DESIGN OF A RESIDENTIAL BUILDING FOR 2BHK WITH 2 BLOCKS

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Abstract

Analyze and designing of a multistoried framed structure for G+4 floors. The analysisof multistoried residential apartment is designed by limited state method. The analysis of frame would be done by kani's method then it is proposed to design the structural elements according to IS 456-2000. The analysis and design id done for one single block and hold for the rest. The height of the room is taken as 3mts and walls are provided with 230mm thickness and inner partition walls are constructed with bricks masonry of 70mm thick. The multistoried consists of 4 floors and each floor is having 2 blocks having total area of 105sq.mts each. The analysis and design is done for one single block which is identical for the rest.

Keywords: *G+4 Multistoried Building, Design, Plan Etc.*

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1. INTRODUCTION

Industrial development in India is enormously increasing the shift of population from villages, towns to cities and hence the rapid urbanization. Due to this urbanization, land value increases unbounded and people are going to multi storied buildings/flats to economically utilize the land area available.

By this urbanization the increases of multi storied building rapidly increases.

2. Design of Slab's

Slabs are plate elements forming floors and roofs of building and carrying distributed loads primarily by flexure. Slabs are to be cast along with the beam and columns. It can be assumed as restrained slabs i.e., corners of the slabs are prevented from lifting.

2.1. Types of Slab's

There are two types of slabs

- Two way slab
- One way slab

2.1.1 Two way Slab

When ratio of long span is less than two, the slab is designed as two way slab. The loads acting on the slabs are self weight of slab, weight of floor finisher, partition walls and live loads. Live load is taken from IS 875-1987. For bending moment in both directions of the restrained slab, the coefficients are taken IS 456-2000. The coefficient varies with edge conditions of slab and ratio of long span to short span.

Slabs are designed by using limit state method.

2.1.2. One Way Slab

When the ratio of long span to short span is greater than two then the slab design is considered to be one way slab. In this loads are carried only along one direction. The main reinforcement is provided in the span direction. Reinforcement is also provided in the transverse direction, to distribute any unevenness that may occur in loading and for temperature and shrinkage effects in that direction. The main reinforcement is called distribution steel or secondary reinforcements. In the design of corridor, one way slab is considered.

This one way slab is designed as per IS 456-2000 main steel is provided along the width wise of corridor and distribution steel id provided along length wise.

Table1: Maximum Span length

Support conditions	Cantilever		Simply supported		Fixed Continuous	
Slab Type	1-Way	2-way	1-Way	2-way	1-Way	2-way
Maximum	1.5m	2m	3.5m	4.5m	4.5m	6.0m

3. DESIGN OF MAIN BED ROOM SLAB

3.1. Data

Grade of Concrete =M15
Grade of Steel =Fe415
Characteristic strength of concrete (f_{ck}) =15N/mm^2
Characteristic strength of steel, (f_y) =415N/mm^2

3.2. Design Constants

The design constants for M15 concrete and Fe415 steel for a balanced section under as per IS 415-2000 of code are
Xu, max/d =0.48
Mu, lim/bd^2 =0.13fck

3.3. Effective Depth of Slab

Assume overall depth of slab D = 120mm
Clear cover of slab d' = 20mm
Effective depth of slab d = 1000mm

3.4. Effective Span of Slab

As per IS 456-2000, effective span for framed structure will be the c/c distance between the supports.

Effective span in longer direction, I_y =4.23m
Effective span in shorter direction = 4.2m

3.4. Effective Span of Slab

Ratio of spans=longest span/shortest span
=4.23/4.2
=1.007 which is less than 2.

