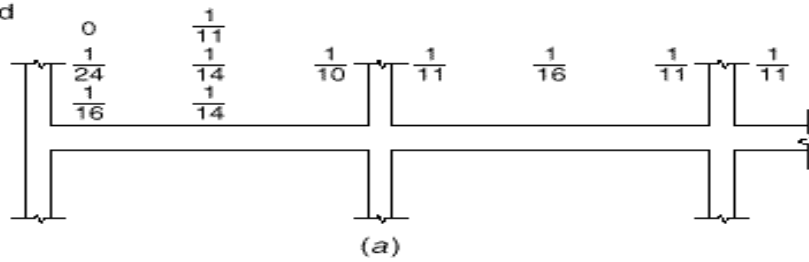
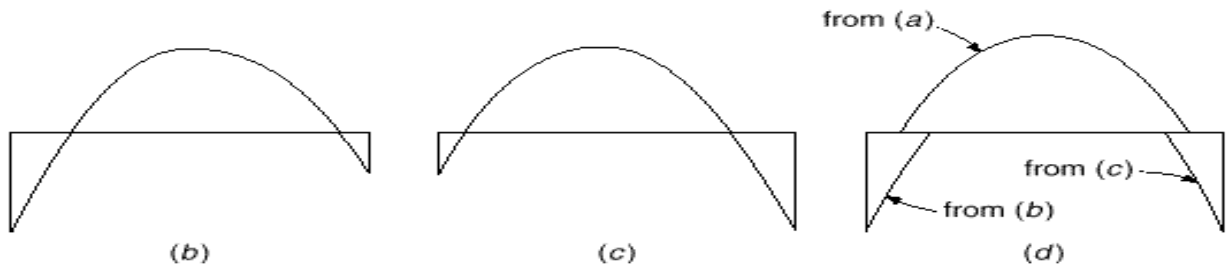
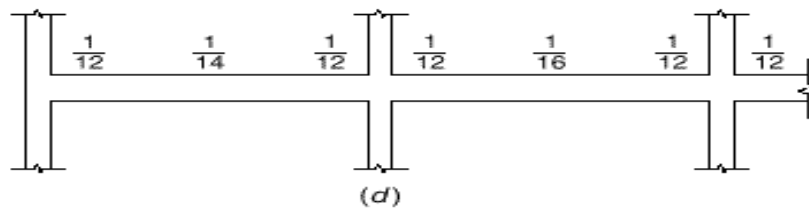
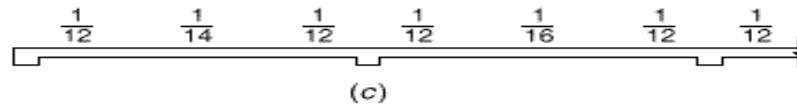
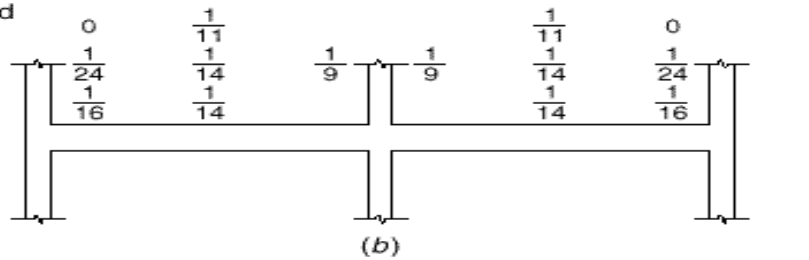


Discontinuous end
unrestrained:
Spandrel:
Column:

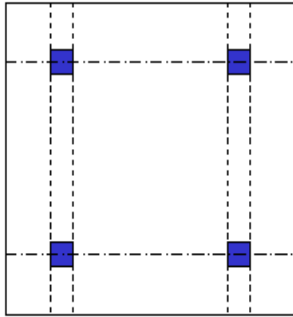


Discontinuous end
unrestrained:
Spandrel:
Column:

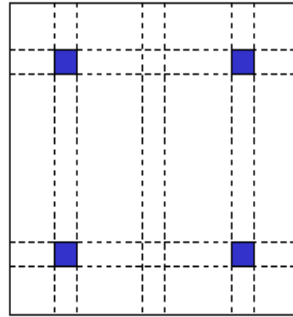


and moment envelope for a continuous beam: (a) maximum positive moment; (b) maximum negative moment at right end; (d) composite moment envelope.

