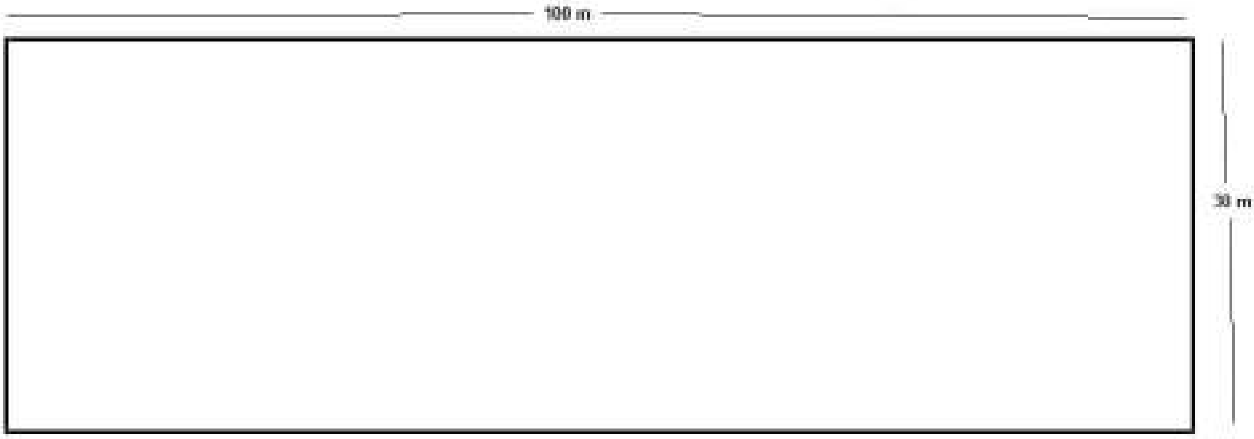
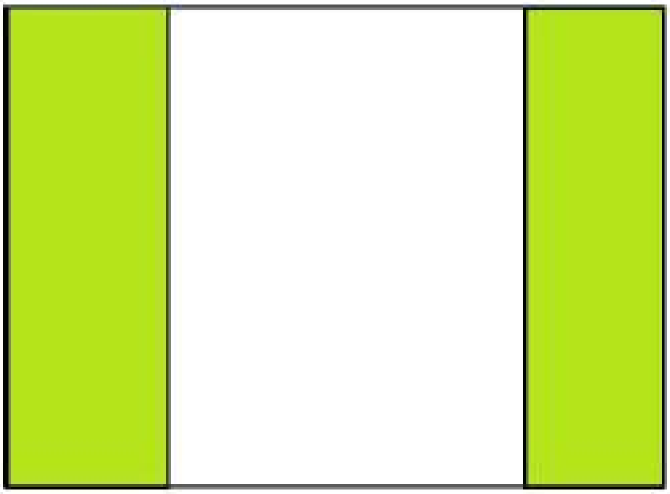
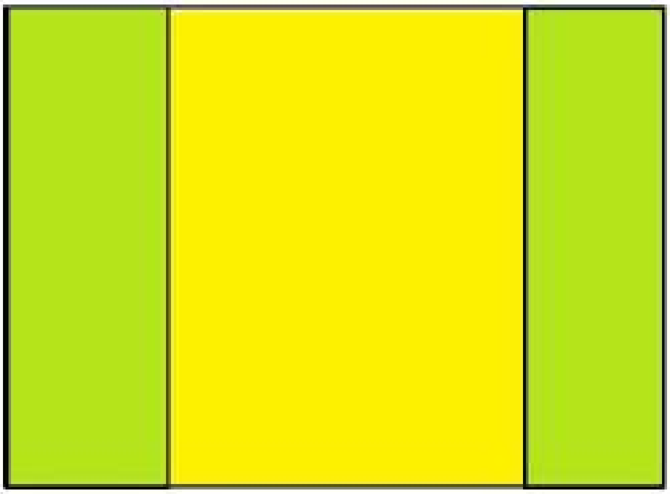
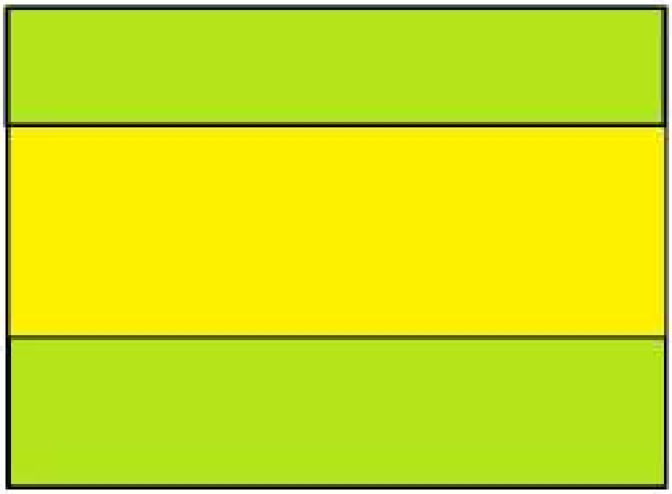
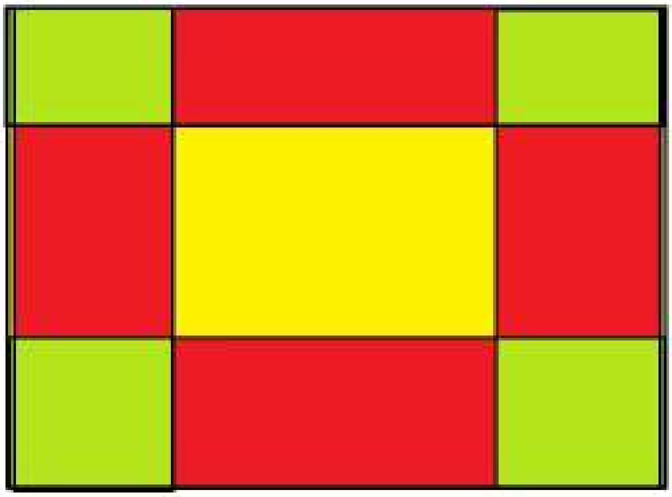
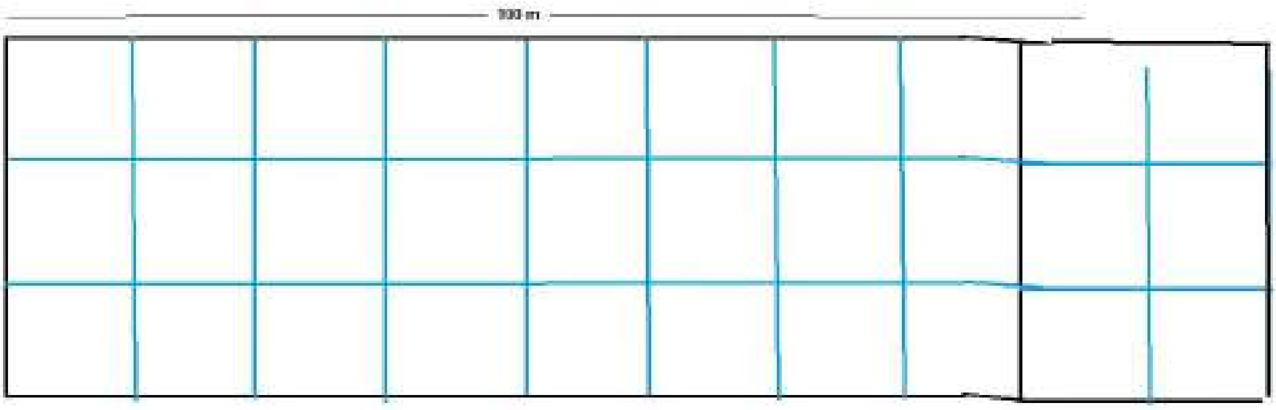