Since the aspect ratio is less than 2, the slab design will be two way slab.
Where L_y =4.23m
L_x =4.2m

3.5. Load On Slab

Consideration the width of the slab =1m
Self weight of slab= volume x density of concrete
= area x 1 x 25
=1 x 0.12 x 1 x 25
= 3kn/m
Weight of the floor finishes = 0.5 x 1
= 0.5kn/m
Live load = 3 x 1
Self weight of partition wall = 1 x 1
Total Load = 1.5 x 7.5
Factored total load W = 11.25kn/m

3.6. Effective Depth

Calculation the effective depth of slab by equation, Mu=Mu, lim

Where Mu= factored or ultimate or design moment
$= \alpha_x Wl^2 x$ or $\alpha_y l^2 x$

Maximum bending moment $= \alpha_x Wl^2 x$
$\alpha_x Wl^2 x$ $=0.138fckbd^2$
$0.037 \times 11.25 \times 4.20^2$ $=7.342 \times 10^6$
d= square root of (7342000/ 0.138 x 1000)
=59.55 < 100mm
Hence it is safe.
However provided effective depth is 100mm
Therefore overall depth of the slab (D) =120mm
Effective depth of slab (d) =100mm

3.7. Bending Moment and Area of Reinforcement for Short Span at Mid Span

Factored bending moment Mu $= \alpha_x Wl^2 x$
Positive moment at mid span $= 0.028 \times 11.25 \times 4.20^2$
= 5.556 KN-m
M_u $= 0.87f_y A_{st}(d-0.42X_{u,Max})$
$X_{u,Max}$ $= 0.87f_y A_{st}/0.36f_{ck}b$ $= 0.06686 A_{st}$
M_u $=0.87 \times 415 \times A_{st} (100-0.42 \times 0.006686 A_{st})$
$5.556 \times 10^6 = 361.05 \times 100 A_{st} 10.138 A_{st}^2$
A_{st} $= 161.156 mm^2$
Assuming 8mm dia bars,
Spacing = (Ast of on bar/ total ast) x 1000
= ((π/4 x64)/ 161.156) x 1000
= 311.56mm.
Checking space
For min reinforcement consideration,

- 311.56mm
- 3d=3 x 100 = 300mm,
- 300mm

Therefore, provide 8mm diameter bars at 300 mm c/c spacing.

For short span at continuous edge

Factored bending moment M_u, $= \alpha_x Wl^2 x$
$= 0.037 \times 11.25 \times 4.2^2$
= 7.34265Kn-m
$M_{u,lim}/bd^2$ = 2.07
$M_{u,li}$ $=20.7 \times 10^6$N-mm
Since $M_{u,li} > M_{u,li,}$ the design is safe.
M_u $=0.87f_y A_{st}(d- 0.42 X_{u,Max})$
$X_{u,Max}$ $=0.87f_y A_{st}/0.36 f_{ck} b= 0.06686A_{st}$
M_u $=0.87 \times 415 \times A_{st}(100- 0.42x 0.06686A_{st})$
$=7.34365 \times 10^6 = 361.05 \times 100 A_{st} – 10.138 A_{st}$
A_{st} $=216.533mm^2$
Assuming 8mm diameter bars,
Area of one bar = $(\pi/4 \times 8^2) = 50.24mm^2$
Spacing = (Ast of one bar / total Ast) x 1000
= (50.24/ 216.533) x 1000
= 232.173mm

Check for Spacing

For min reinforcement consideration,
1. 230mm
2. 3d= 3 x 100= 300mm
3. 300mm

Therefore, provided 8mm diameter bars at 230mm c/c spacing.

For Long span at Mid Span

Positive moment factored bending moment $M_u= \alpha_x Wl^2 x$
$= 0.028 \times 11.25 \times 4.2^2$
= 5.556 kn-m
$(M_{u,lim} / bd^2)$ $= 20.7 \times 10^6$N-mm
Actual bending moment < limiting bending moment
Hence it is safe.

$5.556 \times 10^6 = 361.05 A_{st} \times 100- 101.138 A_{st}^2$
A_{st} $= 161.156 mm^2$

Assuming 8mm dia bars,

Spacing = (Ast of one bar / total Ast) x 1000
= (50.24/ 161.156) x 1000
= 311.56mm

Check for Spacing

For min reinforcement consideration,

1. 310mm
2. 3d= 3 x 100= 300mm
3. 300mm

Therefore, provided 8mm diameter bars at 300mm c/c spacing.

