Design Objectives

Safe workable economical design

Select structural di

Satisfy serviceability requirements

Detailing reinforcement

Building structural systems

Frame system

Frame system with shear walls

Reinforced concrete Load bearing walls

Masonry load bearing walls

Precast concrete system

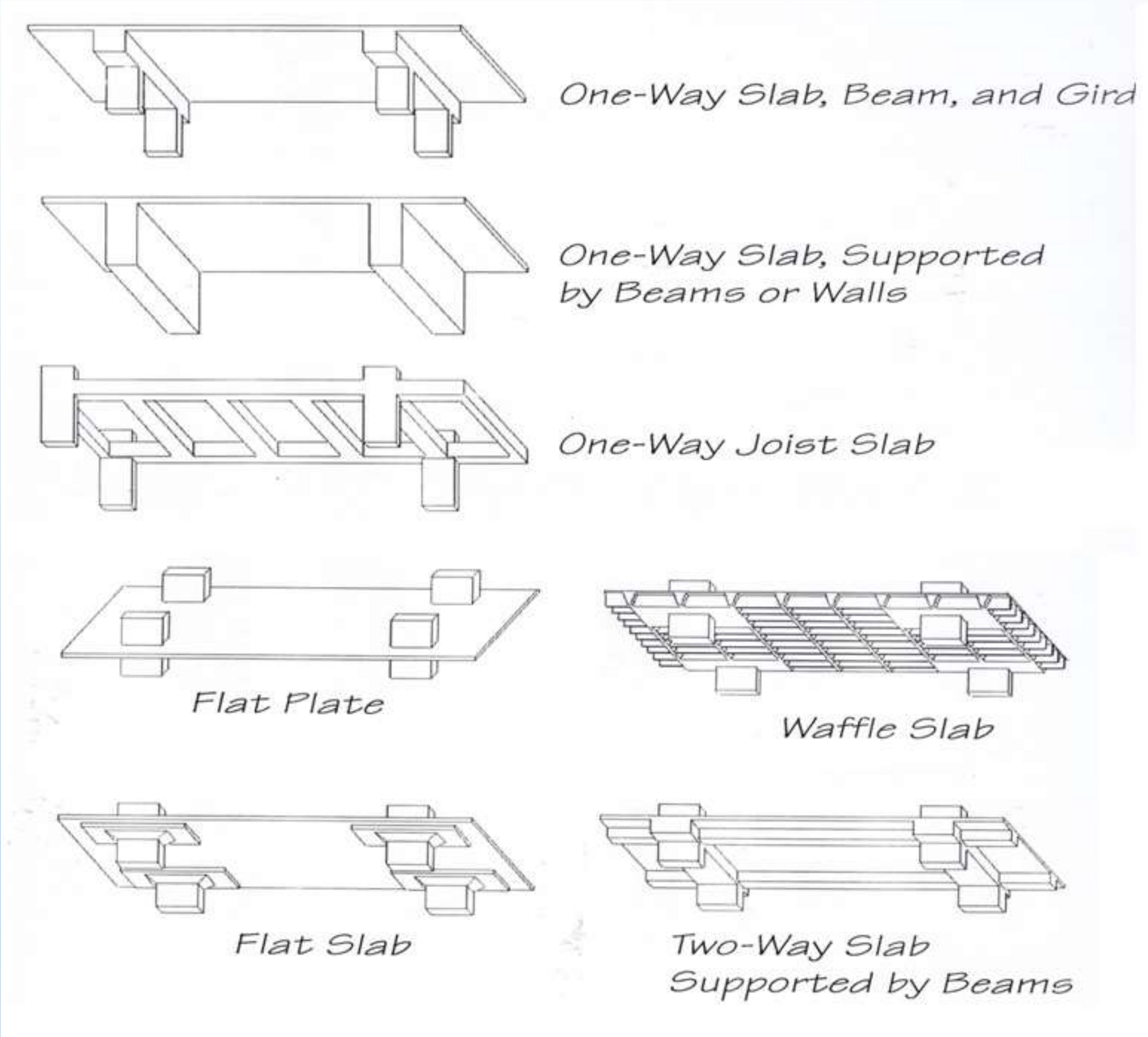
Floor systems

Beams-slab system [one way –two way]
Ribbed (waffle slab)
Flat plate
Flat slab with drop panels with or without capitals

