29.7.15
Saturday

Lec - 1

CE - 315

Dr. Shafiul Bari

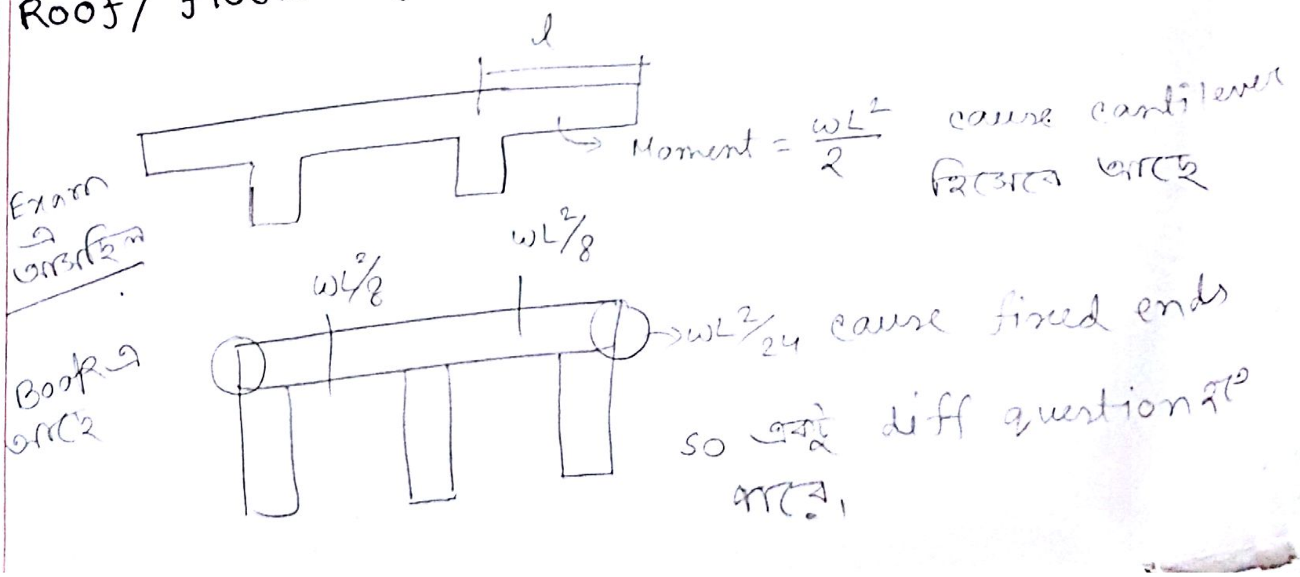
Design of Concrete Structures - I

Book : 14th Edition, by NILSON

* Reinforced Concrete.
other one is pre-stressed concrete
Here in this course we see only reinforced concrete.
Analysis is must for design. Output হিসেবে আমাদের
some drawings. ~~so~~ construction হতে হবে, Drawing
wise construction না করা গেলে its a waste.

Design is not a science. It is an art.
Construction start হয় নিচ থেকে, design starts from the top.

* Roof/ floor system



31.9.15

Monday

Lec - 2

1) BNBC - 1993   VOL - 1   Part I - V
    2006   VOL - 2   Part VI → এটা আলাদা
    VOL - 3   " VII - X

2) Structural Design Guide to ACI Building Code - by Paul Rice (3rd Edition)

Concrete:

1) How to make good concrete
2) Properties of wet & hard concrete

To be a good concrete we need good materials and also good mixing.

Pile এর slump 6" - 8"

Strength,
Concrete এ যে steel used তার rebar → 40 grade, 60, 72.5
steel structure এর steel কে বলে structural steel.
Structural steel এর grade usually 36 ksi, now producing 50 ksi.

Grade বলতে yeild strength বোঝায়। But its not the only criteria.

60 grade এর ultimate strength 90 ksi

40 " " " " 70 ksi

75 " " " " 100 ksi

These testing criterias come from ASTM.

* Is concrete structure good or steel?

18.1 → advantages of concrete structure
Pg-613

Structural System: BNBC ও part VI এ বলা

18.1, 18.2 এ floor system নিয়ে বলা

Floor system/roof system is to resist the gravity — Dead load, live load

Structural system to resist lateral load — wind, earthquake load.

In class only D.L & L.L

loads: 1.3 → learn from BNBC

Gravity Load

Lateral Load

1.4 What do you mean by serviceability?

Less vibration, deflection must

1) deflection must be within allowable limit. Limit is shown in chapter 6 for diff. structures

2) Crack width should be small - chap 6

3) Less vibration

* Strength:

What are the uncertainity which require a factor of safety?

Ans - 1.4

02.9.15
wednesday

Lec - 3

1.3 Loads : (BNBC অনুযায়ী)

DL → Self wt (given or not given)
SDL → FF; PW (self imposed dead load)
LL →

F.F = Floor finish
P.W = Partition wall (BNBC - 2.3.3.3 → provision for PW)
যদি SDL দেয়া না থাকে then ধরে নিতে হবে।

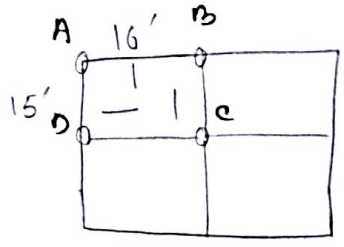
F.F usually 20, 25, 30 psf

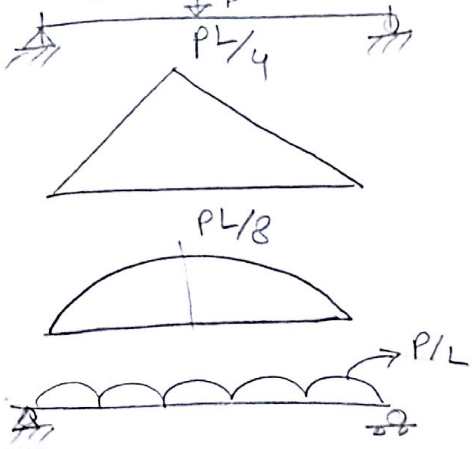
BNBC Vol-II ⇒ chap-1 ⇒ 1.3 এর general design requirement থেকে পড়ব।

concrete — light wt, medium wt, normal wt
(Brick chips used) 125-130 pcf
150 pcf (stone chips used)

Steel এর unit weight = 490 pcf
Bricks ,, ,, = 120 pcf

Partition wall ⇒ line load কে uniformly distribute করতে X 1.33. এভাবে ABCD এর segment wise P.W এর load distribution করতে হবে।





partition ⇒ uniform load ⇒ distribute করলে moment half হয়।

(*) Unit conversion always SI unit ⇒ করব।

L.L:

(*) Live load → Table 6·2·3 , Pg-6-22 (Floor L.L)

occupancy: কোন purpose ⇒ use হচ্ছে সেটার occupancy

Depending on the use of room we need to determine L.L.

Roof L.L: Table-6·2·4

roof flat, slope, roof ⇒ garden etc wise different.

(*) Book: Table 1·1 (Pg-10 -11)

In Bangladesh follow 6·2·3

Q. What is the ~~sour~~ Defn of Factor of safety ?

1·6 → Design Codes & specifications:

1·7 →

$M_u \le \phi M_n$ → capacity (nominal)

$V_u \le \phi V_n$ → table 1·3

$P_u \le \phi P_n$

Table 1·2

ϕ → strength reduction factor

ϕ দিয়ে X করলে design moment capacity

V_n = nominal shear capacity

P_n = Axial " "

M_u = Analysis moment

V_u = " shear

P_u = " axial

$U = 1·2DL + 1·6LL$

load factors

Q. Why load factors are diff for L.L & D.L? Pg-17

Q. Why the strength reduction factor is different?
Pg-(18)

M_n, V_n, P_n এগুলো material property থেকে, এটা থেকে এগুলো capacity.
V_{max}, M_u, P_u এগুলো annalysis of the structure থেকে,

Like: Reinforced elements এর capacity একরকম, অন্য element এ অন্যরকম, এগুলো M_n, V_n, P_n

Main D.L এটার slab থেকে.

7.9.15
Monday

Lec - 4

$\phi M_n \geq M_u$ $\qquad$ $U = 1.2DL + 1.6LL$ → Table 1.2

$\phi V_n \geq V_u$ $\qquad$ $\phi = 0.9$
$\phi P_n \geq P_u$ $\qquad$ $= 0.75$ | Table 1.3

ϕ যত কমাব, safety তত বেশি।

compression controll : 0.65 – 0.75
Tension control : 0.9

strain in steel = strain in concrete

Q. Why Reinforcement used in concrete?
concrete tension নিতে পারে না, এজন্য tension zone এ Reinforcement.

Chap - 2

OPC
PPC – Portland, composite cement

f'_c = concrete strength by cylinder (4" × 8") → Now | Here loads $U = xLL + yD.L$
(2" × 4")
28 day cylinder compressive strength (3" × 6")

ultimate before failure:

f_r = Modulus of rupture (Pg - 47) $7.5\sqrt{f'_c}$ → (must be in psi)

f_t = tensile strength

* f_y = yeid strength of reinforcing steel

When used in concrete reinforcement bars are known as re-bar. Rebars in concrete must be deformed. Plain bar হবে না.

Pg -55

f_y এর 40, 60 grade, 72.5, 80 grade

500 MPa ব্যবহার করি.

Grade হল - 1) yeild
2) ultimate
3) % elongation

Working stress Design:

$f_c = 0.45 f'_c$ Here Load = D.L + L.L

$f_s = 0.40 \sim 0.5 f_y$

E_c = Modulus of elasticity of concrete

$= 57,500 - 57,000 \sqrt{f'_c}$ (psi) (stone chips)

$= \frac{6}{\varepsilon_c}$ ← strain $= 45\,000 \sqrt{f'_c}$ (Brick chips)

$6 = \varepsilon_c \times E_c$ ← এখানে f'_c থেকে

This is for stone chips.

If Brick chips নিয়ে করা হয়

BNBC → Pg 6-134

5·13·2

$E_c = 4700\sqrt{f_c'}$ → for stone chips

$= 3750\sqrt{f_c'}$ → for brick chips

] SI unit

Appendix ↳ converted to F.P.S.

9.9.15

Lec - 5

Chapter - 3

Flexural Analysis and Design of Beams (floors)

Beams layout plan - in plain section

Slab থাকে মাটির লেভেল, Ground এ না.

Beam layout plan থেকে Beam numbering করা হয়.

আমরা only DD & LL এর জন্য analysis করি.

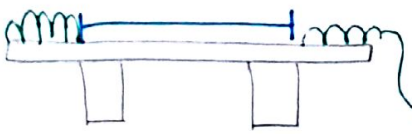
Frame structures indeterminent structures.

Chapter - 12

Pg - 387, Placement of loads

Dead load cost.

L.L. varying



Dead load অবস্থায় নাই, only cantilever part এ L.L, so max^m -ve moment.

Max^m positive moment if L.L in blue part.

Calculate the critical moment

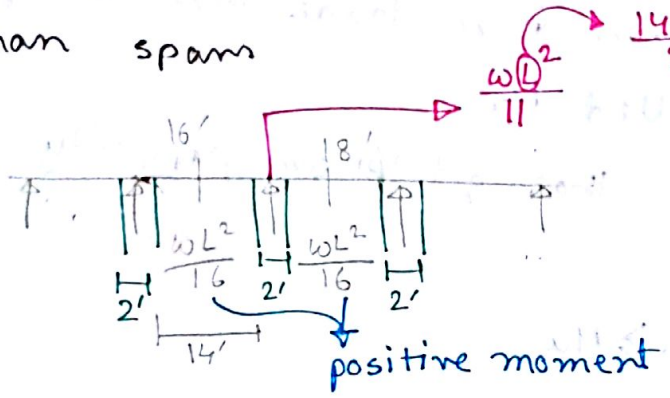
Fig 12.3 → Pg - 390

12.3 → ACI Moment co-eff:

Pg - 406. এই co-eff use করে moment calculate করতে হবে chap 3 এ.

Pg - 408, fig-10

More than span



L = clear span

clear span = 16'

20%. এর বেশি span variation হলে যাবে না

এখানে +ve moment হবেই না cause এর ACI co-eff আসবে না cause spans differ by > 20%.

Table 12.1, Fig -12.10, 12.1 important

Idealization of Structure: Pg - 394

Fig - 12.4

12.9.15
Saturday

Lec - 6

Pg - 67

Basis of design:

Moment that comes from loads that we get from analysis is called Mu.

ϕM_n moments that get from property of beam materials.

Design $\phi M_n \geq M_u$

⊞ What will be the modulus of rupture?

