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Pg # 1

Subject = Plain Reinforcement Concrete Design 1

Q NO: 1 A rectangular beam that must carry a Service Load 2.47 Kips/ft and a calculated dead load 1.05 Kip/ft (without self wt) on 18-ft simple span is limited to 10 inches width and 20 inches total depth for architectural reason if fy = 60000 psi and fc = 4000 psi. Calculate steel area? Draw sketch, trial designs

Solution

Given data:-

LL = 2.47 Kip/ft

D.L = 1.05 Kip/ft (without self wt)

L = 18'

b = 10"

h = 20 in

fc = 4 ksi

fy = 60 ksi

Required Ast = ?

Sol Step No. 1 size and dimension

As due to architectural size cannot be changed so

b = 10" h = 20"

Step #2: load and bending moment

self wt

self wt = unit wt of concrete × volume of beam × section

So $\gamma \times \gamma\ (150\ lb/ft^3) \times \left(\frac{10}{12} \times \frac{20}{12} \times 18\right) =$

$3750\ lb \rightarrow \frac{3750}{1000} = 3.750\ \text{Kips}$

Change this point locate to U.D.L

so $\frac{\text{self wt}}{\text{span length}} = \frac{3.750}{18}$

self wt = 0.2083 Kips/ft

Therefore total D.L will be

D.L = (1.05 + 0.2083)

D.L = 1.2583 Kips/ft

and L.L = 2.47 Kip/ft

Wu = 1.2 D.L + 1.6 L.L = 1.2 × 1.2583 + 1.6 × 2.47

Wu = 5.462 Kip/ft

$Mu = \frac{Wu\,l^2}{8} = \frac{5.462 \times 324}{8} = 221.211$

Mu = 221.211 K.ft × 12

Mu = 2654.532 Kip-inch

Step 3 - $M_n = A_s f_y (d - a/2)$

let $a = 0.2d$ $\quad d = h - 2.5 = 20 - 2.5 = 17.5$

$a = 3.5"$

Putting value of a in

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

$$A_s = \frac{2654.532}{0.9 \times 60 (17 - 3.5/2)} \Longrightarrow \boxed{A_s = 3.121 \text{ in}^2}$$

Now Calculate A from

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{3.121 \times 60}{0.85 \times 4 \times 10} = \boxed{a = 5.5076 \text{ in}^2}$$

Now again

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{2654.532}{0.9 \times 60 (17.5 - 5.5076/2)} = \boxed{A_s = 3.33 \text{ in}^2}$$

For $a = \frac{3.33 \times 60}{0.85 \times 4 \times 10} = \boxed{5.88 \text{ in}^2}$

Again

$$A_s = \frac{M_u}{\phi f_y (d - a/2)} = \frac{2654.532}{0.9 \times 60 (17.5 - 5.88/2)} = \boxed{3.376 \text{ in}^2}$$

$$a = \frac{3.376 \times 60}{0.85 \times 4 \times 10} = \boxed{5.96 \text{ in}^2}$$

Again -

$$A_s = \frac{2654.332}{0.9 \times 60 (17.5 - 5.96/2)} = \boxed{3.385 \text{ in}^2}$$

$a = \frac{3.385 \times 60}{0.85 \times 4 \times 10} = 5.97 \text{ in}^2$

Again

$As = \frac{2654.332}{0.9 \times 60 (17.5 - \frac{5.97}{2})} = 3.386 \text{ in}^2$

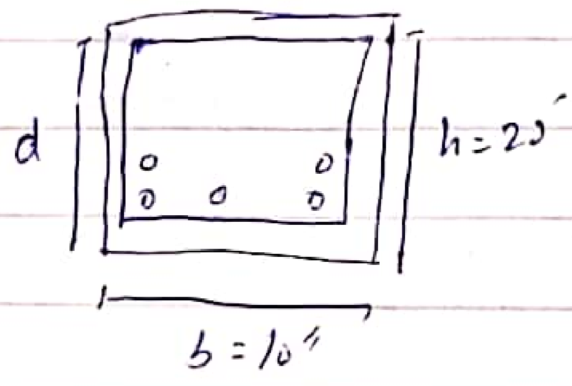
$a = \frac{3.386 \times 60}{0.85 \times 4 \times 10} = 5.977 \text{ in}^2$

Again

$As = \frac{2654.332}{0.9 \times 60 (17.5 - \frac{5.977}{2})} = 3.387 \text{ in}^2$

using # 8 bars so

No 9 bars $= \frac{3.387}{0.79} = 4.29 \approx 5$ bars



the bar are provided into 2 layer

QNO. 7 Bond stress and development length

(a) Bond stress: The stress which is acting on the outer interface to the surrounding concrete over a certain length ~~Concrete~~ is c/d Bond stress.

~~the force in~~ this length of bar required to transfer the force in the bar to the surrounding concrete through bond is c/d Development length.

(b) Doubly Reinforcement.

Doubly reinforced section are generally resorted to in situation where the cross sectional dimension of beam are restricted (By architectural or other construction) where singly reinforced section is not adequate in term of moment resisting capacity.