Basic design relationship:

Reduction factor x Material capacity >
Load factor x actual loads

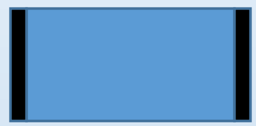
Reduction factors < 1 applied to M, V, etc
Load factors > 1 applied to live, dead, wind, EQ, etc


One-Way Slab, Beam, and Gird
One-Way Slab, Supported by Beams or Walls
One-Way Joist Slab
Flat Plate
Waffle Slab
Flat Slab
Two-Way Slab Supported by Beams

One way Slab

a. If the long span > 2 x short span OR

b. Supported only in one direction



Take a strip from the slab one meter width ….

Find the loads on one m^2 and find moments from

ACI coefficients if the following criteria's are satisfied:

1.There are two or more spans.

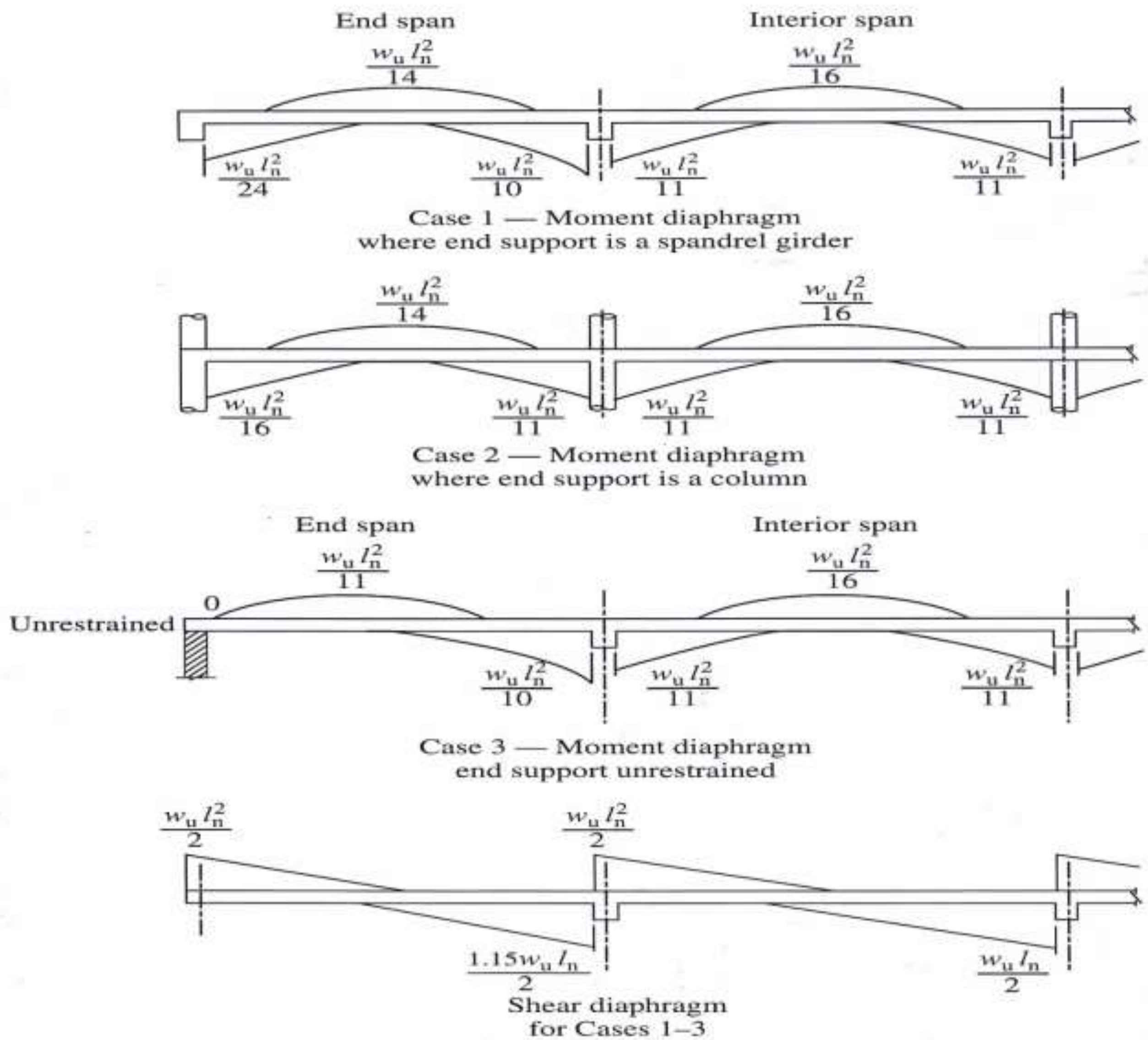
2.Different in span length not more than 20%

