

UNIT-3.

Stair Case:-

Stair case are generally provided to connect successive floors of a building

Flight:-

Flight consist of series of step provided b/w landing

Structural Component

Thread

Rise

Thread:-

It is usually 250 mm - 300 mm. wide depending upon the type of building

Flight of steps generally with 10 to 12 steps

Rise:-

It is the vertical distance b/w the adjacent tread (or) vertical projection of the step

It range from 150 to 190 mm. and depend upon type of building

Landing:-

This the horizontal platform provided at the head of series of steps.

Head Room.

It is the passage under the landing of step. The minimum clear head of the head room is 2.2 m.

The width of the landing is should not smaller than width of the stair

Width of stair

The width of stair varies from 1 m to 1.5 m.

The minimum value of width of stair is 0.9 m.

Types of stair case:

- (1) straight stair case. (with or without landing).
- (2) dog legged stair case.
- (3) Quarter turn
- (4) Isolated cantilever type
- (5) Spiral
- (6) Circular stair case.
- (7)

2. Design a flight of dog legged staircase spanning b/w landing beam by using following data.

(1) No. of step = 10 #

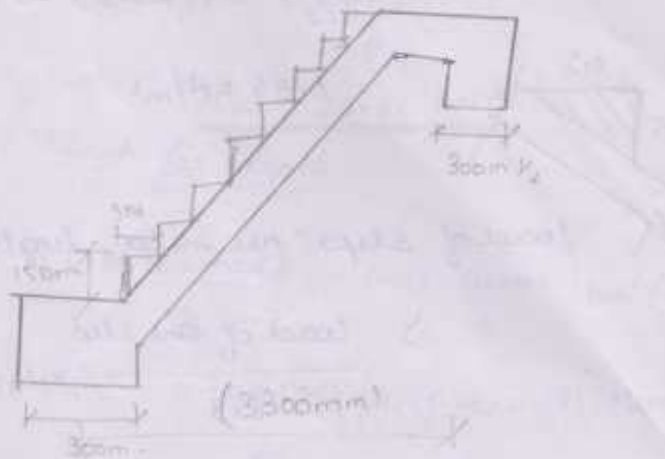
(2) Tread = 300 mm.

(3) Rise = 150 mm.

(4) width of land = 300 mm

use m20 + Fe 415 grade material.

Step 1: Size of component of stair case:



$$\text{Span} \Rightarrow (10 \times 300) + 2\left(\frac{300}{2}\right) = 3300 \text{ mm.}$$

Thickness of base waist slab:

$$\frac{d}{d} = 20 \text{ (for dog leg)}$$

$$\Rightarrow \frac{165}{3300} = d -$$

$$\boxed{d = 165 \text{ mm}}$$

$$\text{Cover} \Rightarrow 25 \text{ mm.}$$

$$\Rightarrow D = d + d'$$

$$= 165 + 25 = 190 \text{ mm.}$$

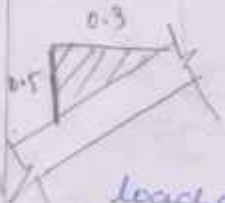
Step 2: Load calculation.

$$\text{Dead load of Slope (or) waist slab} \Rightarrow 0.190 \times 1 \times 25 = 4.75 \text{ kN/m}^2$$

$$\begin{aligned} \text{Dead load (or) slab is horizontal} \\ \text{Inclination} &= \frac{w_s \sqrt{R^2 + T^2}}{T} \\ &= \frac{4.75 \sqrt{0.15^2 + 0.3^2}}{0.3} = 5.31 \text{ kN/m}^2. \end{aligned}$$

Dead load of One step (foot brick 19)

$$\Rightarrow \frac{1}{2} \times 0.15 \times 0.3 \times 25$$

$$= 0.56 \text{ kN/m}^2$$


load of steps per meter length.

$$\Rightarrow \frac{\text{load of One step}}{0.3} \times 1$$

$$= \frac{0.56}{0.3} = 1.86 \text{ kN/m}^2$$

adopt floor finish = 0.5 kN/m^2

Normal live load \Rightarrow for house = 5 kN/m^2

$$\Rightarrow \text{Total dead load} = 1.86 + 0.5 + 5.5$$

$$= 7.67 \text{ kN/m}^2$$

Total service load.

$$\Rightarrow 5 \text{ kN/m}^2$$

$$\therefore \text{Total load} \Rightarrow 7.67 + 5$$

$$= 12.67 \text{ kN/m}^2$$

$$\therefore \text{Factored load} = 1.5 \times \text{Total load}$$

$$= 1.5 \times 12.67$$

$$= 19.005 \text{ kN/m}^2$$

$$= 19 \text{ kN/m}^2$$

$$\text{Factored moment } M_u = \frac{w_u L^2}{8}$$

$$= \frac{19 \times 3.3^2}{8}$$

$$M_u = 25.86 \text{ kNm.}$$

Step 4: Check for depth.

