Name Sajid Saleem

ID # 7793

Submitted to Sir Fawad

Subject PRCD I

Ans 1

Given Data

Width $b = 10''$

Height $h = 20''$

~~Dead~~ Live Load = 2.47 Kips/ft

Dead Load = 1.05 kips/ft

Span = 18''

f_y = 60 Ksi

f_c = 4 Ksi

Required

Area of steel $A_s = ?$

Solution:-

Step # 01

We have to find effective depth

$d = h - 3$

$d = 20 - 3 = 17''$

Effective Cover = 2.5''

Reinforcement Ratio

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

Putting Values

$$= 0.85 \times 0.85 \times \frac{4}{60} \times \frac{0.003}{0.003 + 0.005}$$

$$\rho_{max} = 0.0180$$

Step#2

We have to find Area of Steel

$$\rho_{max} = \frac{A_{st}}{b \times d}$$ By Cross Multiplication

$$A_{st} = \rho_{max} \times (b \times d)$$

$$= 0.0180 \times (10'' \times 17'') = 3.06 \, in''^2$$

Step#03

Find Moment by formula of design moment

$$Mu_2 = \phi \times A_{st} \times f_y \times \left(d - \frac{a}{2}\right)$$

$$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b} = \frac{3.06 \times 60}{0.85 \times 4 \times 10} = 5.4''$$

$$M_{u_2} = 0.90 \times 3.06 \times 60 \times \left(17 - \frac{5.4}{2}\right)$$

$$= 2362.93 \text{ Kip-Inch}$$

Moment due to given load

Beam self weight $= \frac{10}{12} \times \frac{20}{12} \times 150$

$= 208.33$ lb/ft

$=$

Total factored Load $= 1.2(1050 + 208.33) + 1.6(2420)$

$= 5.46$ Kips/ft

Ultimate facted load $= \frac{wl^2}{8}$

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

$M_u = 2653.56$

Now

$Mu_2 < Mu$ which mean Doubly reinforcement is required.

Step#4

$Mu = 2653.56 - 2362.92$

$= 290.64$ Kip-Inch

Step #05

Steel Area in Compression Zone

$Mu_1 = \phi \times A_{st} \times f_y \times (d - d')$

$A_{st} = \dfrac{Mu_1}{\phi \times f_y \times (d - d')}$ putting values

$A_{st} = \dfrac{290.64}{0.90 \times 60 \times (17 - 2.5)}$

$A_{st} = 0.37 \text{ in}^2$

Step# 06 Total Area of steel required

$A_T = A_{st} + A'_{st}$

$3.06 + 0.37 = 3.43\ in^2$

Step #7

Find Dia & No of bars required for Tension & Compression Zone.

Tension Zone

Use #9 bar

Area of #9 bar $= \frac{\pi}{4} d^2 = \frac{3.14}{4}\left(\frac{9}{8}\right)^2 = 0.99\ in^2 = 1\ in^2$

Now

No of #9 Bar $= \frac{A_{st}}{\text{Area of one bar}}$

$= 3.43\ in^2 / 1\ in^2 = 3.43 = 4$

So Use 4 #9 bar for tension zone

Compression Zone

Use #6 bar

Area of #06 Bar $= \frac{\pi}{4} d^2 = \frac{3.14}{4}\left(\frac{6}{8}\right)^2 = 0.44\ in^2$

No of #6 bar $= \frac{Ast}{\text{Area of one bar}}$

$= \frac{0.378}{0.44} = 0.84 = 1$

So using one bar is not Appropiate

So we use 2#6 bars in Compression Zone.

