Name: M-İKRAM

ID # 7874

Sec # B

Paper # PRCD

Teach: Sir Fawad

"Q:- 1"

Ans:

Given data:

$L.L = 2.47 \ k/ft$

$D.L = 1.05 \ k/ft$

$w = 10''$

$h = 20''$

$d = h - 3 = 20 - 3 = 17''$

$d' = 2.5''$

$f_y = 60000 \ psi$

$f_c' = 4000 \ psi$

Sol:-

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

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

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

"Step 2": Area of Steel

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

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

$$= 0.0181 \times 10 \times 17$$

$$\boxed{A_{st} = 3.077\ in^2}$$

"Step 3" Deign factored Moment

$$M_{u2} = \phi \times A_{st} \times f_y \times \left(d - \frac{a}{2} \right)$$

③

$$a = \frac{A_{st} \times F_y}{0.85 f'_c b}$$

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

$$M_{u_2} = 0.90 \times 3.08 \times 60 \times \left(17 - \frac{5.4}{2}\right)$$

$$\boxed{M_{u_2} = 2378.38 \, k''}$$

Now

Moment of given load:

Beam self weight = $b \times t \times \gamma_c$

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

$$= 208.33 \text{ lb/ft}$$

//

Now

Total factored load = 1.2 D.L + 1.6 L.L

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

$= 5461.996 \text{ lb/ft}$

$\boxed{TFL = 5.46 \text{ K/ft}}$

Ultimate factored Moment $= \frac{WL^2}{8}$

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

$$\boxed{= 2653.56 \text{ K}''}$$

⑤

Thus $2378.38 < 2653.56$

It should be Doubly deisghed beam

"**Step 4**"

$$M_{u1} = M_u - M_{u2}$$

$$= 2653.56 - 2378.38$$

$$M_{u1} = 275.18k$$

"**Step 5**:"

$$M_{u1} = \phi \times A_s' \times f_y \times (d-d']$$

$$A_s' = \frac{M_{u1}}{\phi \times f_y \times (d-d')}$$

$$= \frac{275.18}{0.90 \times 60 \times (17-2.5)}$$

$$\boxed{A_s' = 0.35\ in^2}$$

"Step 6":

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

$$= 3.08 + 0.35$$

$$= 3.43\ in^2$$

This lies inthe tension Zone of Steel.

