DESIGN CALCULATION OF (G+III) STORIED RESIDENTIAL BUILDING AT PRE. NO. –111, DIAMOND, IN WARD NO. – 143, BOROUGH NO. – XVI, UNDER K.M.C., [JOKA UNIT], KOLKATA.

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Relevant codes used are :-

(1) I.S. – 456- 2000
(2) S.P.- 16- 1980

Assumption taken in design :-

(1) Grade of conc. Used – M20
(2) Grade of steel used – Fe- 500
(3) Bearing capacity of soil – As per soil report.
(4) Design based on:-
  (a) Working stress method for slab, footing, & column.
  (b) Limit stress method for beam.

(5) Calculation of loading :-

(A) Roof load :-

(a) D.L. of roof slab = 0.1x2500 = 250 Kg/sq m
(b) D.L. of C.P. = 30 Kg/sq m
(c) D.L. of roof treatment = 160 Kg/sq m
(d) Live load = 150 Kg/sq m

Total = 590 Kg/sq m

(B) Floor load :-

(a) D.L. of floor slab = 250 Kg/sq m
(b) D.L. of C.P. = 30Kg/sq m
(c) D.L. of F.F. = 120 Kg/sq m
(d) Live Load = 200 Kg/sq m

Total = 600 Kg/sq m

<u>**Design of R.C.C. slab**</u> **:-**

Max. shorter span = 3825 mm.
Span to eff. Depth ratio = 26
Using 0.2% steel, ‘d’ reqd. = 3825/(26 x 1.6) = 92 mm.
‘D’ reqd. = (92+19) = 111 mm.
Let us provide overall depth = 110 mm.
‘d’ = (110-19) = 91 mm.

Panel Mkd.	Dimensions	Ly/Lx	End conditions	Moment co-efficient			
				αx	αy	$\alpha x'$	$\alpha y'$
P1	3625x3125	1.16	Two adjacent edges discont.	0.045	0.035	0.060	0.047
P2	4125x3825	1.08	One long edge discont.	0.033	0.028	0.044	0.037

W = 0.625 t/sq m.

Panel	$M = (Lx)^2 .W.\alpha$				Ast = [M/(σst. j.d)]x10^7 in sq m			
Mkd.	Mx	My	Mx’	My’	Astx	Asty	Astx’	Asty’
P1	0.275	0.214	0.367	0.287	143	112	191	149
P2	0.302	0.256	0.403	0.339	157	133	210	176

Spacing reqd. (mm.)				Spacing providing (mm.)			
Sx	Sy	Sx’	Sy’	Sx1	Sy1	Sx1’	Sy1’
349	446	261	335	270	270	260	270
318	375	238	284	270	270	230	270

Spacing = (Area of each bar x 1000)/ Ast
Max. spacing = 3d = 3x91 = 273 mm say 270 mm.

Load chart : -

Col. Mkd.	Load in 't'	Group	
C01	33.97	V	
C02	28.14	V	
C03	20.60	V	
C04	26.14	V	
C05	39.33	IV	
C06	39.06	IV	
C07	38.03	IV	
C08	36.11	IV	
C09	46.41	III	*
C10	22.08	V	*
C11	70.38	I	*
C12	53.15	III	
C13	56.90	II	
C14	69.74	I	*
C15	73.66	I	*
C16	57.87	II	
C17	51.34	III	
C18	63.00	II	
C19	49.07	III	
C20	42.70	IV	
C21	33.35	V	
C22	32.56	V	
C23	41.76	IV	
C24	40.09	IV	

<u>Design of R.C.C. column (Gr.- I)</u>

P = 73.66 t.
Considering col. Size = 250x400 mm.
L = 3.375 m.
Leff = 0.65x3.375 = 2.194 m.
Leff/b = 8.775 [Hence short col.]
Now, $73.66 \times 10^4 = 5(250 \times 400 – Asc) + 190Asc$
Asc = 1279 sq mm.
As per I.S. Code, minimum reinforcement = 0.8% = 800 sq mm.
Considering seismic & wind load, let us provide column size 250x450 with 12-16 tor. as longitudinal bars with 8 tor.-4L-lateral ties @ 175 mm c/c.

