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Section B

Semester 6th

Subject PRCD-I

Submitted To,

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Q.1 Given Data :-

- Live Load (L.L) = 2.47 Kips/ft
- Dead load (D.L) = 1.05 Kips/ft
- width of Beam (b) = 10 inch
- Height of Beam (h) = 20 inch
- Span of Beam (L) = 18 ft
- f_y = 60,000 psi = 60 ksi
- f'_c = 4000 psi = 4 ksi

Solution :-

- Effective depth :-

$d = h - 3$

$d = 20 - 3$

$d = 17''$

- Effective Cover (d')

Suppose $d' = 2.5''$

Step ①

Reinforcedment Ratio

$$\rho_{max} = 0.85 * \beta * \frac{f'_c}{f_y} * \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_y}\right)$$

$$\rho_{max} = 0.85 * 0.85 * \frac{4}{60} * \left(\frac{0.003}{0.003 + 0.005}\right)$$

$$\boxed{\rho_{max} = 0.0181}$$

No unit b/c it is Ratio b/w Same unit

Step ② :-

Calculate Area of Steel

We know that,

$$\rho_{max} = \frac{Ast}{b*d}$$

Now

$$Ast = \rho_{max}(bd)$$

$$Ast = 0.0181*(10*17)$$

$$Ast = 3.077\ in^2$$

Step ③ :-

Design Factored Moment

According to Formula

$$Mu_2 = \phi * Ast * fy * (d - a/2)$$

First we Find $a = ?$

As

$$a = \frac{Ast * fy}{0.85 * f'c * b}$$

$$a = \frac{3.08 * 60}{0.85 * 4 * 10} = 5.4''$$

Now

$$Mu_2 = 0.90 * 3.077 * 60 * \left(17 - \frac{5.4}{2}\right)$$

$$Mu_2 = 2368.98\ K''$$

$$\boxed{Mu_2 = 2368.98\ K''}$$

Now Moment due to given Load:-

Beam Self weight = $b * t * \gamma_c$

$= \frac{10}{12} * \frac{20}{12} * 150$

$= 208.33$ lb/ft

Total Factored load:-

$W_T = 1.2 * D.L + 1.6 * L.L$

$= 1.2 * (1050 + 208.33) + 1.6(2470)$

$= 5461.996$ lb/ft

or

$w_T = 5.46$ Kips/ft

Utimate Factored Moment:-

$M_u = \frac{W * L^2}{8} * 12$ b/c $L = 18''$

$M_u = \frac{5.46 * (18)^2}{8} * 12$

$M_u = 2653.56\ k''$

Here

$M_u > M_{u2}$

$M_u = 2653.56 > M_{u2} = 2368.98$

So we provided extra Steel in Compression Zone thus it Should be Doublx Reinforcement Design"

Step (4):-

$$Mu_1 = Mu - Mu_2$$

$$Mu_1 = 2653.56 - 2368.99$$
$$Mu_1 = 284.57 \text{ Kip-inch}$$

For this extra moment we provided extra steel in compression zone.

Step (5):-

$$A's = \frac{Mu_1}{\phi * fy * (d-d')}$$

$$A's = \frac{284.57}{0.90 * 60 * (17-2.5)}$$

$$\boxed{A's = 0.36 \text{ in}^2}$$ thus

Steel area for compression

Step (6):- Total steel area in tensile

$$As = Ast + A's$$
$$As = 3.07 + 0.36$$

$$\boxed{As = 3.43 \text{ in}^2}$$

This steel area provided in tensile zone.

Step 7 :-

Selection of Bars :-

(A) For Tensile Steel :-

Let we try #8 bar
We know
Area of one #8 = $0.785\ in^2 = A_b$
Now
Number of Bars = $\frac{A_s}{A_b}$
Number of Bars = $\frac{3.43}{0.785}$
Number of Bars = $4.369 \cong 5$
So we provided 5 #8 bars in tensile zone.

(B) For Compression Steel :-

let we try #6 bar
Area of one #6 bar = $0.44\ in^2$

Number of Bars = $\frac{A'_s}{A_b}$

= $\frac{0.36}{0.44}$

Number of bars = $0.8181 \cong 1$
So we provided 1 #6 in Compression zone.