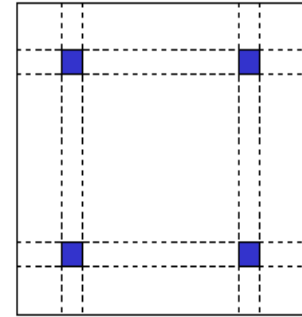
Types of Slab



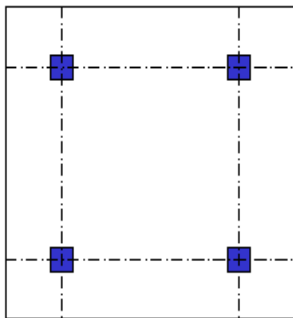
One-way slab



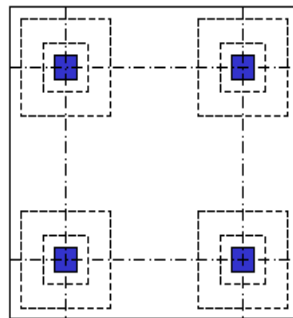
One-way slab



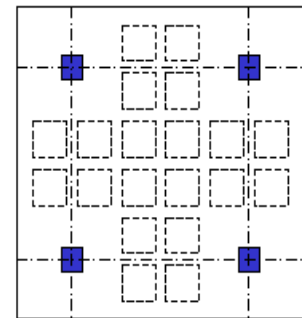
Two-way slab



Flat plate slab

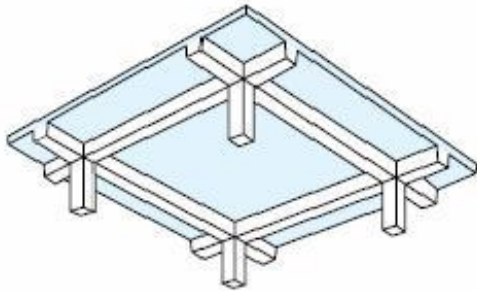


Flat slab

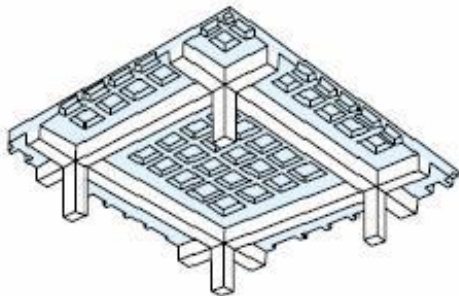


Grid slab

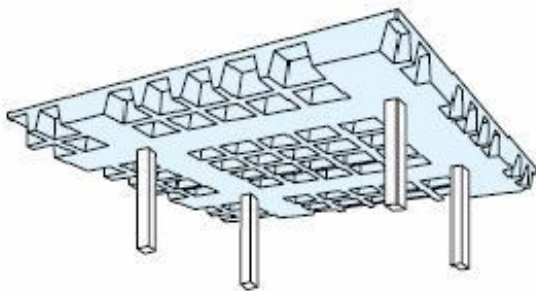
TWO-WAY SLABS



Solid (with beams) p 26

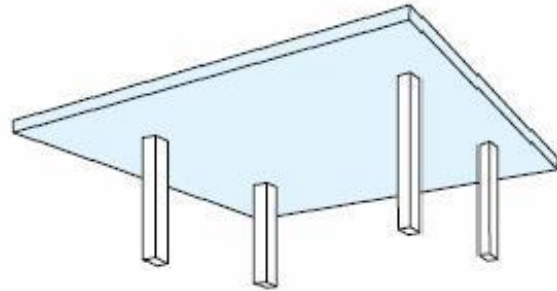


Waffle (with beams) pp 28, 30

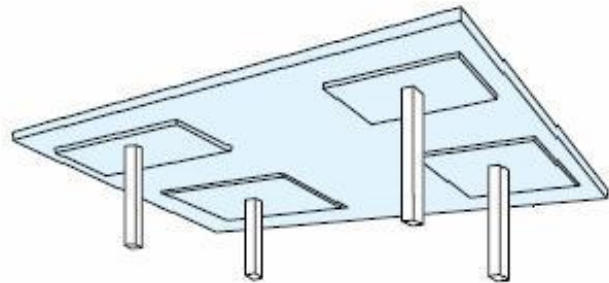


Waffle with integral beams pp 32, 34

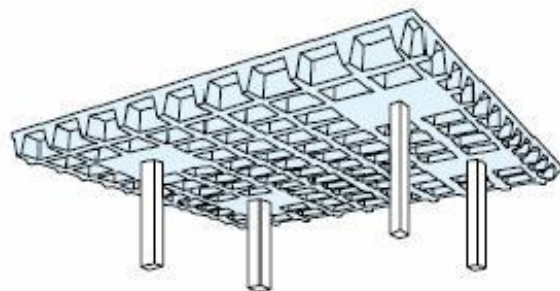
FLAT SLABS



**Solid p 36
(post-tensioned p 106)**



**Solid with drops p 38
Solid with column heads p 40
Solid with edge beams p 42**



Waffle p 44

One way Solid Slab formula:

$$R_n = \frac{M_u/0.9}{1000 * d^2} * 10^6 = _Mpa, \quad d = h - 20 - \frac{d_b}{2} = _mm$$

$$m = \frac{f_y}{0.85 * f_c} = _, \quad \rho = \frac{1}{m} \left(1 - \sqrt{1 - \frac{2 * R_n * m}{f_y}} \right) = _$$

$$A_s = \rho * 1000 * d = _mm^2, \quad A_{s \min} = 0.0018 * 1000 * h = _mm^2$$

$$S_{max} = \min \left(\frac{A_b}{A_s} * 1000, 300mm, 2 * h \right) = _mm$$

for flexural → use $\phi d_b @ S_{max}$

$$A_{s \min} = 0.0018 * 1000 * h = _mm^2$$

$$S_{max} = \min \left(\frac{A_b}{A_s} * 1000, 300mm, 4 * h \right) = _mm$$

for shrinkage → use $\phi d_b @ S_{max}$

Beam formula:-

$$R_n = \frac{M_u/0.9}{1000 * d^2} * 10^6 = _Mpa$$

$$d = 600 - 40 - d_s - \frac{d_b}{2} = _mm \text{ (one layer)}$$

$$d = 600 - 40 - d_s - 25 - \frac{S}{2} = _mm \text{ (two layer)}$$

$$m = \frac{f_y}{0.85 * f_c} = _, \quad \rho = \frac{1}{m} \left(1 - \sqrt{1 - \frac{2 * R_n * m}{f_y}} \right) = _$$

$$A_s = \rho * b * d = _mm^2,$$

$$A_{s \min} (1) = \frac{1.4}{420} * b_w * d = _mm^2$$

$$A_{s \min} (2) = \frac{\sqrt{f_c}}{4 * 420} * b_w * d = _mm^2$$

$$A_{s \min} = \max(A_{s \min} (1), A_{s \min} (2)) = _mm^2$$

check $A_s > A_{s \min}$ ok

$$n = \frac{A_s}{A_b} = \text{real number}$$

check $b_{min} = 80 + 60 + (n - 1)(d_b + 25) > b$ ok

$$\text{if } \frac{a_b}{d} = \beta_1 \left(\frac{600}{600 + f_y} \right) > \frac{a}{d} \quad \therefore f_s = f_y$$

$$\text{if } \frac{a_{TCL}}{d_t} = 0.375 \beta_1 > \frac{a}{d_t} \quad \therefore \text{Tension - controlled section}$$

$$\phi V_c = 0.75 * \frac{\sqrt{f_c}}{6} * b_w * d * 10^{-3} = _kn$$

$$V_s = \frac{V_u - \phi V_c}{0.75} = _kn$$

$$A_v = 2 * \pi \frac{d_s^2}{4} = _mm^2 \text{ (two leg)}$$

$$S = \frac{A_v * f_y * d}{V_s} * 10^{-3} _mm$$

$$\text{if } V_s \leq 2V_c$$

$$S_{max} = \min(600, \frac{d}{2})$$

$$\text{if } 2V_c < V_s \leq 4V_c$$

$$S_{max} = \min(300, \frac{d}{4})$$

$$\text{if } V_s > 4V_c$$

need to increase the section

$$\text{if } V_u < \frac{1}{2} \phi V_c$$

no need for shear reinforcement

$$\text{if } \phi V_c > V_u > \frac{1}{2} \phi V_c$$

need to provide minmume

$$a_v \text{ min} = \max\left\{ \left(\frac{1}{16} \sqrt{f_c} * b_w * \frac{s}{f_y} \right), \left(\frac{b_w * s}{3f_y} \right) \right\}$$