$f_r = 7.5\sqrt{f_c'} = 7.5\sqrt{3.5\times10^3}$ psi $= 443.705$

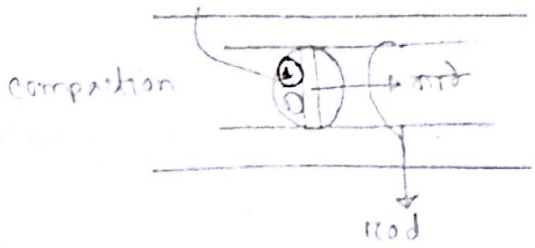
↳ comprenive strength of 28 day cylinder

* f_c' record করতে হবে।

* আমাদের দেশে clear cover বেশি নেয়া হবে because of poor workmanship. Fire protection & corrosion এর জন্য C.C., Must be 20 mm everywhere, minimum.

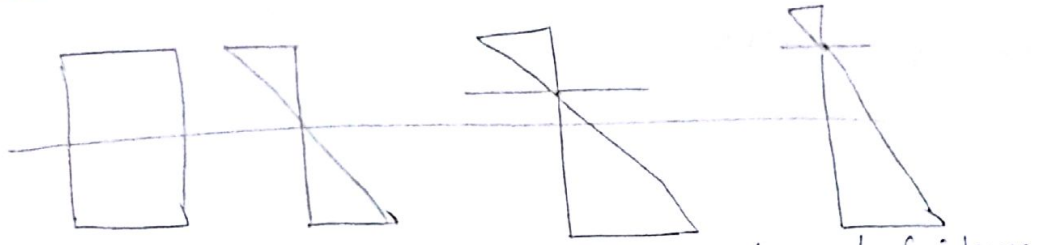
→ C.C. block 28 দিন আগে বানাব, curing করব।

Q. Compaction কিভাবে করি?



compaction করিবার সময় যেখানে support এর against করি। এখানে suppose ① ও compaction করতেছি, back ও কাঠ support হিসেবে দিলাম। Compaction এর কাজ slipage prevent করা। কারণ stress develop করে না। Compaction ঠিকমতো না হলে strength কমে যায় ঠিকমত। construction ও নিচে base, চারদিকে shutter ও ব্যবহার যেহেতু সাপোর্ট নেই। then ঢালাই করি to prevent slipage.

Fig 3·2

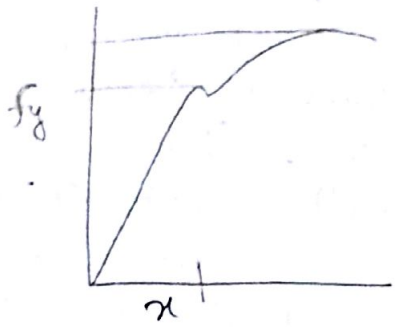


before crack এ যে tension তাই compression diagram.
after crack tension before crack এর 5 গুণ।
At failure after crack এর ৩ 3 গুণ।

14.9.15
Monday

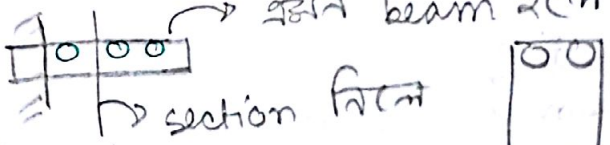
Lec - 7

Cracks can be of 3 Types.

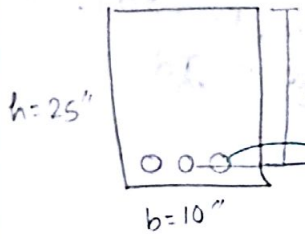


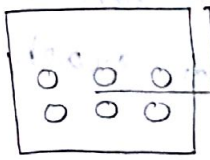
fy এর corresponding deformation x.
fy এর পরেও বাড়ে, but তখন deformation অনেক বাড়ে।

ϵ_c exceeds 0.003, then concrete crush করবে।
↳ stress of concrete



3.1



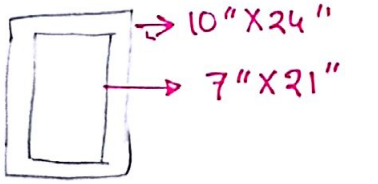


double layer RCC হলে 3.5" ~ 4.5"

minimum
$d = h - 2.5$ single layer RCC
↓
max^m d

Math করার সময় h থেকে 3" বাদ দিব।

Beam size 10"X24" হলে, ring size 7"X21"



φ for #8 এর 25 mm হলে 0.75 mm হবে

$A_s = 3 * 0.79 = 2.37\ in^2$

~~25mm~~ #8 / 8 সুতা rod কোথাও লেখা না। All drawings must be in mm.

25 mm rod এর are $0.75\ in^2$

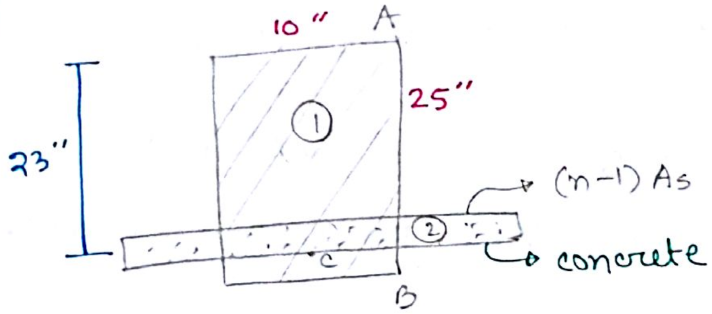
$f_c' = 4000$ psi

$f_r = 475$ psi [না দেয়া থাকলে $7.5\sqrt{f_c'}$ psi]

$f_y = 60,000$ psi

M = 45 ft-kips

We are replacing steel by concrete



n = modular ratio

$= \frac{E_s}{E_c}$

$n = \frac{29\times10^6 \text{ psi}}{57000\sqrt{4000}}$ → if beam of stone chips ↓ Brick chips হলে $45000\sqrt{f_c'}$

$= 8.04$

$\therefore n = 8$ (8.5 এর উপর হলে 9)

$\therefore (n-1)A_s = (8-1)\times 2.37$

$= 16.59\ in^2$

$\bar{y} = \frac{25\times10\times12.5 + 16.59\times23}{25\times10+16.59}$ (from top)

$= 13.153''$

$I = \underbrace{\frac{10\times25^3}{12}}_{bh^3/12} + \underbrace{(25\times10\times(0.653)^2}_{A_1 d_1^2} + \underbrace{16.59\times(23-13.153)^2}_{A_2 d_2^2}$

$= 14.736\times10^3\ in^4$

Kip ft কে pound/in এ নিয়ে

$$\sigma_{top_A} = \frac{45 \times 12{,}000 \times 13.15}{I}$$

$= 481.88$ psi (compression)

$$\sigma_{bottom_B} = \frac{45 \times 12{,}000 \times (25 - 13.15)}{I}$$

$= 434.24$ psi (Tension as in bottom)

as $434.24 < f_r$.
So ~~our~~ there is no crack. So our approch is ok.

<u>In concrete:</u>

$$\sigma_c = \frac{45 \times 12000 \times (23 - 13.15)}{I} = 360.95 \text{ psi}$$

$\sigma_s = n * \sigma_c = 2887.62$ psi $= 2880$ psi

$f_y = 60{,}000$ psi (yeild stress) এর জন্য মাত্র 2880 psi stress instead.

Tensile stress at bottom fiber $< f_r$ then ঠিক আছে & no crack.

But if tensile stress " " " $> f_r$ then then section is cracked. So diff way তে stress বের করতে হবে।

এজন্য বুঝতে suppose M = 60 Kip-ft

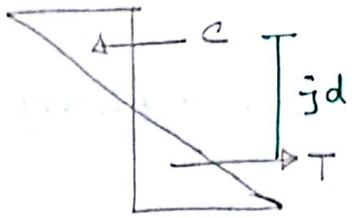
$$\sigma_B = \frac{60 \times 12000 \times 12.5}{10 \times 25^3/12} = \frac{Mc}{I} = 691.2 > f_r.$$

So section cracked.

So 1st এ $\frac{Mc}{I}$ apply করে bottom stress বের করব,
< modulus of rupture হলে এ approch. transformed section.
> f_r হলে approch cracked section.

Cracked section এর জন্য Basic concept beam is in equillibrium.
So compressive stress = tensile stress

→ এ part কোন stress নিবে না in cracked sec



$M = C \times jd$

or $T \times jd$

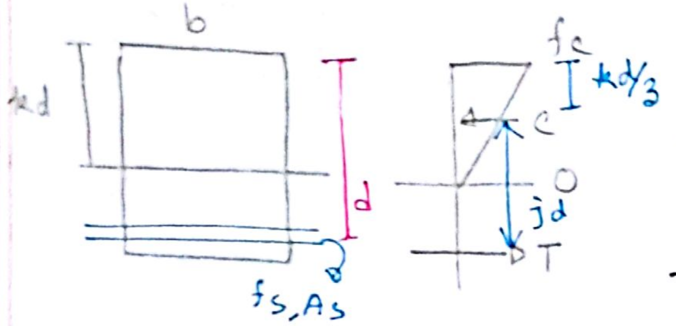
M is moment or couple.

16.9.15

Wednesday

Lec - 8

Fig 3.5



Average stress $= \frac{f_c + 0}{2}$

Area of beam $= bkd$

$\therefore$ com. ~~stress~~ $= \frac{1}{2} f_c\, bkd$

$T = A_s f_s$ —— (3.6)

$jd = d - kd/3$

$j = 1 - k/3$

$\therefore M = Cjd$

$= Tjd$

$= \frac{1}{2} f_c\, k j b d^2$

$= A_s f_s jd$

> ২টার মধ্যে যেটা ছোট সেটা allowable moment capacity

from eqn 3-12: $K = \sqrt{(\rho n)^2 + 2\rho n} - \rho n$

steel ratio

$\rho = \frac{A_s}{bd}$ → ratio of area

$n = \frac{E_s}{E_c}$

Determine the allowable moment capacity.

we need f_c, f_s

if f_c not given $f_c = 0.45 f_c'$

f_s not given $f_s = 0.45 \sim 0.5 f_y$

Ex: 3.2

$M = 90 - K\text{-}ft$

$A_s = 3 \times 0.79 = 2.37$

$$f_b = \frac{Mc}{I} = \frac{90 \times 12000 \times 12.5}{\frac{10 \times 25^3}{12}}$$

$= 1036.8 \text{ psi} > f_r (475$

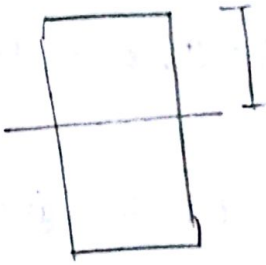
∴ section is cracked

$$\rho = \frac{2.37}{10 \times 23} = 0.0102 \qquad n = 8$$

$$k = \sqrt{(\rho n)^2 + 2\rho n} - \rho n = 0.33$$

$kd = 23 \times 0.33 = 7.63$ | $j = 1 - k/3 = 0.89$

For uncracked section



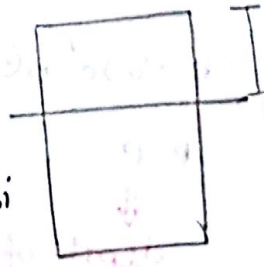
Moment given, so find stresses

$$f_c = \frac{2M}{kjbd^2}$$

$$= \frac{2 \times 90 \times 12000}{0.33 \times 0.89 \times 10 \times 23^2}$$

$= 1390 \text{ psi}$

But now

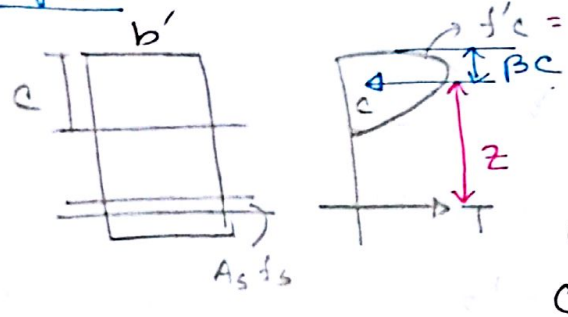


$$f_s = \frac{90 \times 12 \times 10^3}{2.37 \times 0.89 \times 23} = 22261.66 \text{ psi}$$

M_n = nominal moment capacity

যখন stress ultimate এ যায় তখন stress dia not linear, it becomes parabolla.