3.Loads are uniformly distributed.

4.Live load < 3 times dead load.

5.Memebrs are prismatic.

For –ve moment L is average of two adjacent clear spans.

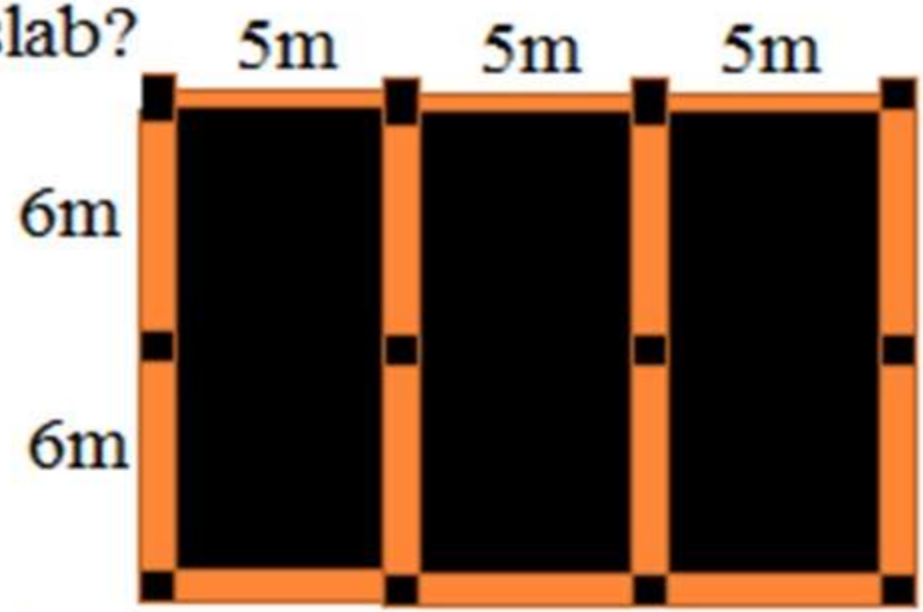


Approximate moment and shear of continuous beams or one-way slabs (ACI 8.3.3).

EXAMPLE

If the slab shown is reinforced with 12mm @ 40 cm c/c at bottom straight and 12mm @40 cm c/c at bottom bent up check the design of the slab?

thickness = 20 cm



beam width = 40 cm

Soln:

min t = L/24 for end span

min t = (5000-400)/24 =

= 192 mm < 200 ok

from ACI coeff: max -ve M at 1st support = $wl^2/10$

find the load w from the drawings and for what purpose the building is constructed, Live load from tables...