For long span at continuous edge

Factored bending moment, M_u = α_y Wl^2 x
Positive moment at mid span = 0.03215x 11.25 x 4.20^2
= 7.343 Kn-m
A_{st} = 216.533 mm^2

Assuming 8mm dia bars,

Spacing = (Ast of one bar / total Ast) x 1000
= ((π/4 x 64) / 216.173) x 1000
= 232.173mm

Check for Spacing

For min reinforcement consideration,

1. 230mm
2. 3d= 3 x 100= 300mm
3. 300mm

Therefore, provided 8mm diameter bars at 230mm c/c spacing.

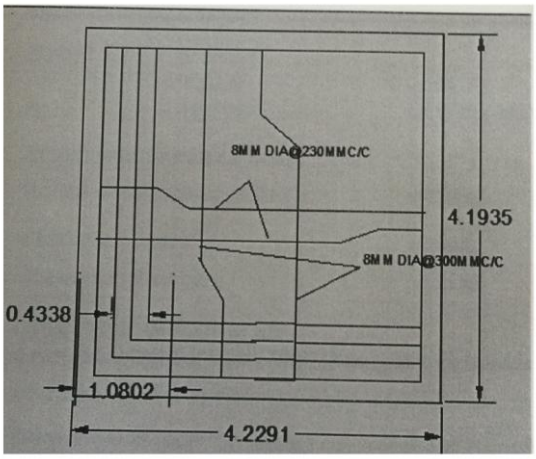

Fig: 1 Main Bed Room Two Way Slab

4. DESIGN OF MAIN BED ROOM SLAB

4.1. Data

Grade of Concrete =M15
Grade of Steel =Fe415
Characteristic strength of concrete (f_{ck}) =15N/mm^2
Characteristic strength of steel, (f_y) =415N/mm^2

4.2. DESIGN CONSTANTS

The design constants for M15 concrete and Fe415 steel for a balanced section under as per IS 415-2000 of code are

Xu, max/d =0.48
Mu, lim/bd^2 =0.138fck = 2.07

4.3. Effective Depth of Slab

Assume overall depth of slab D = 120mm
Clear cover of slab d' = 20mm
Effective depth of slab d = 1000mm

4.4. Effective Span of Slab

As per IS 456-2000, effective span for framed structure will be the c/c distance between the supports.

Effective span in longer direction, I_y =3.90m
Effective span in shorter direction, I_x = 3.60m

4.4. Effective Span of Slab

Ratio of spans=longest span/shortest span
=3.90 / 3.60
=1.083 which is less than 2.

Since the aspect ratio is less than 2, the slab design will be two way slab.

Where L_y =3.90m
L_x =3.60m

4.5. Load on slab

Consideration the width of the slab =1m
Self weight of slab= volume x density of concrete
= area x 1 x 25
=1 x 0.12 x 1 x 25
= 3kn/m
Weight of the floor finishes = 0.5 x 1
= 0.5kn/m
Live load = 3 x 1
Self weight of partition wall = 1 x 1
Total Load = 7.5kn/m
Factored total load W = 11.25kn/m

4.6. Effective Depth

Calculation the effective depth of slab by equation, Mu=M_u, lim
Where Mu= factored or ultimate or design moment
= α_x Wl^2 x or α_y l^2x
Maximum bending moment = α_x Wl^2 x
α_x Wl^2 x =0.138$f_{ck}bd^2$
0.0428 x 11.25 x 3.60^2 =6.24 x 10^6
d= square root of (6240000/ 15 x 1000)
=54.9 < 100mm
Hence it is safe.
However provided effective depth is 100mm
Therefore overall depth of the slab (D) =120mm
Effective depth of slab (d) =100mm

4.7. Bending Moment and Area of Reinforcement for Short Span at Mid Span

Factored bending moment Mu $= \alpha_x Wl^2$ x
Positive moment at mid span $= 0.03215 \times 11.25 \times 3.60^2$
$= 4.687$ KN-m

$M_u = 0.87 f_y A_{st}(d-0.42X_{u,Max})$
$X_{u,Max} = 0.87 f_y A_{st}/0.36 f_{ck} b = 0.06686 A_{st}$
$M_u = 0.87 \times 415 \times A_{st} (100-0.42 \times 0.006686 A_{st})$
$4.687 \times 10^6 = 361.05 \times 100 A_{st}\ 10.138 A_{st}^2$
$A_{st} = 134.93$ mm^2
Assuming 8mm dia bars,
Spacing = (Ast of on bar/ total ast) x 1000
= ((π/4 x64)/ 134.96) x 1000
= 372.56mm.