100 m
30 m

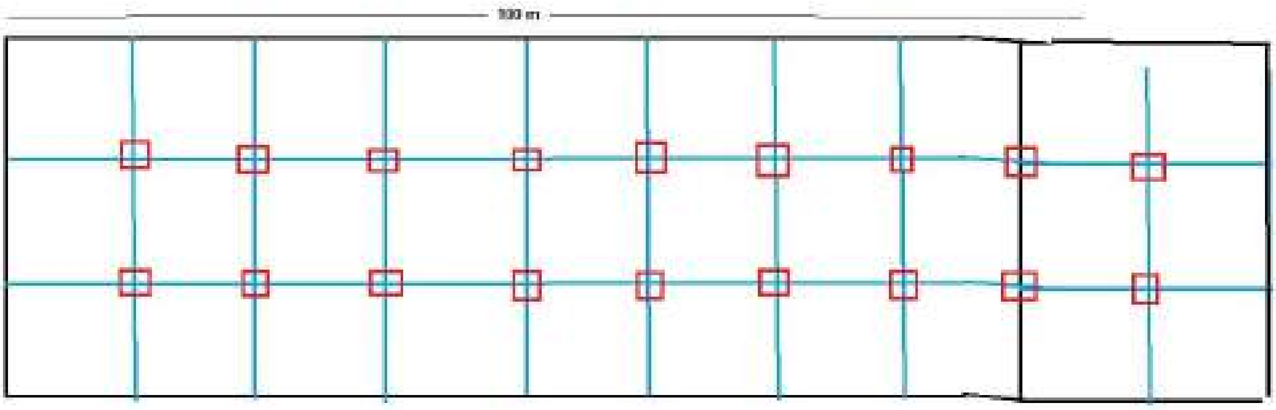


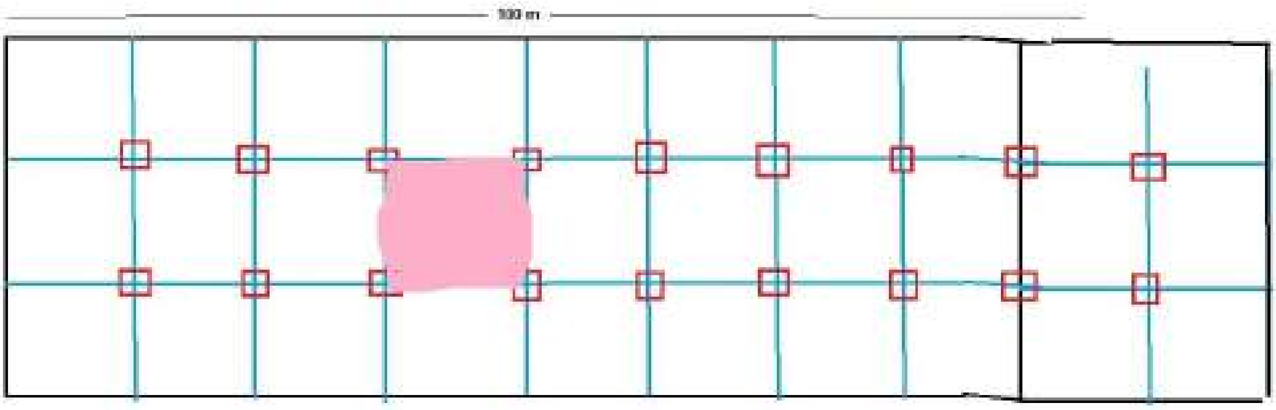


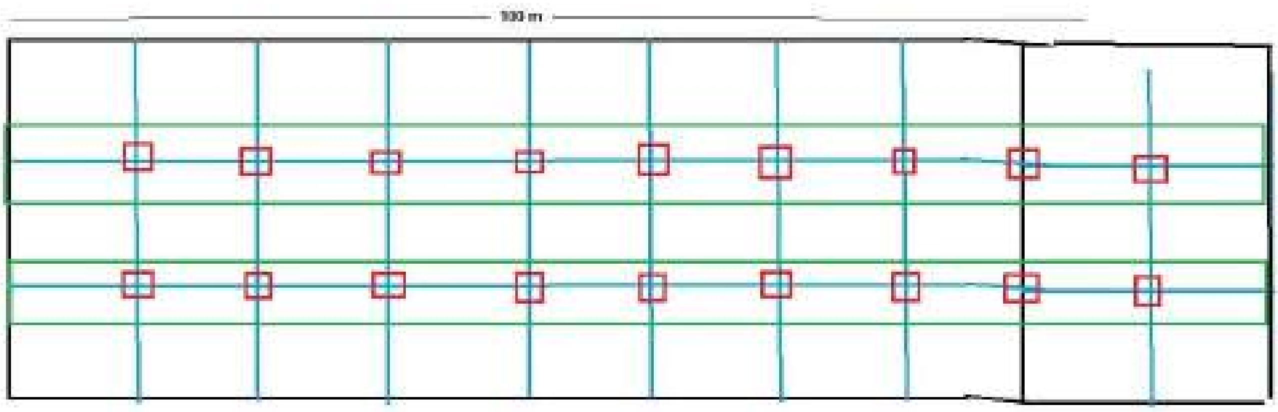


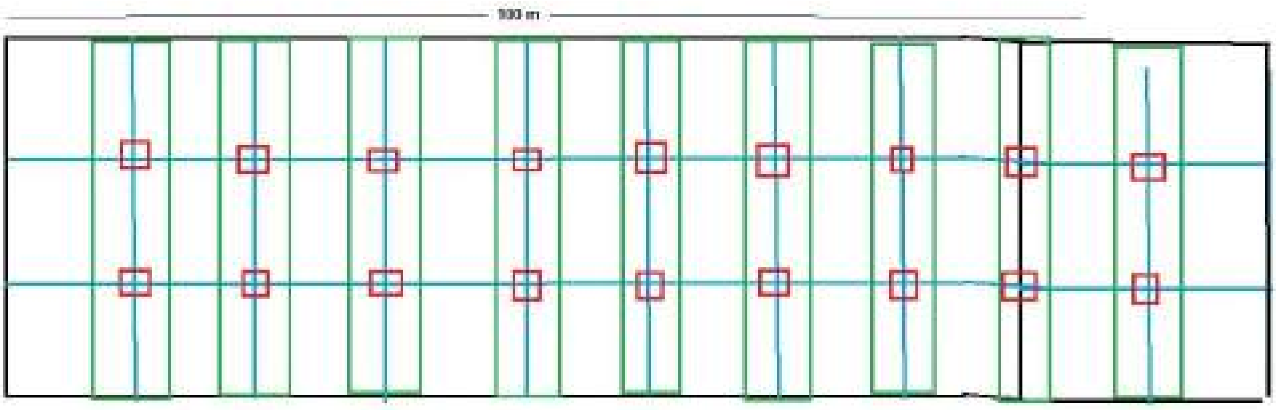


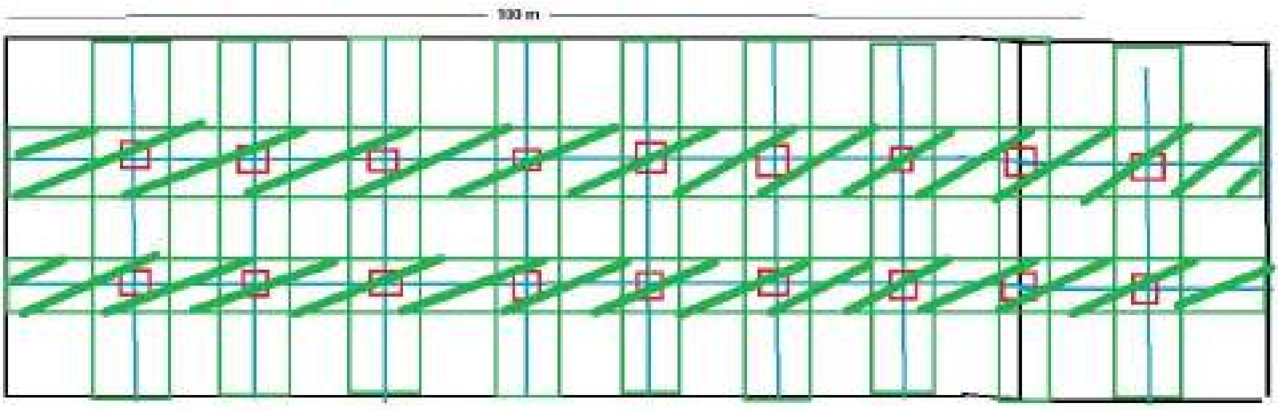