Step#8

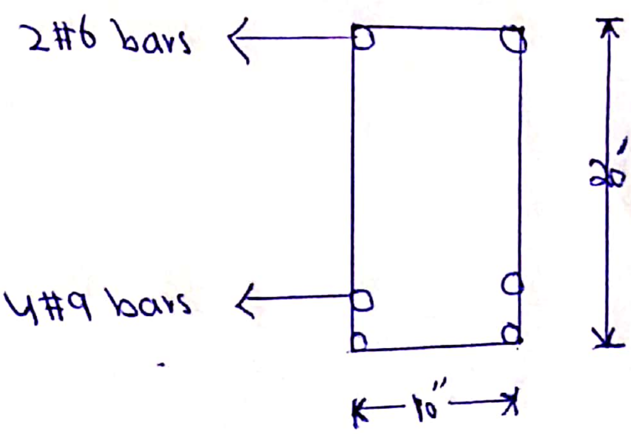
Checking beams Minimum width effective depth & effective Cover

$B_{min} = 2(1.5'') + 2(3/8'') + 4(9/8'') + 4(8/8'')$

$3 + 0.75 + 4.5 + 4$

$12.25'' > 10''$

So We will Arrange Tensions bars in two layer.



Effective depth

$d = 20'' - 1.5'' - 3/8'' - 9/8'' - \frac{1}{2}(9/8)$

$d = 16.44''$

Effective Cover

$d' = 1.5 + 3/8 + \frac{1}{2}(6/8)$

$d' = 1.5 + 0.375 + \frac{1}{2}(0.75)$

$d' = 2.25''$

Step#9 Design Moment check

$Md = \phi \times [A_{st}' \times f_y \times (d - d') + (A_{st} - A_{st}') \times f_y \times d - d \cdot \frac{a}{2})$

$a = \dfrac{(A_{st} - A_{st}') \times f_y}{0.85 \times f_c \times b}$

after putting value

$Md = 2890.46$ K-in

As $Md = 2890.46$ Kin > 2653.56 K-in

So Design is OK

(2) Ans (a)

Bond Strength:-

It may defined as " Stress acting on the outer Interface of Steel to the Surrounding Concrete.

Explanation:-

This type of Stress helps in Keeping bond b/w Concrete & reinforcement. It help and resists any force that tries to pull out the rods from the Concrete. We can't escape the reinforcement from harden Concrete due to bond stresses.

Different bar grades have different bond stress

(b)

Devolpment length:-

It Can be defined as " The Amount of reinforcement length needed to be embeded or Projected into the Coulmn to establish the desire bond Strength b/w Concrete & Steel.

Doubly Reinforcement beam is generally Provided When the depth of the beam is restricted.

Explanation:-

If a beam with limited depth is reinforce on the tension Side only It may have not Sufficient resistance to oppose the bending moment. in order to Increase the moment Carrying Capacity of the Section.

The moment is Subjected to a Shock or impact or accidental lateral thrust.

Doubly reinforcement beam is provided to Increase the moment of resistance of a beam having limited dimensions.

We provide doubly reinforcement beam to Counter wind forces, Seismic forces & temperature stresses. etc.

T-Beam

When slab are Monotithically Casted with beam in a positive moment Zone, Part of the slab acts as a Part of beam & resist the longitudinal Compression

⇒ T-beam are mostly Used in heavy duties & large space Such as bridges

⇒ T-beams are more economical then rectangular beam

⇒ The design procedure of T-beam depends on the location of moment as the Case of its flexural strength.

Rectangular Beam:-

The rectangular beam is generally used as Compression in top fibre & tenstion in bottom fibre of that beam.

⇒ Rectangular beam is less economical as Compare to T-beam.

⇒ In Case of rectangular beam, slab has been Placed on slab, hence no connection b/w slab & beam.

(D) Effect of strength reduction factor on flexural strength

In the design of flexural strength, the strength reduction factor decrease from tension control Section to Compressive Control section to increase Safety with decreasing ductility. This show that to determine the reduction factor for flexural strength of reinforcement Concrete beam according to ACI Code. In the realibity based design, the reliable Concrete members is assured by use of reduction factors Corresponding to different target reability index.

E Design moment

Following two method are Used for designing

1) ASD

2) USD

1) Allowable Stress Design Method.

ASD method is also known as working stress

It is based on the principal that stress devulp should not exceed a certain limit of elastic limit.

=) In this method all loads as service load & no factor is applied to increase these survice load.

2) Ultimate strength Design moment

For structure Subjected to heavy loads the USD (non elastic anylsis)

Ultimate Strength Design method results in more economical design for a building with fewer special needs for customized area of reinforcement.

