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Subject : PRCD II

ID : 7677

Department : Civil Engg

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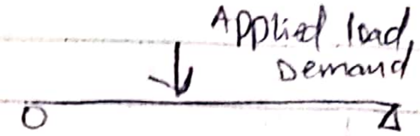
Q1

(a) Capacity

The overall ability of a structure to carry an imposed demand

Beam will resist the applied load up to its capacity & will fail when demand exceeds capacity



Demand

• Demand on a structure refers to all external actions

• Gravity, wind, earthquake, snow are external actions
• These actions when act on the structure will induce internal disturbance (s) in the structure in the form of stresses (such as compression, tension, bending, shear & torsion)
The internal stresses are also called load effects

(B) Design Method

(1) First of all find that that are continue non continous
- than find the size (clear span)

(2) In second steps find the dead load, selfload, and live load and then a
then find the factored load

(3) in third step Analysis occur.
in this step find the Moment due to factored load.

(4) in step 4 ~~find~~ Design find the Area of steel which support the moment
After that find main bar & shrinkage bar reinforcement

(5) in last step Draw the Drafting of design

the step by step method are

size → load → Analysis → Design → Drafting

(c) Effect of strength reduction factor on Flexural strength.

Conventionally, strength reduction Factor is defined as the ratio of elastic strength to yeild strength. The importance of estimating Factor originates in the need For directly deriving inelastic Spectra

The effect of strength reduction factors or material Factors can be calculated. For instance, if the strength reduction factor For Flexure is $O = 0.85$, the nominal Flexural strength is equal to the design Flexural strength multiplied by $1/10 = 1/0.85 = 1.18$.

Q02

~~Dimensions~~

Given Data

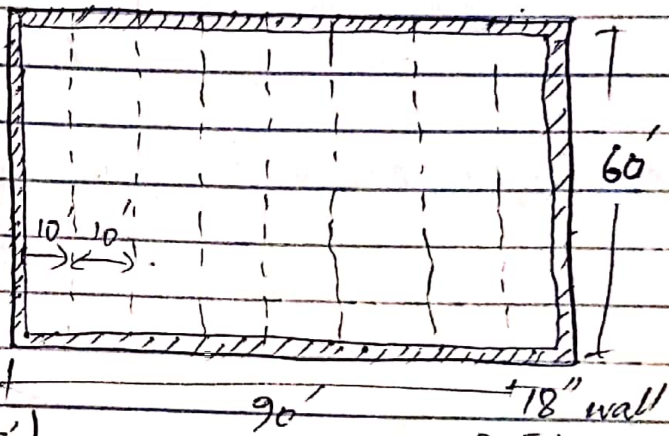
Dimension = 90' × 60' Hall
height = 15'
$f_c' = 3$ Ksi
$f_y = 40$ Ksi
Mud layer = 2"
tile layer = 2"
Live load = 40 psf

Sol

Slab Design

Step no. 1

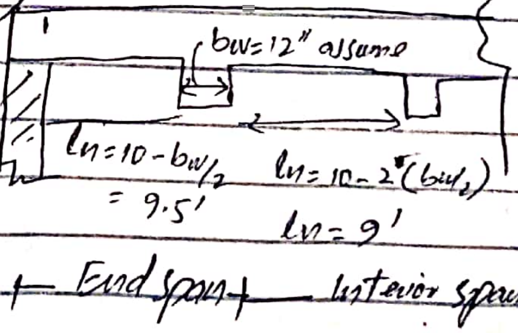
Sizes



$h = l/24 \times (0.4 \times f_y/100000)$

$h = 3.8"$

(Mini by ACI for End span) ($l = 9.5'$)



$h = l/28 \times (0.4 \times f_y/100000)$

$= 3"$

(Mini by ACI for Interior Span ($l = 9'$))

- End span governs. Finally take assumed $h = 6"$
- Effective depth (d) = $h_f - 0.75 - (3/8)/2 = 5"$ (For #3 main bar)