TABLE A–14 Minimum Thicknesses of Non-Prestressed Beams or One-Way Slabs Unless Deflections Are Computed

		Minimum Thickness, h				
Exposure	Member	Simply Supported	One End Continuous	Both Ends Continuous	Cantilever	Source
Not supporting or attached to partitions or other construction likely to be damaged by large deflections	Solid one-way slabs	$\ell/20$	$\ell/24$	$\ell/28$	$\ell/10$	ACI Table 9.5(a)
	Beams or ribbed one-way slabs	$\ell/16$	$\ell/18.5$	$\ell/21$	$\ell/8$	
Supporting or attached to partitions or other construction likely to be damaged by large deflections	All members: $\omega \leq 0.12$[a] and $\frac{\text{sustained load}}{\text{total load}} < 0.5$	$\ell/10$	$\ell/13$	$\ell/16$	$\ell/4$	
	All members: $\frac{\text{sustained load}}{\text{total load}} > 0.5$	$\ell/6$	$\ell/8$	$\ell/10$	$\ell/3$	

[a] $\omega = \rho f_y / f'_c$

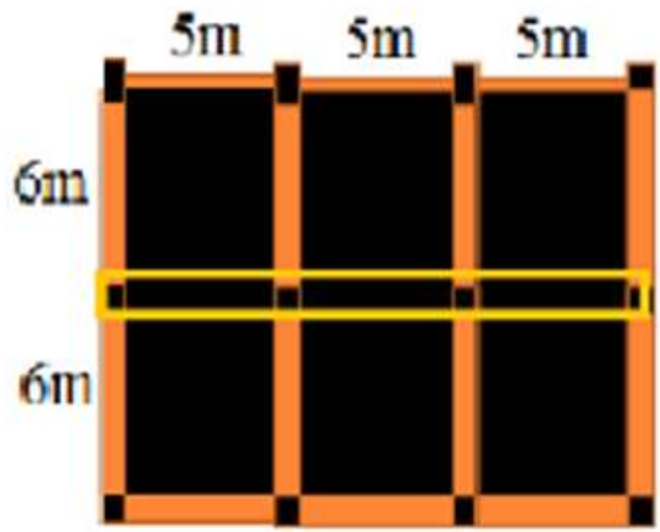
steel area provided = 12 @ 40 cm both sides so = 12@20cm

you have 5 bars /m = 5x113= 565 mm^2 /m ...design ok

Example : Two way slab

Take the interior slab 5 x 6 m slab thickness,as before = 20 cm

Therefore loading as before .
Approximate depth =
perimeter/180



beam width = 40 cm

h = 2 (5+6) /180 =0.13 m
we have 20 cm = 0.2 m ...ok

find moment coefficent from tables, for slab with three edges contineous , one edge dsicontoneous.
short span/long span = 4.6/5.6 = 0.82

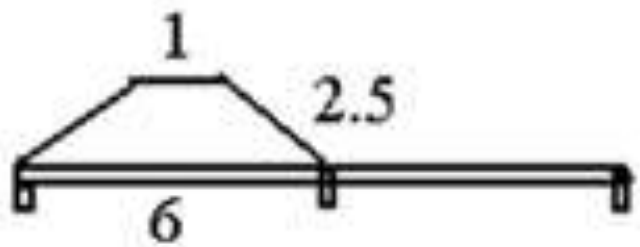
max coeff is for (-ve at top) at contineous edges = 0.055