- ASD better determines design for higher Safety factor needs where a building is more prone to environment pressure.

I

Ans 3

Given Data

Span = 30'

c/c distance = 10'

Slab thickness = 6"

Web width = 14"

Total depth (h) = 28"

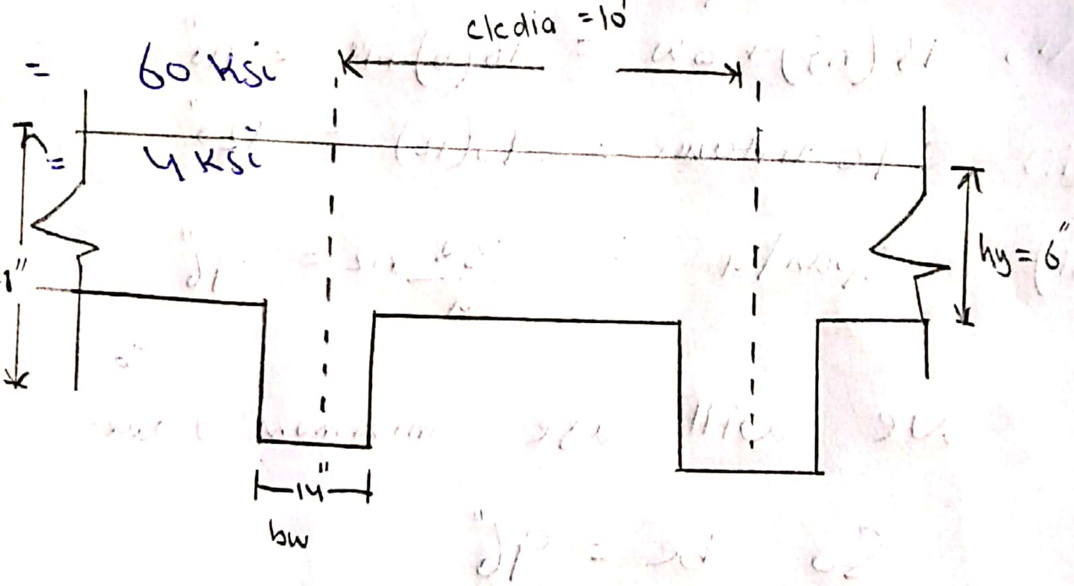
Effective depth = 28" - 3" = 25"

Dead load = 50 lb/ft²

S.S = 225 lb/ft²

fy = 60 ksi

fc = 4 ksi



Step 1*

$$M_u = \frac{W_u \times L^2}{8}$$

to find W

Beam self weight per feet

$W_t = b \times t \times \gamma_c$

$\frac{14}{12} \times \frac{28}{12} \times 150 = 408.33$ lb/ft

Step#2

Total factored load

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

$= 909.99$ lb/ft $= 0.909$ Kip/ft

Moment

To convert into Inch

$\frac{Wl^2}{8} = \frac{0.909 \times 32^2}{8} \times 12 = 1396.23$ Kip..

Effective Breadth

i) $16(h_f)+b_w = 16(6)+14 = 110''$

ii) c/c distance : $10(12) = 120''$

iii) span/4 : $\frac{32}{4} \times 12 = 96''$

We will use minimum value.

So $b_e = 96''$

Step#3. T-beam or Rectangular

Trial#1 let $a = h_f = 6''$

$A_{st} = \frac{M_u}{\phi \times f_y \times (d-\frac{a}{2})} = \frac{1396.33}{0.90 \times 60(25-\frac{6}{2})}$

Scanned with CamScanner

III

$A_{st} = 1.17"^2$

Trial#02

$$a = \frac{A_{st} \times f_y}{0.85 \times f'_c \times b} = \frac{1.17 \times 60}{0.85 \times 4 \times 96}$$

$0.2" < 6"$

So rectangular beam design.

$$A_{st} = \frac{1396.23}{0.90 \times 60 \times \left(25 - \frac{0.2}{2}\right)} = 1.03 \text{ in}^2$$

