SUBJECT: PRC-1

NAME: ASFANDYAR KHAN

ROLL NO: 7399

ANS 1: Solved by hand, pictures attached below:

~~= 0.145 kip/ft³~~

Q1

Solution:

$b = 10''$, $h = 20''$, $l = 18\,ft$, $d = 20 - 3 = 17''$

$f_y = 60{,}000\,psi$, $f_c' = 4000\,psi$, $d' = 2.5''$

Dead load = 1.05 kips/ft

Live load = 2.47 kips/ft.

first we calculate dead load of self wieght

so D.L due to self wieght $= \frac{b \times h}{144} \times$ (unit wieght)

$= \frac{10 \times 20}{144} \times 0.145\,kip/ft^3$

$= 0.201\,kip/ft$.

so total D.L = 0.201 + 1.05

= 1.251 kip/ft

Now we will find total applied moment by

$M_u = \frac{w l^2}{8}$

$w = 1.2(D.L) + 1.6(L.L)$

$= 1.2(1.251) + 1.6(2.47) = 5.453\,kip$

so $w = 5.453\ kip/ft = \frac{5.453}{12}\ kip/in$

$= 0.454\ kip/in$

Now $M_u = \frac{wl^2}{8} = \frac{0.454(18 \times 12)^2}{8}$

$= 2647.7$ kip-inch

Step 1 first check the capacity of section as singly reinforced

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

$$= 0.85 \times 0.85 \times \frac{4000}{60{,}000} \times \left(\frac{0.003}{0.003 + 0.005}\right)$$

$\rho_{max} = 0.0180$ (Reinforcement ratio)

As we know

STEP 2

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

So, $A_{st} = \rho_{max} \times b \times d = 0.0180 \times 10 \times 17$

$= 3.06\ in^2$

Step 3.

$$M_{u_2} = \phi A_{s1} \times f_y \times \left(d - \frac{a}{2}\right)$$

But first, $a = \frac{A_{s1} \times f_y}{0.85 \times f_c' \times b} = \frac{3.06 \times 60000}{0.85 \times 4000 \times 10}$

$a = 5.4''$

$$M_{u_2} = 0.90 \times 3.06 \times 60{,}000 \left(17 - \frac{5.4}{2}\right)$$

$M_{u_2} = 2362.9$ kipinch $< M_u = 2647.7$ kip.inch

so beam is doubly reinforced.

STEP 4

$M_{u_1} = M_u - M_{u_2} = 2647.7 - 2362.9$

$= 284.8$ kip''

STEP 5

$$M_{u_1} = \phi \times A_s' \times f_y \times (d - d')$$

So $A_s' = \frac{M_{u_1}}{\phi \times f_y \times (d - d')} = \frac{284.8}{0.90 \times 60 \times (17 - 2.5)}$

$A_s' = 0.363 \text{ in}^2$

STEP-06: Total steel Area

$A_s = A_{st} + A_s' = 3.06 + 0.363$

$= 3.423 \ in^2$

This total steel shall be provided in tensile zone as tension reinforced.

Step 7

Selection of Bars:

A: for tensile steel.

let's try #8 bar having Area = $0.785 in^2$

No of bars $= \frac{A_s}{A_b} = \frac{3.423}{0.785} = 4.36 \approx 5$ bars #8

B. for compression steel.

let's try #3 bar with Area = 0.11

Number of bars $= \frac{A_s'}{A_b} = \frac{0.363}{0.11} = 3.3 \approx 4$

$= 4$ #3 bars.

STEP 8.