"Step 7": Selection of Bars

for tensile Steel: lets take #8 having area 0.785 in^2

No of bars = $\frac{A_s}{A_b}$

$= \frac{3.43}{0.785} = 4.36 \approx 5$ bars

For Compression Steel; let's take #6 having area 0.442 in²

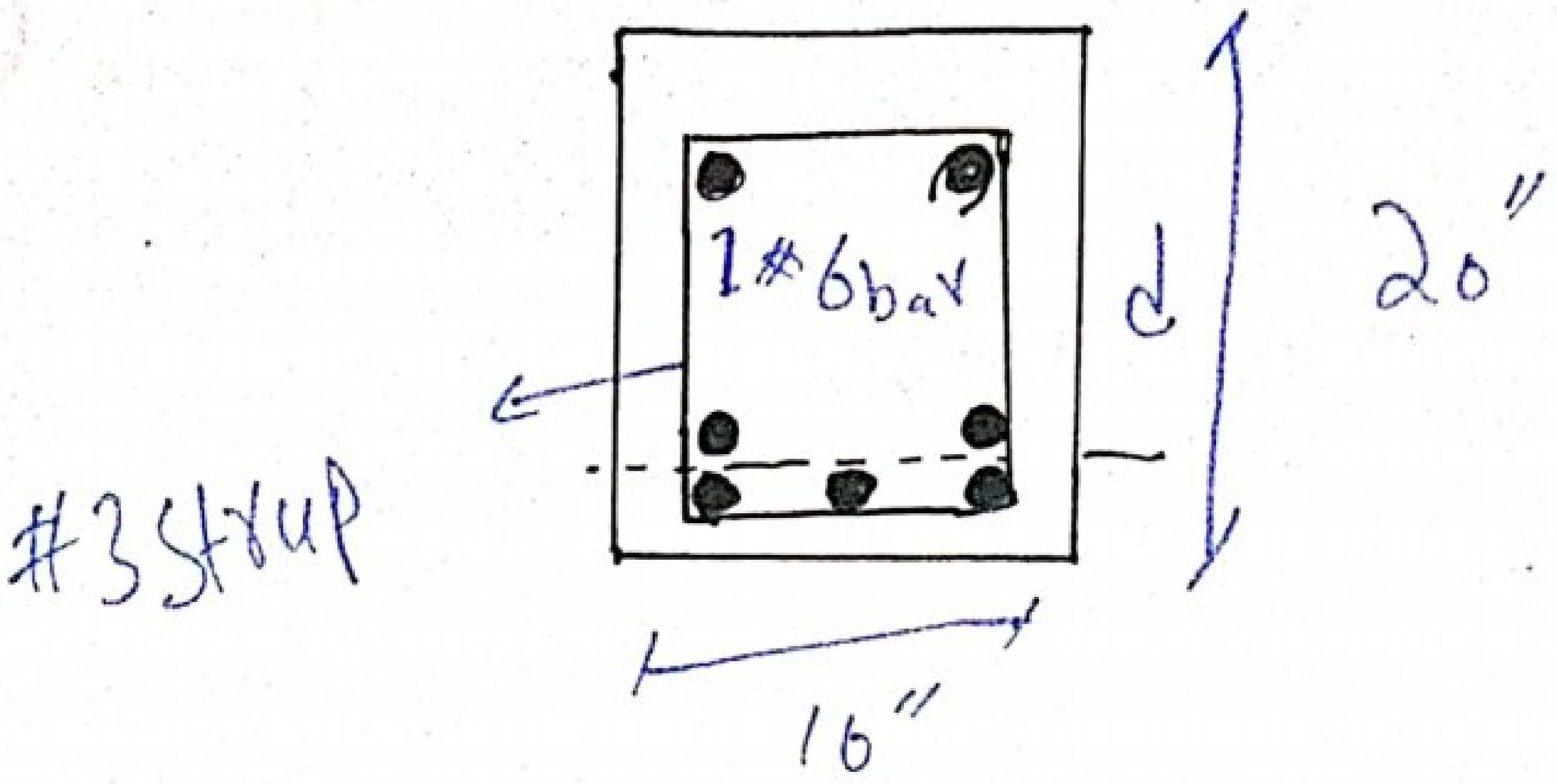
No of bars = $\frac{A_s'}{A_b} = \frac{0.35}{0.442} = 0.79 \approx 1$ b

Step 8: Beam Minimum Width

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

$$= 12.75'' > 10''$$

It should be in multiple layers



$$d = 20 - 1.5 - \frac{3}{8} - \frac{8}{8} - \frac{1}{2}\left(\frac{8}{8}\right)$$

$$d = 16.625''$$

$$d' = 1.5 + \frac{3}{8} + \frac{1}{2}\left(\frac{6}{8}\right) = 2.25''$$

"Step 9": Deign Moment

$$M_d = \phi \times \left[A_s' \times f_y \times (d - d') + (A_s - A_s') \times f_y \times \left(d - \frac{a}{2}\right)\right]$$

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

$$= \frac{(5\times0.785 - 1\times0.44)\times 60}{0.85\times4\times10}$$

$$\boxed{a = 6.15''}$$

$$0.90\times\left[1\times0.44\times60\times(16.625-2.25)+(5\times0.785-1\times0.44)\times60\times\left(16.625-\frac{6.15}{2}\right)\right]$$

