Student No :

Design of Interior Girder : Section 2-2 :

Design for Moment :

M_u (+ve) = 4389.7 K-ft
M_u (-ve) = 0 K-ft

For +ve Moment

Girder depth including slabs thickness, H = 67"

Assuming triple layer of bars, d = H - 2.5 - 2.5 = 67" - 2.5" - 2.5" = 62"

Let, $a_{initial} = t = 7.5"$

$\therefore A_{s\,initial} = M_u / \phi f_y (d - \frac{a}{2}) = 4389.7 \times 12 / .9 \times 60 \times (62 - \frac{7.5}{2}) = 16.7\ in^2$

$\therefore a_{revised} = A_s f_y / .85 f_c' b_{eff} = 16.7 \times 60 / .85 \times 5 \times 90 = 2.62 in$

Here, $a_{revised} < t$ $\therefore$ Rectangular beam.

Now, $A_s = \frac{M_u / \phi f_y (d - \frac{a}{2})}{} = \frac{4389.7 \times 12}{.9 \times 60 \times (62 - \frac{a}{2})} = 16.1\ in^2$

$a = A_s f_y / .85 f_c' b_{eff} = A_s \times 60 / .85 \times 5 \times 90 = 2.5"$

$A_{s,min} = \frac{200}{f_y} b_w d = \frac{200}{60{,}000} \times 18 \times 62 = 3.72\ in^2 < A_s$

$c = \frac{a}{\beta_1} = \frac{2.5}{.8} = 3.13"$

$\beta_1 = .85 - .05 \times \frac{f_c' - 4000}{1000} = .85 - .05 \times \frac{5000 - 4000}{1000} = .8$

$c < \frac{3}{8} d \Rightarrow 3.13 < \frac{3}{8} \times 62 \Rightarrow 3.13 < 23.3$

$\therefore$ Tension controlled.

$\therefore$ 14 #9 and 2 #10 bars $\quad A_{s\,prov} = 14 \times 1 + 2 \times 1.27 = 16.54\ in^2$

A_s, M_u(+ve) = 0 K-ft, $A_{s,min}$ has to be provided.

$\therefore$ 4 #9 bars $\quad A_{s,prov} = 4 \times 1 = 4\ in^2$

CamScanner

Student No : _____

Design for Shear Reinforcement:

$V_u = 128.8\ k$

$d = 62''$

$V_u\ (128.8k) < .25 \times \phi f_c' b_w d \quad (.25 \times .9 \times 5 \times 18 \times 62 = 1255.5k)$

∴ Concrete dimension is OK.

$\phi V_c = \phi .0316 \beta \sqrt{f_c'} b_w d = .9 \times .0316 \times 2 \times \sqrt{5} \times 18 \times 62 = 141.9k$

$V_u\ (128.8k) > \frac{1}{2}\phi V_c\ (70.9)$ ∴ Stirrup is required.

Let, #3 bar and 4 legged stirrup, $A_v = 4 \times .11 = .44\ in^2$

Here, $V_u < \phi V_c$ ∴ Smax stirrup is required.

Check for max spacing:

$V_u\ (128.8k) < .125 \phi f_c' b_w d \quad (.125 \times .9 \times 5 \times 18 \times 62 = 629.8k) \rightarrow .8d$

$$S_{max} = \min \begin{cases} \dfrac{A_v f_y}{.0316 \sqrt{f_c'} b_w} = \dfrac{.44 \times 60}{.0316 \times \sqrt{5} \times 18} = 207 \approx 20.5'' \\ 0.8d = .8 \times 62 = 49.6 \approx 49.5'' \\ 24'' \end{cases}$$

∴ #3 - 4 legged stirrup @ 20.5" c/c

Student No : _____

Design for Skin Reinforcement:

$d_e = d = 62''$

$A_{sk} \geq 0.012(d_e - 30) \leq \frac{A_s}{4}$

$\Rightarrow A_{sk} \geq 0.012(62-30) \leq \frac{16.54}{4}$

$\Rightarrow A_{sk} \geq .384 \leq 4.14$ in^2/ft height per face of girder.

Spacing, $s = \min\begin{cases} d_e/6 = 62/6 = 10.3 \approx 10'' \\ 12'' \end{cases}$

Skin reinforcement should be provided to a height of $\frac{d_e}{2} = \frac{62}{2} = 31''$ from nearest flexural tensile reinforcement.

Let, provide #8 bar @ 10" c/c as skin reinforcement

$A_{sk(prov)} = \frac{12 \times A_b}{s_{prov}} = 0.95$ in^2 per ft per face of girder

$.384 \leq .95 < 4.14$ ∴ OK.