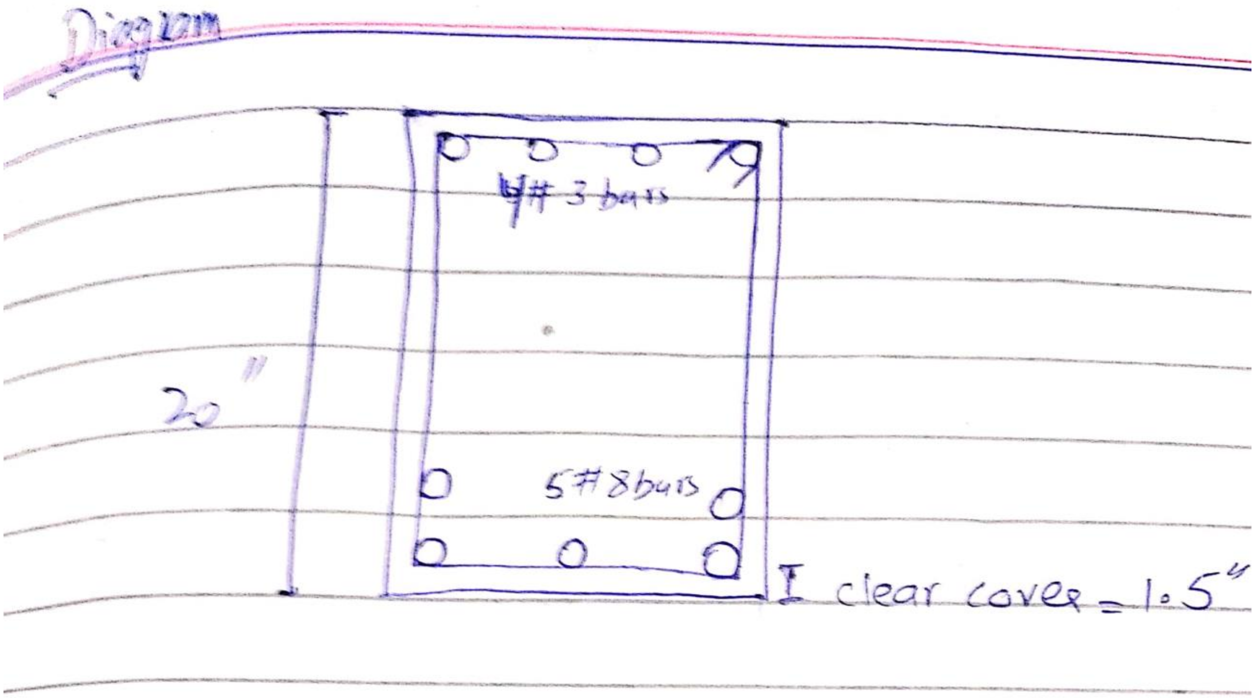
Check on minimum width of a beam

b_{min} = 2 x clear cover + 2 x dia of stirrup + No of main x dia of main bars + No of spaces b/w main bar x dia of main bar

$$= 2 \times 1.5 + 2 \times \frac{3}{8} + 5 \times \frac{8}{8} + 4 \times \frac{8}{8}$$

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

No good in one layer so main bars shall be in two layers



ANS 2:

(a) Bond Stress:

The shear stress that is developed along the contact surface of reinforcement bars and concrete and it helps in preventing of slippage of bars so that stress is called bond stress When the bar is tried to pull out of a concrete it creates stress called bond stress and this is due to adhesive contact force between concrete and curved surface of bar

Development length:

the amount of length of reinforcement bar to be inserted in the column so that a strong bond creates between steel and concrete is called development length
they provide safe bond so that no failure occurs when load is applied.
This length is responsible of transfer of stress from one structural element to other.

(b) Conditions in which double reinforced beam is used:

The double reinforced beam has compression steel in addition to tension steel as compared to single reinforced beam, the double reinforced beam is used due to following reasons:

- When the tension steel is unable to take the total moment applied on beam, so compression steel is provided which makes it double reinforced beam
- When due to architectural reasons we cannot increase depth of beam, but we must increase the moment carrying capacity of beam then double reinforced beam is used

- The compression steel is also provided to hold stirrups in position and it also increase the ductility of beam
- To ensure safety against the reverse stresses of wind forces, seismic forces and temperature forces the double reinforced beam is used

(c) Difference between analysis of rectangular and T beams:

First of all there is a difference in geometry, flexural capacity and design procedure of these beams so that's why the analysis of both also contain differences which will be explained below

- **First we discuss analysis of rectangular beam**
- In this beam we check the given steel with min and max steel with the dimensions
- Next we find the moment bearing capacity of the beam through steel
- Then we find the applied moment by using the applied dead and live loads on the beam
- Then we compare the bearing moment and the applied moment, and we analyze if the bearing one is greater than the applied then the beam is ok and if vice versa the beam is not om and we have design again the beam
- **Now we discuss the analysis of double reinforced beam**
- First, we find the min and max steel of the beam and compare the installed steel in it
- Then we must find weather the neutral axis is in flange or not
- If the neutral axis is in flange, we have a formula for finding moment bearing capacity of beam and if the neutral axis is in the web, we have a different formula for the moment bearing capacity
- Similarly, we find the applied moment on the beam
- Then we compare the moment bearing with the applied moment a check if the beam is designed correctly or not.

(d) Effect of strength reduction factor on flexural strength:

Strength reduction factors are used more making more conservative design , strength reduction factors and load factors are there to be on the safe sides , what we do is make the design safer, we make a design which will give us more strength than the required strength when we use factors

We increase applied moment by some factor and our required strength is increased proportional to that.