Step 02 Loads

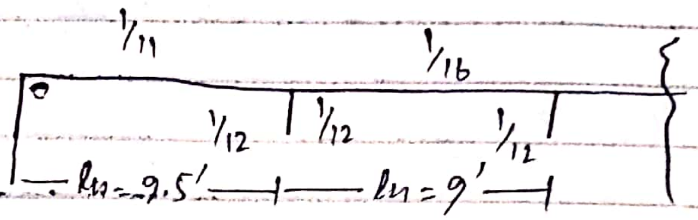
		γ (Kcf)	Load = thickness × γ (Kcf)
Slab	6"	0.15	$(6/12) \times 0.15 = 0.075$
Mud	2"	0.12	$(2/12) \times 0.12 = 0.02$
Tile	2"	0.12	$(2/12) \times 0.12 = 0.02$
		Total	= 0.125 Ksf

Factored load (w_u) = 1.2 D.L + 1.6 L.L
= 1.2(0.125) + 1.6(0.04)

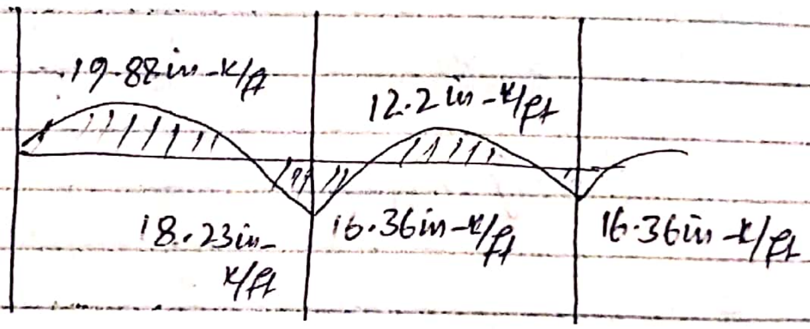
$$w_u = 0.202 \text{ KSf}$$

Step # 03 Analysis

Bending moment diagram for slab



$M = \text{Coefficient} \times w_u \times l_n^2$



Step # 4 Design

- Calculate moment capacity provided by min. reinf in slab
- $A_{s_{min}} = 0.002 b h_f = 0.002 \times 12 \times 6 = 0.144 \text{ in}^2/\text{ft}$
- $\phi M_n = \phi A_{s_{min}} f_y (d - a/2)$

$$= 0.9 \times 0.144 \times 40 \left(5 - \frac{0.188}{2}\right) = 25.4 \text{ in-K/ft}$$

- ϕM_n calculated from $A_{s_{min}}$ is > all moments calculated in step # 03

- Therefore ~~Area of steel~~ $A_s = A_{s_{min}} = 0.144 \text{ in}^2/\text{ft}$

This work for both positive & negative steel as $A_{s_{min}}$ governs.

• Main reinforcement spacing
3hf (According to ACI Max spacing formula)

$3h_f = 3 \times 6 = 18'$
we use #3 @ 9" c/c

• Shrinkage steel (A_{st})

$A_{st} = 0.002bh_f$

$A_{st} = 0.002 \times 12 \times 6 = 0.144\ in^2/ft$
Shrinkage reinfor is same as main reinf.
$A_{st} = A_{smin} = 0.144\ in^2$

According to ACI Max Spacing $= 5h_f$
$= 5 \times 6 = 30"$
Therefore 9" spacing is OK

Placement of positive reinforcement
positive reinf bars are placed in the direction of flexure stresses & placed at the bottom

Placement of negative reinforcement: negative reinfor are placed perpendicular to the direction of support