Fig 3.6



avg stress $= \alpha f'_c$

⇓ factor less than 1

area $= bc$

$C = \alpha f'_c (bc)$

$T = A_s f_y$

$M = C.z = T.z$

$\hookrightarrow z = d - \beta c$

Pg-77 এ given the values of α & β

Always $C = T$ (cause equillibrium এ থাকবে)

$\Rightarrow \alpha f_c' bc = A_s f_y$

$\Rightarrow c = \dfrac{A_s f_y}{\alpha f_c' b} = \dfrac{\rho d b f_y}{\alpha f_c' b} = \dfrac{\rho d f_y}{\alpha f_c'}$

⇓ depth of neutral axis

$$M_n = \rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f_c'}\right)$$ → memorise

$\beta/\alpha = 0.59$ → related to f_c'

(But slight diff হলে তখন constant ধরি)

if ৪ with ৭ can also calculate β/α for given f_c'

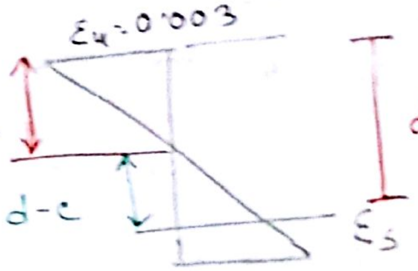
25 –	0.75	# 8
22 →	0.6	# 7
20 →	0.48	# 6
16 –	0.31	# 5
12 –	0.175	# 4
10 –	0.11	# 3

} এগুলো হলো area এদের diff হলো cause these denote inch এ diameter

If failure is initiated by crushing of concrete not yielding of steel then

$\alpha f'_c b c = A_s f_s$

$f_s = E_s \varepsilon_s$ → constant 29×10^3 ksi



from similar triangles,

$$\frac{0.003}{c} = \frac{\varepsilon_s}{d-c}$$

Exm: 3.3 : failure stage

steel stress = f_s = 60,000 calculate করো।

3.10.15
Saturday

Lec - 9

Principal of Beam design:

$$\phi M_n \geq M_u$$

Example : 3.3 :

Q. If the load changes from zero to failure then what will be the position of N.A. → show with sketches?

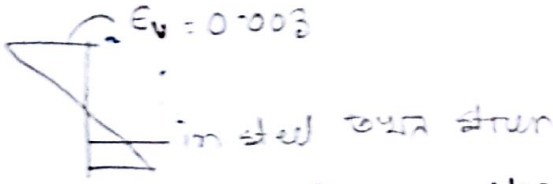
- Fig - 3.9 → Pg 85

  $\epsilon_t = 0.005$ tension controlled

  $\epsilon_t = 0.002$ comp. con.

  $\epsilon_t = 0.002 - 0.005$ transition zone

- Pg - 82 ; Balanced strain condition



At balance failure, the steel strain ϵ_u is ϵ_y when crushing strain, ϵ_u is 0.003

if $\rho < \rho_b$ then under reinforced

then failure will be for yeilding of steel not crushing of steel.

0.85 if f_c' upto 4000 psi, for ↑ 1000psi β_1 increase by 0.5

$$\rho_{max} = 0.85 \beta_1 \frac{f_c'}{f_y} \frac{\varepsilon_u}{\varepsilon_u + 0.004}$$

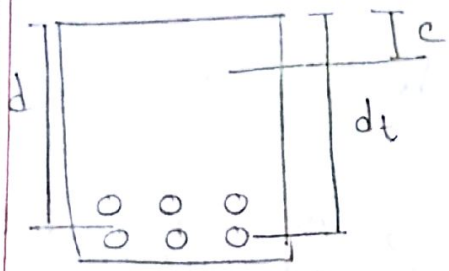
$$\rho_b = 0.85 \beta_1 \frac{f_c'}{f_y} \frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}$$

ϕ will be 0.9 tension controlled when $\varepsilon_t \geq 0.005$

$\therefore \varepsilon_t < 0.005$ upto 0.002 $\quad \phi = 0.75$ $\quad \varepsilon_t < 0.002$, $\phi = 0.65$

if $\rho_{0.005} = 0.85 \times \beta_1 \times \frac{f_c'}{f_y} \underbrace{\frac{0.003}{0.003 + 0.005}}_{3/8}$

if very low axial load then ε_t can't be less than 0.005.



c/d ratio দ্বারা failure tension, compression controlled ~~নির্ণয়~~ check.

Tension controlled হলে eqn 3.31.

Exm 3.4:

$$\rho = \frac{A_s}{bd}$$

$\rho_{max} = \ldots$

$\rho < \rho_{max}$, so undereinforced, so fails in yeild

minimum Reinforcement ratio ρ_{min} নির্ণয়।

Lec – 10

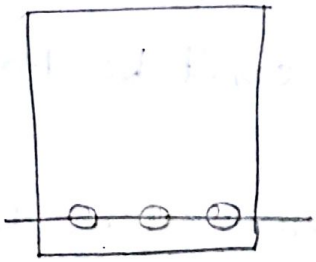
(See Lamiya's lecture)

5.10.15

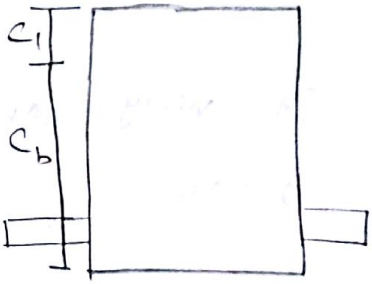
Monday

$$\rho_{max} = 0.85 \beta_1 \frac{f_c'}{f_y} \times 3/7$$

$$\rho_{min} = \frac{200}{f_y}$$



$M_n = A_{s\,min} f_y (d - a/2)$



$$f_r = \frac{M_{cr} C_b}{I}$$

$\beta_1 =$

$$\rho_{0.005} = 0.85 \beta_1 \frac{f_c'}{f_y} 3/8 =$$

$$= 0.85 \times 0.85 \frac{4}{60} \times 3/8 =$$

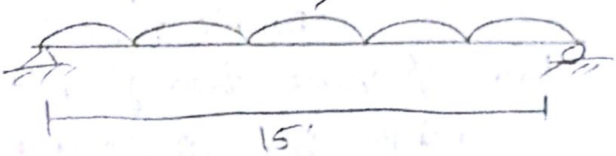
$$\varepsilon_t = \frac{10.58 \times 0.003}{0.692}$$

$$= 0.00458$$

$$\rho = \frac{A_s}{bd} = \frac{4}{12 \times 175} = 0.019$$

Ex 3.6

DL = 1.27
LL = 2.15

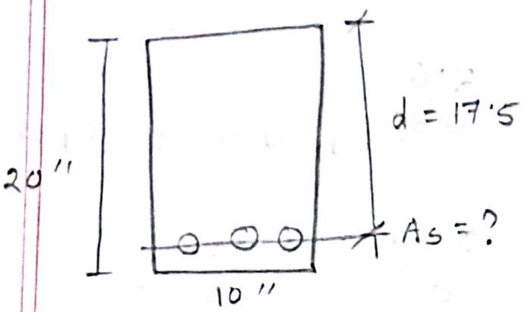


$M_u = \phi M_n$

Lec - 11

7.10.15
Wednesday

Ex 3.7 :



$M_u = 1300 K''$

1st এ a = 2" (10% of h)

$$A_s = \frac{M_u}{\phi f_y (d - a/2)}$$

$$= \frac{1300}{0.9 \times 60 (17.5 - 2/2)}$$

$$= 1.459 \text{ in}^2$$

$$a = \frac{A_s f_y}{.85 f_c' b} = 2.57$$

$$= \frac{1.46 \times 60}{0.85 \times 4 \times 10}$$

[book এ a assumed 4"
checked and found 2.76"]
এখানে বড় আসলো so 2nd trial এ a বাড়াব.

যা দিয়ে start করলাম তার বেশি পেলাম, so a বাড়াব।

Again $a = 2.6$ ∴ $A_s = 1.49 \text{ in}^2$

$$\rho = \frac{A_s}{bd} = \frac{1.49}{10'' \times 17.5} = 0.0085 < \rho_{0.005}$$

∴ under reinforced beam

$\rho_{.005} = 0.0181$

Suppose

if $\rho = 0.019 > \rho_{.005}$

if $\rho > \rho_{max}$ → over reinforced (Double R.B)

$\rho < \rho_{max}$ & $\rho > \rho_{0.005}$ then ϕ value changes, single rei B, but $\phi < 0.9$ (*)

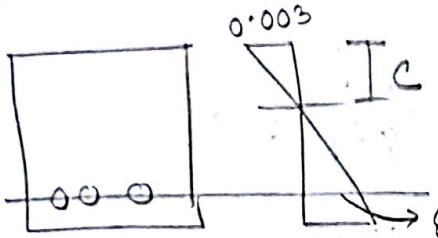
if $\rho = \rho_{max}$ $\epsilon_t = .004$

if $\rho = \rho_{.005}$ $\epsilon_t = 0.005$

if $\rho < \rho_{.005}$ → $\phi = 0.9$ single R.B

(*) সবসময়ই $\rho > \rho_{0.005}$ then ϵ_t এর value বের করতে হবে,

from similar triangle



$c = a/\beta_1 = \frac{2.6}{0.85}$ → upto 4000psi

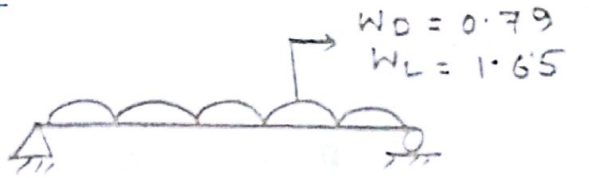
$\frac{0.003}{c} = \frac{\epsilon_t}{17.5 - c}$

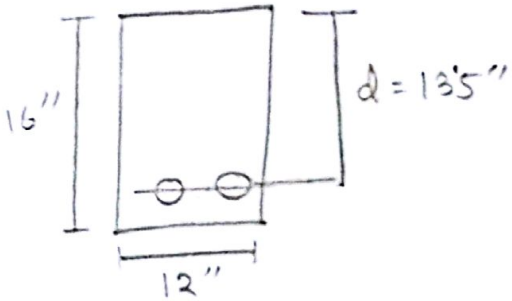
from ϵ_t $\phi = 0.65 + (\epsilon_t - 0.002) \times \frac{250}{3}$

=

[Exm 3.8 ⇒ ϕ value বের করতে]

Ex 3.8 :





$W_u = 1.2DL + 1.6LL = 3.59\ K/'$

$M_u = \frac{W_u d^2}{8} = 2150\ K''$

$a = 1.6''$

$A_s = \frac{2150}{0.9 \times 60 (13.5 - 1.6/2)} = 3.14\ in^2$

$a = \frac{3.14 \times 60}{0.85 \times 5 \times 12} = 3.69''$

1.6 & 3.69 এর diff অনেক বেশি, so assumption অনেক কাছের.

$a = 4.2'' \rightarrow A_s = 3.49''$

$a \doteq 4.10''$ → এরে হোর diff 10%. এর মধ্যে হলে we can leave checking

~~Again a = 4.05~~ if $a = 4.05$ $A_s = 3.53$

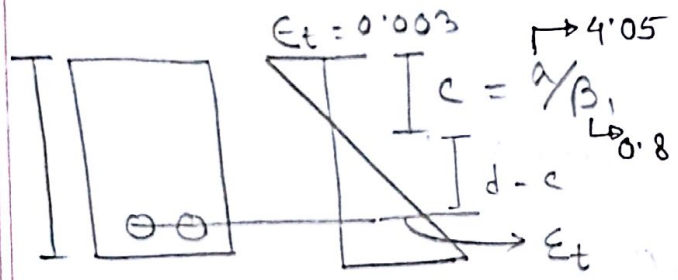
2 times trial এর পর main কাজ করব, go to ρ

$\rho = \frac{3.53}{12 \times 13.5} = 0.02179$

$\rho_{.005} = .85 \times \beta_1 \times 5/60 \times 3/8 = 0.85 \times 0.8 = 0.02125$

$\rho_{max} = 0.85 \times \beta_1 \times 5/60 \times 3/7 = 0.02428$

so $\rho < \rho_{max}$ but $\rho > \rho_{0.005}$



$$\frac{0.003}{c} = \frac{\epsilon_t}{13.5 - 5.06}$$

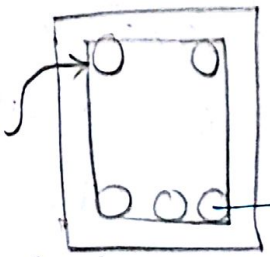
$\therefore \epsilon_t = 0.0053$

$$\therefore \phi = 0.65 + (0.0053 - 0.002) \times \frac{250}{3}$$

$$= 0.90032$$

Over Reinforced Beam হলে $\rho > \rho_{max}$

যদি only compaction steel as hanger bar always দিতে হবে



cause yeilding হবে even at time of failure

So the concrete will crush, not crack

So $M_n = A_s f_s (d - a/2)$

একটা method এ ϵ_s বের করব, (ϵ_s ↓ strain in steel)

Then $f_s = \epsilon_s \times E_s$

[CT → crack হয় কখন, find the cracking moment

12.10.15
Monday

Lecture - 12

3.7 :

SRB ⟶ under (single)

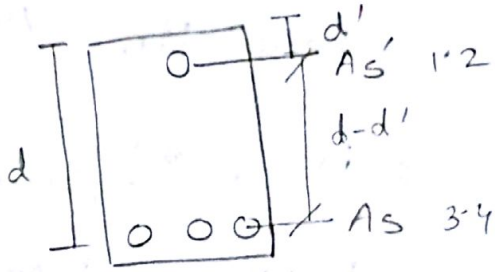
DRB ⟶ over (double)

Short note : what do you mean by single, double, over, under reinforced Beam.