(e) Types of design methods and which one to use:

- **Working stress method:**

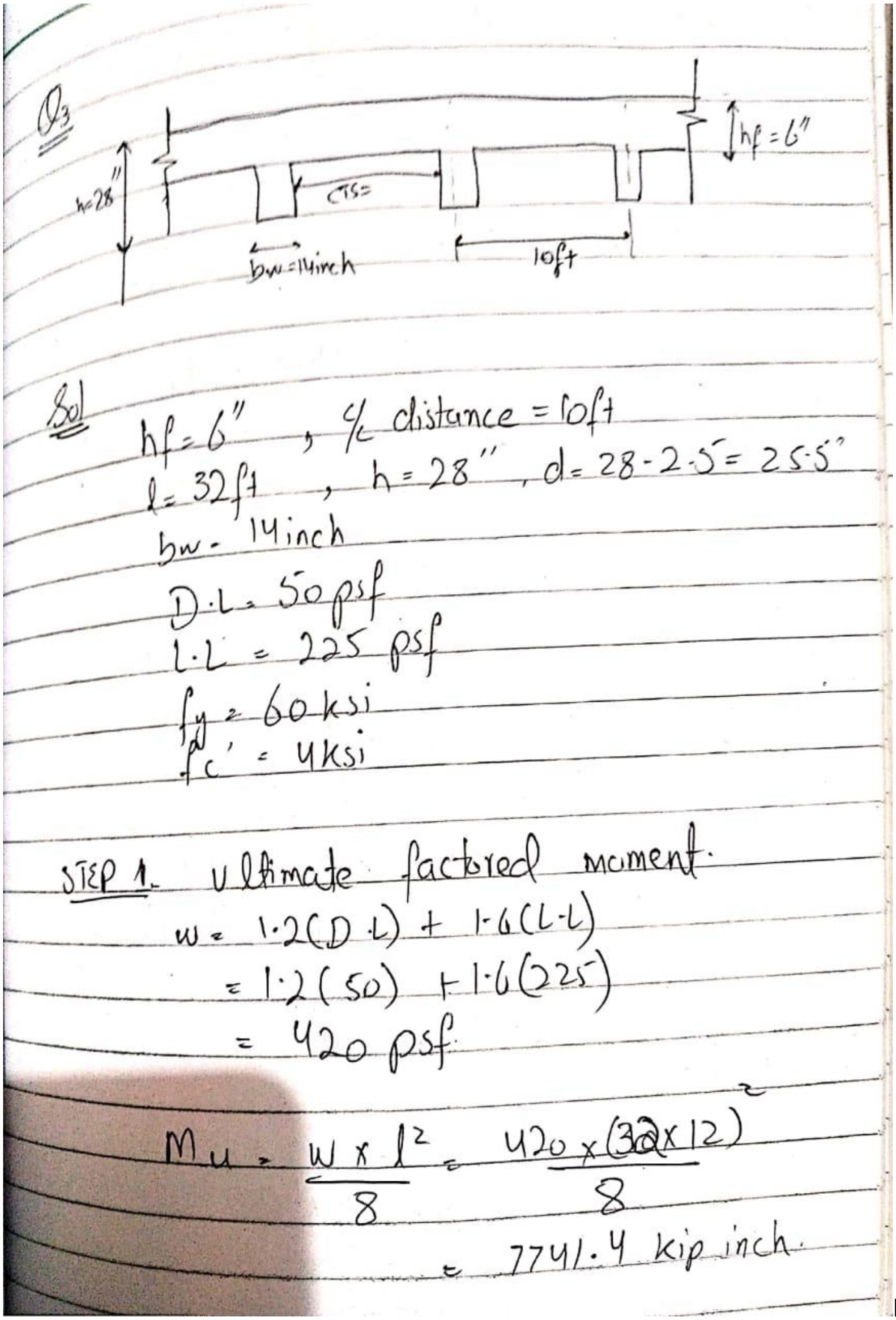
  This is based on elastic theory in which materials are assumed to be stressed well below their elastic limit under the design loads
- **Limit state design method:**

  It considers the ultimate strength of the structure or member. This is based on the concept of safety at ultimate loads and serviceability at working loads

Comparison:

For most designs limit state method is used because the working stress method is old and very conservative and on the other side the limit state method is economical, and thus more and more codes use limit state method.

ANS 3: Solved by hand, pictures attached be



Q3

h=28"

$h_f = 6"$

c/s=

bw=14inch

10ft

Sol

$h_f = 6"$, c/c distance = 10ft

$l = 32ft$, $h = 28"$, $d = 28 - 2.5 = 25.5"$

$b_w = 14inch$

D.L = 50psf

L.L = 225 psf

$f_y = 60ksi$

$f_c' = 4ksi$

STEP 1. ultimate factored moment.