Trial#3

$$a = \frac{1.03 \times 60}{0.85 \times 4 \times 96} = 0.18"$$

$$A_{st} = \frac{1396.23}{0.90 \times 60 \left(25 - \frac{0.18}{2}\right)} = 1.03 \text{ in}^2$$

Step#4

Checking of Reinforcement Ratio

By formula

Max. Reinforcement Ratio is

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

$$= 0.85 \times 0.85 \times \frac{4}{60} \times \frac{0.003}{0.003 + 0.005}$$

$\rho_{max} = 0.018$

$\rho = \frac{A_{st}}{b \times d} = \frac{1.003}{14 \times 25} = 0.002$

$\rho = 0.002$

⇒ Checking the order

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

As ρ is less then ρ_{min}, so we have to find A_{st} on A_{min}.

⇒ $\rho_{min} = \frac{A_{st}}{b \times d}$ ⇒ $A_{st} = \rho_{min} \times b \times d$

$A_{st} = 1.05\ in^2$

Step#5 Selection & No of Bar requirement

let we use #8 bar

So

Dia $= (8/8) = 1''$, Area $\frac{\pi}{4} d^2 = \frac{3.14}{4} (1/8)^2 = 0.785\ in^2$

By formula

No of Bar $= \frac{\text{Area of steel}}{\text{Area of Single bar}} = \frac{1.05}{0.785} = 1.3 \approx 2$

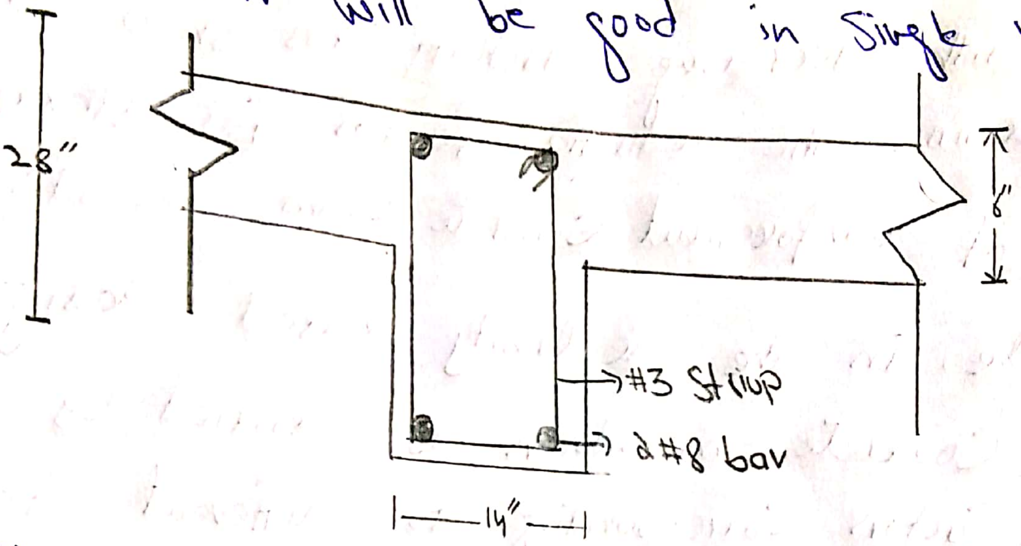
So we use 2 #8 bars

Minimum width for Accomodation of Bars

$b_{min} = 2(1.5) + 2(3/8) + 2(8/8) + 1(8/8)$

$6.75'' < 14''$

So bar will be good in Single layer



Step#7

Design Moment

By formula of Design moment

$Md = \phi \times fy \times A_{st} \times \left(d - \frac{a}{2}\right)$

As from formula

No of bars = $\frac{\text{Area of steel}}{\text{Area of Single bar}}$

Ast = No of bars x Area of Single bar

2×0.785

$Ast = 1.57 \text{ in}^2$

Also

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{1.57 \times 60}{0.85 \times 4 \times 96} = 0.2''$$

putting in the formula

$$Md = 0.90 \times 60 \times 1.57 \times \left(25 - \frac{0.2}{2}\right)$$

$$= 2111.02 \text{ kip-inch}$$

As Design moment > Given Moment

2111.02 kip-inch > 1397.76 kip-inch

So Design is ok.