Pg - 100 , Fig 3.14

A_s' = compression reinforcement

A_s = tension "



$C + A_s' f_s' = A_s f_y$ (T)

↓ compression due to concrete

→ com. due to RCC

$M_n = M_{n1} + M_{n2}$

comp. steel yeild বারতেও পারে, নাও পারে, tension RCC yeilds.

$M_n = M_{n1} + M_{n2}$ [com steel in yeild, tension steel ও in yeild

$= A_s' f_y (d - d') + (A_s - A_s') f_y (d - a/2)$

$$a = \frac{(A_s - A_s') f_y}{0.85 f_c' b}$$

suppose $A_s' = 1.2$ $A_s = 3.4$

so couple form বারতে A 1.2 x fy & 1.2 fy distance d-d'

↓ As

A_s এর বাকি $(3\cdot4-1\cdot2)$ will give $(3\cdot4-1\cdot2)\times f_y\times(d-a/2)$ this is like single RCC.

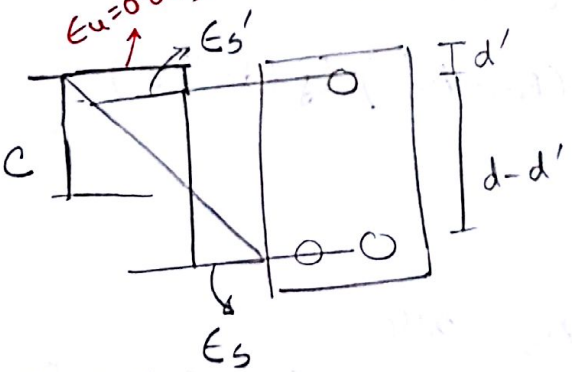
A_s given,

1) $\rho = \frac{A_s}{bd}$, if this $\rho < \rho_{max}$ then com. steel যদি দেয়া থাকে, but then it will work like single RB. হয়ত N.A একটু change হবে।

Here $M_n = A_s f_y (d - a/2)$

2) if $\rho \geq \rho_{max}$ then assume it is Double R.B.

(*) Design a beam for $M_u = 500$ K/ft, এখান থেকে $M_n = A_s f_y (d-a/2)$ থেকে A_s, then find ρ. যদি $\rho < \rho_{max}$ then S.RB. But if $\rho \geq \rho_{max}$ then DRB. যদি D.R.B then after ρ find a. then find $c = a/\beta_1$, then go to strain dia.



So from $\triangle$,

$\frac{0.003}{c} = \frac{\epsilon_s'}{d'}$ → strain in C. steel

$\frac{0.003}{c} = \frac{\epsilon_s}{d-c}$ → strain in T steel

then find $f_s = \epsilon_s \times E_s$ (Tension steel)

$f_s' = \epsilon_s' \times E_s$ (com. steel)

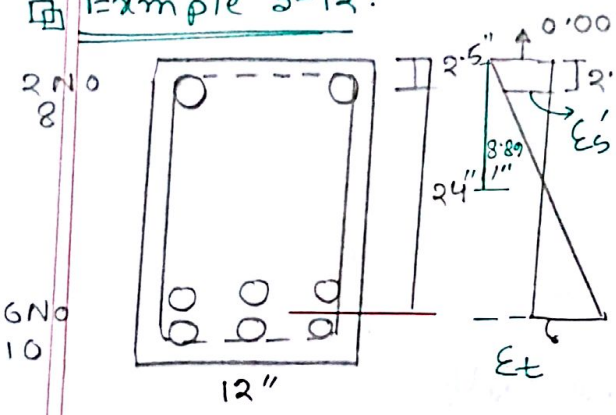
In all cases $f_s > f_y$, so tension steel always yields.

Then $M_n = M_{n1} + M_{n2}$ ⇒ $f_s' > f_y$ হলে -

$M_n = A_s' f_y (d - d') + (A_s - A_s') f_y (d - a/2)$

if $f_s' < f_y$ then f_s' হবে, তার always f_y

Example 3-12:



$A_s = 7.62$ $\rho = 0.0265$

$A_s' = 1.58$ $\rho' = \frac{A_s'}{bd} = \frac{}{12" \times 24"}$

$\rho_{max} = 0.0243$

$\therefore \rho > \rho_{max} \Rightarrow$ DRB

Then $a = \frac{(A_s - A_s') f_y}{f_c' \times 0.85 \times b} = \frac{(7.62 - 1.58)\ 60{,}000}{5{,}000 \times 0.85 \times 12"}$

$= 7.11"$

$c = a/\beta_1 = \frac{7.11}{0.8} = 8.89"$

$\frac{0.003}{8.89} = \frac{\epsilon_s'}{(8.89 - 2.5)} \Rightarrow \epsilon_s' = 0.00215$

$\therefore f_s' = \epsilon_s' \times 29{,}000 = 62.53\ ksi > f_y$

so the compression steel yields

$$\frac{\epsilon_t}{24-8.89} = \frac{0.003}{8.89}$$

$\therefore \epsilon_t = 0.0051$ $\quad f_s = \epsilon_t \times 29,000$

$= 148 \text{ ksi} > f_y$

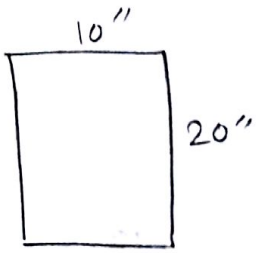
since $\epsilon_t > 0.005$, $\therefore \phi = 0.9$

$\therefore M_n = A_s' f_y (d-d') + (A_s - A_s') f_y (d - a/2)$

$\therefore M_n = 0.9 \times M_n$

[Annalysis Problem]

3.13 Design Problem:



Including self wt / excluding self wt বলতে পারে।

Here self wt = $\frac{20}{12} \times \frac{10}{12} \times 1 \text{ ft} \times 150$

যদি beam size বলা না থাকে then assume the size

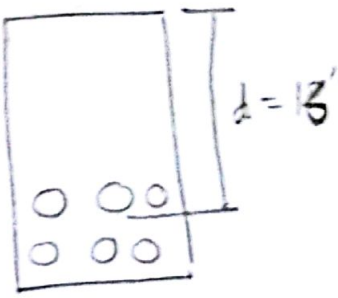
$M_u = \frac{w_u l^2}{8} = \frac{5.21 \times 18^2}{8} = 2530 \text{ k-ft}$

এখানে assumption অনেক।

[Show RCC with neat sketches বলতে পারে]

[যেকেউ 1 layer ~~m~~ assume করতে পারে, But যদি প্রয়োজন না মিলে then লিখে দিলে হবে (if no time) যে double layer লাগবে, so Rod বেশি লাগবে.]

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{2530}{0.9 \times 60 \times (16 - 2/2)} = 3.12$$



[Double RCC, d = 17.5 ও হতে পারে, trial করার জন্য বাদ দিলাম)

$$a = \frac{3.12 \times 60}{.85 \times 4 \times 10} = 5.5''$$

so assume $a = 6''$

Again $$A_s = \frac{2530}{0.9 \times 60 \times (16 - 6/2)} = 3.6 \text{ in}^2$$

$\therefore a = 6.35''$

then $$\rho = \frac{3.6}{16 \times 10''} = 0.0225$$

$$\rho_{max} = 0.85 \times 0.85 \times \frac{4}{60} \times 3/7 = 0.0214$$

$\rho > \rho_{max} \Rightarrow$ DRB

$$M_u = \phi M_{n_1} + \phi M_{n_2}$$

$$\phi M_{n_1} = \phi \rho f_y b d^2 \left(1 - 0.59 \frac{\rho f_y}{f_c'}\right)$$

if $\rho = \rho_{0.005}$ then $\phi = 0.9$

ρ_{max} নিলে $\phi \neq 0.9$ but result কাছাকাছি

$$\phi M_{n_1} = 0.9 \times \left(0.0181 \times 60 \times 10 \times 16^2 \left(1 - 0.59 \frac{0.0181 \times 60}{4}\right)\right.$$

$$= 2101 \text{ K}''$$

$$\phi M_{n_2} = M_u - \phi M_{n_1}$$

$$= 2530 - 2101$$

$$= 429 \text{ K}''$$

ϕM_{n_1} থেকে As পাব,

$$\therefore A_s' = \frac{\phi M_{n_2}}{f_s' \times (d - d')}$$

$$(A_s - A_s') = \rho_{0.005} \times bd = 0.0181 \times 10 \times 16''$$

$$a = \frac{(A_s - A_s') f_y}{0.85 \times f_c' \times b}$$

$c = a/\beta_1$ ϵ_s' f_s' =

14.10.15
Wednesday

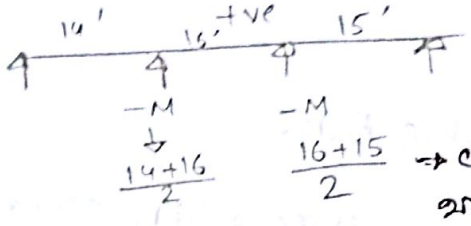
Lecture - 13

Mu = given

Design the beam — size given
                 — Reinforcement ?

Mu =  only +ve moment

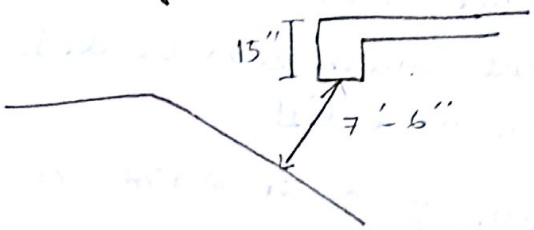
Mu = continuous span হলে (+ve) & (-ve) moment



→ column dimension দেয়া না থাকলে clear span না নিলেও হবে,

But column thickness দেয়া থাকলে centre to centre না, clear span.

(*) Moment given হলে my choice এ SRB or DRB.

(*) 

যদি size given হয় then option নাই এ SRB or DRB

(*) Design এর সময় safe side এ f_c', f_y নিতে হবে,

Exam এ f_c' & f_y given

Design Principle ⇒ $M_u = \phi(M_{n1} + M_{n2})$

Ex : 3.13

if $\phi = 0.9$ then M_{n_1} এ $\rho_{0.005} = 0.0181$ $f_c' = 4$

$f_y = 60$

$\rho bd = A_s \Rightarrow A_s = 2.9\ in^2$

$a = \frac{A_s f_y}{0.85 f_c' b} = 5.12''$ $\quad c = a/\beta_1 = \frac{5.12}{0.85} = 6.02''$

$M_{n_1} = A_s f_y (d - a/2) = 2340\ K''$

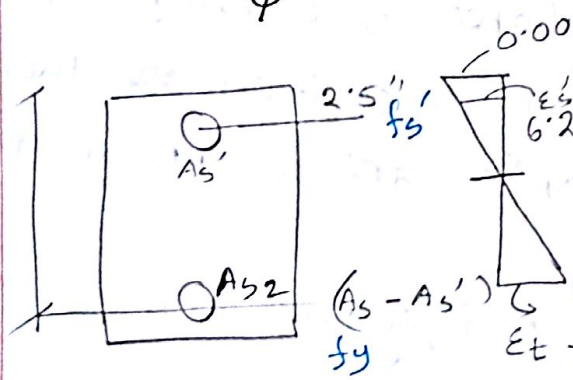
M_u = given = 2530 kip

$M_u/0.9 = 2811.11\ kip''$

$M_u/\phi > M_{n_1}$ then double R.B.

$M_{n_1} < M_u/\phi$ then M_{n_2} লাগবে না, তখন SRB.

$\therefore M_{n_2} = \frac{M_u}{\phi} - M_{n_1} = 470\ K''$



force, moment term same.
but stress can be diff.
So area diff

com. yeild না করলে A_s' বড় হবে
ε_t than A_{s2} cause force দুটোতেই
সমান, so yeild করে না যেহেতু
so area বেশি.