$$M_u = 0.36 \frac{x_{u\max}}{d} \left(1 - 0.42 \frac{x_{u\max}}{d} \right) b d^2 f_{ck}$$

$$(25.86 \times 10^6) = 0.36 \times 0.48 \left(1 - (0.42 \times 0.48) \right) \times 1000 \times d^2 \times 20$$

$$\Rightarrow d = 96.8 < 165 \text{ mm.}$$

Depth required is less than provided

Hence it is Safe

Step 5: Area of Steel:

$$M_u = 0.87 f_y A_{st} d \left(1 - \frac{A_{st} f_y}{f_{ck} b d} \right)$$

$$(25.86 \times 10^6) = 0.87 \times 415 \times A_{st} \times (165) \left(1 - \frac{A_{st} \times 415}{20 \times 1000 \times 165} \right)$$

$$\Rightarrow A_{st} = 460.78 \text{ mm}^2$$

Use 12mm ϕ

$$\Rightarrow \text{Spacing} = \frac{A_{st}}{A_{st}} \times 1000$$

$$= \frac{\pi/4 \times 12^2}{46.78} \times 1000$$

$$= 245.45 \text{ mm}$$

$$\approx 240 \text{ mm. c/c.}$$

Provide 12 mm dia bar at 240 mm center to center as main reinforcement.

Step 6:- Area distribution steel

Area of distribution steel = $0.12\% \cdot b \cdot d$

$$\Rightarrow \frac{0.12}{100} \times (1000 \times 190)$$

$$= 228 \text{ mm}^2$$

Use 8 mm dia bar.

$$S = \frac{a_{st}}{A_{st}} \times 100$$

$$S = \frac{228}{1000} \times 100$$

$$= 22.8 \text{ mm} \approx 23 \text{ mm}$$

Provide 8 mm dia bar at 220 mm c/c as distribut.

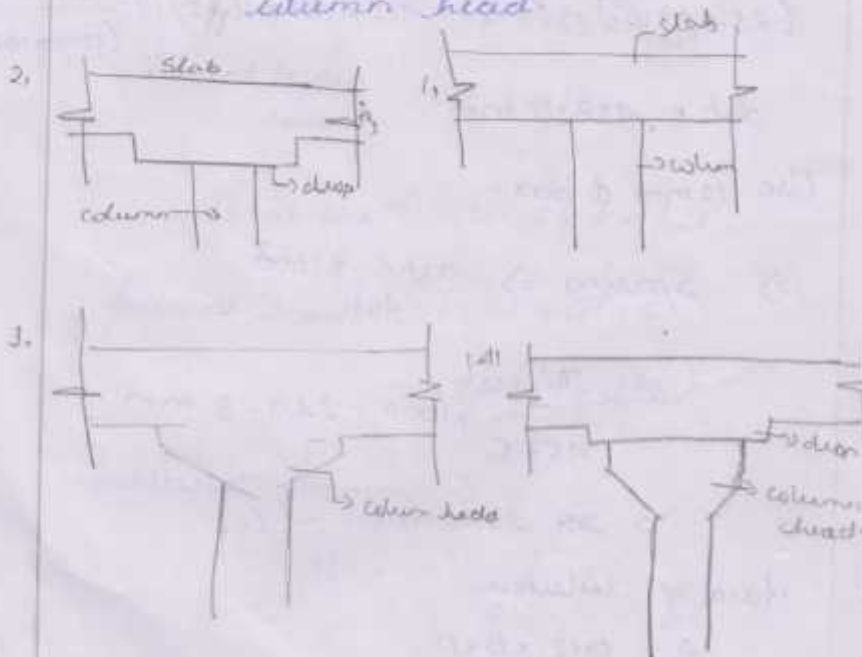
Diagram illustrating the reinforcement details for a slab. The slab width is 1000 mm and the effective depth is 190 mm. The main reinforcement consists of 12 mm diameter bars spaced at 240 mm center-to-center. The distribution reinforcement consists of 8 mm diameter bars spaced at 220 mm center-to-center. The diagram shows the arrangement of bars in the slab cross-section.

1. FLAT SLABS:-

Flat slab is the reinforced concrete slab supported directly by concrete columns without use of beams.

Types of flat slabs:-

1. Slab resting directly on columns
2. flat slab with drop panel.
3. flat slab with column head
4. flat slab with drop panel + column head.



Uses of column head:

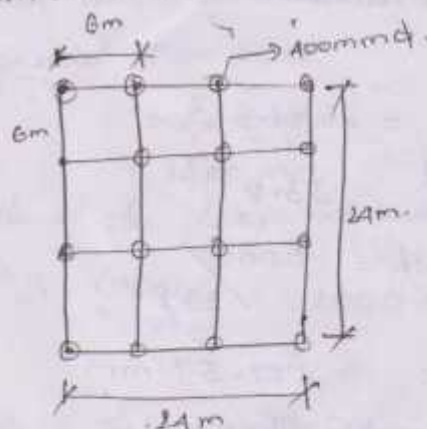
- (i) Increase shear strength of slab
- (ii) Reduce moment in slab by reducing clear (or) effective span.

Uses of drop panel:

- (i) It also increase the shear strength of slab
- (ii) It increase negative moment capacity of slab
- (iii) It stiffen the slab and hence reduce the deflection.

—X—

- i) Design the interior panel of the flat slab floor system for a warehouse. 24×24 m, divided into panel of $6\text{m} \times 6\text{m}$.
loading class = 5 kN/m^2 column size is 400 mm dia. use M20 & Fe415 grade material.



Size of core house = 24×24

Size of One panel = $2 \times 6 \times 6$ m.