Example 1:

The figure shown below shows the architectural plan for 3-story building. The slab will be designed to carry super imposed dead load (2.5KN/m^2) and Live load (3KN/m^2) by compressive strength 25 Mpa and steel yield strength 420 Mpa.

Given data:

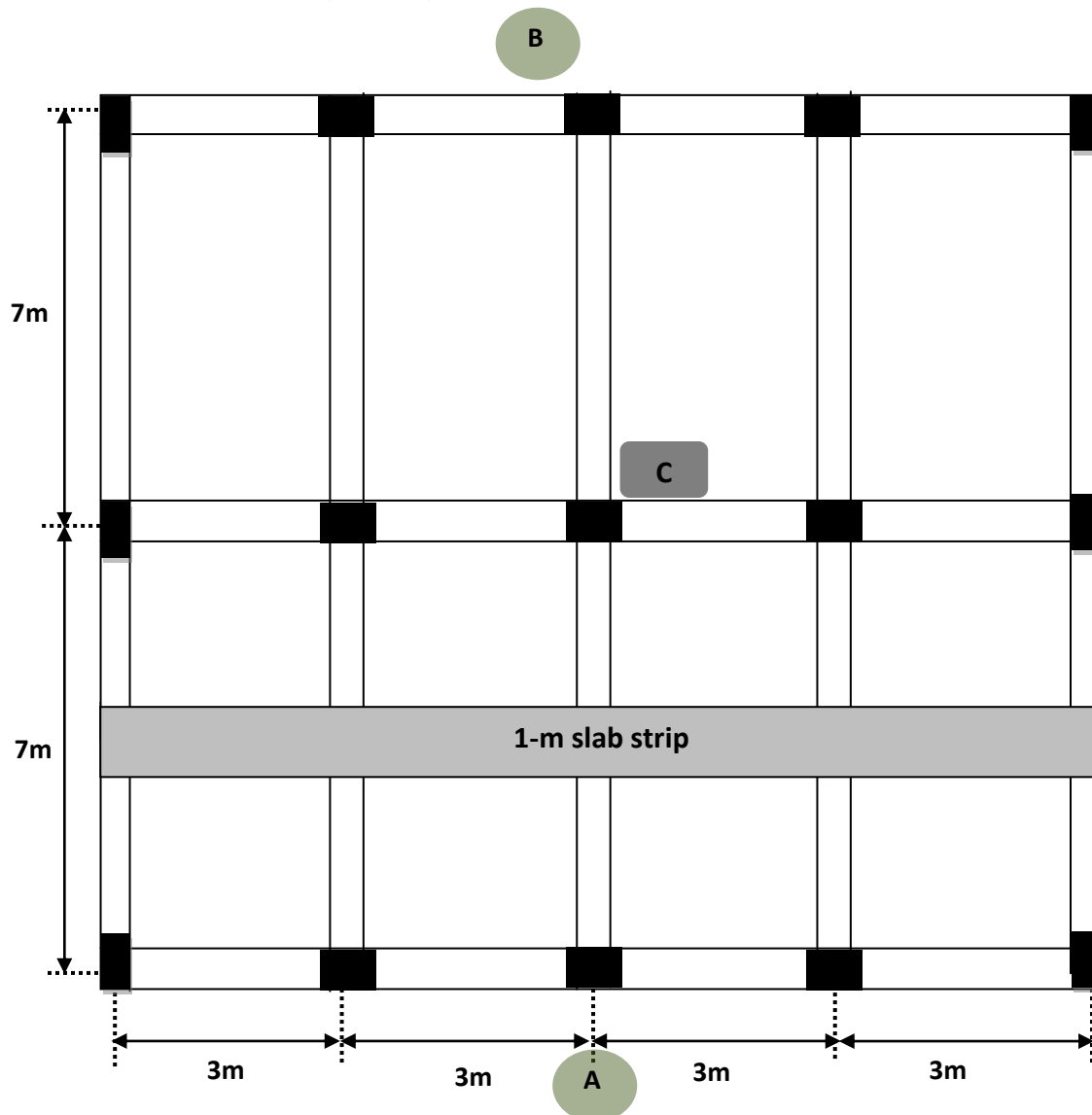
The one way solid slab is used.

Weight of Wall = 15Kn/m

The slab thickness = 130mm

The beams dimensions = (300,600) mm

The columns dimensions = (300,500) mm



Determine the following:

- 1- Check if Slab thickness meets SBC304.
- 2- Design the slab for Max +Ve moment.
- 3- Design the slab for Max -Ve moment.
- 4- Check the slab for Shear reinforcement.
- 5- Draw the details and show all value.
- 6- Design the beam (A-B) for flexure and shear.
- 7- Calculate the axial load acting on column C.

