provided area | > | Required area | | HENCE SAFE | | |
| **Check for ductlity** | | | | | | |
| **End span 1 (bottom)** | | | | | | |
| Compression rft. limit | $P_{c,limit} = (0.87 \times f_y \times (p_t - p_{t,limit})) / (f_{sc} - (0.447 \times f_{ck}))$ | | | | = 0.33 | % |
| $P_{c,limit}$ | < | $P_{c,provided}$ | | HENCE SAFE | | |
| **Mid span (top)** | | | | | | |
| Compression rft. limit | $P_{c,limit} = (0.87 \times f_y \times (p_t - p_{t,limit})) / (f_{sc} - (0.447 \times f_{ck}))$ | | | | = -0.23 | % |
| $P_{c,limit}$ | < | $P_{c,provided}$ | | HENCE SAFE | | |
| **End span 2 (bottom)** | | | | | | |
| Compression rft. limit | $P_{c,limit} = (0.87 \times f_y \times (p_t - p_{t,limit})) / (f_{sc} - (0.447 \times f_{ck}))$ | | | | = 0.33 | % |
| $P_{c,limit}$ | < | $P_{c,provided}$ | | HENCE SAFE | | |
| **Check for deflection** | | | | | | |
| Condition | $(L/d)_{max} > (L/d)_{actual}$ | | | | | |
| | $(L/d)_{max} = (L/d)_{basic} \times K_t \times K_c$ | | | | | |
| | $(L/d)_{basic}$ (From IS456:2000, Clause 23.2.1, P.No:37 | | | | = 20 | |
| Modification factor for tension rft. | $K_t = 1 / ((0.225) + (0.00322 \times f_s) - (0.625 \times \log10(1/p_t)))$ | | | | = 1.126 | |
| Modification factor for compression rft. | $K_c = (1)+((P_c)/(P_c+3)) <= 1.5$ | | | | = 1.140 | |
| Steel stress of service loads | $f_s = (0.58 \times f_y \times$ Area of steel req.)/(Area of steel pro.) | | | | = 232 | $N/mm^2$ |
| Maximum allowable deflection | $(L/d)_{max}$ | | | | = 25.67 | mm |

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| | | | | |
|---|---|---|---|---|
| Actual deflection | $(L/d)_{actual}$ | = | 13.648 | mm |
| $(L/d)_{max}$ > $(L/d)_{actual}$ | HENCE SAFE | | | |
| **Check for shear** | | | | |
| Maximum shear force @ end span | $V_u$ | = | 110 | kN |
| Nominal shear | $\tau_v = V_u / (b \times d)$ (From IS456:2000, Clause 40.1, P.No:72) | = | 1.33 | $N/mm^2$ |
| Design shear strength of concrete | $\tau_c$ (From IS456:2000, clause 31.6.3, P. No:58) | = | 0.700 | $N/mm^2$ |
| $\tau_v$ > $\tau_c$ | HENCE SHEAR RFT. REQUIRED | | | |
| Provide 8 mm dia of 2 legged vertical stirrup rod | | | | |
| Strength of shear reinforcement | $V_{us} = V_u - (\tau_c \times b \times d)$ | = | 52269.4 | N |
| Spacing of stirrups | $S_v = (0.87 \times f_y \times A_{sv} \times d) / (V_{us})$ | = | 345 | mm |
| Maximum spacing, (0.75 d) | | = | 309 | mm |
| | | = | 300 | mm |
| Hence provide 100 mm c/c spacing | | | | |

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# DESIGN OF TYPICALFLOOR SLAB S1

## DESIGN CALCULATIONS

**Design of two way Slab** **S1**

**Basic Data**

| | | | | |
|---|---|---|---|---|
| Grade of concrete (fck) | | = | M 25 | |
| Grade of steel (fy) | | = | Fe 500 | |
| Thickness of slab (D) | | = | 125 | mm |
| Clear cover (cc) | | = | 20 | mm |
| Effective thickness of slab (deff) | = 125 - 20 - 8 /2 | = | 101 | mm |
| Unit weight of concrete | | = | 25 | $KN/m^3$ |
| Effective Shorter Span (Lx) | | = | 3.3 | m |
| Effective Longer Span (Ly) | | = | 3.6 | m |
| Aspect ratio Ly/Lx | | = | 1.09 | **Two way slab** |

Edge Condition : **Three Edges Discontinuous (One Long Edge Continuous)**

**Load Data**

| | | | | |
|---|---|---|---|---|
| Dead Load | = 0.13 x 25 | = | 3.125 | $KN/m^2$ |
| Floor finish | | = | 1.25 | $KN/m^2$ |
| Imposed Load | | = | 2.00 | $KN/m^2$ |
| Total load | | = | 6.38 | $KN/m^2$ |
| Design load ( Wu ) = 1.5 x 6.375 | | = | **9.56** | $KN/m^2$ |

