DESIGN CALCULATION OF (G+IV) STORIED RESIDENTIAL BUILDING AT PRE. NO. –131/2B, BAKRAHAT ROAD, IN WARD NO. – 144, BOROUGH NO. – XVI, UNDER K.M.C., [JOKA UNIT], KOLKATA

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K.M.C. E.S.E.No.-I/131

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

Design of R.C.C. slab :-

Max. shorter span = 3225 mm.
Span to eff. Depth ratio = 26
Using 0.2% steel, 'd' reqd. = 3225/(26 x 1.6) = 78 mm.
'D' reqd. = (78+19) = 97 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	4300x3200	1.34	Two adjacent edges discont.	0.049	0.035	0.065	0.047
P2	4675x3025	1.54	One long edge discont.	0.051	0.028	0.067	0.037

W = 0.6 t/sq m.

Panel	$M = (Lx)^2 .W.\alpha$				Ast = $[M/(\sigma st. j.d)]x10^7$ in sq m			
Mkd.	Mx	My	Mx'	My'	Astx	Asty	Astx'	Asty'
P1	0.301	0.215	0.400	0.289	176	126	234	169
P2	0.280	0.154	0.368	0.203	164	090	215	119

Spacing reqd. (mm.)				Spacing providing (mm.)			
Sx	Sy	Sx'	Sy'	Sx1	Sy1	Sx1'	Sy1'
284	396	213	295	240	240	210	240
304	555	232	420	240	240	230	240

Spacing = (Area of each bar x 1000)/ Ast
Max. spacing = 3d = 3x81 = 243 mm say 240 mm.

Load chart : -

Col. Mkd.	Load in ‘t’	Group
C01	39.94	IV
C02	63.06	II
C03	19.32	V
C04	18.18	V
C05	56.95	II
C06	35.56	IV
C07	82.26	I
C08	78.78	I
C09	53.18	III
C10	57.03	II
C11	54.55	III
C12	47.50	III
C13	29.72	V
C14	49.00	III
C15	77.26	I
C16	77.16	I
C17	33.04	IV
C18	26.43	V
C19	31.38	V
C20	64.80	II
C21	78.86	I
C22	59.16	II
C23	32.20	V
C24	42.53	IV
C25	60.44	II
C26	65.07	II
C27	57.68	II
C28	43.36	IV
C29	29.46	V
C30	52.35	III
C31	53.31	III
C32	50.87	III
C33	29.46	V

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

P = 82.86 t.
Considering col. Size = 250x450 mm.
L = 3.775 m.

Leff = 0.65x3.775 = 2.454m.
Leff/b = 9.815 [Hence short col.]
Now, $82.86 \times 10^4 = 5(250 \times 450 - Asc) + 190Asc$
Asc = 1439 sq mm.
As per I.S. Code, minimum reinforcement = 0.8% = 900 sq mm.
Considering seismic & wind load, let us provide column size 250x450 with 14-16 tor. as longitudinal bars with 10 tor.-4L-lateral ties @ 175 mm c/c.

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

P = 65.07 t.
Considering col. Size = 250x400 mm.
Now, $65.07 \times 10^4 = 5(250 \times 400 - Asc) + 190Asc$
Asc = 815 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 = 54.55 t.
Considering col. Size = 250x350 mm.
Now, $54.55 \times 10^4 = 5(250 \times 350 - Asc) + 190Asc$
Asc = 584 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. pile cap (Gr.- I):-

Total load , P = 82.86 t.
Considering 450ϕ pile
Load bearing capacity of each pile = 37 MT
Reqd. no. of pile = 2.47 (say 3)
Let us provide triangular shape of pile cap.
Length of the pile cap = 2250 mm.
B = 2070 mm.
Upward (each) pile pressure = 27.62 MT.
B.M. at c.g. of the pile cap = 21.52 t-m.
Let us provide overall depth = 700 mm
'd' = 601 mm.

CHECK FOR SHEAR :~

'V' = 55.24 t.
$\tau v = [55.24 \times 10^4] / [1939 \times 601] = 0.47$ N/sq mm $< Ks.\tau c = 0.62$ N/sq mm &
also <or= 4 N/sq mm for punching.
$Ast = [21.52 \times 10^7] / [0.92 \times 230 \times 601] = 1693$ sq mm
Spacing = (1939x201)/1693 = 230 mm c/c
Let us provide 16 tor. Bars @ 175 mm c/c (both ways) at bottom & 12 tor. Bars @ 175 mm c/c at top (both ways).

Design of R.C.C. pile cap (Gr.- II):-

Total load , P = 65.07 t.
Considering 450ϕ pile
Load bearing capacity of each pile = 37 MT
Reqd. no. of pile = 1.94 (say 2)
Let us provide rectangular shape of pile cap.
Length of the pile cap = 2250 mm.
B = 700 mm.
Upward (each) pile pressure = 32.54 MT.
B.M. at c.g. of the pile cap = 21.96 t-m.
Let us provide overall depth = 700 mm
'd' = 601 mm
$Ast = [21.96 \times 10^7] / [0.92 \times 230 \times 601] = 1727$ sq mm
Let us provide 6-20 tor. Bars at bottom & 6-12 tor. Bars at top.

DESIGN OF SHEAR REINFORCEMENT :~

Design shear force, V = 325.4 Kn.
Vu = 488.1 Kn.
$100Ast/(b.d) = 0.448$
$\tau c = 0.46$ N/sq mm.
Vus = 488.1 - (0.46x700x601) /1000 = 294.58 Kn.
Vus/d = 4.901 Kn/Cm.
Let us provide 10 tor.–4L- vertical stirrups @ 200 c/c throughout the span.

Design of R.C.C. pile cap (Gr.- III):-

Total load , P = 54.55 t.
Considering 450ϕ pile
Load bearing capacity of each pile = 37 MT
Reqd. no. of pile = 1.62 (say 2)
Let us provide rectangular shape of pile cap.

Length of the pile cap = 2250 mm.
B = 700 mm.
Upward (each) pile pressure = 27.28 MT.
B.M. at c.g. of the pile cap = 18.41 t-m.
Let us provide overall depth = 700 mm
'd' = 601 mm
Ast = $[18.41 \times 10^7] / [0.92 \times 230 \times 601]$ = 1448 sq mm
Let us provide 5-20 tor. Bars at bottom & 5-12 tor. Bars at top.

DESIGN OF SHEAR REINFORCEMENT :~

Design shear force, V = 272.8 Kn.
Vu = 409.2 Kn.
100Ast/(b.d) = 0.373
τc = 0.41 N/sq mm.
Vus = 409.2 - (0.41x700x601) /1000 = 236.72 Kn.
Vus/d = 3.939 Kn/Cm.
Let us provide 8 tor.–4L- vertical stirrups @ 180 c/c throughout the span.

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

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. = $2.07 \times 250 \times 317^2 = 5.2 \times 10^7$ 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.

DESIGN OF SHEAR REINFORCEMENT :~

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.