$A_s' = \frac{470}{f_s'(d-d')} = 0.7$ ($f_s' \hookrightarrow 50.9$)

$A_{s2} = \frac{470}{f_y(d-d')}$ ($f_y \hookrightarrow 60$)

fs' & fy from strain বের করব,

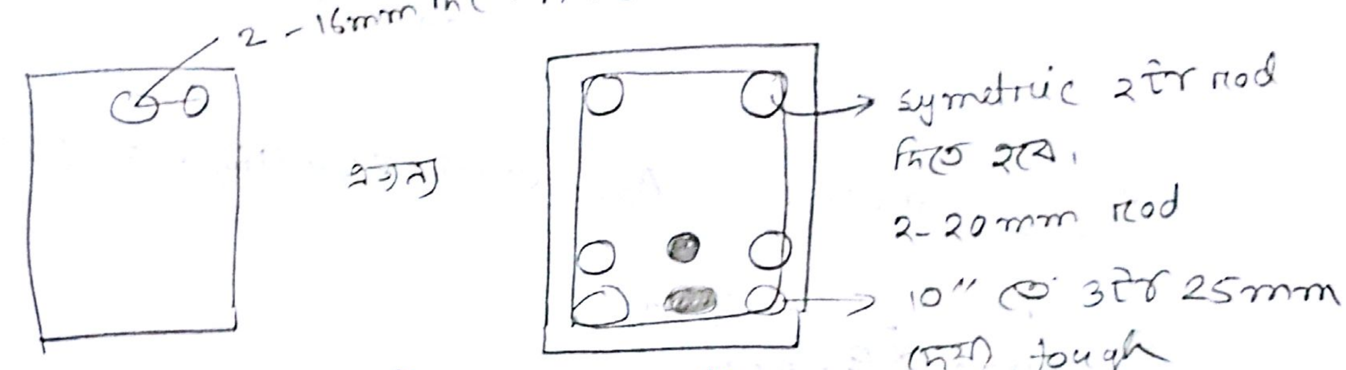
$$\frac{\varepsilon_s'}{c-d'} = \frac{0.003}{6.2} \Rightarrow \varepsilon_s' = 1.7\times10^{-3} \quad f_s' = 50.09\,K$$

$$\frac{\epsilon_t}{16-6.02} = \frac{0.003}{6.2} \Rightarrow \epsilon_t = 0.00482 \quad \therefore f_t = 140.04$$

[illegible] $\epsilon_t < 0.005$ so $\phi \neq 0.9$

$$A_{s1} + A_{s2} = 2.9 + \left(\frac{0.7 \times 50.9}{60}\right) = 3.48$$

2-16mm দিলে A = 0.62 < 0.7 so হবে না

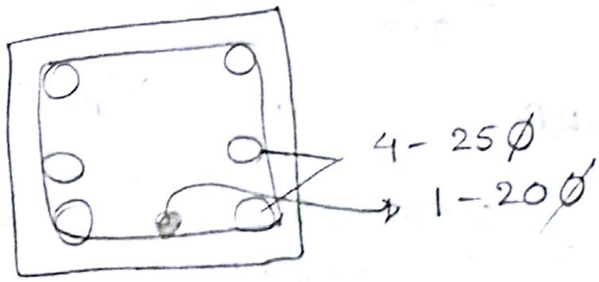


☐ Beam এ 20mm ই used mostly.

$\frac{3.48}{0.75} = 4.64$ ∴ 5টা rod so 6টা হবে না

↳ 25mm rod dia

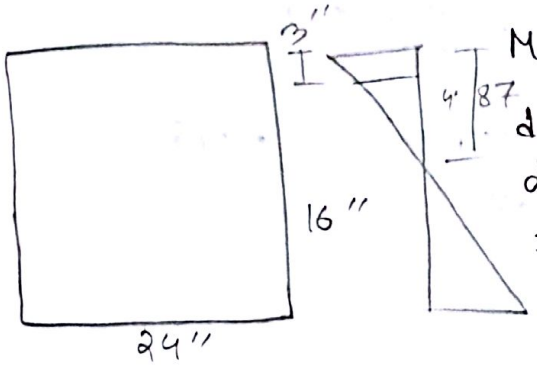
☐ যে rod গুলোর dia বেশি সেগুলো যেন বেশি ব থাকে।



* provided steel must be slightly heigher than the calculated A.

Pg - 117 : 3.9, 3.10
↓ Analysis ↓ Design

3.10



$M_u = 400\ K'$
$d = 13"$
$d' = 3"$
$f_c' = 4$
$f_y = 60$

$\rho_{0.005} = 0.0181$ $\quad A_{s_1} = 0.0181 \times 24 \times 13 = 5.6472$

$$a = \frac{A_s f_y}{0.85 f_c' \times b} = 4.14 \qquad b \hookrightarrow 24"$$

$$M_{n_1} = 5.64 \times 60 \times \left(13 - \frac{4.14}{2}\right) = 3698.712$$

$$\frac{M_u}{\phi} = \frac{400 \times 12}{0.9} = 5333\ K" > M_{n_1}$$

so DRB $\quad c = a/\beta_1 = 4.87"$

$$\epsilon_s' = \frac{0.003(4.87 - 3)}{4.87} = 1.15 \times 10^{-3} \qquad f_s' = 33.40 ksi$$

$$A_s' = \frac{5333 - 3698}{33.3(13-3)} = 4.90$$

$$A_{s_2} = \frac{5333 - 3698}{60(13-3)} = 2.725$$

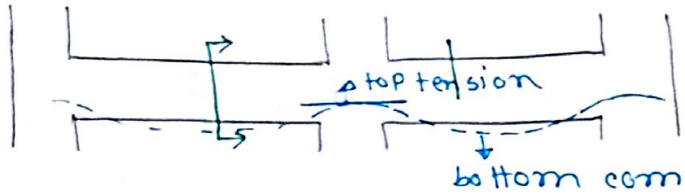
$\epsilon_t = 0.0058 > 0.005 \quad \therefore \phi = 0.9$

$A_s' + A_{s_2} = 4.90 + 2.725 = 7.625 \text{ in}^2$ (Total steel area)

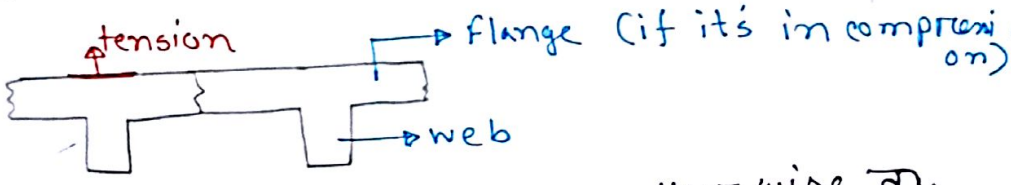
19.10.15
Monday

Lec - 14

3.8 T- Beam:

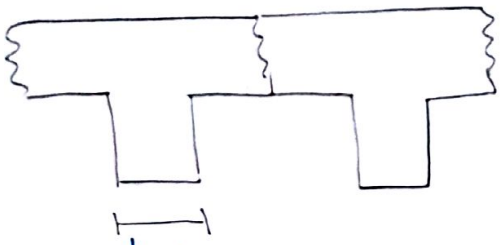


Two span beam with 3 columns.



Flange compression এ থাকলে T beam other wise না,

Effective Flange width: (be)



= effective web width

Q. Short note: Pg - 109 → write the effective flange width (২টা point)
(Provision for L & T beam be)

বুঝতে Pg-114, Example 3.15

৩টা point এর মধ্যে যেটা ছোট সেটা governing.

1st টা point in 3.8(a)

b. Strength Analysis:

i) NA < slab thickness = rectangular beam

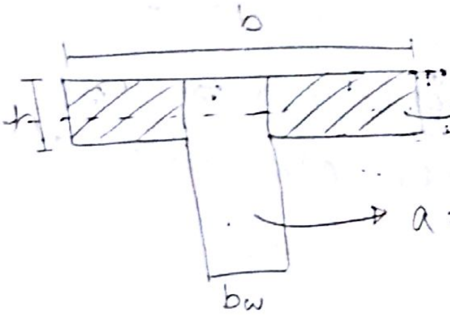
$a < h$

ii) if $a > h$ = T-beam

$$A_{sf} = \frac{0.85 f'_c (b - b_w) h_f}{f_y} \quad \ldots\ldots (3\text{-}59)$$

⇓

required steel for flange



→ $(b - b_w) h$ = flange area

→ $a = \frac{(A_s - A_{sf}) f_y}{0.85 f'_c b_w}$

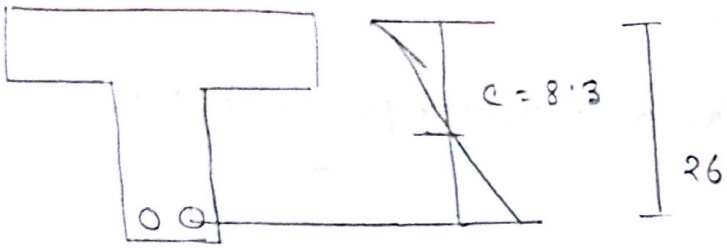
$$M_{n_1} = A_{sf} \cdot f_y (d - h/2)$$

$$M_{n_2} = (A_s - A_{sf}) f_y (d - a/2)$$

⇒ last para of pg - 111

Ex - 3.14:

T না rectangle বলা নাই,
1st এ a & h compare করার time এ a এর
জন্য flange width (b) হবে,



$\epsilon_t = 0.006 \quad \therefore \phi = 0.9$

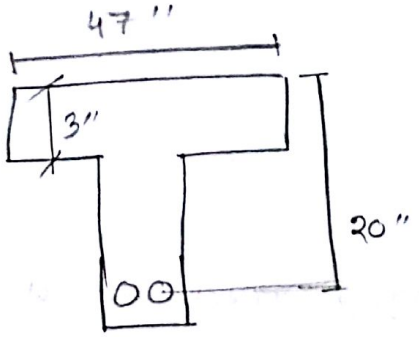
Ex 3·15 :

Web dimensions as determined by -ve moment requirement at the support →

-ve moment always > than +ve moment. -ve moment যেখানে থাকবে সেখানে rectangular beam. -ve " এর dimension দিয়ে design করব otherwise fail করবে।

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{6400}{0.9 \times 60 (20 - 1.5)} = 6.41 in^2$$

ধরে নিলাম $a = 3'' = h_f$



then check $a = \frac{6.41 \times 60}{0.85 \times 3 \times 47}$

$= 3.21''$

$\therefore a > h$

$\therefore$ T- Beam

(*) T & Rectangle এ steel area খুব differ করে না, so prof. life এ not used T-beam.

Slab thickness খুব বেশি হলে বুঝতে হবে T beam হতে পারে।

Exercise → 3-14 → T-Beam Analysis

31.10.15
Saturday

Lec - 15

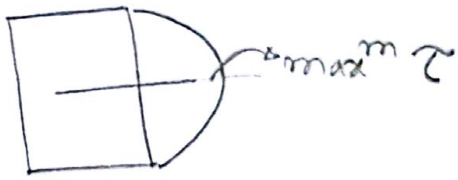
Chapter 4

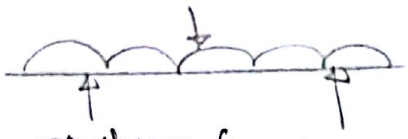
Shear and Diagonal Tension in Beams

4.3

Eqn → 3.1, 3.2

Beam ও shear stress diagram





$$v = \frac{VQ}{bI}$$

$f = \frac{My}{I}$ এখান থেকে Mcracking বের করতে হবে,

Find the moment capacity (allowable) f_c, f_s এর মান দেয়া থাকবে, in working stress method.

$$M_{all} = A_s f_s j d = \tfrac{1}{2} f_c k j b d^2$$

$$M_n = A_s f_y (d - a/2)$$

$$a = \frac{A_s f_y}{0.85 f_c' b}$$

If we find $M_u > M_n$ then design for ~~double~~ double RCC

~~Beam~~ Fig 4.5 : Bending moment (+ve) mid span এ max^m

Pg-128 → Describe the behavior of Beam under increasing load.