Checking space

For min reinforcement consideration,
- 372.56mm
- 3d=3 x 100 = 300mm,
- 300mm

Therefore, provide 8mm diameter bars at 300 mm c/c spacing.

For short span at continuous edge

Factored bending moment M_u, $= \alpha_x Wl^2$ x
$= 0.0428 \times 11.25 \times 3.6^2$
$= 6.24$Kn-m
$M_{u,lim}/bd^2 = 2.07$
$M_{u,li} = 20.7 \times 10^6$N-mm
Since $M_{u,li} > M_{u,li,}$ the design is safe.
$M_u = 0.87 f_y A_{st}(d- 0.42 X_{u,Max})$
$X_{u,Max} = 0.87 f_y A_{st}/0.36 f_{ck} b = 0.06686 A_{st}$
$M_u = 0.87 \times 415 \times A_{st}(100- 0.42 \times 0.06686 A_{st})$
$= 6.24 \times 10^6 = 361.05 \times 100 A_{st} - 10.138 A_{st}$
$A_{st} = 182.145$mm^2
Assuming 8mm diameter bars,
Area of one bar = $(\pi/4 \times 8^2) = 50.24$mm^2
Spacing = (Ast of one bar / total Ast) x 1000
= (50.24/ 182.145) x 1000
= 275.96mm equal to 270mm

Check for Spacing

For min reinforcement consideration,
1. 270mm
2. 3d= 3 x 100= 300mm
3. 300mm

Therefore, provided 8mm diameter bars at 270mm c/c spacing.

For Long span at Mid Span

Positive moment factored bending moment $M_u = \alpha_x Wl^2$ x
$= 0.037 \times 11.25 \times 3.6^2$
$= 5.39$ kn-m
$(M_{u,lim}/bd^2) = 20.7 \times 10^6$N-mm
Actual bending moment < limiting bending moment
Hence it is safe.
$5.39 \times 10^6 = 361.05 A_{st} \times 100- 101.138 A_{st}^2$
$A_{st} = 156.25$ mm^2

Assuming 8mm dia bars,
Spacing = (Ast of one bar / total Ast) x 1000
= (50.24/ 156.25) x 1000
= 329.69mm equal to 300mm

Check for Spacing

For min reinforcement consideration,
1. 329.69mm
2. 3d= 3 x 100= 300mm
3. 300mm

Therefore, provided 8mm diameter bars at 300mm c/c spacing.

For long span at continuous edge

Factored bending moment, $M_u = \alpha_y Wl^2$ x
Negative moment at mid span $= 0.038 \times 11.25 \times 3.6^2$
$= 4.082$ Kn-m
$Mu,lim / bd^2 = 2.07$
Actual bending moment < limited bending moment
Hence it is safe.
$4.082 \times 10^6 x= 361.05 A_{st} \times 100 - 10.138 A_{st}^2$
$A_{st} = 116.89$mm^2
Assuming 8mm dia bars,
Area of on bar = ((π/4 x 64) mm^2 = 50.24mm^2
Spacing = (Ast of one bar / total Ast) x 1000
= (50.24 / 116.89) x 1000
= 429.69mm equal to 300mm

Check for Spacing

For min reinforcement consideration,
1. 429.96mm
2. 3d= 3 x 100= 300mm
3. 300mm

Therefore, provided 8mm diameter bars at 300mm c/c spacing.