100 m

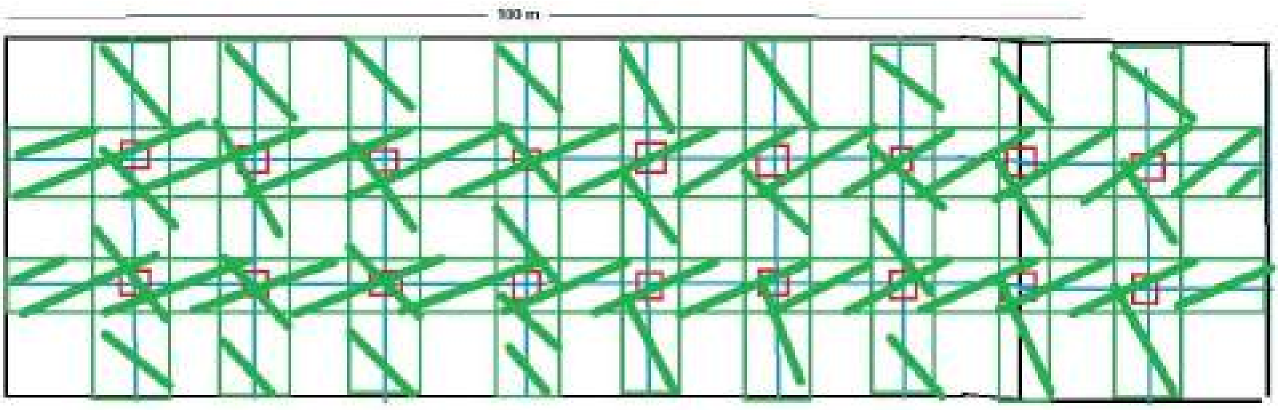

100 m


100 m

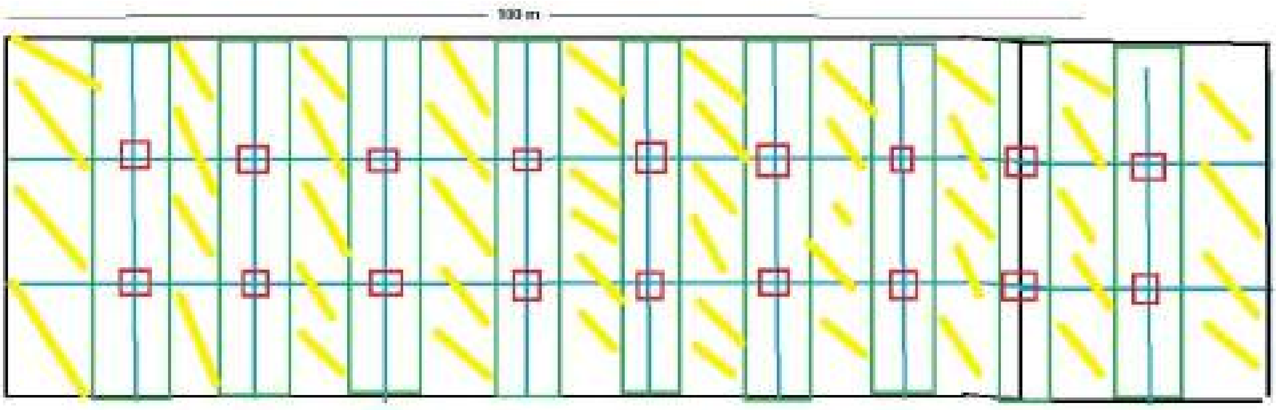

100 m

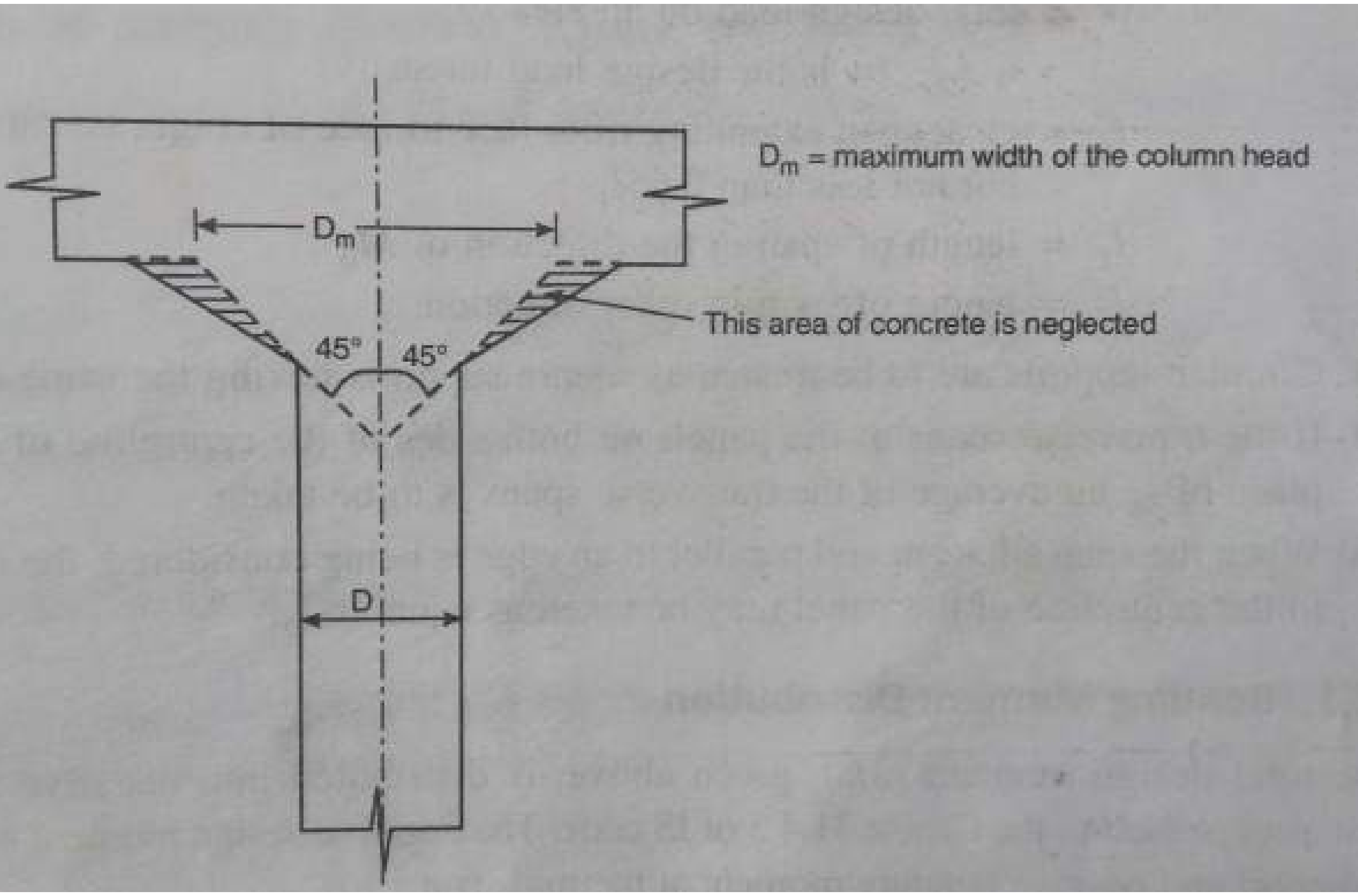

100 m


100 m



Scanned with CamScanner


100 m



