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Dept 6th Semester

To Engr Zawad Saib

Subject PRCD-1

Assignment 02

Plan your
Keep your goal
Take action e
Have a power

* Q. NO # 2 :

(1)

* Part A:

* Bond Stress:-

* Defenition:-

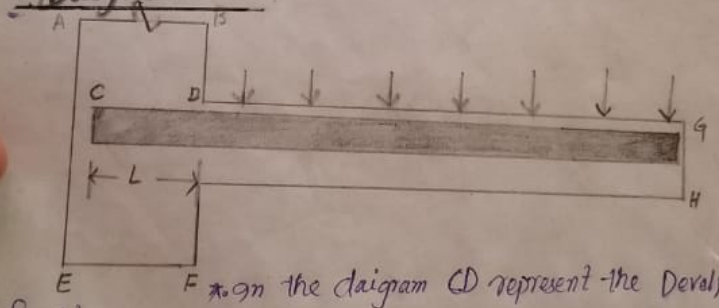
Bond Stress is the stress produced because of the bond b/w concrete surface and the reinforcement steel. It varies depending upon the type of the concrete and reinforcement used.

* It is like a grip, if surface is rough and less slip and if the surface is smooth and rounded.

* Development length:-

Development length is certain minimum length of the bar required on either side of a point of maximum steel stress in order to transfer the load bar to the surrounding concrete through bond without slip so to prevent bar from pulling out under tension.

* Daigram:-



* In the daigram CD represent the Development length.

part B

(2)

Doubly Reinforced Beam:

used due to the following reason. Doubly reinforced beam is

No # 1: When the dimension of the beam (breadth, depth) are limited for architectural or structural purpose.

No # 2: when the section such as, braces in water towers etc. such as subjected to reversal of bending moment.

No # 3: Due to high demand of load (that causes movement) and due to restriction in dimension, section is designed as doubly reinforced.

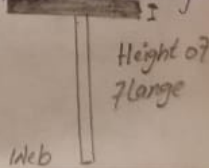
No # 4: In condition T-beam the portion of the beam over middle support has to be designed as doubly reinforced section.

part C

T-Beam Analysis:

T-beam consist of T-shaped structure. The top of T-shaped cross-section serves as a flange or compression member in resisting compression stresses. The lower section web serve to resist the shear stresses. It is economical than rectangular beam and is cast monolithically with the slab.

- $a > h_f$
- a = depth of compression block
- h_f = slab thickness / flange height.



$A_s, 2\%$

Rectangular Beam Analysis:

(3)

is one which is generally used as compression in top fiber and tension in bottom fiber.

* Rectangular beam is more used in office/commercial buildings. These can be cast in-situ using standard reinforcement or precast.

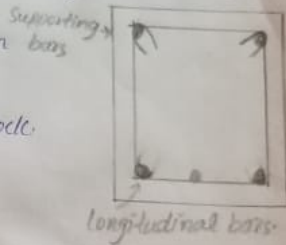
* In rectangular beam, the stress block diagram shows the top fibers are subjected to maximum compression. Compressive stress reduces till the neutral axis.

* Its analysis is required when

$$a \leq hf$$

a = depth of compression block

hf = height of flange



(part D):

Strength Reduction Factors:

ratio of elastic strength to yield strength.

* It is defined as the

Denoted by: ϕ

EFFECT ON STRENGTH:

Strength Reduction Factor shows the strength in terms of percentage while designing a section to resist the moment caused by load.

* Basically it represent the uncertainty in determining the members behaviour to the type of stress as to which it is subjected.

* For Example, during the design process of a beam usually we take 0.75 for shear loads. It shows that 75% of its strength is considered here and the rest of 25% is for future accidental process.

(part E):

Designing methods:

two methods are used for the designing of concrete and different structural members.

1- ASD (Allowable Stress Design method):

2- USD (Ultimate Strength Design method):

(1) Allowable Stress Design method:

ASD method is also known as working stress design method. It is based on the principle that stresses developed in the structural members, should not exceed a certain limit / fraction of elastic limit.

→ In this method, all loads are taken as service loads and no factor is applied to increase these service loads.

(2) Ultimate Strength Design method:

Ultimate strength design method is also known as load factor method or ultimate load factor.

* For structural subjected to large external loads, the ultimate strength is determined by the inelastic (non-linear analysis).