Column Size = $400 \text{ mm } \phi$

M20 & fe 415

Step 2: Dimension of flat slab:

Overall Span by depth ratio = $\frac{\text{Basic value}}{\text{M.F.}}$

Span/
depth

Basic value for two way
continuous slab from IS 456-2000

clauses 22.2.1 [page No: 37] is 26.

Minimum 'act' for the slab is 0.4 & 0.6

page No: 38 (fig: 4)

Modification factor = 1.3

Span/

depth = 26×1.3

depth = 33.8

depth = $\frac{6000}{33.8}$

$= 177.51 \text{ mm}$

$\approx 180 \text{ mm} \rightarrow 150$

150

150

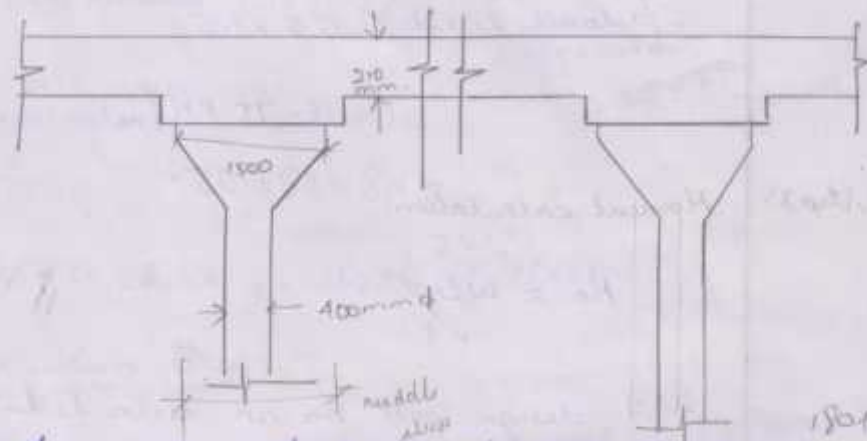
Thickness of middle strip = 180 mm. = d.

$$D = d + d'$$

$$= 180 + 30. \quad 150 + 30$$

Total depth \Rightarrow 210 mm. \Rightarrow 280

Column Strip is should not be less than $\frac{1}{4}$ th of slab thickness and preferably should not be less than 100 mm.



Here the thickness of slab @ drop = $210 + 100 = 310$ mm.

- ② Column ^{head} strip diameter it should not be greater than 0.25L

$$= 0.25 \times 6000$$

$$= 1500 \text{ mm.}$$

- ④ length of the drop should not be less than

$$\frac{L}{3} = \frac{6000}{3} = 2000 \text{ mm.}$$

$$\approx 2 \text{ m.} \quad \Rightarrow 1.7 \text{ m.}$$

width of the middle strip = 2 x column head dia

$$= 2 \times 1.5$$

$$= 3 \text{ m.} \quad \Rightarrow 2.5$$

Step 2:- load calculation:-

$$\begin{aligned} \text{Dead load} &= 5 \text{ kN/m}^2 \\ \text{live load} &= \frac{(0.28 + 0.18)}{2} \times 1 \times 25 \end{aligned}$$

$$= 6.5 \text{ kN/m}^2 \rightarrow 3.75$$

$$\text{floor finish} = 1 \text{ kN/m}^2$$

$$\text{Total load} = 12.5 \text{ kN/m}^2$$

$$\text{factored load} = 12.5 \times 1.5$$

$$= 18.75 \text{ kN/m}^2$$

Step 3:- Moment calculation:- 19.125

$$M_0 = \frac{W L_n}{8}$$

W → design load on an area L_n

L_n → clear span extending from face to face

$$\Rightarrow W = w_u L_n \quad L_n = 6 - 1.5$$

$$= 4.5 \rightarrow 3.75$$

$$\Rightarrow 18.75 \times 6 \times 4.5$$

$$\Rightarrow 506.25 \text{ kN/m}^2 \rightarrow 358.56$$

$$M_0 = \frac{506.25 \times 10^3 \times 4.5}{8}$$

$$M_0 = 284.465 \text{ kNm}$$

$$16000 \times 10^3$$

@ column strip:- (page No: 55)

clauses: 31.4.3.2.

$$\begin{aligned} (-ve) \text{ moment} &= 49\% \text{ of } M_0 = 0.49 \times 284.77 \\ &= 139.53 \text{ kNm.} \end{aligned}$$

$$\begin{aligned} (+ve) \text{ moment} &= 21\% \text{ of } M_0 = 0.21 \times 284.77 \\ &= 59.80 \text{ kNm.} \end{aligned}$$

b. Middle strip:-

$$\begin{aligned} (-ve) \text{ moment} &= 15\% \text{ of } M_0 = 0.15 \times 284.77 \\ &= 42.71 \text{ kNm.} \end{aligned}$$

$$\begin{aligned} (+ve) \text{ moment} &= 15\% \text{ of } M_0 \\ &= 42.71 \text{ kNm.} \end{aligned}$$

Step 4:- check for depth of slab.

for column strip:-

$$M_{u, \text{lim}} = 0.36 \frac{f_{ck} b d^2}{1.15} = 0.42 \frac{f_{ck} b d^2}{1.15}$$

$$(139.53 \times 10^3) = 0.36 \times 0.48 (1 - 0.42 \times 0.48) \times 1000 \times 20 \times d^2$$

$$d = 224.87 - 280 \text{ mm} \Rightarrow d = 172.7 - 250$$

hence safe.