D_m = maximum width of the column head
D_m
This area of concrete is neglected
45°
45°
D

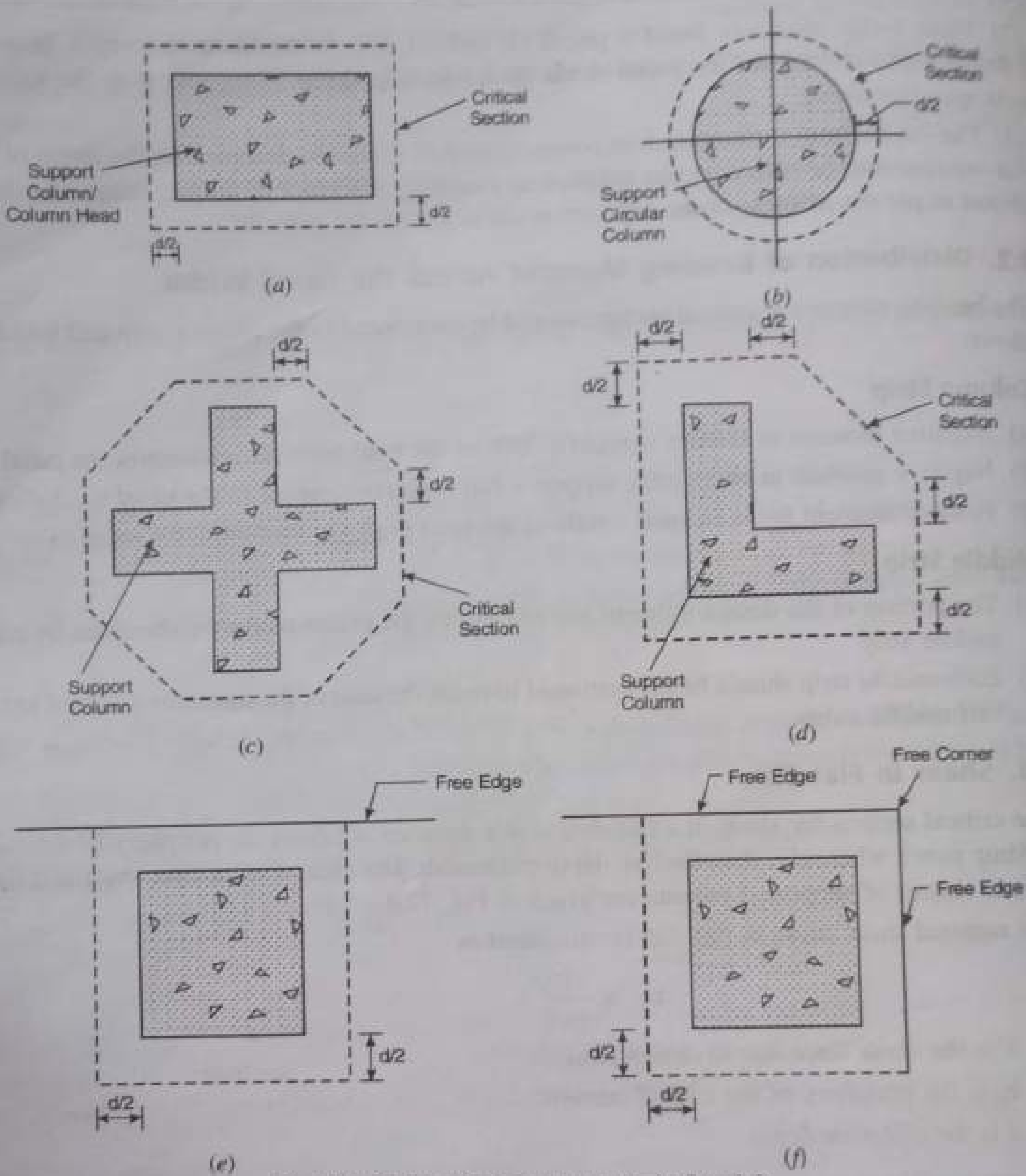
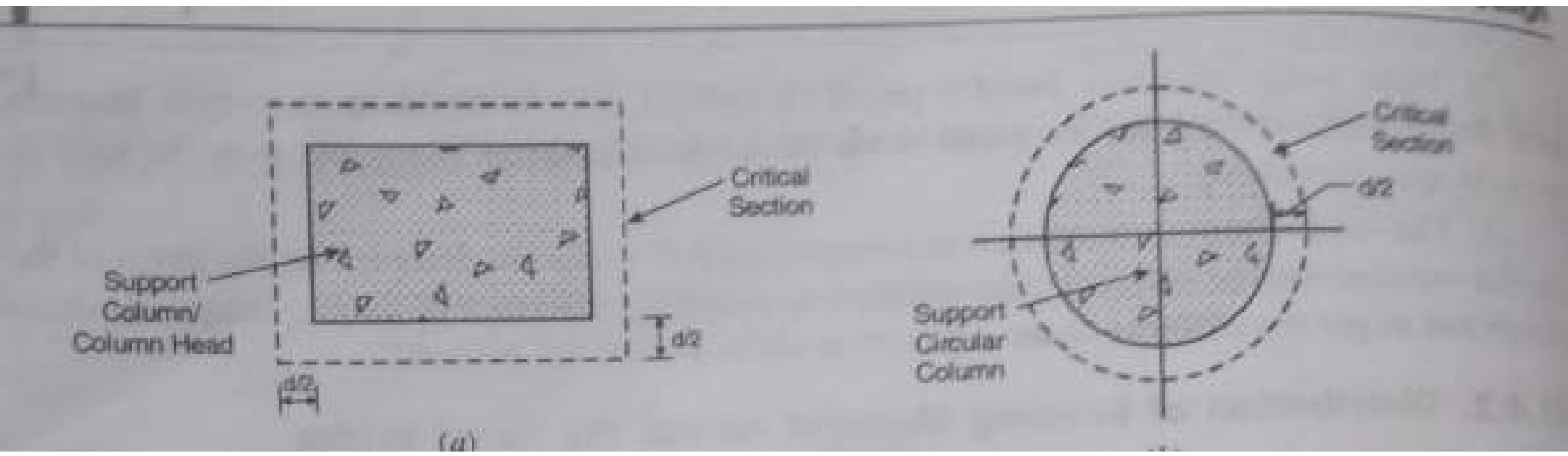
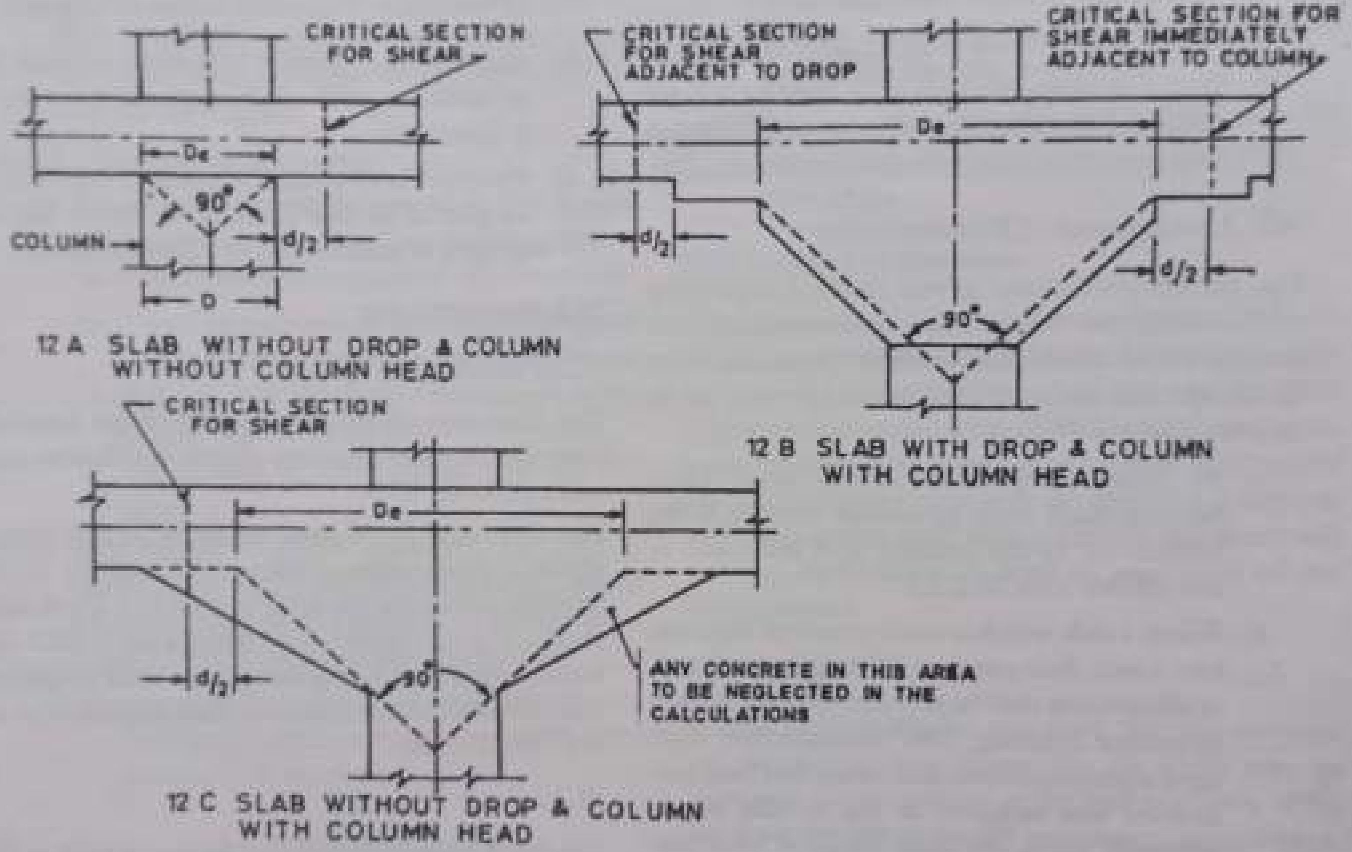