* Ultimate strength design method is best for designing different structural members because of the following.

Factors in
ing a section

Re

(Question 01)

Given Data:

Width (b) = 10', Height (h) = 20', live load (L.L) = $2.47 \frac{\text{kip}}{\text{ft}}$

Dead load = 1.05 kips/ft, span = 18'

$f_c = 4000 \text{ psi} \Rightarrow 4 \text{ ksi}$

$f_y = 60,000 \text{ psi} \Rightarrow 6 \text{ ksi}$

Solution:-

Step No # 1:

$$\text{Effective depth (d)} = h - 3 \Rightarrow 20 - 3 = 17'$$

$$\text{Effective Cover} = d' = 2.5'$$

Reinforcement Ratio:

$$\begin{aligned} \rho_{\text{max}} &= 0.85 \times \beta \times \frac{f_c}{f_y} \times \frac{\epsilon_y}{\epsilon_x + \epsilon_y} \\ &= 0.85 \times 0.85 \times \frac{4}{60} \times \left(\frac{0.003}{0.003 + 0.005} \right) \end{aligned}$$

$$\rho_{\text{max}} = 0.0180$$

Step No # 2:

Finding area of steel

$$\begin{aligned} \rho_{\text{max}} &= \frac{A_{\text{st}}}{b \times d} & A_{\text{steel}} &= \rho_{\text{max}} \times (b \times d) \\ & & &= 0.0180 \times (10 \times 17) \end{aligned}$$

$$= 3.06 \text{ inch}^2$$

* Step no #4:-

$$m_u = 2653.56 - 2362.96$$

$$m_u = 290.64 \text{ Kip-inch}$$

Step no #5:-

Steel area in Compression zone will be

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

$$A_{steel} = \frac{m_u}{\phi \times f_y \times (d - d')} \Rightarrow \frac{290.64}{0.90 \times 60 \times (17 - 2.5)}$$

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

Step no #6:-

$$A_s = A_{st} + A'_{st} \Rightarrow 3.06 + 0.37 = 3.43 \text{ in}^2$$

$$A_s = 3.43 \text{ inch}^2$$

Step no #7:-

We used bar no #8

$$(\text{dia} = \frac{8}{8} = 1')$$

$$\text{Area} = 0.785 \text{ inch}^2$$

$$\text{No. of bars} = \frac{A_s}{\text{Area of one bar}} \Rightarrow \frac{3.43}{0.785}$$

$$\rightarrow 4.36 \rightarrow 5 \text{ bar}$$

So 5 #8 bars are for tensile zone.

Compression Steel:-

(a)

use #6 bars.
dia ($\frac{5}{8}$) = 0.75, Area = 0.44 in²

$$\text{No. of bars} = \frac{A_{st}}{\text{Area of one bar}} = \frac{0.37}{0.44} \Rightarrow 0.84$$

no. of bars = 0.84 \approx 1 bar

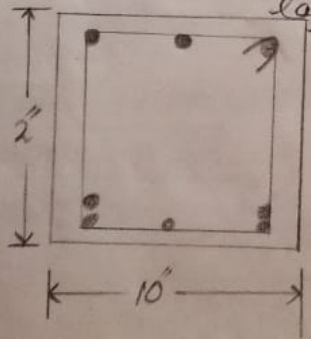
So 1 #6 bar in Compression Zone.

Step NO# 8

Beam minimum width:

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

= 12.75 > 10 \rightarrow These are used in multiple layers.



Effective Depth:-

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

$$d = 16.62$$

Effective Cover:- (d')

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

$$d' = 2.25$$

Step No # 9:-

Design moment is

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

$$a = \frac{(A_{st} - A_{st}') \times f_y}{0.85 \times f_c' \times b} \Rightarrow \frac{(5 \times 0.785 - 1 \times 0.44) \times 60}{0.85 \times 4 \times 10}$$

$$a = 6.15$$

$$M_d = 0.90 \times [(1 \times 0.44) \times 60 \times (16.62 - 2.25) + (5 \times 0.785 - 1 \times 0.44) \times 60 \times (16.62 - \frac{6.15}{2})]$$

$$M_d = 2890.46$$

$$M_d = 2890.46 > 2653.56$$

* The Given Designed is right.