Design of R.C.C. column (Gr.- II)

P = 63 t.
Considering col. Size = 250x400 mm.
Now, $63x10^4$ = 5(250x400 – Asc) + 190Asc
Asc = 703 sq mm.
As per I.S. Code, minimum reinforcement = 0.8% = 800 sq mm.
Considering seismic & wind load, let us provide column size 250x400 with 10-16 tor. as longitudinal bars with 8 tor.-4L-lateral ties @ 175 mm c/c.

Design of R.C.C. column (Gr.- III)

P = 53.15 t.
Considering col. Size = 250x350 mm.
Now, $53.15x10^4$ = 5(250x350 – Asc) + 190Asc
Asc = 508 sq mm.
As per I.S. Code, minimum reinforcement = 0.8% = 700 sq mm.
Considering seismic & wind load, let us provide column size 250x400 with 8-16 tor. as longitudinal bars with 8 tor.-4L-lateral ties @ 175 mm c/c.

Design of R.C.C. col. footing (Gr.- II):-

Total load , P = 63 t.
Considering bearing capacity of soil = 8.1 t./sq m.
Reqd. area of footing = (63x1.1)/8 = 8.56 sq m.
Provided area of footing = 2.9 m x 2.9 m
Upward soil pressure = 63/(2.9x2.9) = 7.49 t./sq m.
Pedestal size = 450x600 mm.
B.M. at the face of pedestal = $(7.49x2.9x1.225^2)/2$ = 16.3 t-m.
'd' reqd. = $[(16.3x10^7)/(0.914x2900)]^{0.5}$ = 248 mm.
Let us provide overall depth = 500 mm.
'd' = 432 mm.

CHECK FOR ONE WAY SHEAR :~

'V' at a distance 'd' from the face of the pedestal = 7.49x2.9x0.793 = 17.23 t.
τv = $[17.23x10^4]$ / [2900x432] = 0.137 N/sq mm < K.τc = 0.24 N/sq mm.

CHECK FOR TWO-WAY SHEAR.

'V' at a distance d/2 from the face of the pedestal =$7.49[2.9^2 –(1.032x0.882)]$ = 56.17 t.
τv = $[56.17x10^4]$ / [2900x432] = 0.45 N/sq mm < Ks.τc = 0.62 N/sq m.
Ast = $[16.3x10^7]$ / [0.92x230x432] = 1784 sq mm.
Spacing = [113x2900]/1784 = 183 mm c/c.

Let us provide 12 tor. @ 175 mm c/c, in the both directions.

Design of R.C.C. col. footing (Gr.- III) :-

Total load , P = 53.15 t.
Reqd. area of footing = (53.15x1.1)/8.1 = 7.22 sq m.
Provided area of footing = 2.7 m x 2.7 m
Upward soil pressure = 53.15/(2.7x2.7) = 7.29 t./sq m.
Pedestal size = 450x600 mm.
B.M. at the face of pedestal = $(7.29 \times 2.7 \times 1.125^2)/2$ = 12.46 t-m.
Let us provide overall depth = 450 mm.
'd' = 382 mm.
Ast = $[12.46 \times 10^7] / [0.92 \times 230 \times 382]$ = 1542 sq mm.
Spacing = [113x2700]/1542 = 197 mm c/c.
Let us provide 12 tor. @ 175 mm c/c, in the both directions.

DESIGN OF R.C.C. COMBINED STRIP-FOOTING [C9,C10,C11,C14,C15]

P = 282.27 t.
Area of footing reqd. = (282.27X1.1)/6.7 = 46.65 sq m.
Area of footing provided = 41.86 sq m.
Let us provide 400 mm wide rib beam.
Net upward soil pressure = 6.05 t/sq m.

Design of footing slab.