Solution:

$$h_{min} = \frac{l}{28} = \frac{3000}{28} = 107.14 \text{ mm}$$

$$h_{min} = \frac{l}{24} = \frac{3000}{24} = 125 \text{ mm}$$

$$h_{min} = \max(107.14, 125) = 125 \text{ mm}$$

$$h > h_{min} \rightarrow ok$$

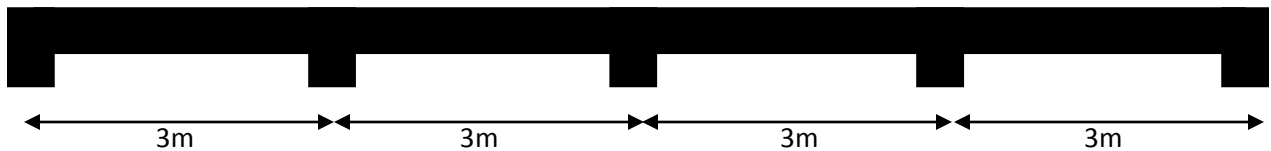
DL = own weight + superimposed

$$DL = (0.13 * 25) + 2.5 = 5.75 \text{ kn/m}^2$$

$$LL = 3 \text{ kn/m}^2$$

$$Wu = 1.4DL + 1.7LL$$

$$Wu = 1.4(5.75) + 1.7(3) = 13.15 \text{ kn/m}^2$$



Lu (m)	3m			3m			3m			3m		
Ln (m)	2.7m			2.7m			2.7m			2.7m		
Cm	1/12	1/14	1/12	1/12	1/16	1/12	1/12	1/16	1/12	1/12	1/14	1/12
Wu(kn/m ²)	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15	13.15
Mu(kn.m)	7.99	6.85	7.99	7.99	5.99	7.99	7.99	5.99	7.99	7.99	6.85	7.99
D (mm)	104	104	104	104	104	104	104	104	104	104	104	104
Rn (Mpa)	0.821	0.704	0.821	0.821	0.615	0.821	0.821	0.615	0.821	0.821	0.704	0.821
P	0.002	0.0017	0.002	0.002	0.0015	0.002	0.002	0.0015	0.002	0.002	0.0017	0.002
As (mm ²)	208	176.8	208	208	156	208	208	156	208	208	176.8	208

$A_{s\ min}(\text{mm}^2)$	234	234	234	234	234	234	234	234	234	234	234	234
$A_s(\text{mm}^2)$	234	234	234	234	234	234	234	234	234	234	234	234
$S_{\max}(\text{mm})$	260	260	260	260	260	260	260	260	260	260	260	260
$A_{s\ \text{rinkashge}}(\text{mm}^2)$	234	234	234	234	234	234	234	234	234	234	234	234
$S_{\max}(\text{mm})$	300	300	300	300	300	300	300	300	300	300	300	300
C_v	1		1.15	1		1	1		1	1		1
$V_u(\text{kn})$	17.75		20.42	17.75		17.75	17.75		17.75	20.42		17.75
$\phi V_c(\text{kn})$	65		65	65		65	65		65	65		65

sample of cacluations

$$L_u = 3m, \quad L_n = 3 - 0.15 - 0.15 = 2.7m$$

$$C_m = \frac{1}{12}, \quad M_u = \frac{1}{12} * 13.15 * 2.7^2 = 7.99 \text{ kn.m}$$

$$d = 130 - 20 - \frac{12}{2} = 104\text{mm}, \quad R_n = \frac{7.99/0.9}{1000 * 104^2} * 10^6 = 0.821 \text{ Mpa}$$

$$m = \frac{420}{0.85 * 25} = 19.765, \quad \rho = \frac{1}{19.765} \left(1 - \sqrt{1 - \frac{2 * 0.985 * 19.765}{420}} \right) = 0.002$$

$$A_s = 0.002 * 1000 * 104 = 208 \text{ mm}^2, \quad A_{s\ min} = 0.0018 * 1000 * 130 = 234 \text{ mm}^2$$

$$S_{\max} = \min \left(\frac{113.04}{234} * 1000 = 483.1 \text{ mm}, 300\text{mm}, 2 * 130 = 260 \right) = 260\text{mm}$$

for flexural → use $\phi 12@260 \text{ mm}$

$$A_{s\ shrinkage} = 0.0018 * 1000 * 130 = 234 \text{ mm}^2$$

$$S_{\max} = \min \left(\frac{113.04}{234} * 1000 = 483.1\text{mm}, 300\text{mm}, 4 * 130 = 520 \right) = 300\text{mm}$$

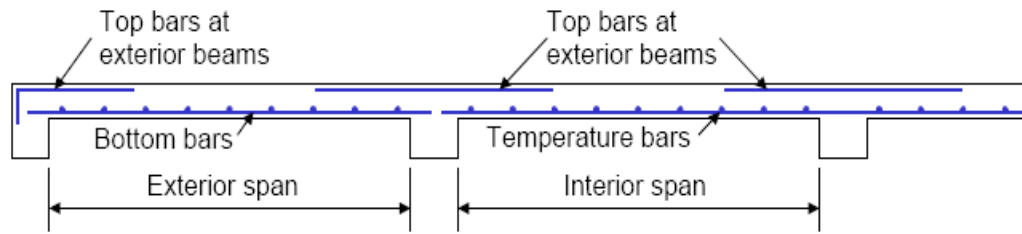
for shrinkage → use $\phi 12@300 \text{ mm}$

$$C_v = 1.15, \quad V_u = \frac{1.15 * 13.15 * 2.7}{2} = 20.42 \text{ kn}$$

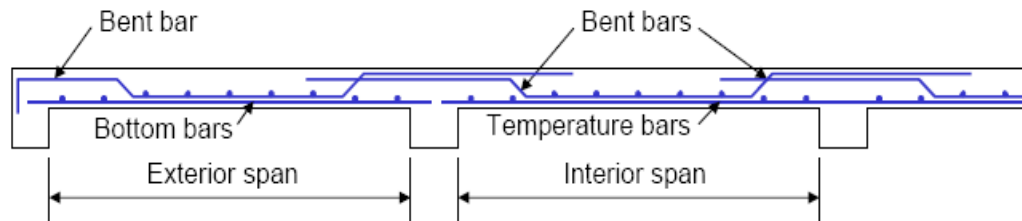
$$\phi V_c = 0.75 * \frac{\sqrt{25}}{6} * 1000 * 104 * 10^{-3} = 65 \text{ kn}$$