hence safe.

for middle strip:-

$$(42.71 \times 10^3) = 0.36 \times 0.48 (1 - 0.42 \times 0.48) \times 20 \times 1000 \times d^2$$

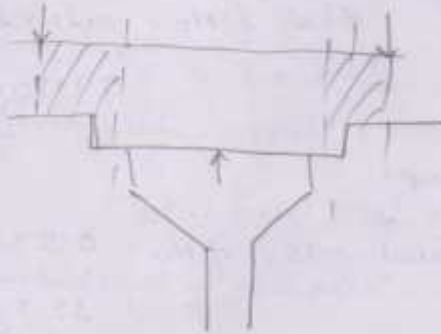
$$d = 124 \text{ mm} < 180 \text{ mm} [210 - 30]$$

$$d = 124 > 150 \text{ mm hence safe.}$$

Hence safe.

Step 5: check for shear:

shear stress is checked near the column head at Section $[D+d]$



Total load on circular area $(D+d)$

$$\Rightarrow W_1 = \frac{\pi}{4} (D+d)^2 w_c$$

$$\Rightarrow \frac{\pi}{4} \left(\frac{1.5}{1000} + 0.28 \right)^2 \times 18.75 \Rightarrow$$

$$= 46.6 \text{ kN} \Rightarrow 33.79 \text{ kN}$$

$$\text{Shear force} = W - W_1$$

$$\Rightarrow (18.75 \times 6 \times 4.5) - 46.6$$

$$= 459.65 \text{ kN} \Rightarrow 336.52 \text{ kN}$$

$$\text{Shear force / m} = 459.6$$

$$(D+d)$$

$$= 258.23 \text{ kN}$$

$$= 224.34$$

shear stress (pg No: 42)

$$Z_v \Rightarrow \frac{V}{bd}$$

$$= \frac{(258.2 \times 10^3)}{(1000 \times 280)}$$

$$= 0.92 \text{ N/mm}^2 \Rightarrow 0.89 \text{ N/mm}^2$$

permissible shear stress (pg No: 58)
(clause 31.6.3)

$$\Rightarrow K_s Z_c$$

$$K_s = (0.5 + B_c)$$

$$B_c = \left(\frac{L_1}{L_2} \right) = \frac{6}{6} = 1$$

$$\Rightarrow K_s = (0.5 + 1) \Rightarrow 1.5$$

$$1.5 > 1 \text{ So adopt } K_s = 1$$

$$Z_c = 0.25 \sqrt{f_{ck}}$$

$$= 0.25 \sqrt{20}$$

$$= 1.11 \Rightarrow 1.11$$

$$\Rightarrow K_s Z_c = 1.11$$

actual shear stress < permissible shear

\Rightarrow hence it is safe in shear.

Since self shear

Step 6: Area of steel

As_t for negative bending moment \rightarrow

$$\Rightarrow M_u = 0.87 f_y A_{st} \left[1 - \frac{f_y A_{st}}{bd f_{ck}} \right] d$$

$$(82.35 \times 10^6)$$

$$(134.53 \times 10^6) (0.87 \times 415 \times 61 \times 280) \left(1 - \frac{A_{st} \times 415}{1000 \times 280 \times 20} \right)$$

$$A_{st} = 1560.71 \text{ mm}^2$$

for (+ve Bending moment),

$$\Rightarrow (M \cdot 10^6) = 0.87 \times 415 \times A_{st} \times 280 \left(1 - \frac{415 \times A_{st}}{20 \times 100 \times 280} \right)$$

$$A_{st} = 620 \text{ mm}^2 \Rightarrow 40 \times 5$$

Spacing for -ve B.M.

Use 12 mm ϕ

$$\Rightarrow S = \left(\frac{\pi}{4} \times 12^2 \right) \Rightarrow 113.6$$

$$\frac{(1560.7)}{17} \text{ approx.} \Rightarrow 72.46 \text{ mm.}$$

adopt $S = 100 \text{ mm.}$

$$\Rightarrow 110 \text{ mm.}$$

Spacing for +ve B.M.

\Rightarrow use 12 mm ϕ

$$\Rightarrow \text{Spacing} = \frac{\pi}{4} \times 12^2$$

$$110 \times \left(\frac{620}{110} \right) \Rightarrow 379$$

$$\Rightarrow 270 \text{ mm}$$

$$= 182.4 \approx 180 \text{ mm}$$

Provide 12 mm ϕ at 100 mm ϕ as

-ve surface $\frac{1}{2}$ 12 mm ϕ at 180 mm ϕ as

+ve reinforcement $\frac{1}{2}$ 12 mm ϕ at 180 mm ϕ as

2. Design the ^{external panel} ~~overlayment~~ of flat slab floor system for a warehouse 24×24 m. divided into panel of 6×6 m, load calcn $\rightarrow 5 \text{ KN/m}^2$, column size 400 mm dia height of story 3 m . Use M20 & FE415.

Step 1 dia of slab:

i Thickness of slab.

ii Column head dia

iii width of column strip

width of the middle strip are similar to those calculated in previous problems.