$$Md = 2891.5245$$

$$\boxed{Md = 2891.5245 > 2653.56\,k}$$

Design is OK

④

"Bond Stress":-

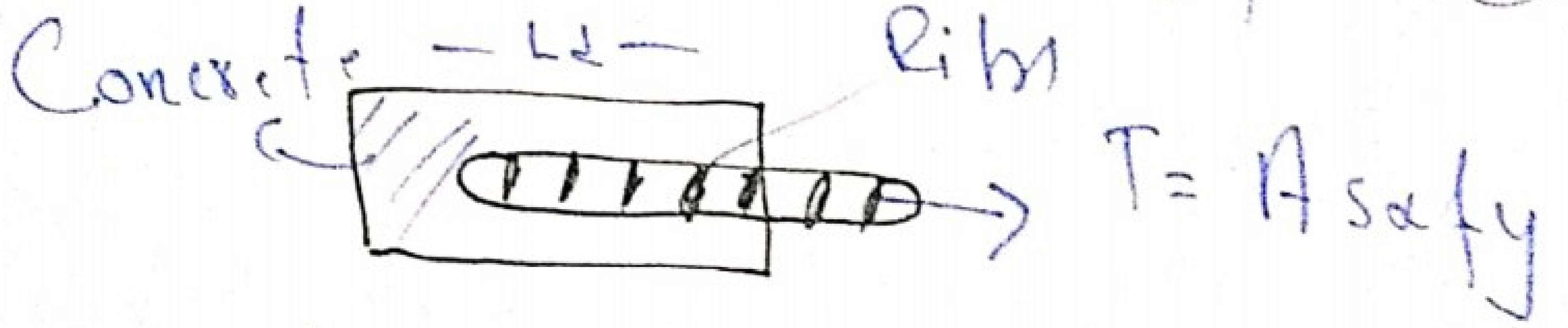
The pulling out of Steel bar from Concrete is resisted by gripping action of Concrete is Known as Bond and the resulting Stress is Called Bond Stress.

⇒ Resisting offered to Slipping of bars is due to three Reasons.

① Chemical adhesion b/w two materials.

② Friction due to natural roughness of bars

③ Due to closely spaced rib-shaped deformation made on the bar surfaces



Bond can also be increased by providing.

① Sufficient cover
② Rich mix concrete
③ Deformed Bars

"Development length:"

The neccessary length between the point of maximum stress in a bar and the end of bar"

for #11 or smaller bar the development length must not be less than the value obtained from the following three equation

⇒ for tension $L_d = \frac{0.04\alpha A_b \alpha f_y}{\sqrt{f_c}}$

⇒ for compression $L_{dc} = \frac{0.02\alpha d_b \alpha f_y}{f_c}$

Q1 (D)

(b)

Ans:

Doubly reinforced Section are generally resorted to in Situation where the Cross Sectional dimension of the beam are restricted.

where Singly reinforced Section is ~~not~~ not adequate in term of moment resisting Capacity.

and as well when applied load is more and the depth are restricted than we apply doubly reinforced beam

Q2 ⓒ

Ans:

The resistance of T-beam is higher for positive moment because the flange Section would be in Compression. But for negative moment it yield the Same without the flange. while rectangular Section only depend on location of reinforcement to yield the Flexural capacity

⇒ and another words in T-beam Slab and Beam are Connected with one another act as one Member

In Case of rectangular there is no Connection

Q2: (d)

(d) **Ans:**

The effect of strength reduction factor on flexural strength is briefly explained by ACI (440.2R-08)

Two distinct modes of failure given the behaviour of the members externally strengthened with FRP, and thus affect the calculation of equation

The first mode is initiated by the Crushing Concrete ($\varepsilon_c = 0.003$) it also state that the effect on Flexural strength due to strength reduction factor also relies on the member design parameter.

Q2: ⓔ

Ans:

There are two types of design methods

① Ultimate Strength Design Method
② Allowable Stress design Method

USDM: Due to this method we Can find thickness of beam & depth of the beam

ASDM: In this method we only Count Service load. In this method actual loads are considered means (live load + dead load)

* ASDM is more preferable because it Consider actual loads

Given data:-

c/c distance = 10'

Span = 32'

Slab thickness = 6"

Web width = 14"

Total depth = 28"

Effective depth = 28"-3" = 25"