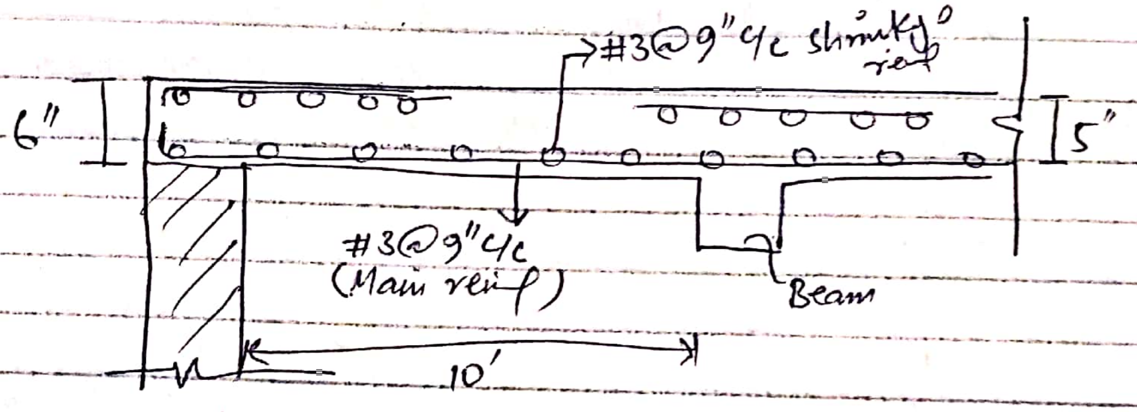
Placement of negative reinf: All the far end the chair are provided to support the negative reinf As each bar will need a ~~spe~~ separate chair therefore reduce the number of chair supporting bars are provided perpendicular to the direction of negative reinf

Reinforcement at discontinous support

At the discontinous end the ACI code recand to provide reinf. equal to 1/3 times the positive reinf provided at the mid span. it comon Field pratic to provide #3 @ 18" c/c

Step # 5 Drafting

- Main reinf. = #3@9" c/c (positive & negative)
- Shrinkage reinf = #3 @ 9" c/c
- Supporting bar = #@ 18" c/c



Beam Design

Step #01

h_{min} (simply supported) = $l/16$

l = clear Span (l_n) + depth of member (beam) ≤ C/C distance b/w supports

Let depth of beam = 5 ft

l_n + depth of beam = 60' + 5' = 65'

C/C distance b/w beam support = 60 + 2(9/12)
= 61.5'

· therefore l = 61.5'

$$\text{Depth}(h) = \left(\frac{61.5}{16}\right) \times \left(0.4 + \frac{f_y}{100000}\right) \times 12$$

h = 36.9" (Mini by ACI)

· Take h = 5' = 60"

$d = h - 3$

d = 57"