Step 2: Stiffness calculation:

ratio of flexural stiffness of column to flexural stiffness of slab is given by.

$$k_c = \frac{K_c}{K_s}$$

Pg No: 56

Stiffness of column.

$$I_{cc} = \left[\frac{4 E I_c}{L} \right]$$

$$= \frac{4 \times E \times 7 \times 100^4}{64 \times 3000}$$

$$K_c = 1.67 \times 10^6 \times E$$

Stiffness of slab:

$$K_s = \frac{4EI_s}{L}$$

$$= \frac{4 \times E \times 6000 \times 280^3}{12 \times 6000}$$

$$= 7.31 \times 10^6 E$$

$$\alpha_c = \frac{K_c}{K_s} = \frac{[1.67 \times 10^6 E]}{[7.31 \times 10^6 E]}$$

$$\alpha_c = 0.23$$

from IS 456: 2000, Table 17.56:

$$\frac{l_2}{l_1} \text{ ratio } \alpha_c = 0.1 \text{ min}$$

assumable stiffness co-f.

Step 3: Bending moment calculation

$$M_o = \frac{W_n}{8}$$

$$W_n = W_n + L_s \times L_n = (18.75 \times 6 \times 4.5)$$

$$= 506.25$$

$$L_n = 6 - 1.5 = 4.5$$

$$= 4.5$$

$$M_o = \frac{506.25 \times 10^3 \times 4.5}{8}$$

=

$$M_o \Rightarrow 284.76 \cdot 76 \text{ kN} \cdot \text{m}$$

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Extreme negative design moment.

In the end span total design moment shall be design according to IS 456:2000.

Interior negative design:

$$\left[\frac{0.75 - \frac{0.10}{2}}{1 + \frac{1}{\alpha_c}} \right] M_o$$

$$= \left[\frac{0.75 - \frac{0.10}{2}}{1 + \frac{1}{0.7}} \right] (284.76 \times 10^3)$$

$$= 201.8 \text{ kNm}$$

Positive design moment:

$$\left[\frac{0.63 - \frac{0.28}{2}}{1 + \frac{1}{\alpha_c}} \right] M_o$$

$$= \left[\frac{0.63 - \frac{0.28}{2}}{1 + \frac{1}{0.7}} \right] (284.76)$$

$$= 146.57 \text{ kNm}$$

Extreme negative

$$= M_o \left(\frac{0.65}{1 + \frac{1}{\alpha_c}} \right) = \left(\frac{0.65}{1 + \frac{1}{0.7}} \right) (284.76)$$

$$= 76.21 \text{ kNm}$$

Moment in column & middle strip are obtained by interior negative design moment.

(i) Interior (-ve) design moment

$$\begin{aligned}\text{for column strip} &= 75\% \text{ of int (-ve) moment} \\ &= 0.75 \times 201.8 = 151.35 \text{ kNm.}\end{aligned}$$

for middle strip = 0.25 of int (-ve) design moment.

$$\begin{aligned}&= 0.25 \times 201.8 \\ &= 50.45 \text{ kNm.}\end{aligned}$$

(ii) Exterior (-ve design)

$$\text{for column strip} = 16.21 \text{ kNm}$$

$$\text{for middle strip} = 0$$

(iii) Interior (+ve) moment

$$\begin{aligned}\text{column strip} &= 60\% \times 146.57 \\ &= 87.942 \text{ kNm.}\end{aligned}$$

$$\begin{aligned}\text{middle strip} &= 40\% \times 146.57 \\ &= 58.628 \text{ kNm.}\end{aligned}$$

Step 4:- check for tk of slab:-

@ column:-

$$M_{u \text{ line}} = 0.36 \left(\frac{x_{u \max}}{d} \right) \left[1 - \frac{0.42 x_{u \max}}{d} \right] f_{ck} b d^2$$

$$(151.35 \times 10^6) = (0.36 \times 0.48) \left[1 - (0.42 \times 0.48) \right] (20 \times 1000 \times d^2)$$

$$d^* = 234.2 \text{ mm. } \geq 280 \text{ mm.}$$

~~hence depth provided is smaller than~~
~~required depth adopt that column depth~~

~~$$d = 235 \text{ mm}$$~~

~~$$d = 235 + 30$$~~

~~$$d = 265 \text{ mm.}$$~~

hence safe in depth.

@ middle strip:-

$$(58.62 \times 10^6) = (0.36 \times 0.48) \left[1 - 0.42 \times d \cdot 48 \right] \times 20 \times 1000 \times d^2$$

$$\Rightarrow d = 145.7 \text{ mm. } < 180 \text{ mm.}$$

required & provided.

Hence safe.

Step 5:- Area of steel:-

Area of column strip (ist).

(i) for (+ve) moment.

Moment $M_u = 0.87 f_y A_{st} \left[1 - \frac{f_y A_{st}}{b d f_{ck}} \right] d$

Column

$\Rightarrow (87.94 \times 10^6) = 0.87 \times 415 \times A_{st} \times 250 \left[1 - \frac{415 \times A_{st}}{20 \times 1000 \times 250} \right]$

$A_{st} = 934.6 \text{ mm}^2$

Use 12 mm ϕ

$S = \frac{a_{st}}{A_{st}} \times 1000$

$= 121.01 \text{ mm} \%$

$\approx 120 \text{ mm} \%$

Provide 12 mm ϕ at 120 mm $\%$ as +ve reinforcement for internal column clasp.