TABLE 4.7 Elastic Moment Coefficients for Two-Way Slabs

Moments	Short span: Span ratio, short/long 1.0	0.9	0.8	0.7	0.6	0.5 and less	Long span, all span ratios
Case 1—Interior panels							
Negative moment at:							
Continuous edge	0.033	0.040	0.048	0.055	0.063	0.083	0.033
Discontinuous edge	—	—	—	—	—	—	—
Positive moment at midspan	0.025	0.030	0.036	0.041	0.047	0.062	0.025
Case 2—One edge discontinuous							
Negative moment at:							
Continuous edge	0.041	0.048	0.055	0.062	0.069	0.085	0.041
Discontinuous edge	0.021	0.024	0.027	0.031	0.035	0.042	0.021
Positive moment at midspan	0.031	0.036	0.041	0.047	0.052	0.064	0.031
Case 3—Two edges discontinuous							
Negative moment at:							
Continuous edge	0.049	0.057	0.064	0.071	0.078	0.090	0.049
Discontinuous edge	0.025	0.028	0.032	0.036	0.039	0.045	0.025
Positive moment at midspan:	0.037	0.043	0.048	0.054	0.059	0.068	0.037
Case 4—Three edges discontinuous							
Negative moment at:							
Continuous edge	0.058	0.066	0.074	0.082	0.090	0.098	0.058
Discontinuous edge	0.029	0.033	0.037	0.041	0.045	0.049	0.029
Positive moment at midspan:	0.044	0.050	0.056	0.062	0.068	0.074	0.044
Case 5—Four edges discontinuous							
Negative moment at:							
Continuous edge	—	—	—	—	—	—	—
Discontinuous edge	0.033	0.038	0.043	0.047	0.053	0.055	0.033
Positive moment at midspan	0.050	0.057	0.064	0.072	0.080	0.083	0.050

weight of wall per meter of beam =

(3.5 - 0.5) 5.2 = 15.6 kN/m length..



weight of beam = 0.4x0.5x25=5 kN/ m

$$\text{wt from slab on beam} = w\left[\frac{(1+6)}{2} \times 2.5\right]\frac{2}{6} \times 1.25 = 3.65w$$

dead load from slab = 3.65 x 6.35 = 23.2 kN/m.L

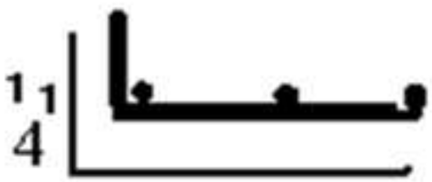
Total dead load = 15.6 + 5 + 23.2 = 43.8 kN/m

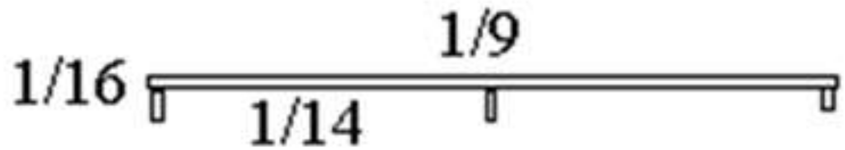
total live load on beam = 3.65 x 4 = 14.6 kN/m

factored load = 43.8 x 1.4 + 14.6 x 1.7 = 86.1 kN/m max -ve moment = $wL^2 / 9 = 86.1 (5.6)^2 / 9 = 300$ kN.m

$A_s = 300 \times 10^6 / (0.9 \times 420 \times 0.9 \times 440) = 2004$ mm^2

= 4 bars 25 mm....check with the bars provided...





beam min depth = h = L/18.5 = 5.6/18.5 = 0.3 m < 50 cm ok

beam min A_s = 0.0033 bd = 0.0033x400x500= 660 mm^2 < 2000ok

Columns

Approximate load calculation based on area supported from this approximate equation:

$P_u = 0.4\, f_c'\, A_c + 0.5\, f_y\, A_s$ where :

P_u : max load on col.

f_c' : concrete cylinder compressive strength $= f_{cube} / 1.25$

f_y : steel yield strength

A_s : total steel area in col. $0.01\, A_c < A_s < 0.04\, A_c$

Design load on col. = K x load based on static calculation of reaction (based on area supported)

K factor

column location	top storys	next to top	lower storys
internal	1	1	1
external	4.5	2	1.4
corner	6	2.3	1.8