Fig 4.7 → Describe the diagonal - - - -

Closed Stirrup → Pg 132 Fig 4.8

Stirrup alway closed, open করব না, অনেক সময় construction এর পর stirrup দেই, তখন open দেই,

(See someone's lecture)

Short direction এ guarder দেয়া হয়,

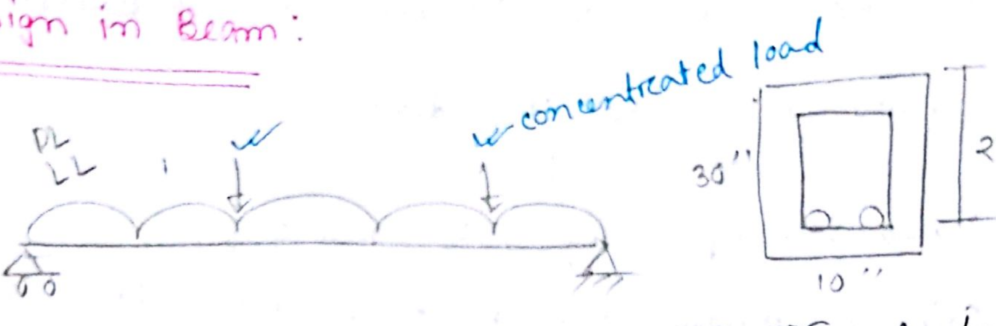
Show the critical section of shear design (Exam এ)

4.11.15
Wednesday

Lec-17

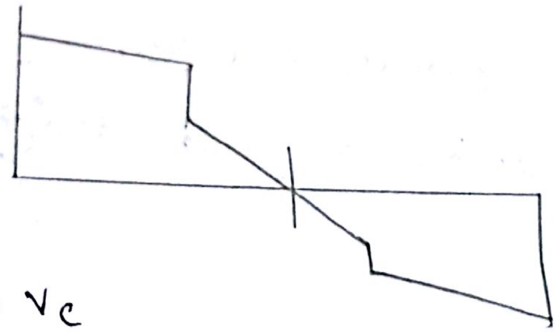
$\phi = 0.75$ for shear design

Shear Design in Beam:



factored load দেয়া থাকলে DL, LL আলাদা calculate করার দরকার নেই।

V_u মানে shear force diagram আঁকাতে হবে।



* mostly symetric দিবে
* half নিয়ে কাজ করব

face বলা নাই, so centre থেকে d distance দূরে।

$V_{u,d} < \phi V_c$

$V_{u,d} < \phi \frac{V_c}{2}$ পর্যন্ত দেয়া লাগে না shear Reinforcement

If $V_{u_d} > \phi V_c$ then shear reinforcement লাগবে,

$\phi \frac{V_c}{2} > V_u < \phi V_c \rightarrow$ minimum " "

Q. why ϕ is diff for diff ~~shear reinforc~~ strength of diff structure?

ϕ use করি capacity determination এর জন্য column এ uncertainty, risk factor বেশি তাই strength reduction factor বেশি ব্যবহার হয়।
Shear সম্পর্কে prediction, idea কম আমরা।
Beam এ reduction 10%. হয়, 25%. shear RCC তে
Load factor ও এই জন্যই diff in DL & LL.

$V_u = \phi V_c + \underbrace{\phi V_s}_{\text{limit আছে,}}$

$\phi V_c = \phi 2 \sqrt{f_c'}\, bd$

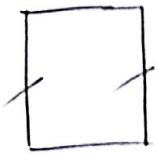
if $\phi V_s \leq 4\sqrt{f_c'}\, bd$ হয় then $S_{max} = 24'' = d/2$

if $\phi V_s > 4\sqrt{f_c'}$, $S_{max} = 12'' = d/4$ $\quad S = \text{Spacing}$

$S_{min} = 4''$ [3'5" ~ 4"]

$$S = \frac{\phi A_v f_y d}{V_u - \phi V_s}$$

S যদি S_{min} then S_{min} then change A_v. we can increase the diameter of stirrup.



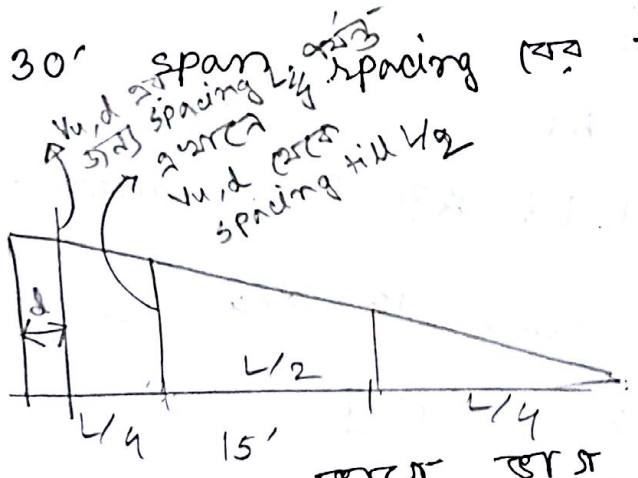
2 leg stirrup $\quad$ 10mm হলে = 0.22 = A_v
dia

$\phi V_s \not> 8\sqrt{f_c'}\, bd$ → Principal

যদি $\phi V_s > 8\sqrt{f_c'}\, bd$ হয়ে যায় then we have to increase the size of the beam, শুধু steel দিয়ে shear resist করা যাবে না।

যদি slab এ $V_u > \phi V_c$ থাকে then don't use shear rather wish to increase ϕV_c.

Q. Suppose 30' span এর beam এ shear RCC করবে।



Whole beam কে 3 ভাগে ভাগ

9.11.15
Monday

Lec - 18

Chapter-5

Bond, anchorage, development length

Bond : Stress এর জন্য strain develop করতে হবে, এজন্য proper bonding থাকতে হবে betn concrete & steel.

Anchorage : pull out test

Development length : যে পরিমাণ length concrete এ দুকালে rod yeild এ fail করার পর বের হয়ে আসবে.

20mm 40 grade rod = 0.48×40 = 18...

60 " " = 0.48×60 = 28.8kip

so 60 grade এ D.length বেশি cause বেশি strength resist করতে হবে.

concrete ছাল হলে D.length বাড়ে লাগবে cause ধরে রাখবে, rod paint করে দিলায় Dlength বেশি লাগবে cause surface smooth হয়ে যাবে.

Q. Describe in brief the factors affecting development length.

Q. Define development length — 174 (b, c)

clear cover বাড়ে হলে D.L ↓.

16mm এর d.L 20mm এর চেয়ে ↓.

Last para - 176 : Finally . . .

Q. Find the dev. length for 16mm, 25mm bar f'_c, f_y দেয়া

16mm rod use করলে 16mm < 20 so diff formula

কোন কিছুর value না দিলে $\psi_s, \psi_e, \lambda, c = 1$.

25mm এ $0.05 \frac{f_y}{\sqrt{f'_c}} d_b =$

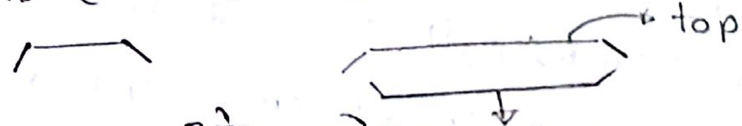
16mm এ $0.14 \frac{f_y}{\sqrt{f'_c}} d_b$

Pg - 177 (5.4)

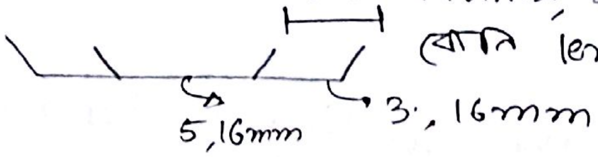
Pg - 181 5.4 : Anchorage :

a. Standard Dimensions :

⊛ Deformed bar এ hook বাঁকা হয় না,
But বোঝানোর জন্য কোনটা top, bottom এটার জন্য



২টা কাটাকাটি bottom
কোন length এ কাটা এটা বোঝানোর জন্য।



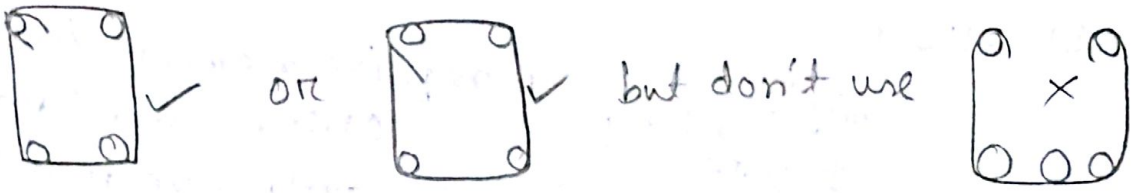
But মাঝে মাঝে hooks দেয়া হয়,

Hook করলে eqn 5.4 এর চেয়ে D. L কম, cause 5.4 is for no hooks.

Pg - 182 → b : Here hooks দিলে কিভাবে D.length change হবে।

⇒ 5.5 বাদ

⇒ Pg - 189 : 5.6 Always use closed stirrup.



⇒ 5.8 :

⇒ 5.9 : change factors

⇒ 5.10 : Pg - 197

Fig : 5.20

Imp* Show cut of or bend points in approx equal span & uniformly dist. load

End span এ না কাটা ভাল.

clear span এর $\frac{1}{8}$ ভাগ কাটা যায়।

Bottom part support এ min 6" ঢুকতেই হবে।

support থেকে top bar $L/3$ এ কাটব,

মাঝে rod নাই, তাই intermidiate moment resisting frame.

Chapter - 20: শুধু শুধু appendix, Pg - 747

208, → Article : last para: For beams

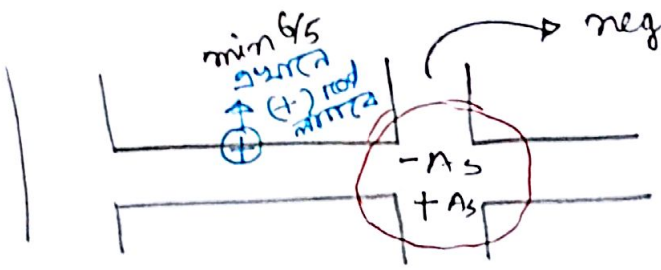
শুধু must for design

11.11.15
Wednesday

Lec-19

Pg 747:

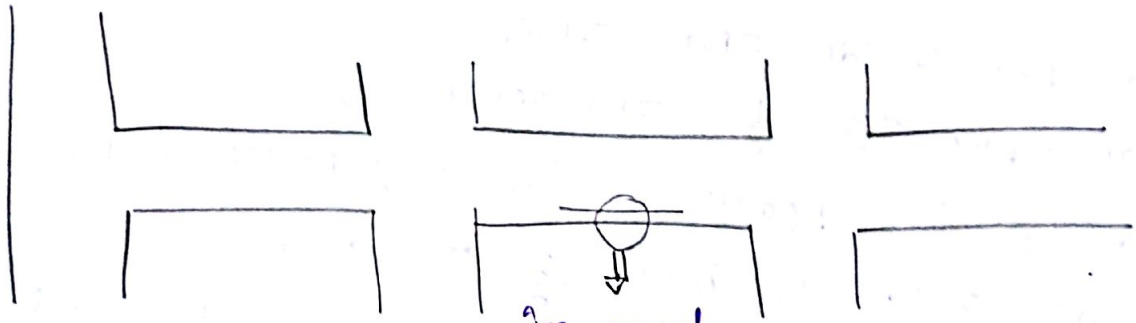
Last paragraph - for Beams & columns
এর আগের building code 2008 এ preface এ
ACI 21.3.4



negative moment Analysis
করলে -6 in" rod
আবার -ve rod লাগবে
১০ $\frac{1}{3}$ rd rod
+ve এ লাগবে,

$$+A_s = \frac{M_u}{\phi f_y (d - a/2)}$$

-ve joint এ 6 লাগলে
throughout (min) $\frac{6}{5}$ rod লাগবে



In most cases extra ~~top~~ bottom
দেয় লাগে

Pg 197 : Fig 120

Pg : 726 : ACI PROVISIONS FOR EARTHQUAKE

Fig 20·12

Pg : 727 : 20·5 ACI PROVISION for special moment

Weak Beam - strong column :

Earthquake এ প্রথমে হওয়া উচিত, তাহলে beam fails not column, so less damage.

এজন্য ACI code 21·6·2

Pg : 730 : 20·21(a) (b)

[Earthquake provisions chap 8·3 in volm 6.

Pg 204 : 5·13 : BAR SPLICES :

max^{m} rod পাওয়া যায় 12m.

Lap length insufficient হলে welding করে, but that's additional cost. But always " করা যায় না।

Q : Find the development length.

What factors effect the " ".

Main parameter 3টা

100% lap দেয়া যাবে না।

যেখানে লাগত 4 but 8/9 দিচ্ছি ওখানে class A

cause suppose 1st floor a requirement 12",
12" থেকে সরাসরি 4" তে যাওয়া যাবে না, তাই
class A.

16.11.15
Monday

Lec-20

- Pg - 197 → Fig 5.20 (calculation ছাড়া cut off points)
- Pg - 192

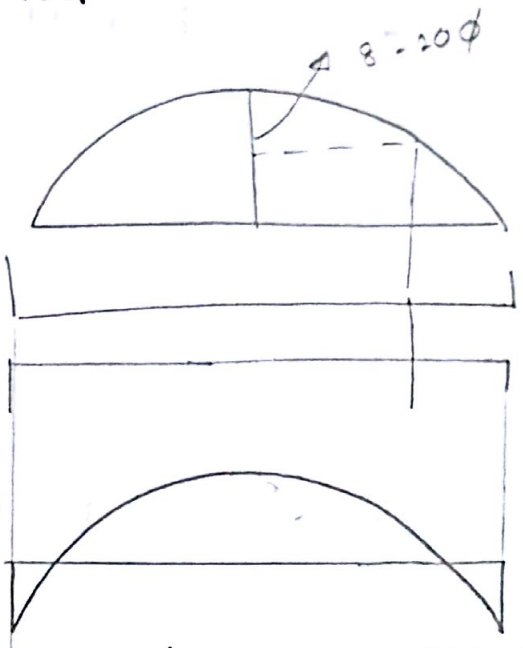


Fig: 5.19

যেখানে moment half সেখানে cut করা যাবে.

negative & +ve moment এর জন্য rod

(*) [এর calculation করা difficult, so general guideline in Fig 5.20. Fig 5.20 ধরে করলে কবি criterias satisfied.]