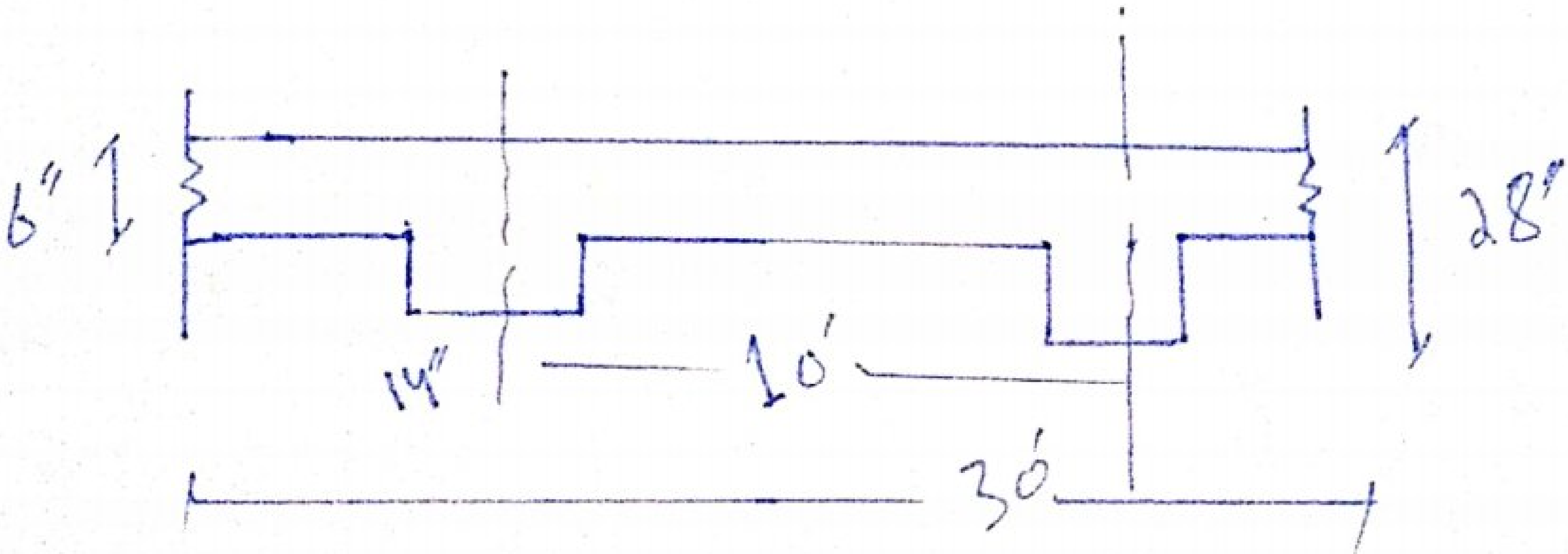
~~D.L~~ D.L = 50 lb/ft

S.S = 225 lb/ft

fy = 60,000 psi

fc' = 4000 psi

Sol:-



"Step: 1"

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

1-

Beam self weight Per feet

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

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

Total Factored Load:

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

$$= 909.99\ lb/ft = 0.909\ kp/ft$$

Moment:

$$\frac{WL^2}{8} = \frac{0.909 \times (32)^2 \times 12}{8}$$

$$= 1396.23\ \text{Kp-inch}$$

⇒ Effective Breadth:

① $16(h_f)+b_w = 16(6)+14 = 110''$

② c/c distance $= 10(12) = 120''$

③ Span/4 $= \frac{32}{4}\times 12 = 96''$

So $\boxed{b_e = 96''}$

Step: 3: "Rectangular or T-Beam"

"Trial: 1" let $a = h_f = 6''$

$$A_{st} = \frac{M_u}{\phi \times f_y \times (d - a/2)} = \frac{1396.23}{0.90 \times 60(25-6/2)}$$

$$A_{st} = 1.17 \text{ in}^2$$

"Trial 2"

$$a = \frac{Ast \times fy}{0.85 \times f'c \times b} = \frac{1.17 \times 60}{0.85 \times 4 \times 96}$$

$$= 0.22'' < 6''$$

So Rectangular Beam ~~Design~~ analysis is required

$$Ast = \frac{1396.23}{0.90 \times 60 \times (25 - 0.2/2)}$$

$$\boxed{= 1.03\,\text{in}^2}$$

"Trial 3":

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

$$Ast = \frac{1396.23}{0.90 \times 60 \times (25 - 0.18/2)} \boxed{= 1.03\,\text{in}^2}$$

Step. 4: Check ρ_{max} and ρ_{min}

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

$$\rho_{max} = 0.18$$

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

$$\Rightarrow \rho = \frac{Ast}{b \times d} = \frac{1.03}{14 \times 25} = 0.0029$$

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

$$0.003 < 0.02 < 0.018$$

As ρ is less than ρ_{min}

So,

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

$$A_{st} = 0.003 \times 14 \times 25 = 1.05\,in^2$$

"Step 5": No and Selection of Bar

let use #8 bar, then

$$dia = \left(\frac{8}{8}\right) = 1'' \qquad Area = 0.785\,in^2$$

$$\text{No of bar} = \frac{1.05}{0.785} = 1.3 \simeq 2$$

So we use 2 #8 bars.