(2) For (-ve) moment:

$\Rightarrow (151.55 \times 10^6) = 0.87 \times 415 \times A_{st} \times$

$A_{st} = 1751.1 \text{ mm}^2$

Use 16 mm dia ϕ bars

$S = \frac{a_{st}}{A_{st}} \times 1000$

$= 114.9 \approx 115 \text{ mm} \%$

Provide 16mm ϕ at 115 mm/c as end lap
column strip

(3) det for middle strip...

for (-ve) moment:-

$$(50.45 \times 10^6) = 0.87 \times 415 \times A_{st} \times 180 \left[1 - \frac{415 A_{st}}{20 \times 1000 \times 180} \right]$$

$$\Rightarrow A_{st} = 961 \text{ mm}^2$$

use 12mm ϕ

$$S = \frac{a_{st}}{A_{st}} \times 1000$$

$$= 131.3 \approx 130 \text{ mm/c.}$$

Provide 12mm ϕ at 130mm/c.

for (+ve) Moment:-

$$(58.52 \times 10^6) = 0.87 \times 415 \times A_{st} \times 180 \left[1 - \frac{415 A_{st}}{20 \times 1000 \times 180} \right]$$

$$A_{st} = 1022 \text{ mm}^2$$

Spring-

use 16mm ϕ

$$\Rightarrow S = \frac{\pi/4 \times 16^3}{1022} = 196 \approx 195 \text{ mm/c.}$$

Provide 16mm ϕ at 195 mm/c as \pm use for far
middle strip

1st for column strip (exterior).

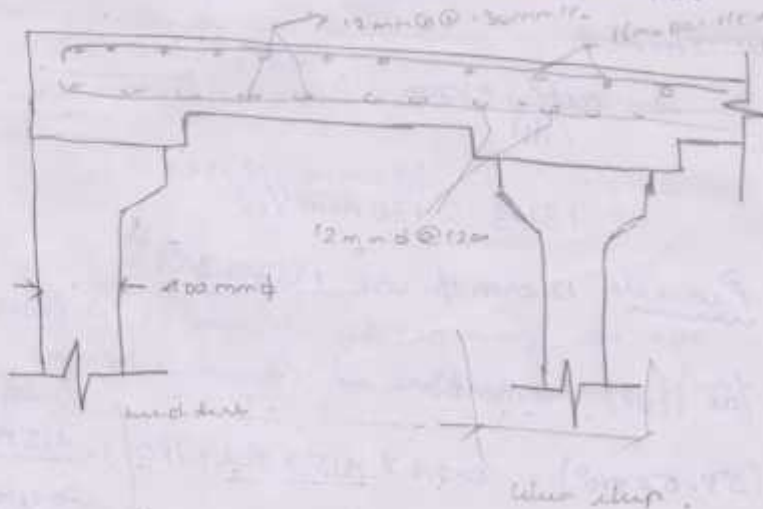
$$76.2 \times 10^6 = 0.87 \times 415 \times A_{st} \times 280 \left[1 - \frac{415 A_{st}}{20 \times 1000 \times 280} \right]$$