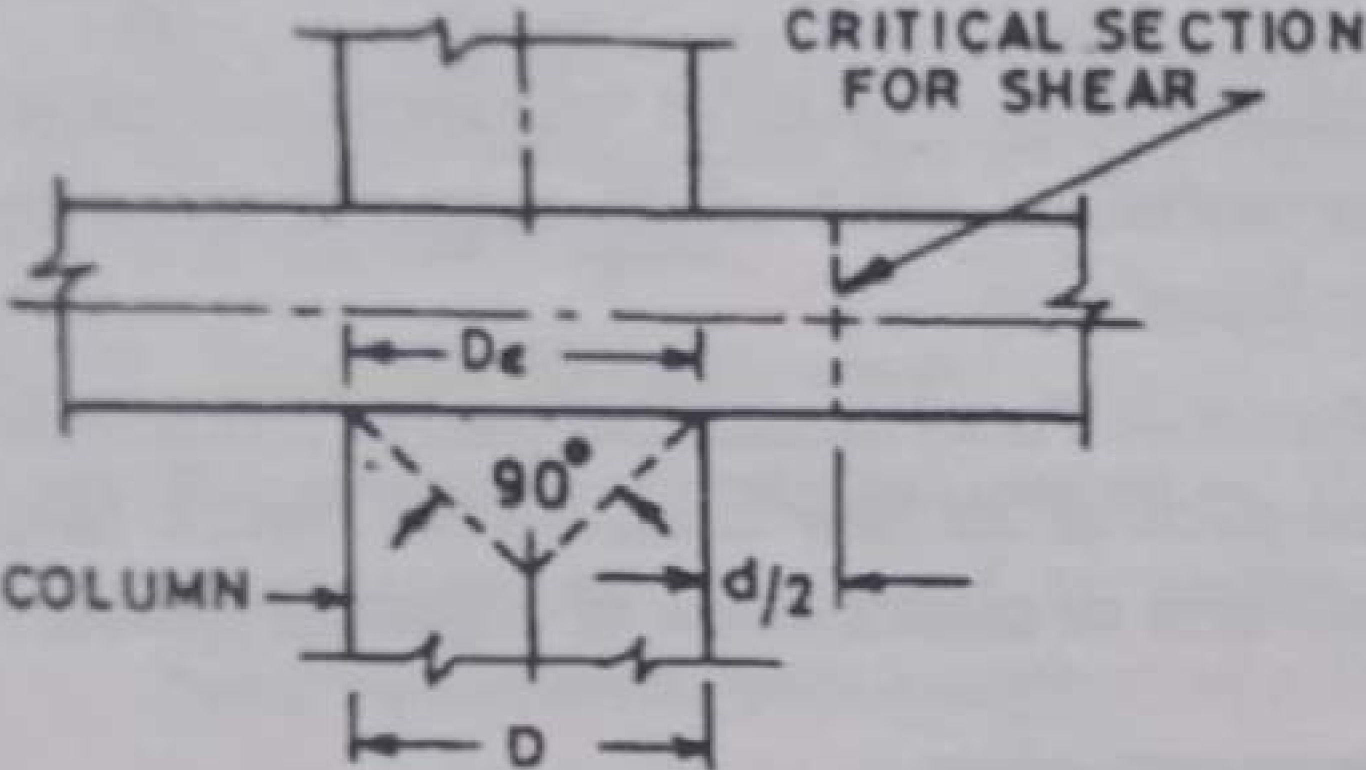
Fig. 17.4. Critical Sections for shear in flat slab


Critical Section
Support Column/ Column Head
d/2
d/2
Critical Section
d/2
Support Circular Column

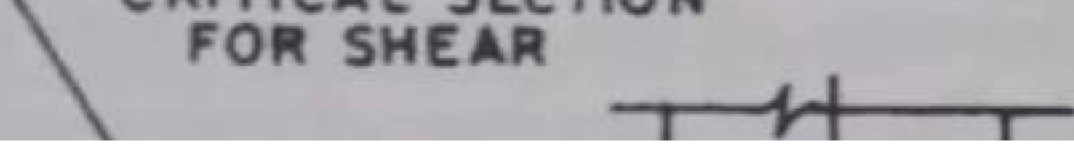


NOTE — D_e is the diameter of column or column head to be considered for design and d is effective depth of slab or drop as appropriate.