**Moment and Shear Calculations**

**Short Span Direction**

| | | | | | | |
|---|---|---|---|---|---|---|
| ax for positive moment | | | 1 | → | 0.043 | |
| | | | 1.1 | → | 0.048 | |
| | | for 1.09 | αx | = | 0.048 | |
| Positive moment Mx : | 0.048 x | 9.56 x | 3.3 ^2 | = | **4.95** | KN-m |
| ax for negative moment | | | 1 | → | 0.057 | |
| | | | 1.1 | → | 0.064 | |
| | | for 1.09 | αx | = | 0.063 | |
| Negative moment Mx : | 0.063 x | 9.56 x | 3.3 ^2 | = | **6.60** | KN-m |

**Long Span Direction**

| | | | | | | |
|---|---|---|---|---|---|---|
| For positive moment | | | αy | = | 0.043 | |
| Positive moment My : | 0.043 x | 9.56 x | 3.3 ^2 | = | **4.48** | KN-m |

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For negative moment $\alpha y$ = 0.000

Negative moment My : 0.000 x 9.56 x 3.3 ^2 = **0.00** KN-m

Shear force $V_u$ = 9.56 x 3.3 x 0.5 = **15.78** KN

**Check Effective Depth for Bending**

Depth required = $(M_x / (0.133x \text{ fck x b}))^{1/2}$ = 44.55 mm

Depth provided = 125 - 20 - 8 /2 = 101 mm

**Hence O.K**

**Reinforcement calculations**

**Short Span Direction @ Support**

$Mu/bd^2$ = 6.60 x 10 ^ 6 / (1000 x 101 x 101) = **0.647**

Pt = **0.15** %

Area of steel Ast = 0.00153 x 1000 x 101 = 155.019 $mm^2$

Minimum area of steel: 0.0012 x 1000 x 125 = 150.00 $mm^2$

Spacing of Y **8** bars 50.27 x 1000 / 155.02 = 324.088 mm

Ast provided = 335.104 $mm^2$

**Check for Spacing**

Minimum of 1) 3d = 303 mm

2) = 300 mm

3) = 324.09 mm

Therefore provide Y **8** @ **150** mm C/C

**Short Span Direction @ Mid Span**

$Mu/bd^2$ = 4.95 x 10 ^ 6 / (1000 x 101 x 101) = 0.485

Pt = 0.114 %

Area of steel Ast = 0.00114 x 1000 x 101 = 115.386 $mm^2$

Minimum area of steel: 0.0012 x 1000 x 125 = 150.00 $mm^2$

Spacing of Y **8** bars 50.27 x 1000 / 150.00 = 334.933 mm

Ast provided = 335.104 $mm^2$

**Check for Spacing**

Minimum of 1) 3d = 303 mm

2) = 300 mm

3) = 334.93 mm

Therefore provide Y **8** @ **150** mm C/C

Provided % of Tension Reinforcement (pt) = **0.332** %

100

**Long Span Direction @ Support**

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$Mu/bd^2$ = 0.00 x 10 ^ 6 / (1000 x 101 x 101) = 0.000

Pt = 0.000 %

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Area of steel Ast | = | 0.00000 | x | 1000 x | 101 | = | 0 | $mm^2$ |
| Minimum area of steel: | | 0.0012 | x | 1000 x | 125 | = | 0.00 | $mm^2$ |
| Spacing of Y **8** bars | | 50.27 | x | 1000 / | 0.00 | = | 0 | mm |
| Ast provided | | | | | | = | 335.104 | $mm^2$ |

**Check for Spacing**

| | | | | |
|---|---|---|---|---|
| Minimum of | 1) 3d | = | 303 | mm |
| | 2) | = | 300 | mm |
| | 3) | = | 0.00 | mm |

Therefore provide Y **8** @ **150** mm C/C

**Long Span Direction @ mid Span**

$Mu/bd^2$ = 4.48 x 10 ^ 6 / (1000 x 101 x 101) = 0.439

Pt = 0.103 %

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Area of steel Ast | = | 0.00103 | x | 1000 x | 101 | = | 104.117 | $mm^2$ |
| Minimum area of steel: | | 0.0012 | x | 1000 x | 125 | = | 150.00 | $mm^2$ |
| Spacing of Y **8** bars | | 50.27 | x | 1000 / | 150.00 | = | 334.933 | mm |
| Ast provided | | | | | | = | 402.125 | $mm^2$ |

**Check for Spacing**

| | | | | |
|---|---|---|---|---|
| Minimum of | 1) 3d | = | 303 | mm |
| | 2) | = | 300 | mm |
| | 3) | = | 334.93 | mm |

Therefore provide Y **8** @ **125** mm C/C

**Check for Deflection:**

| | | | |
|---|---|---|---|
| Basic Span/depth Ratio | = | 20 | |
| % of Tension Reinforcement provided ( pt ) | = | 0.332 | % |
| Service stress of steel (fs) : 0.58fy(Ast_r/Ast_p) | = | 99.86 | $N/mm^2$ |
| Modification Factor for Tension Reinforcement (F1) | = | 2.00 | |
| Allowable Span/Eff Depth Ratio | = | 40 | |
| Actual Span/Eff Depth Ratio = 3.3 x 1000 / 101 | = | 32.67 | |

**Hence O.K**

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