$\phi V_c > V_u \rightarrow$ *shear reinforcment is not needed*

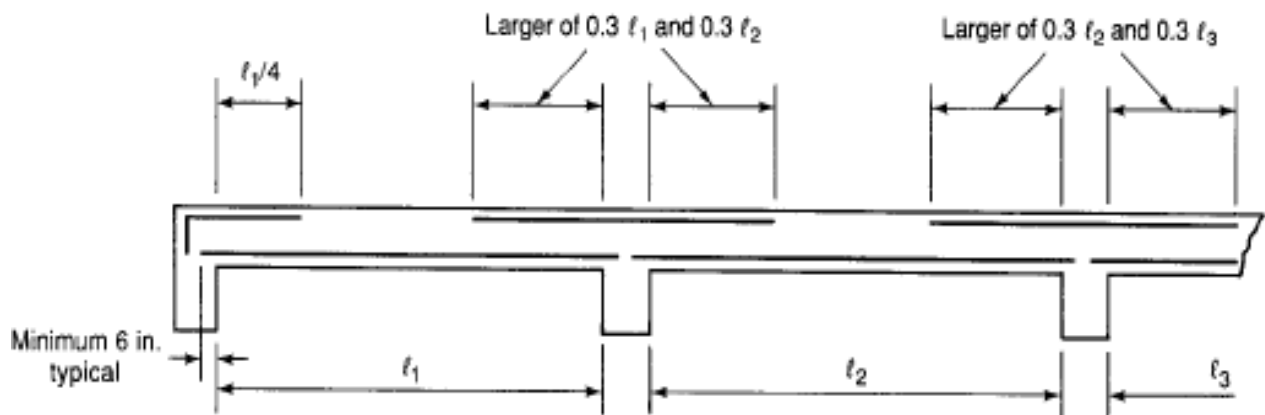
Typical reinforcement in a one-way slab



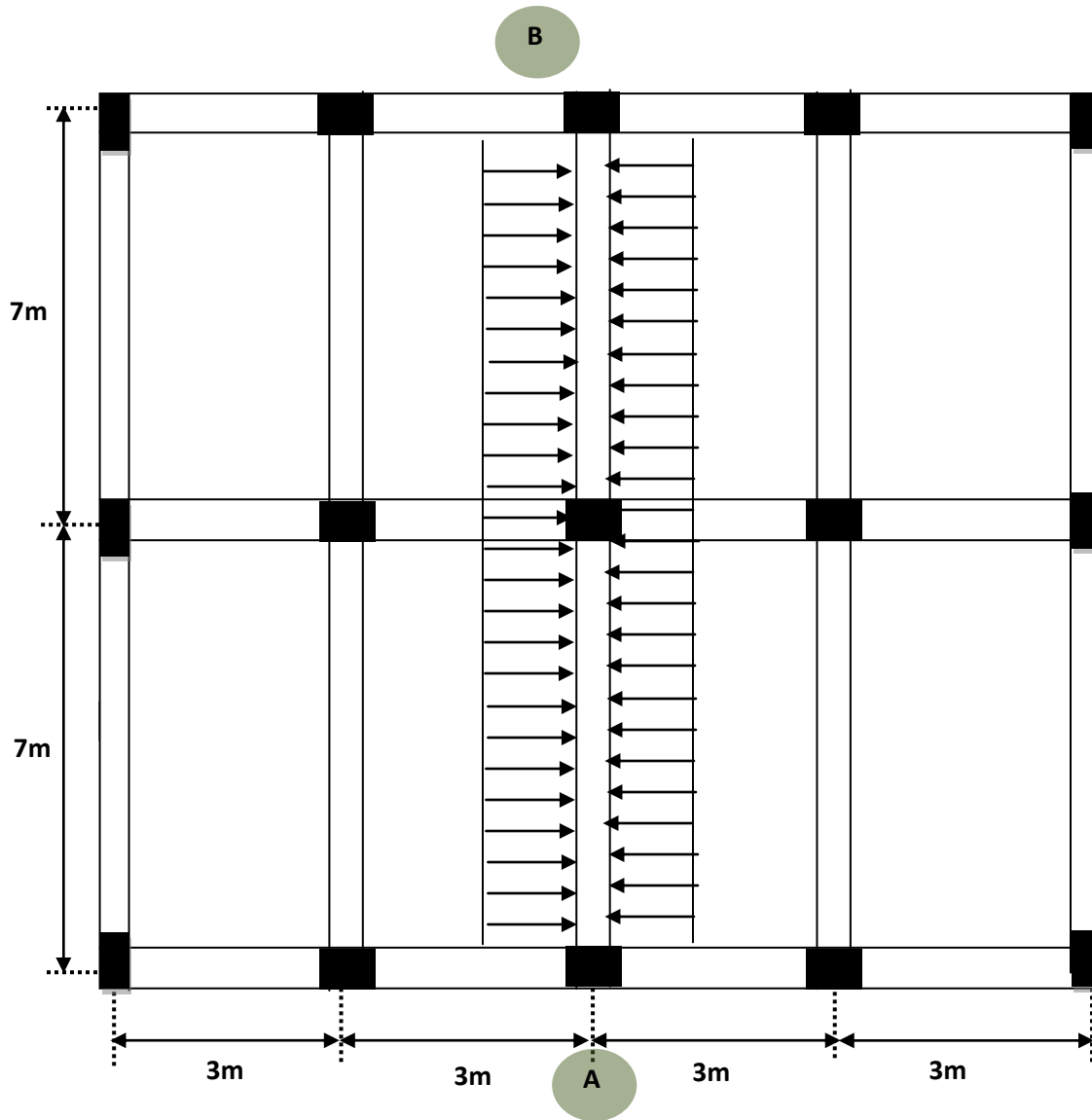
(a) Straight top and bottom bars



(b) Alternate straight and bent bars



(c) One-way slab

Design of beam (A-B) :-**Load acting on the beam (A-B)**

1- Dead load:

$$DL = 5.75 * (1.5 + 1.5) + 15 + (0.47 * 0.3 * 25) = 35.775 \text{ kn/m}$$

2- Live load

$$LL = 3 * (1.5 + 1.5) = 9 \text{ kn/m}$$

$$W_u = 1.4(35.775) + 1.7(9) = 65.385 \text{ kn/m}$$



Lu (m)	7m			7m		
Ln(m)	6.7m			6.7m		
Wu(kn/m)	65.385					
Cm	1/16	1/14	1/9	1/9	1/14	1/16
Mu (kn.m)		210	326.13	326.13	210	
d(mm)		540 (one layer)	517.5(two layer)	517.5(two layer)	540 (one layer)	
Rn(Mpa)		2.667	4.51	4.51	2.667	
P		0.00681	0.01221	0.01221	0.00681	
As(mm²)		1103.2	1896	1896	1103.2	
As_{min}(mm²)		540	517.5	517.5	540	
n		3.51≈4	6.03≈7	6.03≈7	3.51≈4	
Fs=Fy		Ok	Ok	Ok	Ok	
TCL		Ok	Ok	Ok	Ok	
b_{min}(mm)		275	275	275	275	
Use		4Ø20	7Ø20	7Ø20	4Ø20	
Cv	1		1.15	1.15		1
Vu (kn)	219.04		252	252		219.04
φVc (kn)	101.25		97.03	97.03		101.25
Vs (kn)	157.05		206.67	206.67		157.05
Av (mm²)	157		157	157		157
S (mm)	226.72		165.1	165.1		226.72
S_{max} (mm)	270		258.75	258.75		270
Use	Ø10@270		Ø10@160	Ø10@160		Ø10@270

sample of cacluations

$$L_u = 7m, \quad L_n = 7 - 0.15 - 0.15 = 6.7m$$

$$C_m = \frac{1}{9}, \quad M_u = \frac{1}{9} * 65.385 * 6.7^2 = 326.13 \text{ kn.m}$$

$$d = 600 - 40 - 10 - \frac{20}{2} = 540 \text{ mm (one layer)}$$

$$R_n = \frac{326.13/0.9}{300 * 540^2} * 10^6 = 4.14 \text{ Mpa}$$

$$m = \frac{420}{0.85 * 25} = 19.765, \quad \rho = \frac{1}{19.765} \left(1 - \sqrt{1 - \frac{2 * 4.41 * 19.765}{420}} \right) = 0.0111$$

$$A_s = 0.0111 * 300 * 540 = 1798.2 \text{ mm}^2,$$

$$A_{s \min} = \frac{1.4}{420} * 300 * 540 = 540 \text{ mm}^2$$

$$A_{s \min} = \frac{\sqrt{25}}{4 * 420} * 300 * 540 = 483 \text{ mm}^2$$

$$A_{s \min} = \max(540, 483) = 540 \text{ mm}^2$$

$$n = \frac{1798.2}{314} = 5.72 \approx 6$$

$$b_{\min} = 80 + 60 + (5)(20 + 25) = 365 \text{ mm} > b = 300 \therefore \text{use two layer}$$

$$d = 600 - 40 - 10 - 20 - \frac{25}{2} = 517.5 \text{ mm (two layer)}$$

$$R_n = \frac{326.65/0.9}{300 * 517.5^2} * 10^6 = 4.51 \text{ Mpa}$$

$$m = \frac{420}{0.85 * 25} = 19.765, \quad \rho = \frac{1}{19.765} \left(1 - \sqrt{1 - \frac{2 * 4.51 * 19.765}{420}} \right) = 0.01221$$

$$A_s = 0.01224 * 300 * 517.5 = 1896 \text{ mm}^2,$$

$$A_{s \min} = \frac{1.4}{420} * 300 * 517.5 = 517 \text{ mm}^2$$

$$A_{s \min} = \frac{\sqrt{25}}{4 * 420} * 300 * 517.5 = 462.1 \text{ mm}^2$$

$$A_{s \min} = \max(517, 462.1) = 517 \text{ mm}^2$$

$$n = \frac{1900.3}{314} = 6.03 \approx 7$$

$$a = \frac{7 * 314 * 420}{0.85 * 25 * 300} = 144.81 \text{ mm}$$

$$\frac{a_b}{d} = 0.5 > \frac{a}{d} = 0.28 \quad \therefore f_s = f_y$$

$$\frac{a_{TCL}}{d_t} = 0.31875 > \frac{a}{d_t} = 0.268 \quad \therefore \text{Tension - controlled section}$$

for flexure use 7Ø20

$$C_v = 1.15, \quad V_u = \frac{1.15 * 65.385 * 6.7}{2} = 252 \text{ kn}$$

$$\phi V_c = 0.75 * \frac{\sqrt{25}}{6} * 300 * 517.5 * 10^{-3} = 97.03 \text{ kn}$$

$$V_s = \frac{252.3 - 97.03}{0.75} = 206.67 \text{ kn}$$

$$A_v = 2 * \pi \frac{10^2}{4} = 157 \text{ mm}^2 \text{ (two leg)}$$

$$S = \frac{157 * 420 * 517.5}{206.67} * 10^{-3} = 165.1 \text{ mm}$$

$$V_s \leq 2V_c$$

$$S_{max} = \min\left(300, \frac{517.5}{2} = 258.75\right) = 258.75 \text{ mm}$$

use $\phi 10 @ 160 \text{ mm}$

Axial load on column C:-

Beam s in x- direction:

$$DL = \left\{((0.3 * 0.47 * 25) + 15) * \frac{3}{2}\right\} + \left\{((0.3 * 0.47 * 25) + 15) * \frac{3}{2}\right\} = 55.575 \text{ kn}$$

$$LL = 0 + 0 = 0 \text{ kn}$$

Beams in y- direction:

$$DL = \left\{((0.3 * 0.47 * 25) + (15) + (5.75 * 3)) * \frac{7}{2}\right\} + \left\{((0.3 * 0.47 * 25) + (15) + (5.75 * 3)) * \frac{7}{2}\right\}$$

$$= 250.425 \text{ kn}$$

$$LL = \left\{(3 * 3) * \frac{7}{2}\right\} + \left\{(3 * 3) * \frac{7}{2}\right\} = 63 \text{ kn}$$

$$Wu = 1.4(55.575 + 250.425) + 1.7(63) = 388.5 \text{ kn}$$

Example 2:**Given data:-**

$$f_c = 30 \text{ Mpa} \quad , f_y = 420 \text{ Mpa}$$

$$\text{super imposed} = 2.5 \text{ kn/m}^2 \quad , \quad LL = 3 \text{ kn/m}^2$$