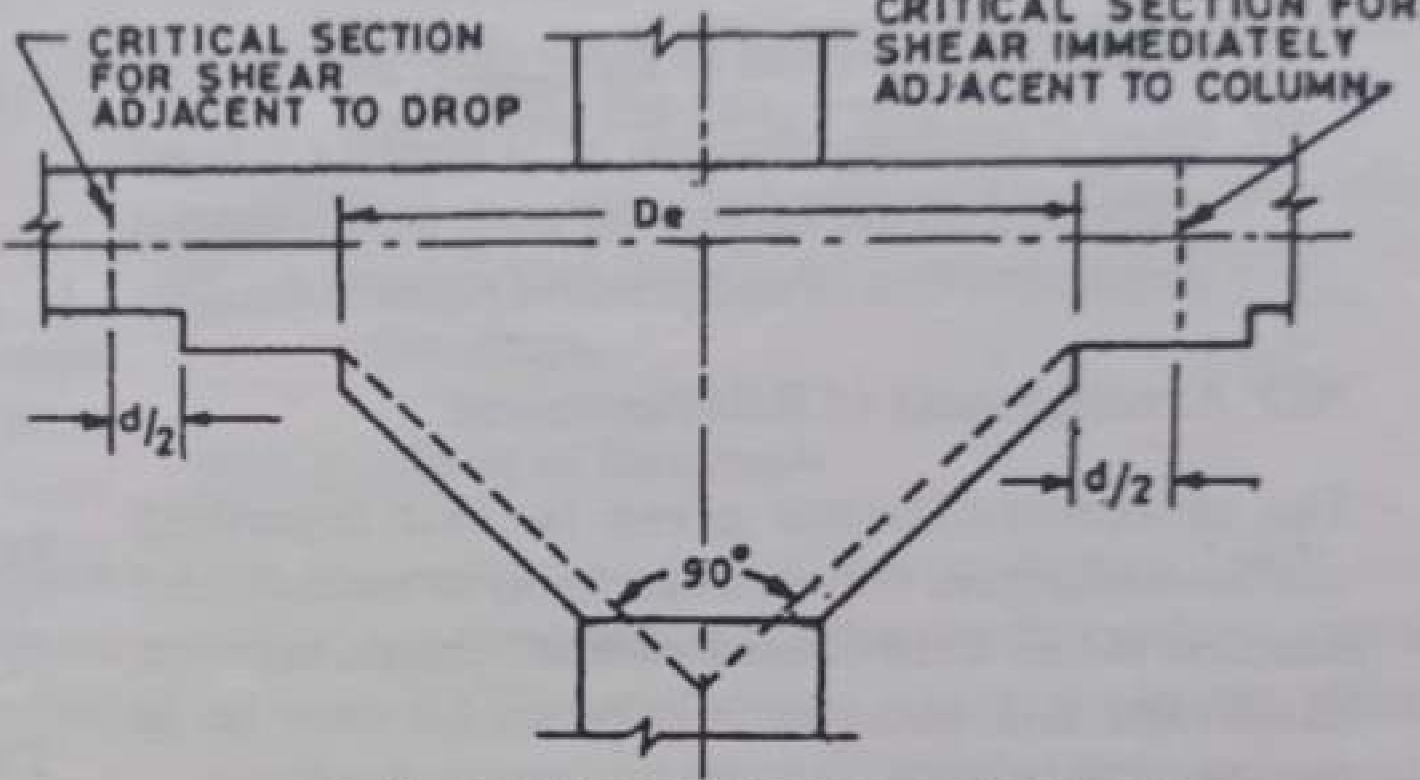
Fig. 12 Critical Sections for Shear in Flat Slabs



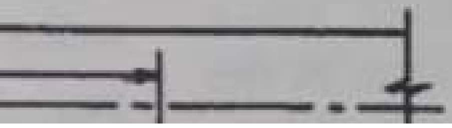
12 A SLAB WITHOUT DROP & COLUMN WITHOUT COLUMN HEAD