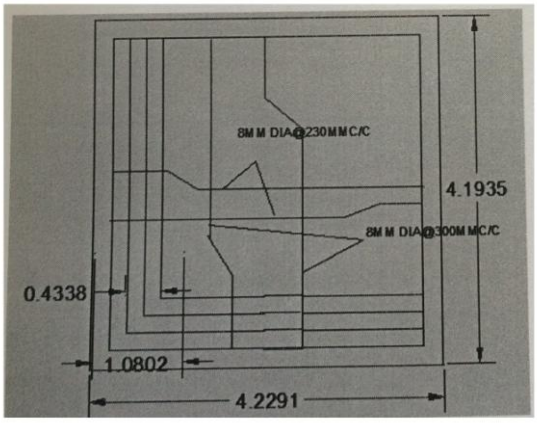

Fig: 2 Kitchen Room Two Way Slab

In the same way Hall, children bed room and other rooms can be designed.

4. Plan Drawings

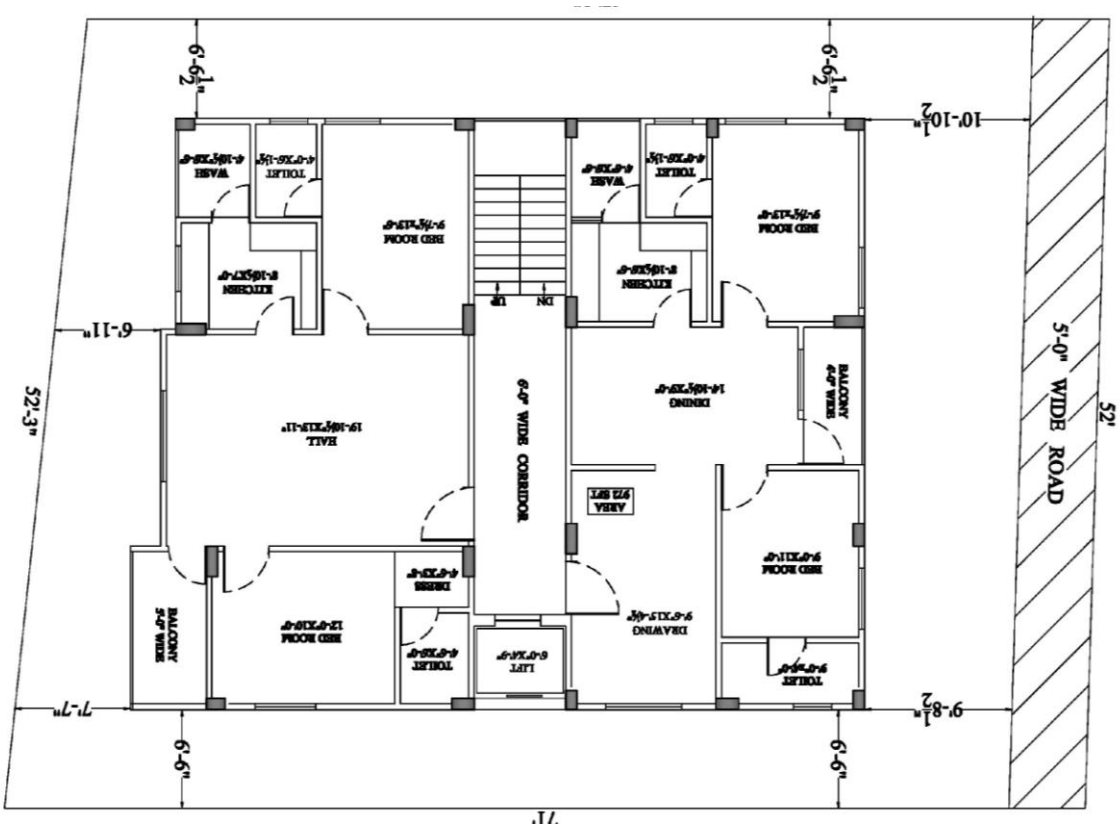

Fig: 3 Design of Two Way Slab

CONCLUSION

1. The bed room and kitchen slab design concludes that the rod 8mm bars at particular c/c spacing can take proper load for long time.
2. The design for rest of the house will be provided with all the proper steel bars c/c for taking proper load. The design of residential building with 2bhk to blocks helps us to find the load by using one way slab design.
3. The one way design helps the design easy to construction the load of the building.

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BIOGRAPHIES

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