$$\text{weight of wall} = 12 \text{ kn/m}$$

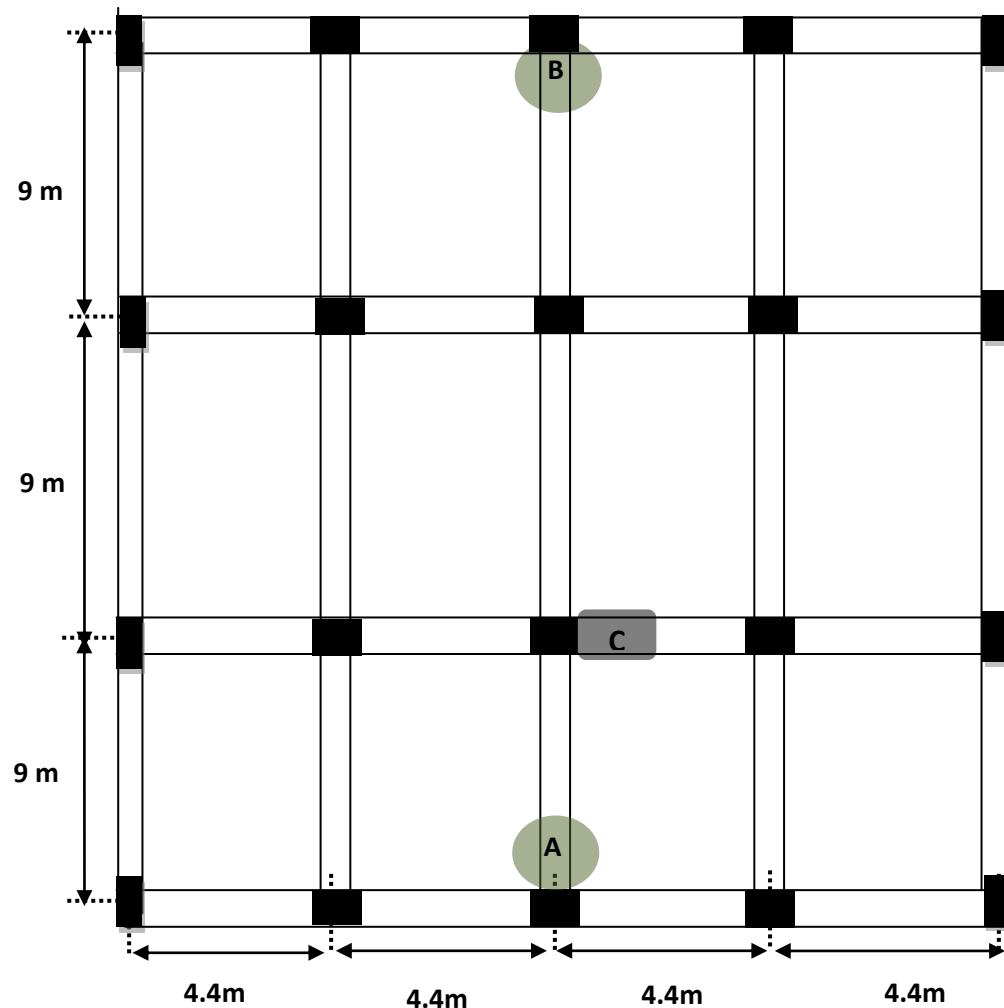
$$h_s = 170 \text{ mm} \quad , \text{ beam size} = (700, 400) \quad , \text{ columns size} (500, 400)$$

Required:-

Design the one way solid slab for flexure and shear.

Design the beam (A-D) for flexure and shear.

Compute the axial load on column C.



CE472

$$h_{min} = \frac{l}{28} = \frac{4400}{28} = 157.14 \text{ mm}$$

$$h_{min} = \frac{l}{24} = \frac{4400}{24} = 183.33 \text{ mm}$$

$$h_{min} = \max(157.14, 183.33) = 183.33 \text{ mm}$$

$h < h_{min} \rightarrow$ not satisfied deflection requiremnt

$DL =$ own weight + superimposed

$$DL = (0.17 * 25) + 2.5 = 6.75 \text{ kn/m}^2$$

$$LL = 3 \text{ kn/m}^2$$

$$Wu = 1.4DL + 1.7LL$$

$$Wu = 1.4(6.75) + 1.7(3) = 14.55 \text{ kn/m}^2$$



Lu (m)	4.4m			4.4m			4.4m			4.4m		
Ln (m)	4m			4m			4m			4m		
Cm	1/24	1/14	1/10	1/11	1/16	1/11	1/11	1/16	1/11	1/10	1/14	1/24
Wu(kn/m ²)	14.55	14.55	14.55							14.55	14.55	14.55
Mu(kn.m)		16.63	23.28							23.28	16.63	
d (mm)		144	144							144	144	
Rn (Mpa)		0.891	1.25							1.25	0.891	
P		0.00216	0.0031							0.0031	0.00216	
As (mm ²)		311	446.4							446.4	311	
As _{min} (mm ²)		306	306							306	306	
As (mm ²)		311	446.9							446.9	311	
S _{max} (mm)		300	253							253	300	
AS _{rinkashge} (mm ²)		306	306							306	306	
S _{max} (mm)		300	300							300	300	
Cv			1.15							1.15		
Vu (kn)			33.465							33.465		
φVc (kn)			98.59							98.59		

sample of cacluations

$$L_u = 4.4m, \quad L_n = 4.4 - 0.2 - 0.2 = 4m$$

$$C_m = \frac{1}{10}, \quad M_u = \frac{1}{10} * 14.55 * 4^2 = 23.28kn.m$$

$$d = 170 - 20 - \frac{12}{2} = 144mm, \quad R_n = \frac{23.28/0.9}{1000 * 144^2} * 10^6 = 1.25 Mpa,$$

$$m = \frac{420}{0.85 * 30} = 16.471, \quad \rho = \frac{1}{16.471} \left(1 - \sqrt{1 - \frac{2 * 1.25 * 16.471}{420}} \right) = 0.0031$$

$$A_s = 0.0031 * 1000 * 144 = 446.4 mm^2, \quad A_{s \min} = 0.0018 * 1000 * 170 = 306 mm^2$$

$$S_{max} = \min \left(\frac{113.04}{446.4} * 1000 = 253.22mm, 300mm, 2 * 170 = 340 \right) = 253.22mm$$

for flexural → use Ø12@250 mm

$$A_{s \text{ shrinkage}} = 0.0018 * 1000 * 170 = 306 mm^2$$

$$S_{max} = \min \left(\frac{113.04}{306} * 1000 = 452.88mm, 300mm, 4 * 170 = 680 \right) = 300mm$$

for shrinkage → use Ø12@300 mm

$$C_v = 1.15, \quad V_u = \frac{1.15 * 14.55 * 4}{2} = 33.465 kn$$

$$\phi V_c = 0.75 * \frac{\sqrt{30}}{6} * 1000 * 144 * 10^{-3} = 98.59 kn$$

$\phi V_c > V_u \rightarrow$ *shear reinforcment is not needed*

Load acting on the beam (A-B)