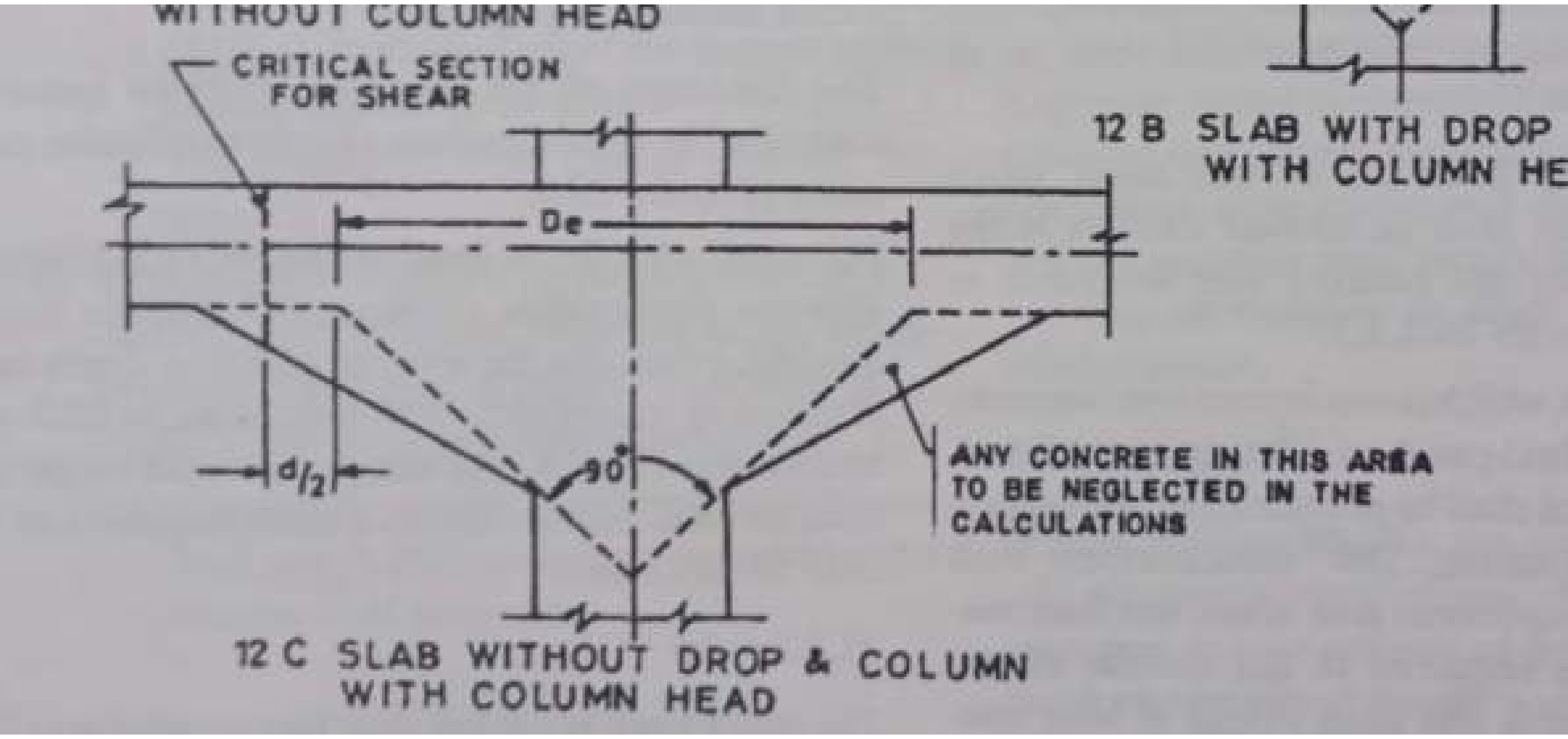


MN



12 B SLAB WITH DROP & COLUMN
WITH COLUMN HEAD




WITHOUT COLUMN HEAD
CRITICAL SECTION
FOR SHEAR
De
d/2
90°
ANY CONCRETE IN THIS AREA
TO BE NEGLECTED IN THE
CALCULATIONS
12 B SLAB WITH DROP
WITH COLUMN HE
12 C SLAB WITHOUT DROP & COLUMN
WITH COLUMN HEAD

structure or finishes or partitions. The deflection shall generally be limited to the following:

a) The final deflection due to all loads including the effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, roofs and all other horizontal members, should not normally exceed span/250.

b) The deflection including the effects of temperature, creep and shrinkage occurring after erection of partitions and the application of finishes should not normally exceed span/350 or 20 mm whichever is less.

23.2.1 The vertical deflection limits may generally be assumed to be satisfied provided that the span to depth ratios are not greater than the values obtained as below:

a) Basic values of span to effective depth ratios for spans up to 10 m:

Cantilever	7
Simply supported	20
Continuous	26

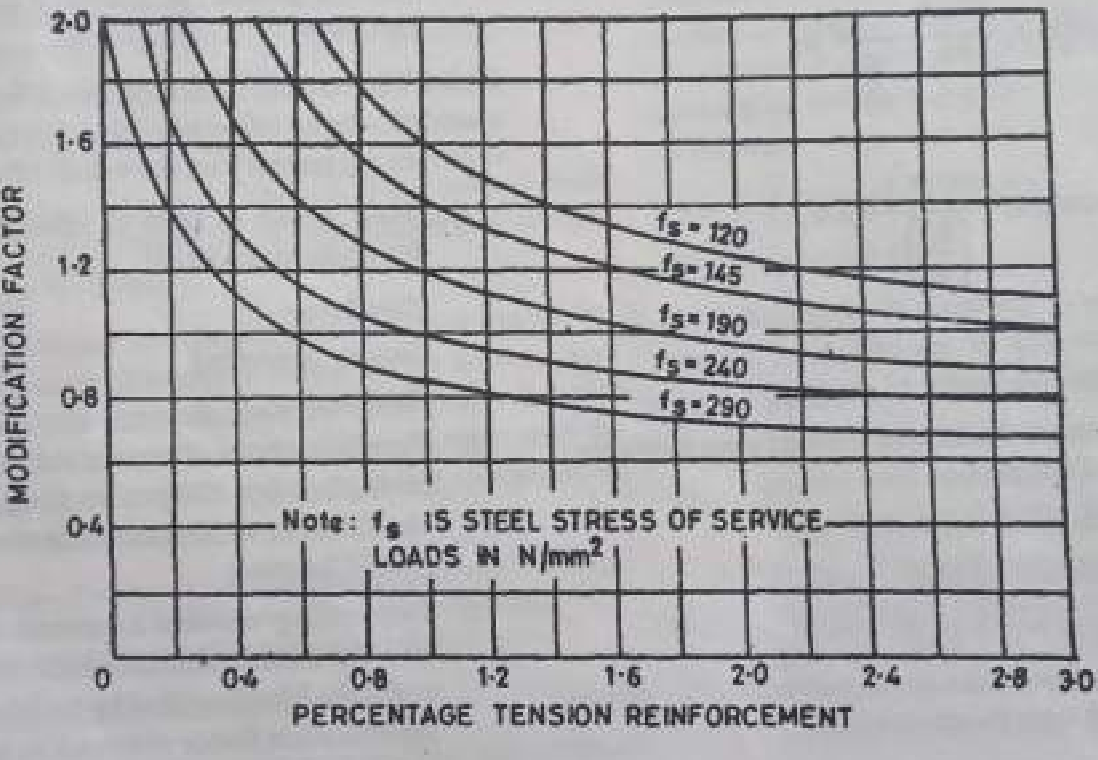
b) For spans above 10 m, the values in (a) may be multiplied by 10/span in metres, except for cantilever in which case deflection calculations should be made.

c) Depending on the area and the stress of steel for tension reinforcement, the values in (a) or (b) shall be modified by multiplying with the modification factor obtained as per Fig. 4.

d) Depending on the area of compression reinforcement, the value of span to depth ratio be further modified by multiplying with the modification factor obtained as per Fig. 5.

c) For flanged beams, the values of (a) or (b) be modified as per Fig. 6 and the reinforcement percentage for use in Fig. 4 and 5 should be based on area of section equal to $b_f\,d$.

NOTE—When deflections are required to be calculated, the method given in Annex C may be used.



$$f_s = 0.58\, f_y \frac{\text{Area of cross-section of steel required}}{\text{Area of cross-section of steel provided}}$$

FIG. 4 MODIFICATION FACTOR FOR TENSION REINFORCEMENT

31.2 Proportioning

31.2.1 *Thickness of Flat Slab*

The thickness of the flat slab shall be generally controlled by considerations of span to effective depth ratios given in **23.2**.

For slabs with drops conforming to **31.2.2**, span to effective depth ratios given in **23.2** shall be applied directly; otherwise the span to effective depth ratios obtained in accordance with provisions in **23.2** shall be multiplied by 0.9. For this purpose, the longer span shall be considered. The minimum thickness of slab shall be 125 mm.

31.4 Direct Design Method

31.4.1 *Limitations*

Slab system designed by the direct design method shall fulfil the following conditions:

a) There shall be minimum of three continuous spans in each direction,

b) The panels shall be rectangular, and the ratio of the longer span to the shorter span within a panel shall not be greater than 2.0,

c) It shall be permissible to offset columns to a maximum of 10 percent of the span in the direction of the offset notwithstanding the provision in (b),

d) The successive span lengths in each direction shall not differ by more than one-third of the longer span. The end spans may be shorter but not longer than the interior spans, and

e) The design live load shall not exceed three times the design dead load.

31.4.2 *Total Design Moment for a Span*

31.4.2.1 In the direct design method, the total design moment for a span shall be determined for a strip bounded laterally by the centre-line of the panel on each side of the centre-line of the supports.