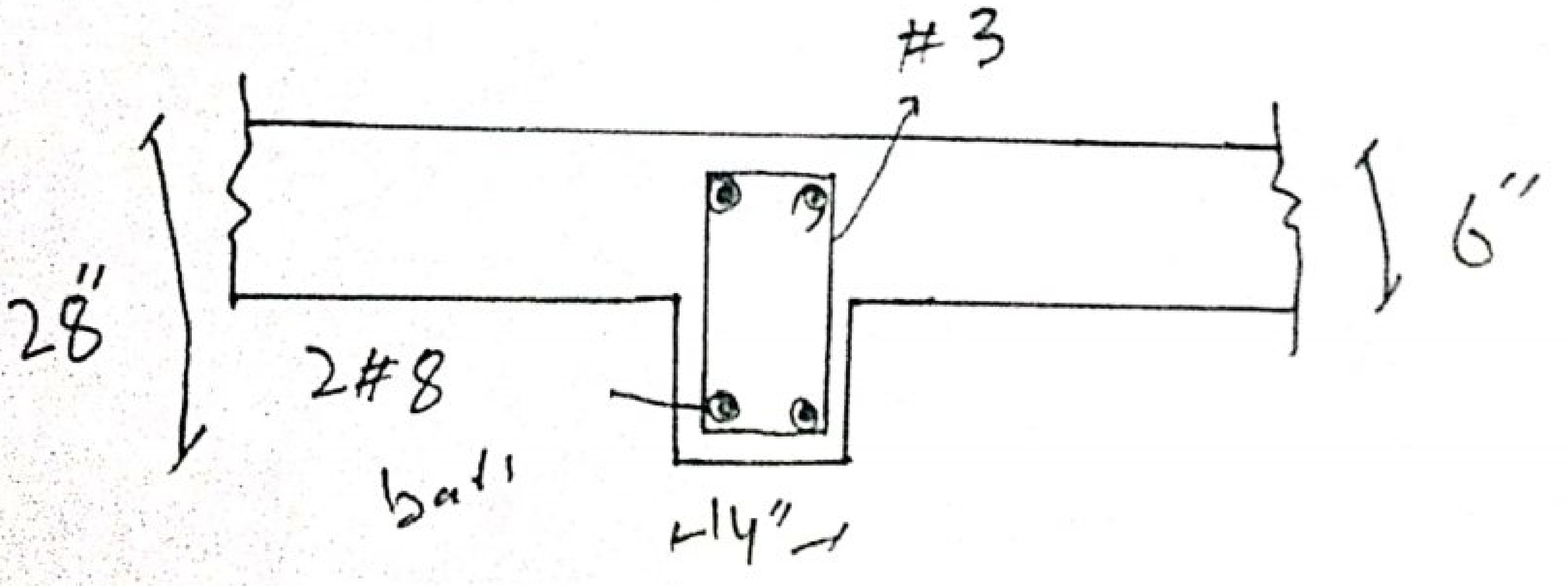
Step 6" Minimum width

~~bmin = 2(1.5)+(2~~

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

$= 6.75" < 14"$

So good in one layer.



Step 7" Deisgn moment

$M_d = \phi \times f_y \times A_{st} \times (d - a/2)$

Area of Steel = Area of one x No of bar

$= 0.785 \times 2 = 1.57 \text{ in}^2$

$$a = \frac{1.57 \times 60}{0.85 \times 4 \times 96} = 0.2''$$

$\Rightarrow M_d = 0.90 \times 60 \times 1.57 \times (25 - 0.2/2)$

$= 2111.02$ Kp-inch

As, $2111.02 > 1396.23$
✓

Design is OK.