1- Dead load:

$$DL = 6.75 * (2.2 + 2.2) + 12 + (0.53 * 0.4 * 25) = 47 \text{ kn/m}$$

2- Live load

$$LL = 3 * (2.2 + 2.2) = 13.2 \text{ kn/m}$$

$$Wu = 1.4(47) + 1.7(13.2) = 88.24 \text{ kn/m}$$



Lu (m)	9m			9m			9m		
Ln(m)	8.6m			8.6m			8.6m		
Wu(kn/m)	88.24								
Cm	1/16	1/14	1/10	1/11	1/16	1/11	1/10	1/16	1/11
Mu (kn.m)		466.2	652.6				652.6	466.2	
d(mm)		615.5	615.5				615.5	615.5	
Rn(Mpa)		3.4	4.8				4.8	3.4	
P		0.009	0.0128				0.0128	0.009	
As(mm²)		2215.8	3151.4				3151.4	2215.8	
As_{min}(mm²)		821	821				821	821	
N		7.05~8	10.03~11				7.05~8	10.03~11	
b_{min}(mm)									
Fs =Fy		Ok	Ok				Ok	Ok	
TCL		Ok	Ok				Ok	Ok	
Use		8φ20	11φ20				8φ20	11φ20	
Cv			1.15				1.15		
Vu (kn)			436.35				436.35		
φVc (kn)			168.56				168.56		
Vs (kn)			357.1				357.1		
Av (mm²)			226.08				226.08		
S (mm)			163.7				163.7		
S_{max}(mm)			307.75				307.75		
Use			Φ12@160				Φ12@160		

sample of cacluations

$$L_u = 9m, \quad L_n = 9 - 0.2 - 0.2 = 8.6m$$

$$C_m = \frac{1}{10}, \quad M_u = \frac{1}{10} * 88.24 * 8.6^2 = 652.6 \text{ kn.m}$$

$$d = 600 - 40 - 12 - 20 - \frac{25}{2} = 615.5 \text{ mm (two layer)}$$

$$R_n = \frac{652.6/0.9}{400 * 615.5^2} * 10^6 = 4.8 \text{ Mpa}$$

$$m = \frac{420}{0.85 * 30} = 16.471, \quad \rho = \frac{1}{16.471} \left(1 - \sqrt{1 - \frac{2 * 4.8 * 16.471}{420}} \right) = 0.0128$$

$$A_s = 0.0128 * 400 * 615.5 = 3151.4 \text{ mm}^2,$$

$$A_{s \text{ min}} = \frac{1.4}{420} * 400 * 615.5 = 821 \text{ mm}^2$$

$$A_{s \text{ min}} = \frac{\sqrt{30}}{4 * 420} * 400 * 615 = 803 \text{ mm}^2$$

$$A_{s \text{ min}} = \max(821, 803) = 821 \text{ mm}^2$$

$$n = \frac{3151.4}{314} = 10.03 \approx 11$$

$$a = \frac{11 * 314 * 420}{0.85 * 30 * 400} = 142.22 \text{ mm}$$

$$\frac{a_b}{d} = 0.5 > \frac{a}{d} = 0.23 \quad \therefore f_s = f_y$$

$$\frac{a_{TCL}}{d_t} = 0.31875 > \frac{a}{d_t} = 0.222 \quad \therefore \text{Tension - controlled section}$$

for flexure use 11Ø20

$$C_v = 1.15, \quad V_u = \frac{1.15 * 88.24 * 8.6}{2} = 436.35 \text{ kn}$$

$$\phi V_c = 0.75 * \frac{\sqrt{30}}{6} * 400 * 615.5 * 10^{-3} = 168.56 \text{ kn}$$

$$V_s = \frac{436.35 - 168.56}{0.75} = 357.1 \text{ kn}$$

$$A_v = 2 * \pi \frac{12^2}{4} = 226.08 \text{mm}^2 \text{ (two leg)}$$

$$S = \frac{226.08 * 420 * 615.5}{357.1} * 10^{-3} = 163.7 \text{mm}$$

$$V_s < 2V_c$$

$$S_{max} = \min \left(300, \frac{615.5}{2} = 307.75 \right) = 300 \text{mm}$$

use $\emptyset 12 @ 160 \text{mm}$

Axial load on column C:-

Beams in x- direction:

$$DL = \left\{ ((0.4 * 0.53 * 25) + 12) * \frac{4.4}{2} \right\} + \left\{ ((0.4 * 0.53 * 25) + 12) * \frac{4.4}{2} \right\} = 76.12 \text{ kn}$$

$$LL = 0 + 0 = 0 \text{ kn}$$

Beams in y- direction:

$$DL = \left\{ ((0.4 * 0.53 * 25) + 12 + (6.75 * 4.4)) * \frac{9}{2} \right\} + \left\{ ((0.4 * 0.53 * 25) + 12 + (6.75 * 4.4)) * \frac{9}{2} \right\} \\ = 423 \text{ kn}$$

$$LL = \left\{ (3 * 4.4) * \frac{9}{2} \right\} + \left\{ (3 * 4.4) * \frac{9}{2} \right\} = 118.8 \text{ kn}$$

$$Wu = 1.4(76.12 + 423) + 1.7(118.8) = 900.728 \text{ kn}$$