$w = 1.2(D.L) + 1.6(L.L)$

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

$= 420 psf$

$M_u = \frac{w \times l^2}{8} = \frac{420 \times (32 \times 12)^2}{8}$

$= 7741.4$ kip inch.

low:

STEP 2 calculate effetive width "be" for T beam

1) $16 \times hf + bw = 16 \times 6 + 14 = 110''$
2) c/c distance $= 10 \times 12 = 120''$
3) span/4 $= \frac{32}{4} \times 12 = 96''$

so be = least value = $96''$

STEP 3 chech weather rectengular or T beam design is required.

Trail #01

let $a = hf = 6''$

$$A_{st} = \frac{Mu}{\phi \times f_y \times (d - \frac{a}{2})} = \frac{2241.4}{0.90 \times 60 \times (25.5 - \frac{6}{2})}$$

$$A_{sT} = 6.37 \text{ in}^2$$

Trail #2

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

$$a = \frac{6.37 \times 60}{0.85 \times 4 \times 96} =$$

$a = 1.17'' < h_f = 6''$

=> Rectegular beam design.

$$A_s = \frac{7741.4}{\phi \times 60 \times \left(25.5 - \frac{1.17}{2}\right)}$$

$A_s = 5.75 \text{ in}^2$

Trail #3

$$a = \frac{5.75 \times 60}{0.85 \times 4 \times 96} = 1.02$$

$$A_s = \frac{7741.4}{\phi \times 60 \times \left(25.5 - \frac{1.02}{2}\right)} = 5.75 \text{ in}^2$$

STEP #4

Chech ρ_{max} and ρ_{min}

$$\rho_{max} = 0.85 \times \beta \times \frac{f_c'}{f_y} \times \left(\frac{\varepsilon_u}{\varepsilon_u + \varepsilon_t}\right)$$

P.T.O

Date:

Day: M T W T F S S

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

$$= 0.018$$

$$\rho_{min} = \frac{200}{f_y} = \frac{200}{60{,}000} = 0.003$$

$$\rho = \frac{A_{st}}{b \times d} = \frac{5.75}{14 \times 25.5} = 0.0161$$

so $\rho_{min} < \rho < \rho_{max} \Rightarrow$ ok

STEP 5

Selection and no of bars

lets try # 10 main bars having Area of one # 10 bar $= 1.27 \text{ in}^2$

$\Rightarrow$ No of bars $= \frac{A_{ST}}{A_b} = \frac{5.75}{1.27} = 4.52 \approx 5$

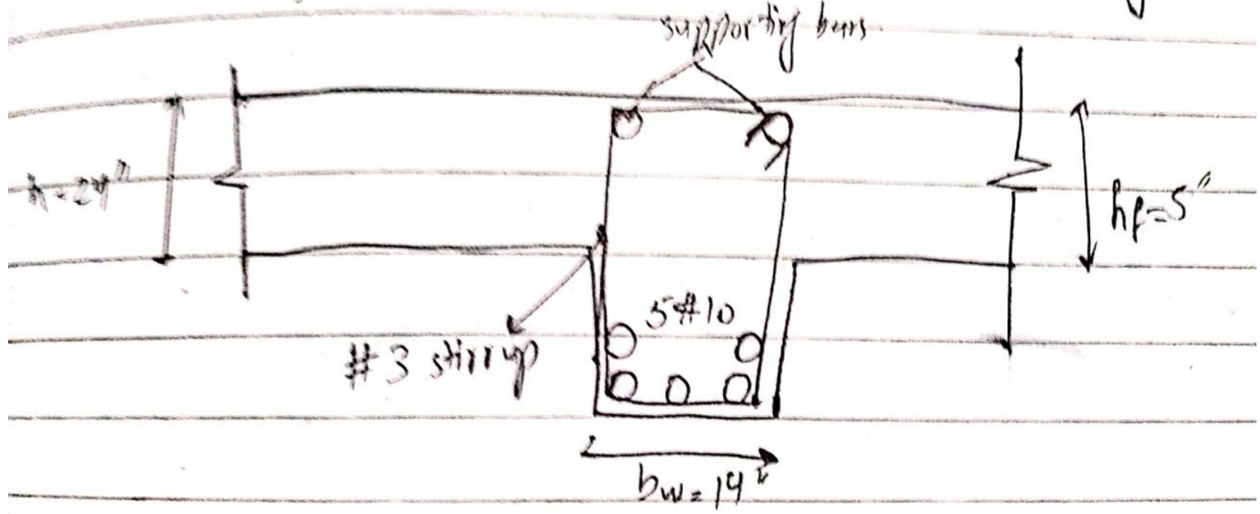
so take 5 # 10 main bars

STEP #6 Check on minimum width.

$$b_{min} = 2\times1.5 + 2\times\left(\frac{3}{8}\right) + 5\times\left(\frac{10}{8}\right) + 4\times\left(\frac{10}{8}\right)$$

$$= 15 > 14''$$

main bars shall be in two layers



THE END