31.4.2.2 The absolute sum of the positive and average negative bending moments in each direction shall be taken as:

$$M_o = \frac{W l_n}{8}$$

where

M_o = total moment;

W = design load on an area $l_2 l_n$;

l_n = clear span extending from face to face of columns, capitals, brackets or walls, but not less than $0.65\,l_1$;

l_1 = length of span in the direction of M_o; and

l_2 = length of span transverse to l_1.

31.4.2.3 Circular supports shall be treated as square supports having the same area.

31.4.2.4 When the transverse span of the panels on either side of the centre-line of supports varies, l_2 shall be taken as the average of the transverse spans.

31.4.2.5 When the span adjacent and parallel to an edge is being considered, the distance from the edge to the centre-line of the panel shall be substituted for l_2 in 31.4.2.2.

31.4.3 *Negative and Positive Design Moments*

31.4.3.1 The negative design moment shall be located at the face of rectangular supports, circular supports being treated as square supports having the same area.

31.4.3.2 In an interior span, ...

Exteri

α_c i colun taken and i

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31.4 mon mon is nc

31. desi desi a c dist the

31. *Pa*

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31.

31. sha

31.4.2.2 The absolute sum of the positive and average negative bending moments in each direction shall be taken as:

$$M_o = \frac{W l_n}{8}$$

where

M_o = total moment;

W = design load on an area $l_2 l_n$;

l_n = clear span extending from face to face of columns, capitals, brackets or walls, but not less than $0.65 l_1$;

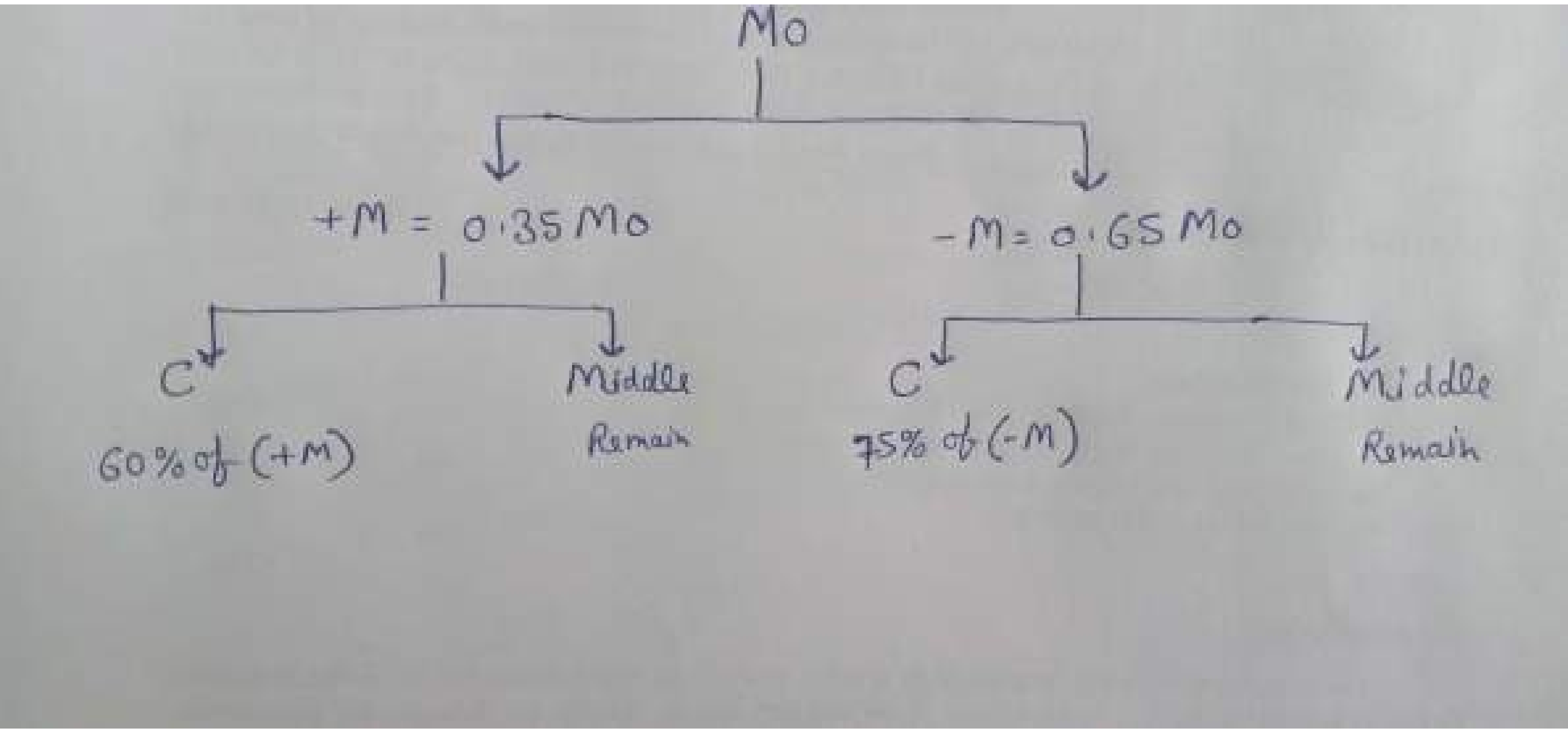
l_1 = length of span in the direction of M_o; and

l_2 = length of span transverse to l_1.

31.4.2.3 Circular supports shall be treated as square supports having the same area.

31.4.3.2 In an interior span, the total design moment M_0 shall be distributed in the following proportions:

Negative design moment	0.65
Positive design moment	0.35


Mo
+M = 0.35 Mo
-M = 0.65 Mo
C
60% of (+M)
Middle
Remain
C
75% of (-M)
Middle
Remain

where

$k_s = (0.5 + \beta_c)$ but not greater than 1, β_c being the ratio of short side to long side of the column/ capital; and

$\tau_c = 0.25\sqrt{f_{ck}}$ in limit state method of design, and $0.16\sqrt{f_{ck}}$ in working stress method of design.

31.6.3.2 When the shear stress at the critical section exceeds the value given in **31.6.3.1**, but less than $1.5\,\tau_c$ shear reinforcement shall be provided. If the shear stress exceeds $1.5\,\tau_c$, the flat slab shall be redesigned. Shear stresses shall be investigated at successive sections more distant from the support and shear reinforcement shall be provided up to a section where the shear stress does not exceed $0.5\,\tau_c$. While designing the shear reinforcement, the shear stress carried by the concrete shall be assumed to be $0.5\,\tau_c$ and reinforcement shall carry the remaining shear.

α_c is the ratio of flexural stiffness of the exterior columns to the flexural stiffness of the slab at a joint taken in the direction moments are being determined and is given by

$$\alpha_c = \frac{\Sigma K_c}{K_s}$$

where

K_c = sum of the flexural stiffness of the columns meeting at the joint; and

K_s = flexural stiffness of the slab, expressed as moment per unit rotation.

Table 17 Minimum Permissible Values of α_c
(*Clause* 31.4.6)

Imposed Load/Dead Load	Ratio $\frac{l_2}{l_1}$	Value of $\alpha_{c\,min}$
(1)	(2)	(3)
0.5	0.5 to 2.0	0
1.0	0.5	0.6
1.0	0.8	0.7
1.0	1.0	0.7
1.0	1.25	0.8
1.0	2.0	1.2
2.0	0.5	1.3
2.0	0.8	1.5
2.0	1.0	1.6
2.0	1.25	1.9
2.0	2.0	4.9
3.0	0.5	1.8
3.0	0.8	2.0
3.0	1.0	2.3
3.0	1.25	2.8
3.0	2.0	13.0