b_w = 18" assumed

Step #02 Loads

$W_{u\,Beam}$ = Factored load of slab + Factored self load

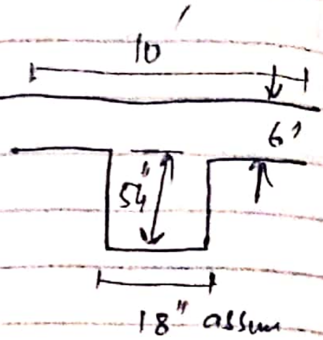
Factored load of slab = 0.202 KSF

Load on beam from slab = 0.202 × 10
= 2.02 K/ft

Factored self load of beam web

$= 1.2 \times (54 \times 18/144) \times 0.15$

$= \boxed{1.215\ K/ft}$

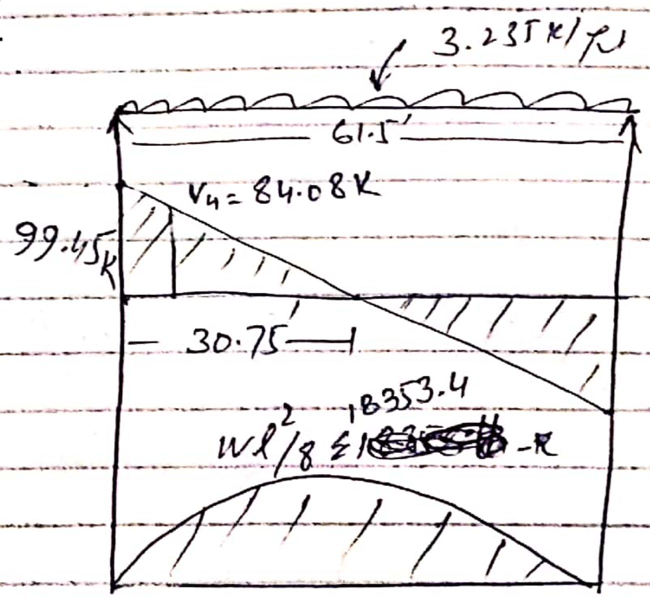


Total load on beam $= 2.02 + 1.215$

$w_u = \boxed{3.235\ K/ft}$

Step #03 Analysis

- $V_u = 84.08$ Kip
- $M_u = 18353.4$ in-kip



Step # 4 Design

* Design For Flexure

Step (a) according to ACI b_{eff} For T-beam is min of

- $16h_f + b_w = 16 \times 6 + 18 = 114''$
- (c/c span of beam)/4 $= (61.5/4) \times 12 = 184.5''$
- c/c spacing b/w beams $= 10' \times 12 = 120'$
- So $b_{eff} = 114''$

Step (6) check if beam is to be desired as rectangular beam or T-beam.

- Assume $a = h_f = 6''$ & calculate A_s:

$$A_s = M_u / [\phi f_y (d - a/2)]$$

$$= 18353 / [0.9 \times 40 (57 - \frac{6}{2})]$$

$$= 9.44 \text{ in}^2$$

- Rectang calculate "a"

$$a = A_s f_y / (0.85 f'_c b_{eff})$$

$$a = (9.44 \times 40) / (0.85 \times 3 \times 144)$$

$$a = 1.02'' < h_f$$

Therefore design beam as rectangular beam

- After trial $A_s = 9.02 \text{ in}^2$ [$A_{s,max} = 20.83 \text{ in}^2$, $A_{s,min} = 5.13 \text{ in}^2$]

Therefor $A_s = 9.02 \text{ in}^2$ [12 #8 bars]

No. of bars $= \frac{9.02}{0.785}$

$= 11.49$

≈ 12 bars

- Skin Reinforcement

effective depth > 36 inch
so longitudinal skin reinfo is required

A_{skin} = Main flexural reinf/2

= 9.02/2 = 4.51 in²

Range up to skin reinf is provided
d/2 = 56.625/2 = 28.3125"

- For #8 bar used in skin reinf (spacing used)

spacing = d/6 = 56.625/6

spacing = 9.44 ≈ 9" c/c

- with this spacing 3 bars on each reinforced required. And for #8 bar the total Area of skin reinf is

A_{skin} = 6×0.79

A_{skin} = 4.8 in⁴

Design for shear

V_u = 84.08 kip

$\phi V_c = \phi 2\sqrt{f_c'} b_w d = (0.75 \times 2 \times \sqrt{3000} \times 18 \times 57)/1000$

ϕV_c = 84.29 kip

$\phi V_c > V_u$ (Theoretically shear reinf is not required)

but However ACI codes requires provision of at least min area.

(12)

$S_d = \phi A_v f_y d / (V_u - \phi V_c)$

- using #3, 2 legged stirrups with $A_v = 0.11 \times 2 = 0.22 in^2$

$S_d = 0.75 \times 0.22 \times 40 \times 57 / (84.08 - 84.29)$

$S_d = 1791''$

- Max spacing & mini reinfor... is requi'd as per ACI
- $A_v f_y / 50 b_w = 0.22 \times 40000 / 50 \times 18 = 9.5''$
- $d/2 = 57/2 = 28.5''$
- 24''
- $A_v f_y / 0.75 \sqrt{f_c'} b_w = 0.22 \times 40000 / \{0.75 \sqrt{3000} \times 18\}$
  $= 11.90''$

Therefore $S_{max} = 9.5''$

- $\phi V_c / 2 = 84.29 / 2 = 42.15$ Kip at a distance of 17.5 Ft from face of support. There fore no reinforcement is required in this zone. however we will provided #3, 2-legged vertical stirrup at 12'' c/c