Step 8 :-

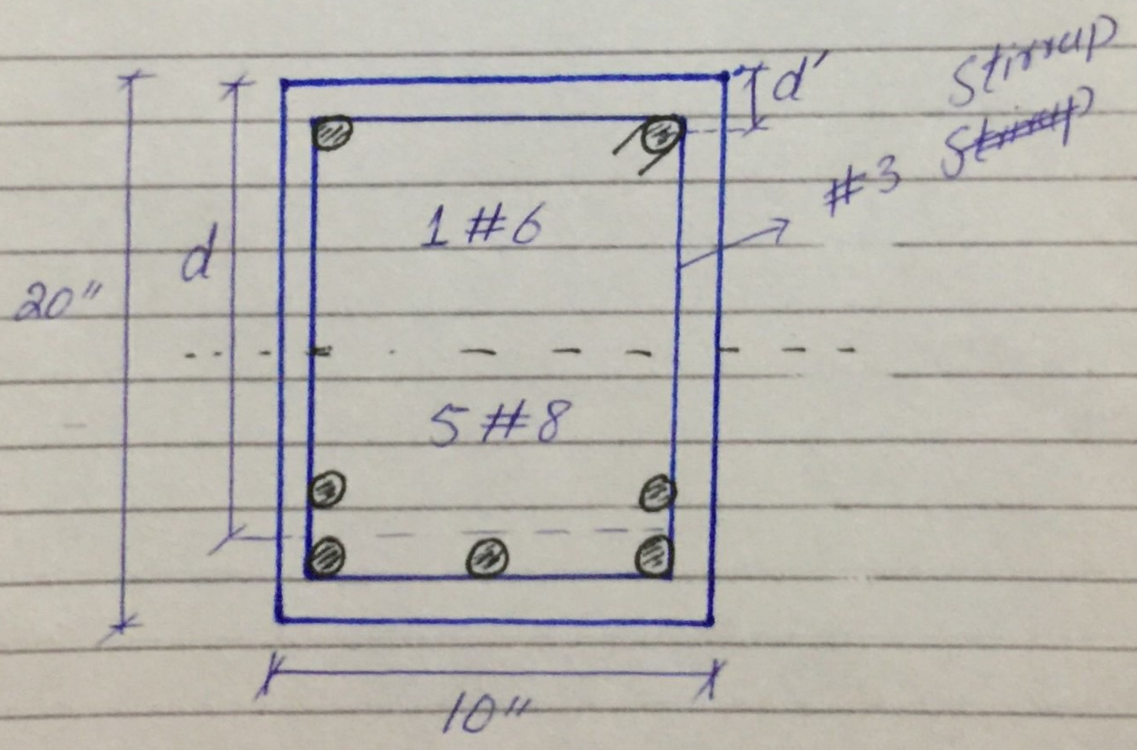
"Beam Minimum Width"

$$b_{min} = 2(1.5) + 2(3/8) + 5(8/8) + 4(8/8)$$

$$b_{min} = 12.75'' > 10''$$

Not Good on one layer to provide main bar

Thus It Should be provided into two layer.



- effective depth = d = 16.62"
- effective Cover d' = 2.25"

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Step (9) :-

"Final Step Design moment"

According TO Formula

$$md = \phi * [A's * fy * (d-d') + (Ast - A'st) * fy * (d - a/2)] \quad (*)$$

$a = ?$

$$a = \frac{(Ast - A'st) * fy}{0.85 * f'c * b}$$

$$a = \frac{(5 * 0.785 - 1 * 0.44) * 60}{0.85 * 4 * 10}$$

$a = 6.15 \ in^2$

Now put values in eq (*)

$$md = 0.90 [1 * 0.44 * 60 (16.62 - 2.25) + (5 * 0.785 - 1 * 0.44 * 60) * (16.62 - 6.15/2)]$$

Solve it we get;

$md = 2890.42 > 2653.56$

Thus the Design is OKay //

Q.2

(a) **Bond Stress :-**

Those stress which is acting on the outer interface of the steel to the surrounding concrete is known as bond stress.

- The resulting stress of bond is called bond stress.
- These stresses help in keeping bond b/w reinforced and concrete.
- Due to the Bond stress result any force that tries to pull out the rods from the concrete.
- When we try to pull out the reinforcement bar from hardened concrete then bond stress resists the bar to come out.

Development length :- (Ld)

It can be define as;

The length of steel bar needed to be embeded into the column to establish the desired bond strength b/w concrete and steel is called development length.

- It hold two concrete members togather such as; Beam, Column, Footing etc

Reason For Providing Development length :-

- To creates a safe bond b/w Bar surface and concrete.
- Reinforcement bars should not slip through the concrete.
- To transfer stresses or load from Beam to column smothly.