These factors to be used for checking if no moment is considered

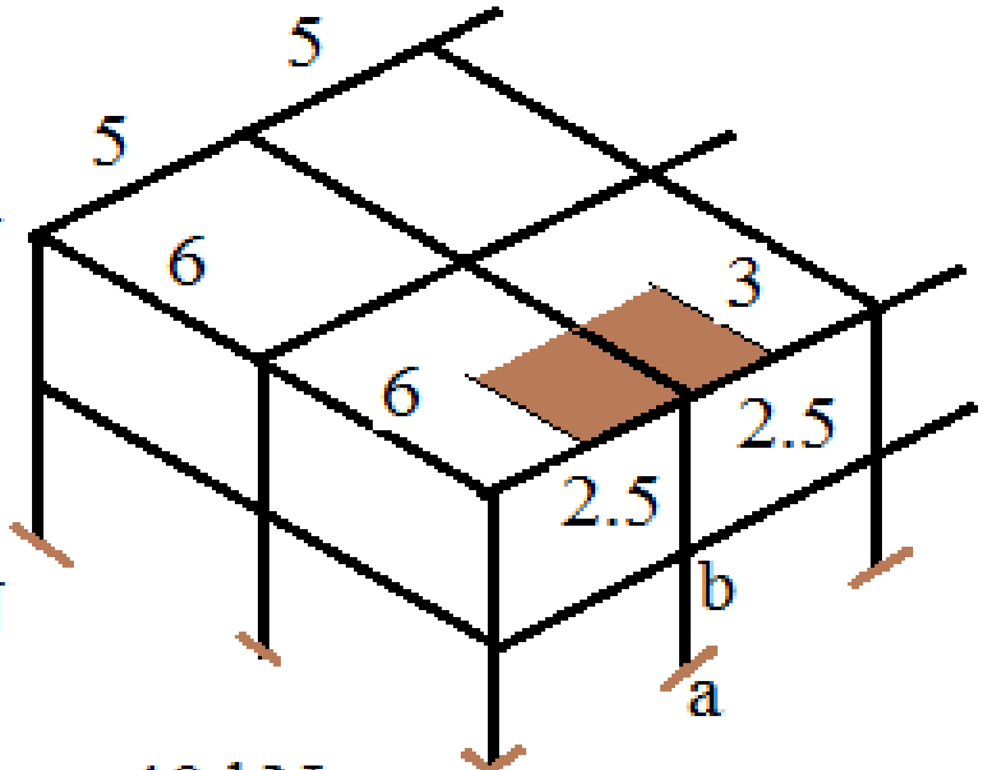
EXAMPLE

our frame example suppose it is two storied building

col to be checked is (ab) at ground floor

area supported =(2.5+2.5)(6/2)=15 m^2

load on column :



from roof :live load
15x 2 (assumed)=
30 kN
dead load :
slab + tile + ceiling
= 6.35 x 15 = 95kN
from beams =
(2.5+2.5+3)x 5 kN/m = 40 kN

total dead load from roof = 135 kN

From first floor : live load =15x4=60kN

dead load : slab + tile + ceiling = 6.35 x 15 = 95kN

from beams = (2.5+2.5+3)x 5 kN/m = 40 kN

from walls=(5+3)x15.6 =125 kN

column wt say =0.3x0.3x3.5x25= 7.875=8 kN

total dead load from 1st floor = 95+40+125+8=268kN

col wt of ground floor = 0.3x0.3x5x25=11.25=12kN

note :if you have tie beam add wt of tie beam and wall on it

total live load on col(ab)=30+60=90kN

total dead load on col(ab)=135+268+12= 415 kN

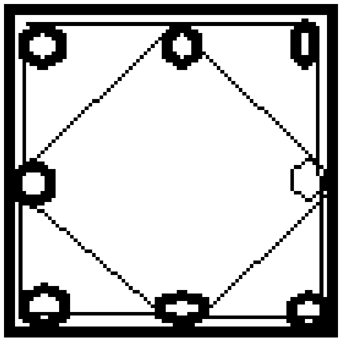
factored load= 1.4x415+1.7x90=734kN

since this is an external column and next to the top story then K factor is 2 , and P u = 2 x 734 = 1468 kN

Now check your column : suppose your col is 30x30 cm with 8 bars of 16 mm...and concrete f c' = 25 Mpa

Then: P_u =0.4x25x300x300+0.5x420x8x200=1236000N
= 1236kN < 1468kN ..not good

if the steel was 8 / 20 mm , then P_u = 1428 kN app 1468 ok



Footing

check the single footing for col (ab) of last example:
suppose your soil allowable bearing capacity =14T/m2
and the footing dimension is 2x2x0.4m at depth of 1.5 m
from ground level.