(3) T beam / Rectangular beam

T beam	Rectangular beam
① T beam having beam and slab composite section	① Rectangular beam having compression in top and tension in bottom
② T beam is more economical than rectangular beam	② Rectangular beam is less econom than T beam
③ T beam are used in larger ~~span~~ as like	③ rectangular beam are more

T beam	rectangular
span such as bridge these are always precast reinforcement	often used in office & commercial building. this can be cast in using standard reinforcement
① in case of T beam slab are connected with one another and act as one member	① in case of rectangular beam slab are placed on the beam so no there is no connected b/w slab and beam

(D) effect of strength reduction factor flexural strength

in the design of flexural strength the strength reduction decrease from tension ~~to~~ controll section to the compression controll section the increase with saftey and decrease with ductility this show to determine the reduction factor for flexural strength of reinforcement concrete

(e) design method

there are ~~three~~ two method

1) ASD method
2) USD method

① ASD method

ASD method is also known as working stress method. it is based on principal that stresses develop in the structural number in this method all load are taken are Service load and no factor is applied to increase service load

② ~~USD~~ USD method

Ultimate Strength design method is also known as load factor method is also known as load factor for the structural subjected to large external load the ultimate strength is determine by the inelastic USD ~~USD method~~

Q NO: 3

Given data

C/C distance = 10 ft

Total span = L = 37 ft

Slab = hf = 6 inch

width = bw = 14 inch

depth = h = 28 inch

D.L = 50 psf = 50 lb/ft^2

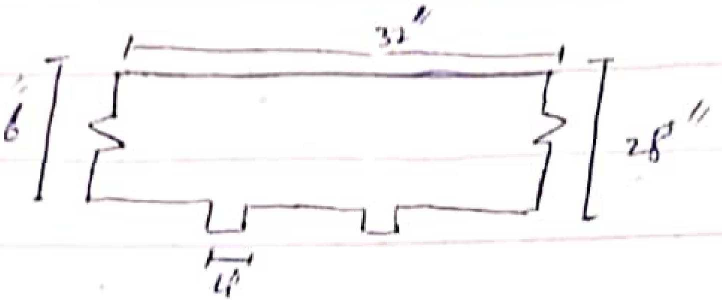
L.L = 225 psf = 225 lb/ft

fc = 4000 psi = 4 ksi

fy = 6000 psi - 60 ksi

effective depth = h - 3

28 - 3 = 25 inch



Step 1

To find factored load
To find beam self wt

$\Rightarrow Wt = b \times h \times rc$

$Wt = 14/12 \times 28/12 \times 150 \ lb/ft^2$

$Wt = 408.33 \ lb/ft$

Total factored load

$Wu = 1.2 \times D.L + 1.6 \times L.L$

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

$Wu = 909.996 \ lb/ft \Rightarrow Wu = 0.91 \ kip/ft$

Step 2

Ultimate factored moment

$Mu = \frac{Wu l^2}{8} = \frac{0.91 \times (32)^2 \times 12}{8}$ $Mu = 1397.76 \ kip/in$

Step 3 :- Effective depth (bc)

$16 \times h_f + b_w$

(1) $16 \times 6 + 14 \Rightarrow 110$ inch

(2) C/c distance $\Rightarrow 10 \times 12 = 120$ inch

(3) $\frac{Span}{4} = \frac{32}{4} = 8' = 8 \times 12 = 96"$

then the $b_e = 96$ inch

Step 4

To check which type of analysis is required

Trial 01: Suppose $a = h_f = 6''$

then $A_{st} = \frac{M_u}{\phi f_y (d - a/2)} = \frac{1397.76}{0.9 \times 60 (25 - 6/2)}$

$A_{st} = 1.177 \text{ in}^2$

Trial 2

$a = \frac{A_{st} \times f_y}{0.85 \times f_c' \times b} = \frac{1.177 \times 60}{0.85 \times 4 \times 96} \Rightarrow a = 0.216'' < h_f = 6''$

$A_{st} = \frac{1397.76}{0.9 \times 60 (25 - \frac{0.216}{2})}$ $A_{st} = 1.04 \text{ in}^2$

Trial 3

$a = \frac{1.04 \times 60}{0.85 \times 4 \times 96} = 0.19 \text{ in}^2$

$A_{st} = \frac{1397.76}{0.9 \times 60 \times (25 - \frac{0.191}{2})}$ $A_{st} = 1.04 \text{ in}^2$

Step 5: to find ρ_{max} and ρ_{min}

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

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

$\rho_{max} = 0.0121$

$\rho_{min} = \frac{200}{fy} = \frac{200}{60000} = 0.0033$

As we know that

$\rho = \frac{Ast}{bed} = \frac{1.04}{14 \times 25}$

$\boxed{\rho = 0.00297}$

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

Now $\rho_{min} = \frac{Ast}{bed} = Ast \Rightarrow b \times d \times \rho_{min}$

$14 \times 25 \times 0.0033$

$Ast \Rightarrow 1.155 \, in^2$

Step 6 No of bar and bar section

let #8 bar use

No of bar = 1.47 ≅ 2

We take 2 #8 bar as main bar

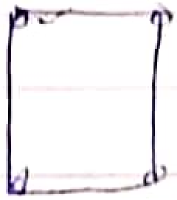
Step 7 minimum width

$b_{min} = 2 \times c.c + 2 \times strip + 2 \times main\ bar + 1 \times Spacing$

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

b min = 6.75 < 14"

So the main bar are good

2#8 

<u>Step 8</u> <u>Design moment</u>

$$Md = \phi \times fy \times As (d - a/2)$$

$$0.9 \times 60 \times 1.57 (25 - \frac{0.289}{2})$$

$$Md = 2160.24$$

$$Md > Mu$$

Design ok