What happen if we dont provide Development length :-

- If we dont provide or less provid development length then the Structure will Occure Slipage of Joints in Such a Case the bars will not break first but the failure will happen First on Joint and then the Reinforcement bar will ~~Sl~~ Split from Concrete.

Formula For Development length :-

$$L_d = \frac{\phi f_s}{4 \tau_{bd}}$$

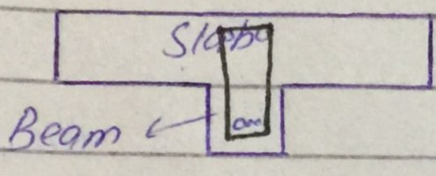
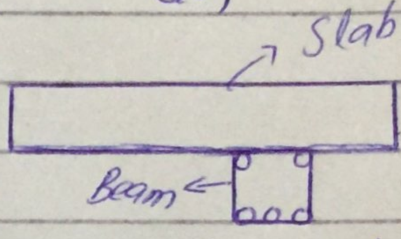
- L_d = Development length
- ϕ = Nominal dia of Reinf.
- f_s = Stress in bar at Section Considerd at design load.
- τ = Design bond Stress.

(b) We Provided Doubly reinforced beam due to following Reason.

- When depth are Restrictions.
- In Continuous Beam Flood System.
- Where it is Required to increase Stiffness of the beam.
- Compression Steel increase the ductility and Structure With High ductility Respond better to Seismic Forces.
- When the Restrictions Occure in the Size (cross-Section) of beam.

For Example :- If the depth of beam Should not be greater then 20" and the external load on beam is very much in which can not resists a Singly reinf. Such a Condition we provided Doubly Reinforced beam.

(C)

T- Beam	Rectangular Beam
⊙ Shap OF T-Beam look like as; 	⊙ Shape OF Rectangular beam look like as; 
⊙ Slab and Beam are monolithically Connected.	⊙ No Joint between Slab and Beam
⊙ It is used mostly in heavy duty	⊙ It is used in Commercial building.
⊙ It act as a Single member.	⊙ Here beam Support the Slab
⊙ Here Reinforced (Beam) emerged in Slab	⊙ Here Reinforced (Beam) not emerged in Slab.
⊙ It is more economical than Rectangular Beam	⊙ It is less ecnomical than T- Beam.

(d) Effect of Strength Reduction factor on flexural Strength:-

If we design fluxural Strength. The Strength Reduction factor decrease from tension Control Section to Compression. Controlled Section to increase Safty with decreasing ductility This show to determine the reduction factor Flextural Strength of reinforcement Concrete.

(e) Design Methods:-

Mostly there are two method used For Designing different Structure.

(1) Allowable Stress Design (ASD) method.

(2) Ultimate Stress Design Method (USD)

(1) ASD Method :-

- It is also Known as working Stress design Method.

- It is based on the principle that stresses developed in the structural member should not exceed a certain limit Friction of elastic limit.

- In this type method all load are taken as a service load.

- No Factor is applied to increase those service load.

- To evaluate Forces and Stresses using linear material.

- In this method allowable material stress must be greater then maximum material stress which caused by load.

(2) USD Method :-

- USD method also know as Load factor method.

⊙ When a structure Subjected to large external load the Ultimate Strength is determine by the elastic analysis.

⊙ It is Apply ultimate factored load.

⊙ Evaluate Sectional demand using linear or yielded materials.

⇒ ⊙ **"USD is better due to Following ~~Metho~~ Reason"**

⊙ As the Ultimate Strength of materials is to be Considered we will get mach stander as Campare to "ASD" method.

