STRUCTURAL DESIGN CALCULATIONS

(LOAD CALCULATIONS)

STRUCTURE:

The proposed Building has been envisaged as R.C Framed Structure with STILT + 5 Upper floors. STILT Floor is for Car Parking Utility.1st to 5TH floors are intended for Residential Utility.

ANALYSIS & DESIGN:

The Structure has been idealized as 3D Frame, with R.C Slab & Beam. All Beams are interconnecting with Columns. The design of all R.C components is done using Limit State Method.

The following codes of the Indian Standards are adopted in the Structural Design:

IS: 456-2000	-	Plain and Reinforced Concrete-code of Practice (Fourth Revision)
IS: 875-1987	-	Code of Practice for Design loads (other than Earthquake) for Buildings and Structures.
		Part (1) - Dead Loads-Unit Weights of Building Materials and Stored Materials (second revision)
		Part (2) - Impact Loads (second revision)
		Part (3) - Wind Loads (second revision)
		Part (4) - Snow Loads (second revision)

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		Part (5) - Special Loads and Load Combinations.
IS: 1893-2002	-	Criteria for Earthquake Resistant Design of Structures (Fifth Revision).
IS: 13920-1993	-	Ductile Detailing of Reinforced Concrete Structures Subjected to Seismic Forces-Code of Practice.
SP7:1983	-	National Building Code of India 1983.
SP: 34(S&T)-1987	-	Hand Book on Concrete Reinforcement and Detailing.
SP: 23(S&T)-1982	-	Hand Book on Concrete Mixes.
SP: 16(S&T)-1980	-	Design Aids for Reinforced Concrete to IS: 456-1978.

The concrete grade used for all R.C members is M 25. The Steel grade used in the building is Fe 500.

FOUNDATION:

The columns are supported on Isolated footings at 2.0.m below NGL and the allowable SBC of soil is taken as 16 Tonne/ m2

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TYPICAL FLOOR LOADS:

Self Wt. Of the slab = 0.115m x 25 KN/m^3	=	2.875 KN/m^2
Floor Finish	=	1.0 KN/m^2
Ceiling Plastering	=	0.5 KN/m^2
Live Load	=	2.0 KN/m^2
		6.375 KN/m^2

Say 6.5 KN/ m^2 (DL-4.5 KN/m^2+ LL-2 KN/m^2)

TERRACE SLAB:

Self Wt. Of the slab = 0.115m x 25 KN/m^3	=	2.875 KN/m^2
Weathering Course = 0.1m x 20 KN/m^3	=	2.00 KN/m^2
Ceiling Plastering	=	0.5 KN/m^2
Live Load	=	1.50 KN/m^2
		6.875 KN/m^2

Say 7.0 KN/ m^2 (DL-5.5 KN/m^2+ LL-1.5 KN/m^2)

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TOILET SLAB:

Self Wt. Of the slab	= 0.125m x 25 KN/m^3	=	3.125 KN/m^2
Filling load	= 0.25m x 20 KN/m^3	=	5.0 KN/m^2
Ceiling Plastering		=	0.5 KN/m^2
Live Load		=	1.50 KN/m^2
			10.125 KN/m^2

Say 10.5 KN/ m^2 (DL-9 KN/m^2+ LL-1.5 KN/m^2)

STRUCTURAL MATERIALS:

Concrete Grade	M25 (1:1:2)
Steel Grade	Fe500.

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DESIGN OF CRITICAL COLUMN:

Maximum axial load on column P =800 kN

M_X =30 kN-m

M_Z =10 kN-m

Factored loads P_U =1200 kN

M_{UX} =45 kN-m

M_{UY} =15 kN-m

Assume column size as 230mm x 600mm

fck – 25N/mm^2

fy-500N/mm^2

$$d'/D = \frac{48\text{mm}}{600\text{mm}} = 0.0866$$

$$d'/D = \frac{48\text{mm}}{230\text{mm}} = 0.21$$

$$\frac{P_U}{fckbD} = \frac{1200\text{ kN} \times 1000}{25\text{N/mm}^2 \times 230\text{mm} \times 600\text{mm}} = 0.34$$

assume Pt = 2%

Pt/fck = 2/25 = 0.08

We shall refer chart 45, SP 16

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$$\frac{M_u}{f_{ck} b D^2} = 0.11$$

$$M_{UX1} = \frac{0.11 \times 25 N/mm^2 \times 230mm \times (600mm)^2}{1 \times 10^6}$$