Ultimate load from the col = 734 kN and the service loads (unfactored) = 415 + 90= 505kN see col.loads

weight of footing=2x2x0.4x25= 40kN

weight of soil above footing = (1.5-0.4)x2x2x19=84 kN
total wt on the footing base=505+40+84=629kN
required area of footing = 629/140=4.5 m^2=2.12x2.12
> 2x2 not ok very close lets say ok

Check the steel provided..suppose it is 16mm@15cm check depth for punching shear,

ultimate bearing pressure= 734/ (2x2) =183.5 kN/m^2

punching perimeter=0.65x4=2.6m=2600mm b_o

punching area=0.65x0.65=0.4225m^2

punching load=734 - 183.5x0.4225=656.5kN

concrete punching shear capacity $V_c=0.33\sqrt{f_c'}\ x\ b_o x d$

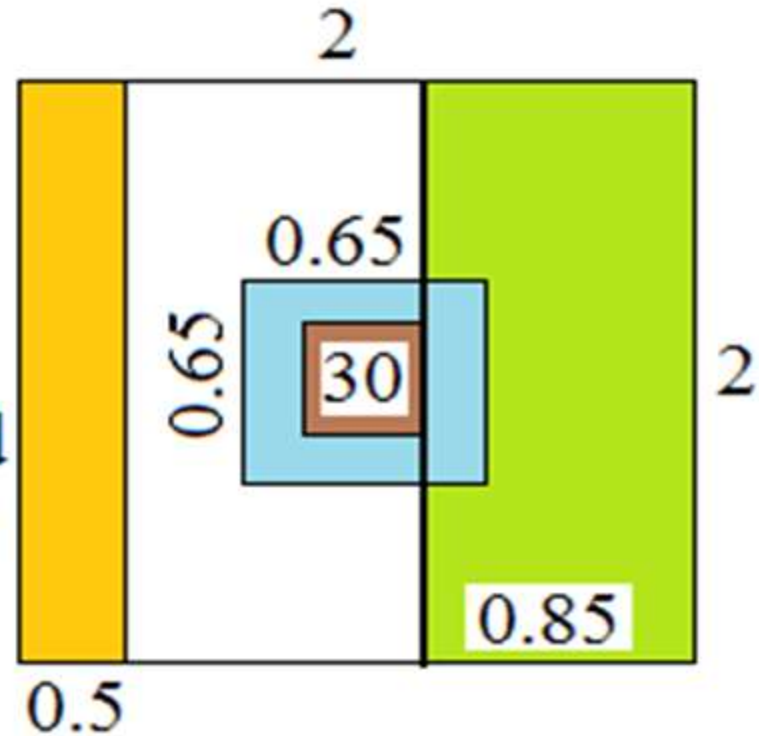
=o.33x5x2600x350=1502kN

> 734kN ok

check beam shear: $V_c=0.17\sqrt{f_c'}bd$

V_c=0.17 x5x2000x350=595 kN

Vu=0.5x2x183.5=183.5kN ok



moment at face of column= w L^2 /2

= (183.5x2) $(0.85)^2$ /2 =132.6 kN/2m

A s = 132.6x10^6 / (0.9x420x0.9x350) = 1112 mm^2/2m

provided 16mm @ 20cm c/c = 5 bars / m = 5x200=

1000 mm^2 /m = 2000 mm^2 / 2m > 1112 ok

Thank YOU