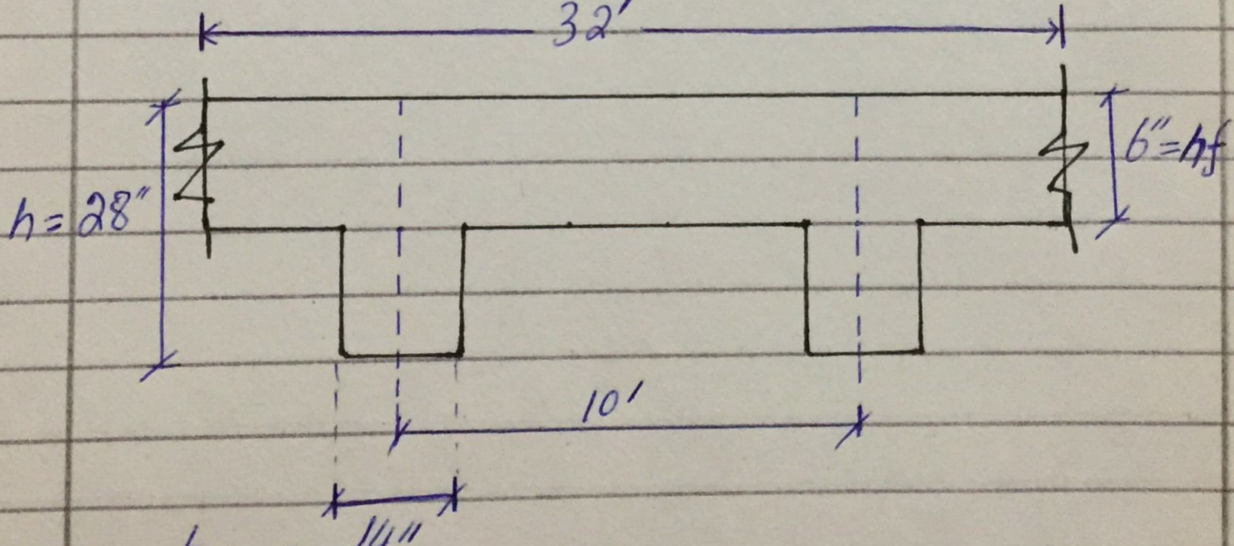
⊙ It is more economical design for a building with fewer Special need for customized area and reQuirment.

⊙ "These design method utilizes a more realistic Factor of Safety."

Q.3 Given Data :-

- Span of Beam (L) = 32'
- c/c distance = 10'
- Thickness of Slab (h_f) = 6"
- width of web (b_w) = 14"
- Total depth (h) = 28"
- effective depth (d) = $h - 3 = 28 - 3$
  $d = 25"$
- Dead load (D.L) = 50 lb/ft^2
- live load (L.L) = 225 lb/ft^2
- f_y = 60,000 psi = 60 ksi
- f'_c = 4000 psi = 4 ksi

Solution :-



bw = 14"

Step ① :-

Utimate Factored moment

$$M_u = \frac{wL^2}{8}$$

i- Find Self weight per feet :-

$wt = b * t * \gamma_c$

$wt = \frac{14}{12} * \frac{28}{12} * 150$ ∴ γ_c RCC = 150 lb/ft

$wt = 408.33$ lb/ft

ii - Find Total Factored load :-

$wt = 1.2 * D.L + 1.6 * L.L$

$wt = 1.2(50 + 408.33) + 1.6(225)$

$wt = 0.909$ kips/ft

As Moment :-

$Mu = \frac{0.909(32)}{8} * 12$

$Mu = 1396.22$ kips/ft

Step (2) :-

Find effective width "be"

(1) $16 * hf + bw = 16 * 6 + 14 = 110''$

(2) C/C distance $= 10 * 12 = 120''$

(3) Span/4 $= \frac{32}{4} * 12 = 96''$

Here 96" is Smallest value

So

$be = 96''$

Step ③ :-

TO checked whether Rectangular or T- Beam Analysis is needed.

Trail # 01 :-

let $a = hf = 6''$

$$Ast = \frac{Mu}{\phi * fy * (d - a/2)}$$

$$Ast = \frac{1396.22}{0.90 * 60 * (25 - 6/2)}$$

$$\boxed{Ast = 1.175 \text{ in}^2} \text{ — (i)}$$

Trail # 02 :-

As $a = \frac{As * fy}{0.85 * f'c * be}$

$$a = \frac{1.175 * 60}{0.85 * 4 * 96}$$

$$a = 0.21'' < 6''$$

"Thus Rectangular Beam Design"

$$Ast = \frac{1396.22}{0.90 * 60 * (25 - \frac{0.21}{2})}$$

$$\boxed{Ast = 1.03 \text{ in}^2} \text{ — (ii)}$$

Trial # 03 :-

$$a = \frac{As * fy}{0.85 * f'c * be}$$

$$a = \frac{1.03 * 60}{0.85 * 4 * 96} = 0.18''$$

Now

$$Ast = \frac{1396.22}{0.90 * 60 \left(25 - 0.18/2\right)}$$

$$\boxed{Ast = 1.03 \ in2} \text{ ——— (iii)}$$

eq (ii) = eq (iii)