Other checks

checks for depth of beam

- $\phi V_s \le \phi 8 \sqrt{f_c'} b_w d$

$\phi 8 \sqrt{f_c'} b_w d = 0.75 \times 8 \times \sqrt{3000} \times 18 \times 57 / 1000$

$= 337.18 K$

$\phi V_s = (\phi A_v f_y d) / s$

$= (0.75 \times 0.22 \times 40 \times 57) / 9.5$

$39.6 K < 337.18 K$ (OK)

Depth is ok

check if $\phi V_s \le \phi 4 \sqrt{f_c'} b_w d$

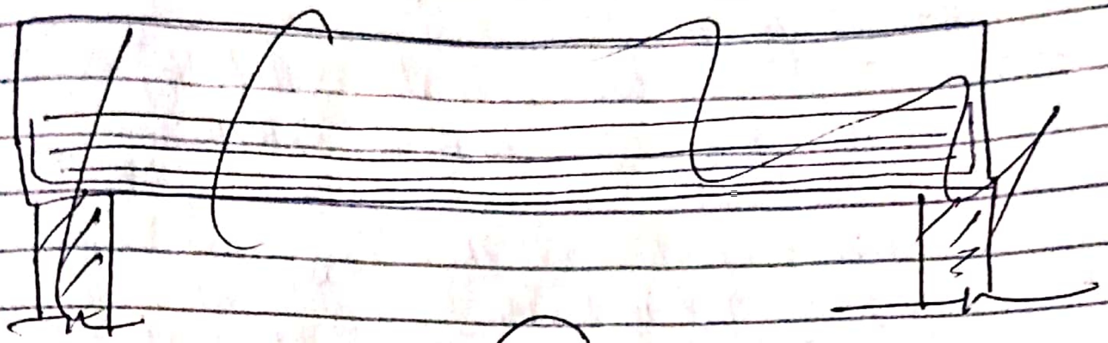
If $\phi V_s \le \phi 4 \sqrt{f_c'} b_w d$ the max span is OK otherwise reduce spacing by onehalf

$\phi 4 \sqrt{f_c'} b_w d = 0.75 \times 4 \times \sqrt{3000} \times 18 \times 57 / 1000$