$$A_{st} = 801 \text{ mm}^2$$

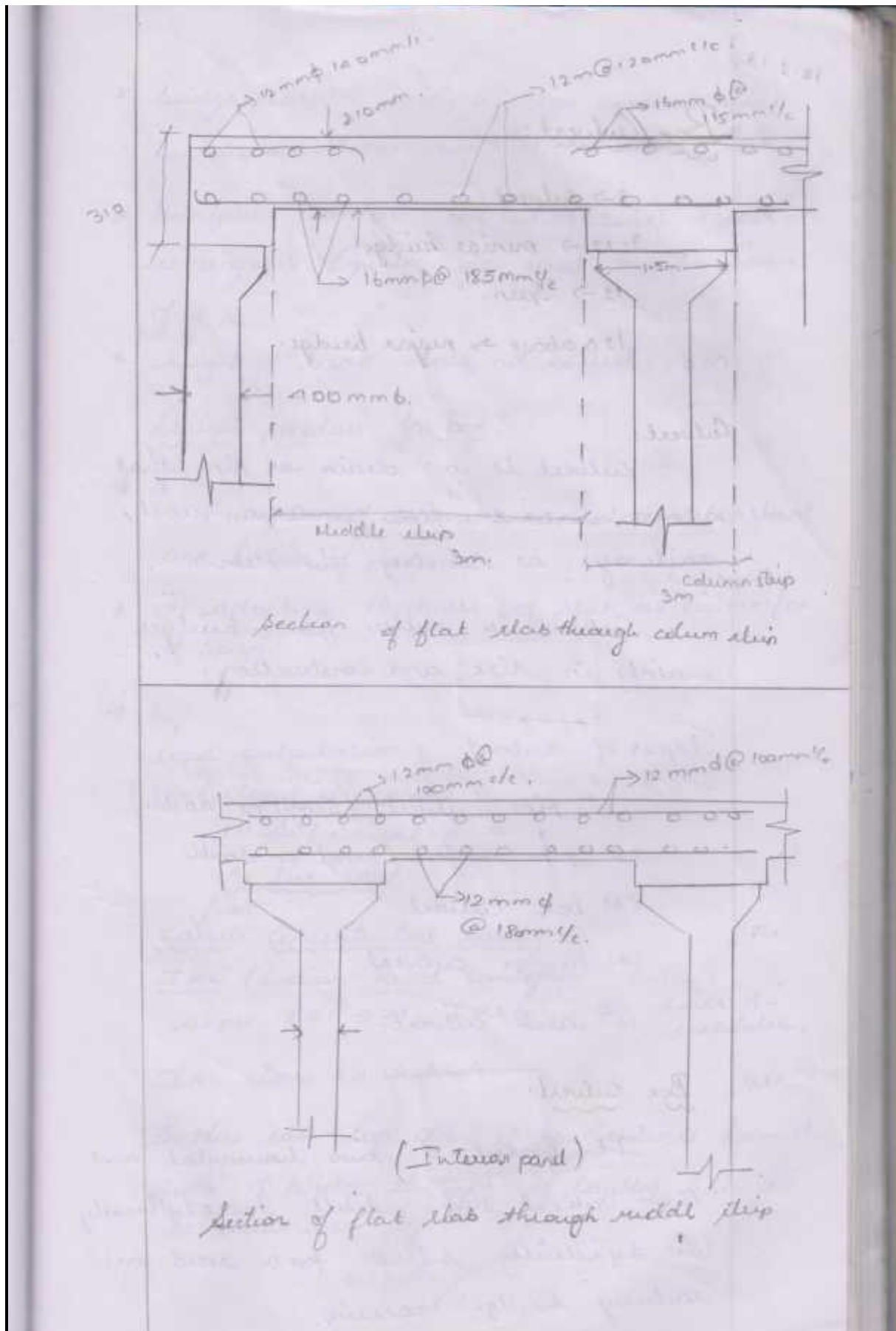
Provide 12 mm dia

$$\Rightarrow \text{Spacing} = \frac{\pi/4 \times 12^2}{A_{st}} \times 1000$$

$$= 141 \text{ mm} \approx 140 \text{ mm c/c.}$$



Section of flat slab shows
column strip
middle



19-2-13

Box Culvert:

3 → culvert.

3-12 → minor bridge

12 → Span.

12 & above → major bridge.

Culvert:

Culvert is a drain or pipe that allow water to flow under a road, railways, or temporary obstruction.

Culvert is differ from bridges mainly in size and construction.

Types of culvert

- (1) pipe culvert (single or double)
- (2) pipe arch (single or double)
- (3) box culvert
- (4) bridge culvert.
- (5) arch culvert.

Box Culvert:

It consist of two horizontal and two vertical slabs built monolithically (or) rigidly. suitable for a road or railway bridge crossing.

- * bridge crossing with a high embankment crossing a stream, with a limited flow.
- * Reinforced concrete box culvert with square or rectangular opening are used up to span of 4m.
- * height of bank does not exceed 3m.

Design procedure for box:-

- * 1
 - (i) assumption of dimension, design constant and section of material.
 - (ii) adopting thickness of slab as 100mm/m of span.



* 2

load calculation (
(load in cases)

- (i) Self weight
- (ii) live load.



Case (i) concentrated load:

IRC (Indian Road Congress)

upto IRC 21, IRC 6, IRC class A- vehicles,

IRC class AA vehicle

In this case top class of box culvert from the depth of bridge. the type of loading have to be determined by

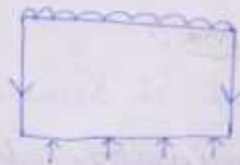
$$W = \frac{P \cdot L}{2}$$

where, $p \rightarrow$ wheel load.

$I =$ Impact load

$w =$ Concentrated load.

Case 2: Uniformly distributed load:



Case 3: Weight of Side wall.



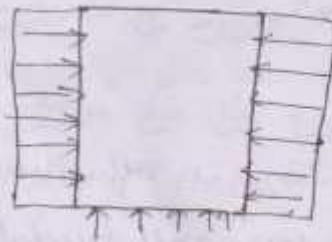
Case 4: \rightarrow water pressure inside culvert:-



Case 5: Earth pressure on Vertical Side walls.



Case 6: uniform lateral load on side wall.



(8) (2)
18-13

* 3

Analysis of moment, shear and thrust:

(i) Various loading patterns considered in each step are moment, shear and thrust corresponding to the different case of loading and evaluated using coefficient of different loading cases. For

(ii) Design forces resulting from the combination of various cases yielding maximum moment and shear at support of mid span. 5. → ③
8. → ④

13. → ⑤

*

Design of reinforcement:

(i) Reinforcement are designed by moment for mid span of the bottom slab, support section and vertical side wall and distributed reinforcement:

(ii) 0.3% of cross sectional area, is provided as the minimum rebar.

(iii) for vertical side wall, minimum rebar \Rightarrow 0.8% of cross sectional area.

Raft Foundation:

Def:

Raft foundation is otherwise known as mat foundation (or) raft foundation it support no. of heavily loaded columns situated on a soil of low bearing capacity.

Columns are interconnected with beam & beam are connected with RCC Slab.

The slab is supported on soil, types of Raft:

(i) Raft (or) mat.

A thick slab like footing of reinforced concrete supporting a no. of columns (or) entire building.

ii. Ribbed mat:-

A mat foundation reinforced by a grid of ribs above or below the slab.

iii. Cellular mat.

A composite structure of reinforced concrete slab at basement walls forming as a mat foundation.

design principle of mat or Raft foundation:

Required data for the raft foundation are

- (i) Size of building
- * Spacing of column
- * arrangement of service load of each column,
- * Size of column, safe bearing capacity of soil and characteristics of material.