Considering 1m wide footing.
B.M. at the face of the rib beam = 4.36 t-m.
'd' reqd. = $[(4.36 \times 10^7)/(0.914 \times 1000)]^{0.5}$ = 219 mm.
Let us provide overall depth = 400 mm.
'd' = 332 mm.
Ast = $[4.36 \times 10^7] / [0.92 \times 230 \times 332]$ = 621 sq mm.
Spacing = [113x1000]/621 = 181 mm c/c.
Let us provide 12 tor. @ 175 mm c/c, in both directions.

DESIGN OF RIB BEAM [RB1]:-

Design moment, M = 12.89 x 10^7 N-mm.
Mu = 19.34 x 10^7 N-mm.
Considering beam size = 500x550 mm.
'd' = (550-50-16-8) = 476 mm.
Mu,lim. = $2.07 \times 500 \times 476^2$ = 23.45x 10^7 N-mm > Mu.
Mu/$(b.d^2)$ = 1.7 N/sq mm. Pt = 0.44
Ast = (500x476x0.44)/100 = 1048 sq mm.

Let us provide (4-16 tor. + 2-16 tor.) at bottom & 4-16 tor. at top for supports and (4-16 tor. + 2-12 tor.) at top & 4-16 tor. at bottom for span.

DESIGN OF SHEAR REINFORCEMENT :~

Design shear force, V = 214 Kn.
Vu = 321 Kn.
100Ast/(b.d) = 0.507
τc = 0.48 N/sq mm.
Vus = 321 - (0.48x500x476) /1000 = 206.76 Kn.
Vus/d = 4.3447 Kn/cm.
Let us provide 8 tor.–4L- vertical stirrups @ 170 c/c, throughout the length.

DESIGN OF R.C.C. BEAM [B1]:-

Design moment, M = 6.25 x 10^7 N-mm.
Mu = 9.38 x 10^7 N-mm.
Considering beam size = 250x400 mm.
'd' = (400-25-8) = 367 mm.
Mu,lim. = 2.07x250x367^2 = 6.97x 10^7 N-mm < Mu (Double reinforced).
Mu/(b.d^2) = 2.79 N/sq mm. d'/d = 0.1
Pt = 0.968 Pc = 0.012
Ast = (250x367x0.968)/100 = 889 sq mm.
Asc = (250x367x0.012)/100 = 11 sq mm.
Let us provide 5-16 tor. at top & 2-16 tor at bottom for supports & 2- 16 tor. at top and 4–16 tor. at bottom for span.

DESIGN OF SHEAR REINFORCEMENT :~

Design shear force, V = 76.8 Kn.
Vu = 115.2 Kn.
100Ast/(b.d) = 1.095
τc = 0.62 N/sq mm.
Vus = 115.2 - (0.62x250x367) /1000 = 58.32 Kn.
Vus/d = 1.589 Kn/cm.
Let us provide 8 tor.–2L- vertical stirrups @ 175 c/c throughout the span.

DESIGN OF R.C.C. BEAM [B2]:-

Design moment, M = 5.03 x 10^7 N-mm.
Mu = 7.55 x 10^7 N-mm.
Considering beam size = 250x350 mm.
'd' = (350-25-8) = 317 mm.
Mu,lim. = 2.07x250x317^2 = 5.2x 10^7 N-mm < Mu (Double reinforced).

$Mu/(b.d^2)$ = 3 N/sq mm.   d'/d = 0.1
Pt = 1.003   Pc = 0.299
Ast = (250x317x1.003)/100 = 795 sq mm.
Asc = (250x317x0.299)/100 = 237 sq mm.
Let us provide 4-16 tor. at top & 2-16 tor at bottom for supports & 2- 16 tor. at top and 4–16 tor. at bottom for span.

<u>DESIGN OF SHEAR REINFORCEMENT</u> :~

Design shear force, V = 45.1 Kn.
Vu = 67.65 Kn.
100Ast/(b.d) = 1.014
τc = 0.6 N/sq mm.
Vus = 67.65 - (0.6x250x317) /1000 = 20.1 Kn.
Vus/d = 0.634 Kn/cm.
Let us provide 8 tor.–2L- vertical stirrups @ 175 c/c throughout the span.