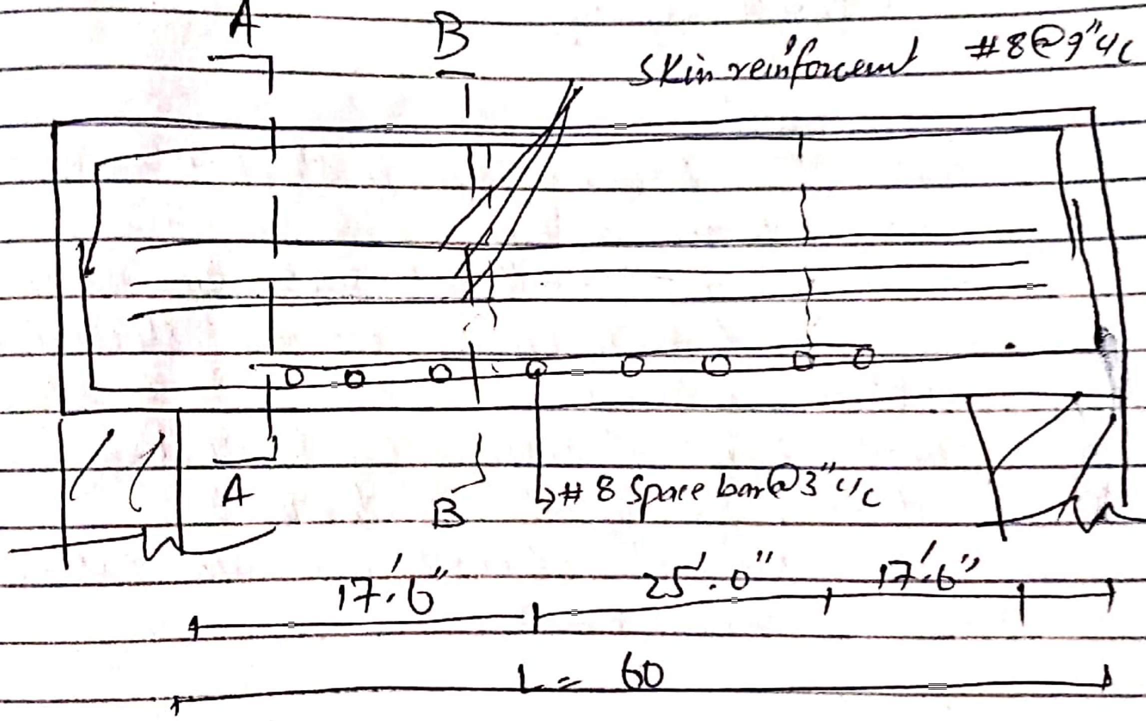
$= 168.58 K$

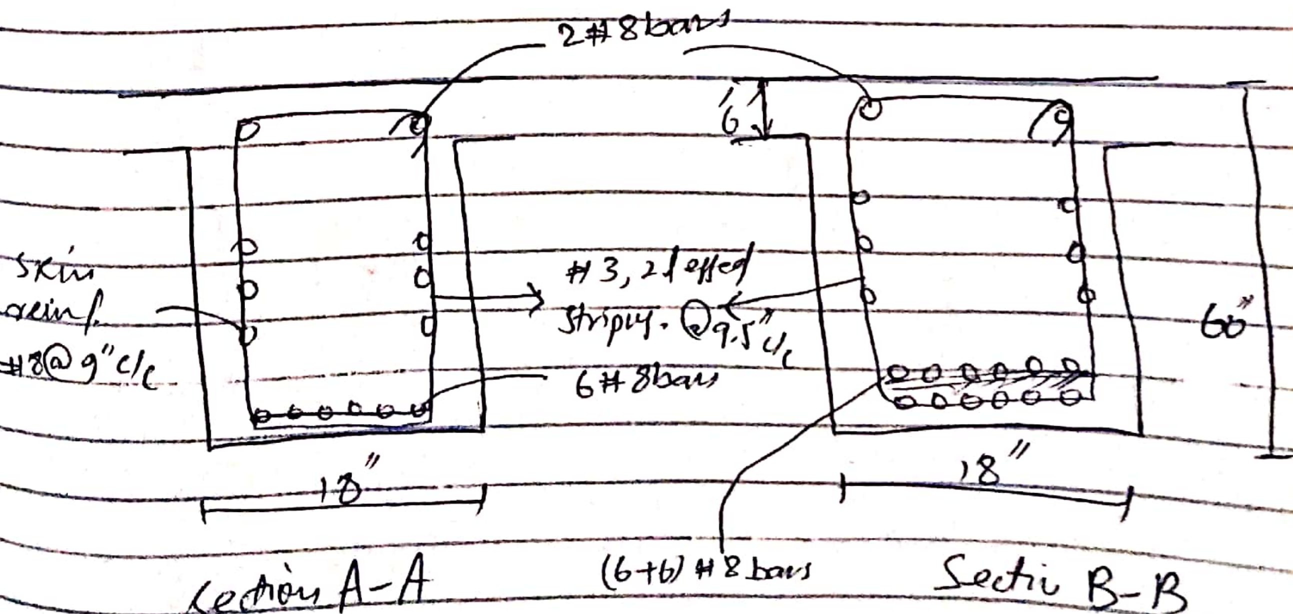
$\phi V_s = 39.6 K < 168.58 K$ (OK)

(14)



(14)


A
B
Skin reinforcement #8@9" c/c
A
B
#8 Space bar@3" c/c
17'6"
25'0"
17'6"
L = 60


2#8 bars
6"
Skin reinf. #8@9" c/c
#3, 2 legged stirrup. @9.5" c/c
6#8 bars
60"
18"
18"
(6+6) #8 bars
Section A-A
Section B-B