Step (4) :-

Checked ρmax and ρmin

- $$\rho max = 0.85 * \beta * f'c/fy * \left(\frac{\varepsilon u}{\varepsilon u + \varepsilon t}\right)$$

$$\rho max = 0.85 * 0.85 * 4/60 \left(\frac{0.003}{0.003 + 0.005}\right)$$

$$\therefore \rho max = 0.018$$

- $$\rho min = \frac{200}{fy} = \frac{200}{60,000} = 0.003$$

- $$\rho = \frac{Ast}{bd} = \frac{1.03}{14 * 25}$$

$$\rho = 0.00294$$

Here $\rho_{min} > \rho < \rho_{max}$

$0.003 > 0.00294 < 0.018$

As "ρ" is less than ρ_{min} then we have:

$$\rho = \frac{Ast}{bd} \Rightarrow Ast = \rho * bd$$

$$\rho = 0.003 * (14 * 25) = 1.05 \ in^2$$

Step ⑤ :- Selection and No. of Bar :-

let try #10 main bar

Area of 1 #10 = 1.27 in2

$$No.s \ of \ Bar = \frac{Ast}{Ab} = \frac{1.05}{1.27}$$

No. of Bar = 1.3 ≅ 2

So take 2 #10 Main Bars

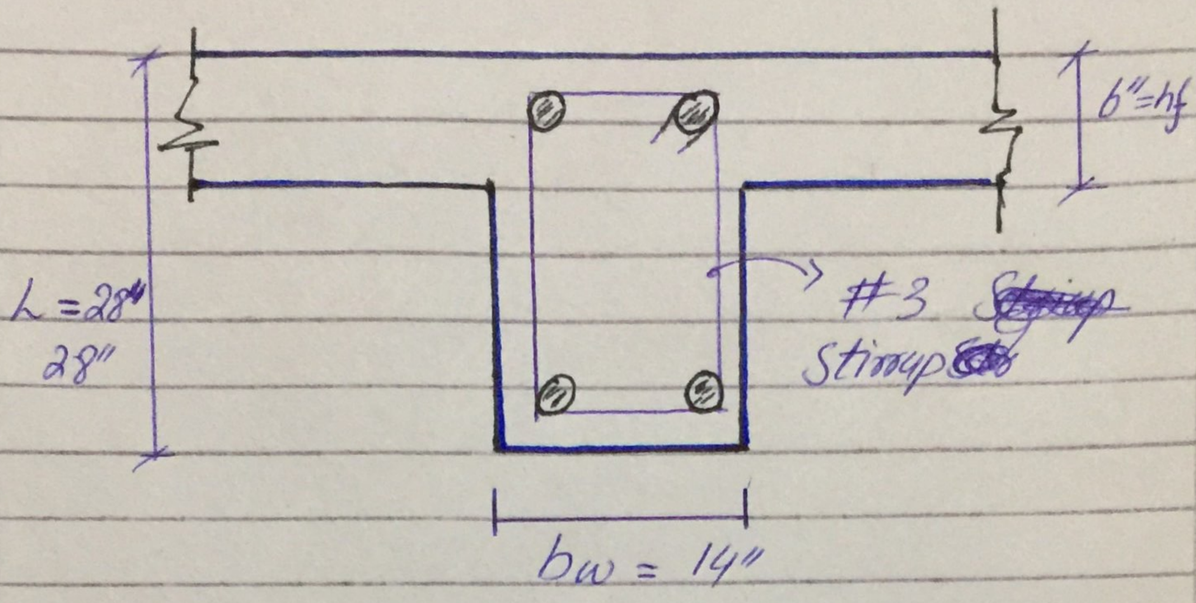
Step ⑥ :-

"Checked On Minimum Width"

$$b_{min} = 2 * 1.5 + 2 * \left(\frac{3}{8}\right) + 2\left(\frac{10}{8}\right) + \left(\frac{10}{8}\right)$$

$b_{min} = 7.5'' < 14''$

"So it is good in One layer"



Step (7) :- "Design Moment"

$md = \phi * fy * Ast * (d - a/2)$ —— (*)

First a=?

Ast = area of 1 bar * No. of Bar

Ast = 1.27 * 2 —: Area of 1 #10 = 1.27 in2

Ast = 2.54 in2

Now

$$a = \frac{Ast * fy}{0.85 * f'c * be} = \frac{2.54 * 60}{0.85 * 4 * 96}$$

a = 0.46"

put values in eq (*) we got (md)

$$md = 0.90 * 60 * 2.54 * \left(25 - \frac{0.46}{2}\right)$$

md = 3396.9

Here 3396.9k" > 1396.22 k"

"Thus Design is Okay"