$$= 227.5 \text{ kN-m}$$

from chart 46, SP16

$$\frac{M_u}{f_{ck} b D^2} = 0.09$$

$$M_{UY1} = \frac{0.09 \times 25 N/mm^2 \times 600mm \times (230mm)^2}{1 \times 10^6}$$

$$= 71.4 \text{ kN-m}$$

from chart 63, P_{UZ}

$$P_{UZ}/Ag = 14.5 N/mm^2$$

$$P_{UZ} = \frac{14.5 N/mm^2 \times 230mm \times 600mm}{1000}$$

$$= 2001.5 kN$$

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P_U 1200 kN

--- = ---------- = 0.6

P_{UZ} 2001.5kN

M_{UX} 45 kN-m

------ = ---------- = 0.2

M_{UX1} 227 kN-m

M_{UY} 15 kN-m

----- = ---------- = 0.21

M_{UY1} 71.4 kN-m

From char 64, SP 16

Allowable $\frac{M_{UX}}{M_{UX1}}$ = 0.89

$\frac{M_{UY}}{M_{UY1}}$ = 0.91

Hence 0.k & safe

So, for critical column, we shall adopt the following

Size -230mm x 600mm

M25, Fe 500

Reinf. verticals – 8-25Y +3-12Y

Ties – 10y@ 175mm c/c (4 LEGGED)

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CRITICAL COLUMN FOOTING DESIGN:

Maximum Axial Load on column	=	800 KN
SBC of soil	=	160 KN/ m2
Area of Footing spread	=	800 x 1.05
		----------
		160 KN/ m2
	=	5.25 m2

We shall adopt footing size of 2440 x 2440

Provided area	=	5.95 m2

Hence for critical Column Footing

We shall adopt size	=	2440 mm x 2440 mm
Overall Depth	=	600 mm

Flat projection beyond column footing 100mm alround

Reinforcement

Bottom	=	12 Y @ 125 c/c B/w

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DESIGN OF SLAB:

Self-Wt. Of the slab = 0.115m x 25 KN/m3	=	2.875 KN/m2
Floor Finish	=	1.0 KN/m2
Partition Load	=	1.0 KN/m2
Ceiling Plastering	=	0.5 KN/m2
Live Load	=	2.0 KN/m2
Total	=	7.375 KN/m2

Say 7.5 KN/ m2

Negative Moment for the Shorter Span = 0.0751 x 11.75 x 3.5 x 3.5 x 1.5

= 16.214 kNm

MUx

------ short = $16.214 \times 10^6 / (1000 \times 105^2)$ = 1.47

bD2 Table 2 of SP 16 Pt

MUy

------ long = $10.2 \times 10^6 / (1000 \times 105^2)$ = 0.92

bD2 Table 2 of SP 16 Pt

Ast = Along Shorter direction – 0.714 x 1000 x 105/100

= 751 mm2

Reinf. Provided - 10Y@ 125mm c/c (Shorter Direction)

Distributor – 10Y@ 135mm c/c (Longer Direction)

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DESIGN OF BEAM

Clear span = 6.1 m

Effective span = 6.33 m

Load from slab = 850 x (6.33 / 2)

= 2690 Kg/m

Load from 5.5cm partition wall = 0.055 x 2.70 x 6.1 x 1920

= 1739 Kg/m

Total = 4440 Kg/m

Maximum bending moment = (4440 x (6.33)²) / 10

= 17791Kgm

M ultimate = 1.5 x 17791

= 26686 Kg/m

= 277.3 KNm

Size of beam = 23cm x 60.0 cm (effective depth 57cm)

Mu/bd² = (277.3 x 1000) / (23 x57 x 57)

= 3.71 N/mm²

From table 50;

d' / d = 0.1

pt = 1.3 pc = 1.1

Ast = (1.3 / 100) x 23 x 57 = 17.0 sq.cm

Asc = (1.1 x 23 x 57) / 100

= 14.42 Sq cm

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Area of steel provided:

Bottom 3nos of 20mm +3nos of 20mm

area provided 18.84Sq cm which is more than 17.0 Sq cm.

Top 3nos of 20mm +3nos of 20mm.

Hence safe.

CHECK FOR SHEAR

Maximum shear force (V) = (4440 x 6.1) / 2

= 13542 kg

141.0 KN

V ultimate = (141 X 1.50)

= 211.5 KN

(τv) = Vu / bd

=211.5 x 10 /(23 x57)

= 1.61 N/mm²

Which is less than (τc) max 2.80 N/mm² for M25 concrete.

Hence safe

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