Q. NO #3

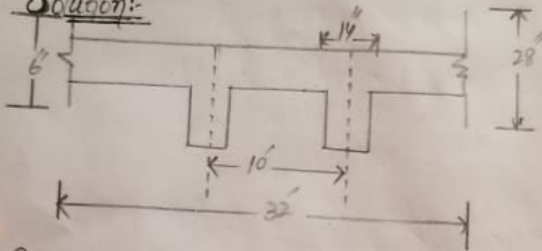
Given Data:

Clear Cover = 10', Span = 32', 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

f_y = 60,000 psi, f'c = 4000 psi

Solution:



Step No #1:

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

* Beam Self weight per foot.

$$w_t = b \times t \times \gamma_c \Rightarrow \frac{14}{12} \times \frac{28}{12} \times 150 \Rightarrow 408.33 \frac{\text{lb}}{\text{ft}}$$

Total Factored Load:

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

$$\Rightarrow 909.99 \frac{\text{lb}}{\text{ft}} \Rightarrow 0.909 \text{ Kip/ft}$$

Moment:

$$\Rightarrow \frac{wL^2}{8} \Rightarrow \frac{0.909 \times (32)^2 \times 12}{8} = 1396.23 \text{ Kip inch}$$

Effective Breadth:

$$\Rightarrow \frac{1}{6}(h_f) + b_w = \frac{1}{6}(28) + 14 = 11.67$$

$$\Rightarrow \text{c/c distance} = 10(12) = 120$$

$$\Rightarrow \text{Span}/4 = \frac{32}{4} \times 12 = 96 \therefore b_e = 96"$$

Step NO# 3ⁿ

(Rectangular or T beam)

Trail NO# 1: Let $a - hf = 6''$

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

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

Trail NO# 2:

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

$$= 0.2'' < 6''$$

So Rectangular Beam is designed:

$$A_{st} = \frac{1396.23}{0.90 \times 60 \times (25 - 0.2/2)} \Rightarrow 1.03 \text{ inch}^2$$

Trail NO# 3:

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

$$A_{steel} = \frac{1396.23}{0.90 \times 60 \times (25 - \frac{0.18}{2})} \Rightarrow 1.03 \text{ inch}^2$$

Step NO# 4: Check f_{max} and f_{min}

$$f_{max} = 0.85 \times 0.85 \times \frac{4}{60} \left(\frac{0.003}{0.003 + 0.005} \right) \Rightarrow f_{max} = 0.018$$

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

$$f = \frac{A_{st}}{b \times d} = \frac{1.03}{14 \times 25} \Rightarrow 0.0029$$

$$\rightarrow f_{min} < f < f_{max} \quad (12)$$

$$\rightarrow 0.003 < 0.002 < 0.018$$

→ As f is less than f_{min}

So, $f = \frac{A_{st}}{b \times d} \Rightarrow A_{st} = f_{min} \times b \times d$

$$A_{steel} = 0.003 \times 14 \times 25 \Rightarrow 1.05 \text{ in}^2$$

Step NO 5: No. and Selection of bars. Let use #8 bar, then

$$\text{dia}(\#8) = 1'' \quad , \quad \text{Area} = 0.785 \text{ in}^2$$

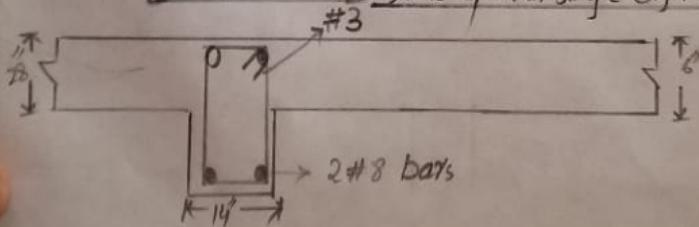
$$\text{No. of bars} = \frac{1.05}{0.785} = 1.3 \approx 2$$

→ We use 2#8 bars.

Step NO # 6: Minimum width

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

$$= 6.75 < 14'' \rightarrow \text{It is good in single layer or one}$$



Step NO# 7:-

(14)

Design moment

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

$$\begin{aligned} \text{Area Steel} &= \text{Area of 1 bar} \times \text{No of bars} \\ &= 0.785 \times 2 = 1.57 \text{ in}^2 \end{aligned}$$

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

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

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

$$A_s, 2111.02 > 1396.23$$

Result: the Designed is ok.