- 13.14 → Pg - 447 Fig

50% Bar 0.2LL & 50% Bar 0.3LL পর্যন্ত টানতে হবে.

যদি development length হিসাব করতে না চাই then suppose 20' span এর $l/8 = \frac{20}{8} = 2.5'$ এ কেটে দিতে পারব,

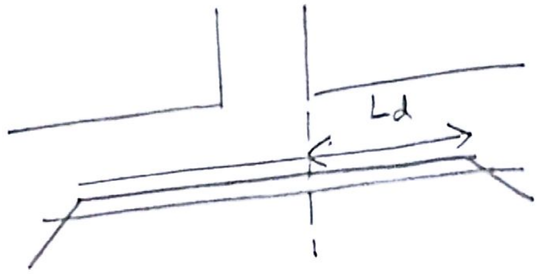
- Pg - 194 : Page last article

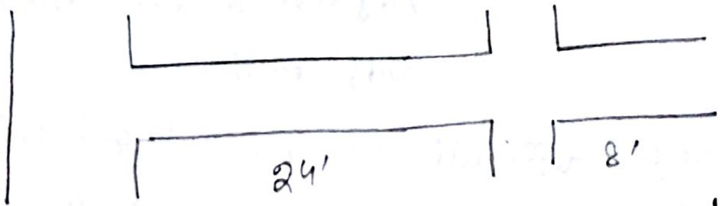
3 ভাগের 1 ভাগ support এ দিব

যে point এ rod লাগে না সেখানে d, $12d_b$, $\frac{1}{16}$th of clear span rod insert করতে হবে।

2nd layer এ bar এ rod দিলে bend করি, তবু additional Rein. লাগে।

তার must development lenth Ld এর সমান। Calculation না করলে L/4.





can't apply 5.20 fig. Nearly equal span হতে হবে।

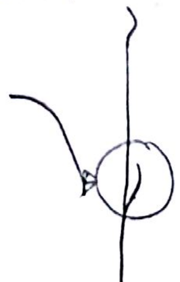
⊛ Beam supported on brick wall L/??

" " " RCC " L/8 এ কাটব

* Beam এর আগে brick wall হলে L/7 এ ~~cracked~~ crancked

* RCC wall হলে L/4 এ crancked (if interior + exterior RCC wall)

* Lap length



Lap length compression এ pg-206

যদি sure থাকি যে column এ কোন tension আসবে না then compression splice.

Tension splice

Pg 207 - in ref to fig 5.8

Pg 180 এ 5.1 example দেখব

18.11.15

Wednesday

Lec - 21

Chapter - 13

Pg - 424

Analysis and Design of Slabs

Fig 13·1 → Types of structural slab

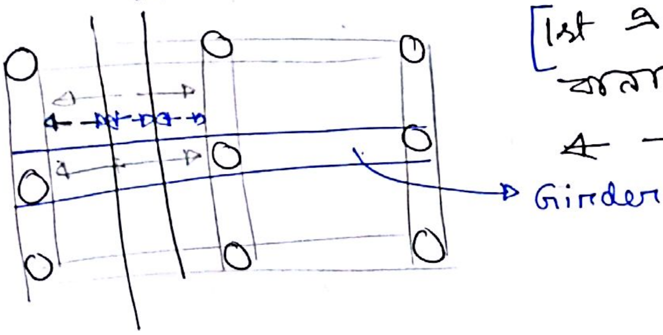
Pg - 614 → 18·2 → Floor & roof system

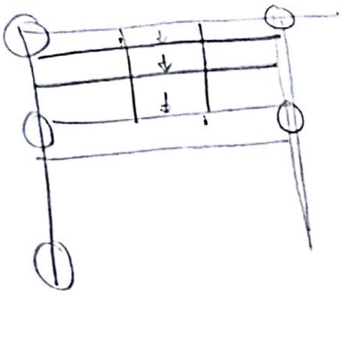
Design one & two way slab using ACI code

How to design system:

1) Floor system → verticle load resisting system
2) Structural " → lateral " " "

আগে column দিলে support এর জন্য আগে beam (Girder)
[1st এ column then beam বানায় দুটা বানালে load 4 → transfer]





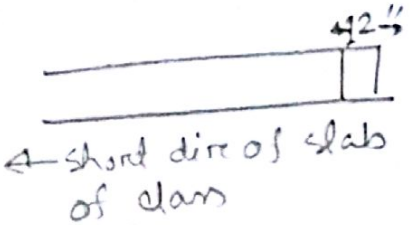
2way slab
9 slabs here
(Beams in 2 direction)

$$Mu = Asfy\,(d - a/2)$$

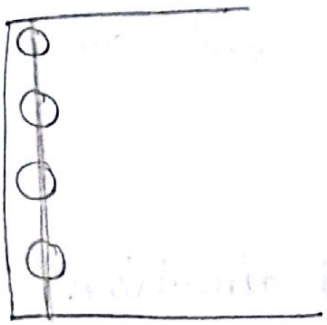
$$a = \frac{Asfy}{0.85 f'_c\, b}$$ b = for slabs

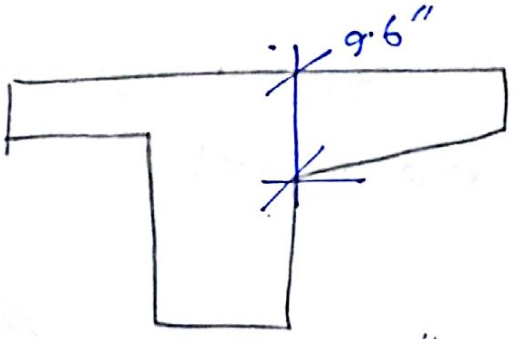
Mu এর unit হল k'/ft, cause we take 12" of the slab.

এজন্য k' per ft ই.

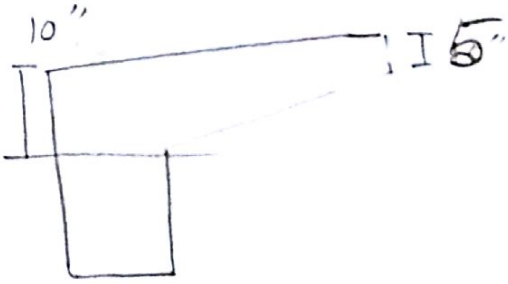


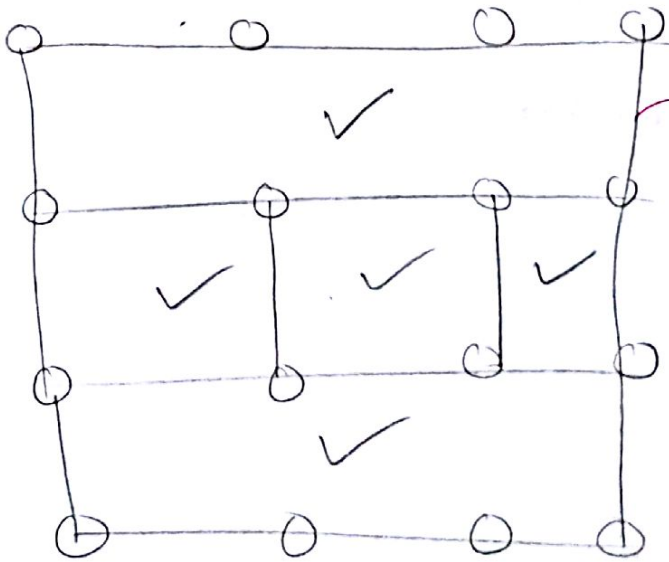
so works like a small beam





এটা না বাড়ে





beam

প্রতি panel এ long & short

$\frac{long}{short} > 2$ হলে one way slab

↓

aspect ratio

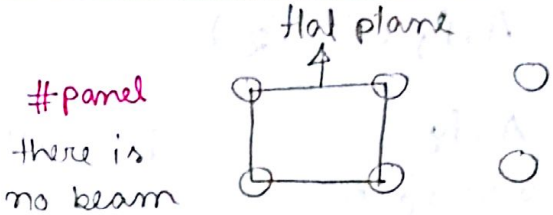
$\frac{long}{short} < 2$,, 2 way slab

21.11.15
Saturday

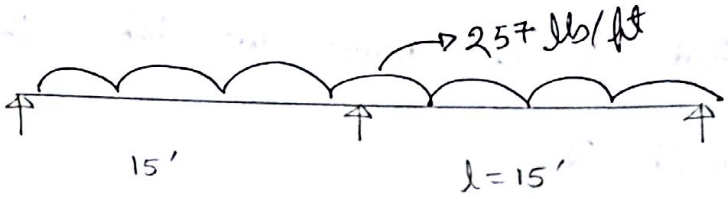
Lec - 22

Ex: 13.1

Pg - 430

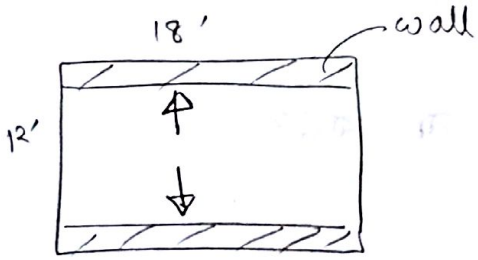


#panel
there is
no beam

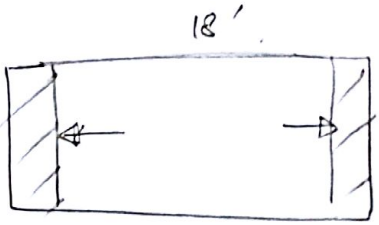


$t = l/28$ depending on the support condition [Table 13.1]

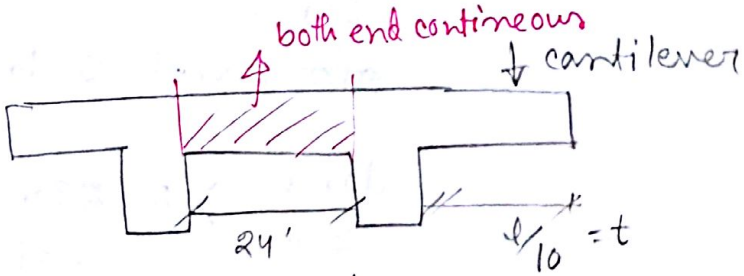
[প্রকারভেদে $l/24$ দিয়ে বাড়া যায় as one end contineous and other end is not]



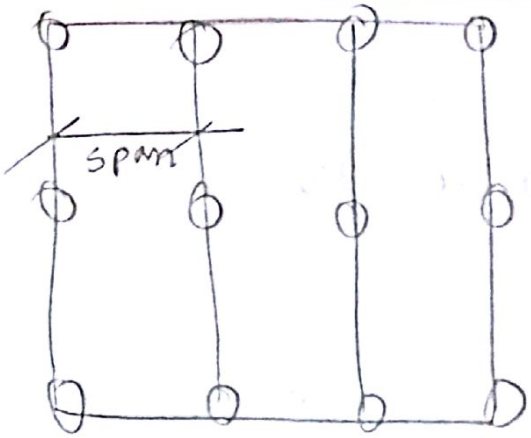
প্রথম load direction প্রকারভেদে
so span 12',



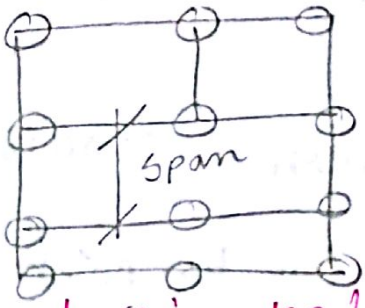
one way
span 18'



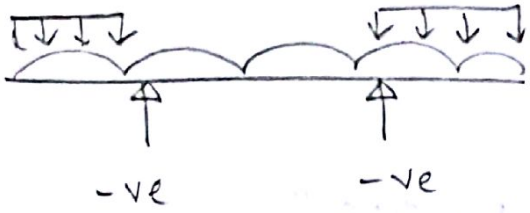
so $t = l/28$



Beams এভাবে বলে span



Design slab for live and dead load. Live load can occupy any position.



For max^m -ve moment LL on the cantilever part.

For max^m +ve moment LL in the middle.