* Step 1: Design of Raft Slab:

→ Total working load for all columns
 $\Rightarrow \text{No. of column} \times \text{service load per column}$

→ Self weight of Slab + beams.

$= 10\% \text{ of column load}$

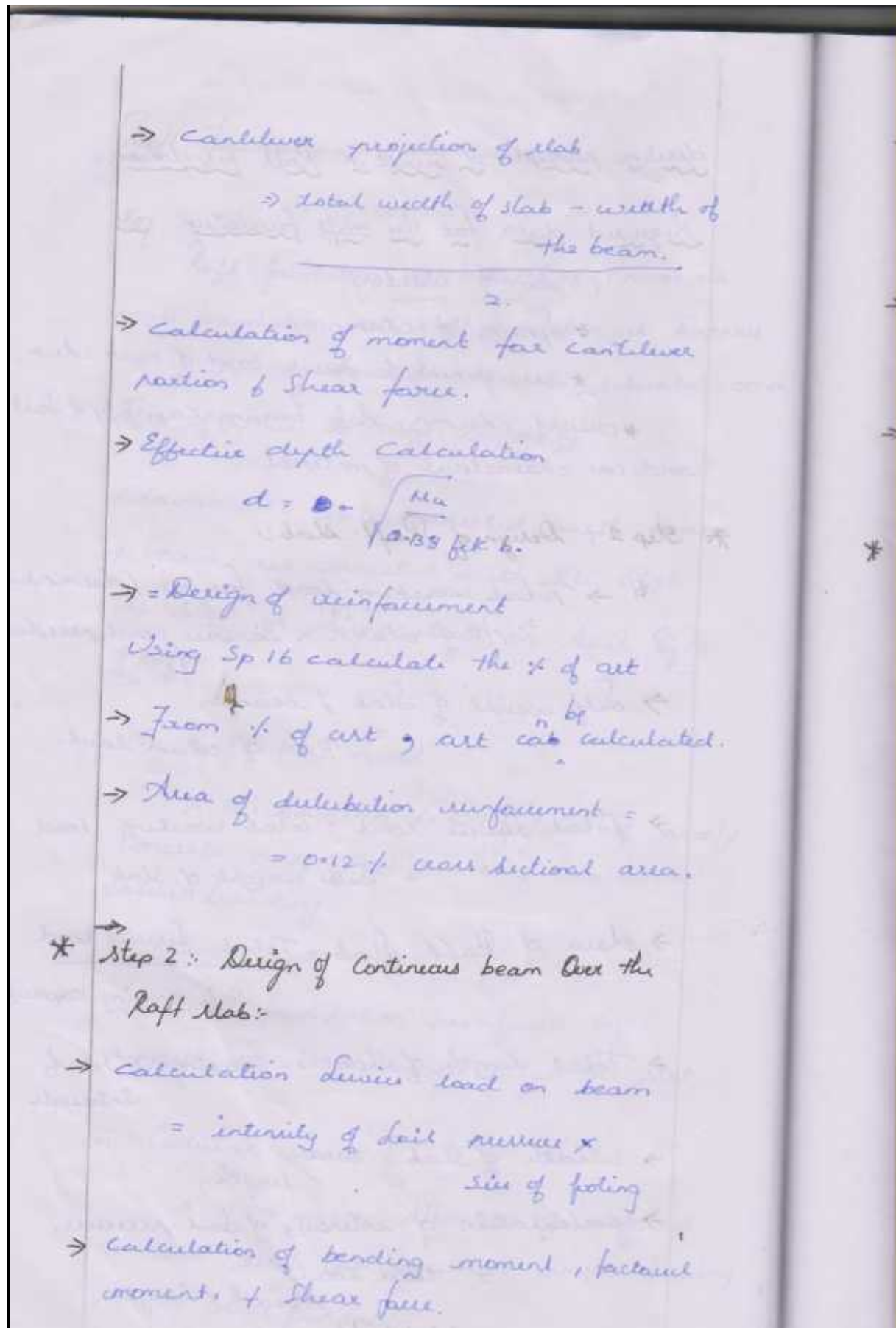
→ Total service load = Total working load
 + Self weight of Slab

→ Area of Raft Slab = $\frac{\text{Total service load}}{\text{Safe bearing capacity}}$

→ Total length of Slab = $\frac{\text{Spacing} \times \text{No. of intervals}}$

→ width of Slab = $\frac{\text{area}}{\text{length}}$

→ Calculation of intensity of soil pressure.
 $= \frac{\text{total load}}{\text{width} \times \text{length}}$



→ breadth of beams.

Normally breadth of beam := width of column.

→ Effective depth of beam = d

$$d = \sqrt{\frac{M_{ux}}{1.38 f_k b}}$$

→ Calculation of percentage of reinforcement + reinforcement can be calculated by % of ast

* Step 3 :- Shear reinforcement:-

From the Shear force we can calculate the nominal shear stress τ_v

If $\tau_v < \tau_c$ the minimum shear reinforcement is provided.

If $\tau_v > \tau_c$ then design a shear reinforcement.

—x—

Design the interior plate of flat slab for a auditorium building 25 m x 25 m is divided by panel of 5 x 5 m loading class = 6 kN/m² size of column is 350 mm dia use M20 / Fe 415 grade material.