Pg 391 → Art 12·3
392 → fig 12·3 , Pg-406 → 12·8 Table 12·1

continuation of 13·1:

$t = l/28 = 6'43'' \approx 6'5''$

DL = $6'5 \times \underbrace{12'5}_{150/12} = 81$ LL = 100 psf

$W_u = 1·2DL + 1·6LL = 257$ psf

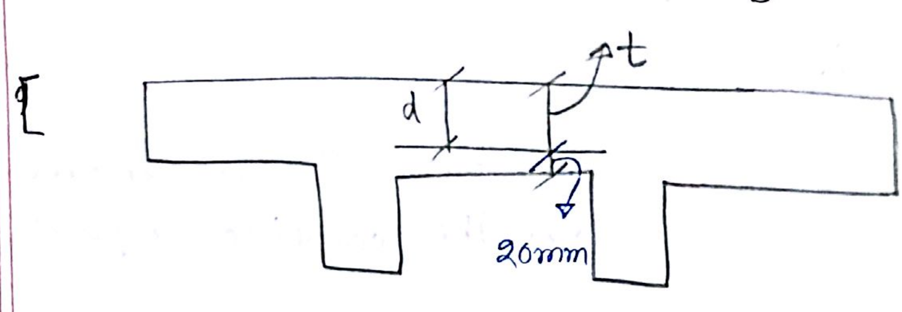
we design for 1' ~~height~~ width. so $b = 12''$

Temp shrinkage = 0.0018

$\rho_{min} = 200/f_y = \frac{200}{60} = 0.00333$

$\rho_{temp/sh} = 0.0018$

A_s for temp/sh $= \rho_{Temp/sh} \times \underbrace{12}_{b} \times \underbrace{6.50}_{t}$



for beam h & d ⇒ d = h − 2.5"

for slab clear cover min 20mm

In we use brick cheaps in slab/ beam then temp/sh. আর যেটা that multiplied by 1.5.

∴ then $A_{s\,temp} = 1.5 \times 0.0018\,bt$

Q. If slab made of brick chips ... ?

$E_c = 57000\sqrt{f'_c}$ → for stone chips

$\frac{WL^2}{2}$ for cantilever

for this portion section নিয়ে বের করতে হবে.

15" 0.2

25.11.15
Wednesday

Lec - 23

Pg - 432: Bihaviour of 2 way edge supported

Fig 13.5 : simply supported এ support এ M=0, mid span এ max m
short dir M↑ , long dir moment ↓

Fig-13.6, 13.7

Shallow beam → reinforcement দেয়া হয় → Fig 13.7.

ACI code 1995 for ACI moment co-efficient.
এটা দিয়ে 2way slab design করা যায়।

BNBC → 6-177 (co-efficients)

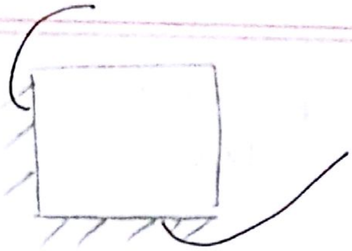
Table exam → দিতে দেয় & annalysis এ math আসে,

(এটা 12th edition এ 12th chapter এ)

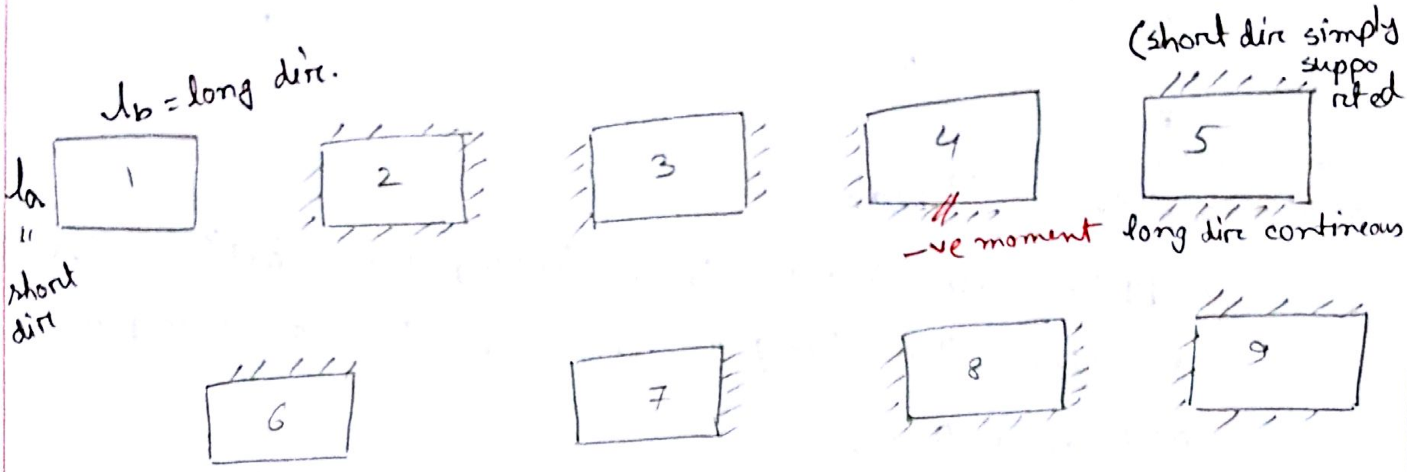
BNBC (1-9)
case

কিছু দেয়া নাই so simply supported, beam

slab supported on beam/ brickwall and continuous (on hatched side)

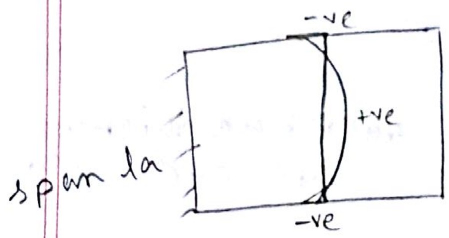


২দিকে contineous and supported on: beam/brick walls.



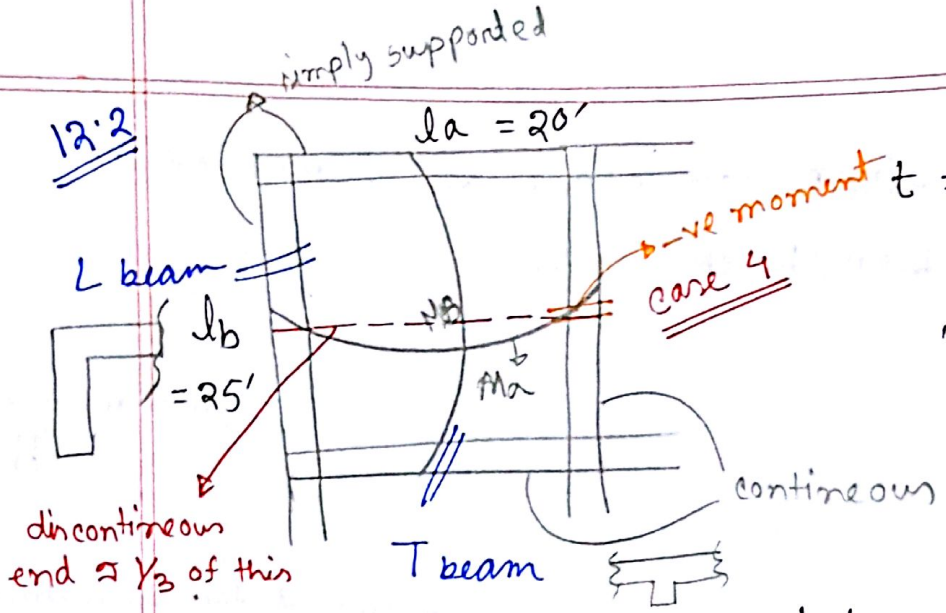
$m = \frac{l_a}{l_b}$

$M_{a,negetive} = C_{a neg} \cdot W_u \cdot l_a^2$



$M_{b,neg} = C_{b neg} \cdot W_u \cdot l_b^2$

12·2



$$t = \frac{\text{perimeter}}{180}$$

$$m = \frac{la}{lb} = 0.8$$

suppose $m = 0.77$ then interpolate betn 0.7 & 0.8.
or take the larger moment co-eff comparing 0.7 and 0.8.

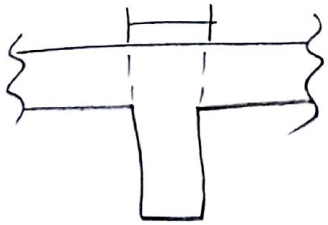
$$t = \frac{(20+25)\times 2\times 12}{180} \text{ in} = 6 \text{ (upper rounding করব & add .5" (Always ½" বাড়ায় ধরব)}$$

$\therefore t = 6.5"$

eqn → Pg 448 ~~Table 13.5~~ 13.8 (a) (b) (c)

α বের করলে beam & slab এর ~~thickness~~ thickness বের করতে হবে,

if T beam



$$+M_A = \left[\underbrace{C_a + W_{DL}}_{\text{for DL}} + \underbrace{C_a - W_{LL}}_{\text{for LL}}\right] la^2$$

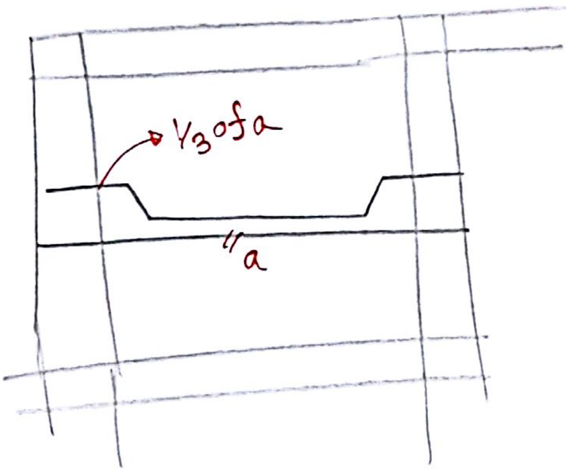
must remember

⊛⊛ always short dire এ Moment বেশি, Both +ve & -ve

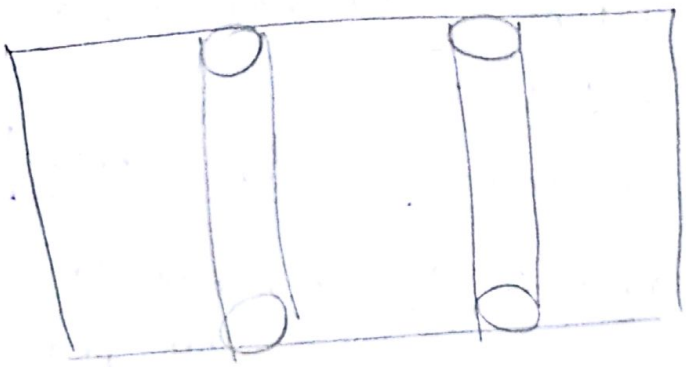
$+A_{s\,short} = \dfrac{+M_A}{\phi f_y (d - a/2)}$ → unit always k'/ft

a needs to be assumed. $a = d/10$ suppose

discontineous end এ 1/3 according to code.
we provide 1/2.



Lec - 24

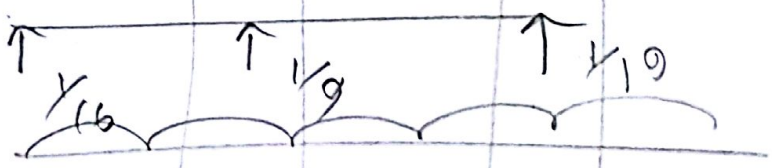


$t = L/10 = \frac{5 \times L}{10} = 6''$

$d = 5''$

$a = 0.5''$

180 psf



Art 1.4

P-12

(C) P-424
Art 13.3
Table 13.2

2(b) → 20.9

Pg – 127, Fig 520

Eq - 5.5(a) 5.5(b) → 3(a)

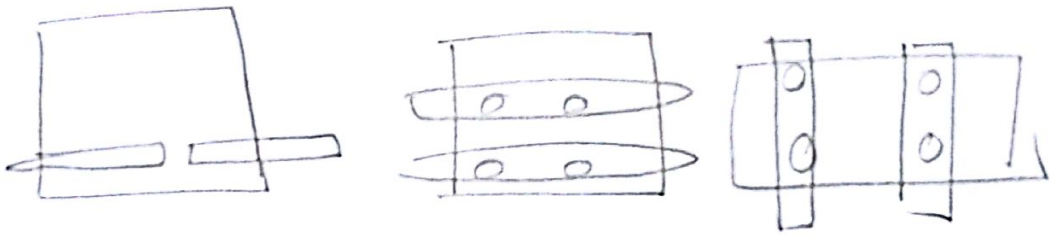
3(a) → PP – 246

4(a)

Sec - B

5(a) :

Fig : 1.16 P : 22



$P = [A_g + (n-1) A_{st}] \times f_c$

5(b) → Exmp 1.2

III) Exmp 1.2

$d/24 \rightarrow 7.5''$