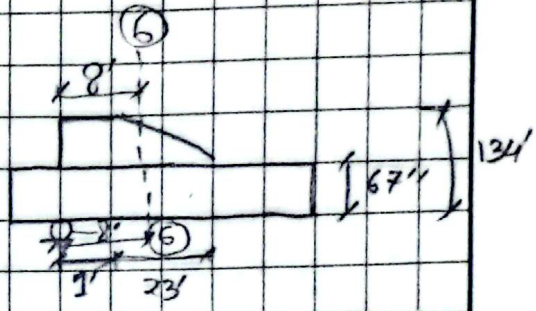
∴ #8 bar @ 10" c/c as skin reinforcement

Design for Haunch Reinforcement:

Provide #3 @ 6" c/c as haunch reinforcement.

Student No : _____

Design of Interior Girder : Section 6-6 :



Design for Moment :

M_u (+ve) = 0 k-ft

M_u (-ve) = -4632.9 k-ft

For -ve Moment :

$H \Rightarrow \frac{67}{23} = \frac{x}{24-8} \Rightarrow x = 46.6 \approx 45.$ $\therefore H = 67 + 45 = 112"$.

Assuming single layer of tension bar, $d = 112 - 2.5 = 109.5"$

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

$= 4632.9 \times 12 / .9 \times 60 (109.5 - \frac{a}{2})$

$= 9.74 in^2$

$a = A_s f_y / .85 b_{web} f_c'$

$= A_s \times 60 / .85 \times 18 \times 5$

$= 7.6 in$

$A_{s,min} = \frac{200}{f_y} b_w d = \frac{200}{60,000} \times 18 \times 109.5 = 6.57 in^2 < A_s$

$c = \frac{a}{\beta_1} = 7.6 / .8 = 9.5"$

$c < \frac{3}{8} d \Rightarrow 9.5 < \frac{3}{8} \times 109.5 \Rightarrow 9.5 < 41.06$

$\therefore$ Tensioned controlled

$\therefore$ 8 #9 and 2 #10 bars as negative bar $A_{s\,prov} = 8 \times 1 + 2 \times 1.27 = 10.54 in^2$

A_s, M_u (+ve) = 0 k-ft ; $A_{s,min}$ has to be provided.

$\therefore$ 6 #10 bar as positive bar. $A_{s\,prov} = 6 \times 1.27 = 7.62 in^2$

Student No : _____

Design for shear reinforcement:

$V_u = 359.6\ k$

$d = 109.5''$

$V_u\ (359.6) < .25\phi f_c' b_w d\ (.25 \times .9 \times 5 \times 18 \times 109.5 = 2217.3k)$

∴ Concrete dimension is OK

$\phi V_c = \phi .0316 \beta \sqrt{f_c'} b_w d = .9 \times .0316 \times 2\sqrt{5} \times 18 \times 109.5 = 250.7k$

$V_u\ (356.9k) > \frac{1}{2}\phi V_c\ (125.3k)$ ∴ Stirrup required.

let, #3 bar and 4- legged stirruped. $A_v = .11 \times 4 = .44\ in^2$

$$\therefore S_{req} = \frac{\phi A_v f_y d}{V_u - \phi V_c} = \frac{.9 \times .44 \times 60 \times 109.5}{359.6 - 250.7} = 23.6'' \approx 23.5''$$

Max spacing check:

$V_u\ (359.6k) < .125\phi f_c' b_w d\ (.125 \times .9 \times 5 \times 18 \times 109.5 = 1108.7k) \rightarrow .8d$

$$S_{max} = \min \begin{cases} \frac{A_v f_y}{.0316\sqrt{f_c'} b_w} = \frac{.44 \times 60}{.0316 \times \sqrt{5} \times 18} = 20.8 \approx 20.5'' \\ .8d = .8 \times 109.5 = 87.6 \approx 87.5'' \\ 24'' \end{cases}$$

∴ # 3 - 4 legged stirruped @ 20.5" c/c

Student No :_____

Design for Skin Reinforcement :

$d_l = d = 109.5''$

$A_{sk} \geq .012 (d_l - 30) \leq \frac{A_s}{4}$

$\Rightarrow A_{sk} \geq .012 (109.5 - 30) \leq \frac{10.54}{4}$

$\Rightarrow A_{sk} \geq 0.95 \leq 2.64 \text{ in}^2$

$\therefore S_{max} = \min \begin{cases} d_l/6 \\ 12'' \end{cases} = 109.5/6 = 18.2 \approx 18''$

Skin rein should be provided to a height of $\frac{d_l}{2} = \frac{109.5}{2} = 54.8$ from nearest flexural reinforcement.

Let provide #8 bar @ 8" c/c

$A_{sk\,prov} = \frac{12 \times A_b}{S_{prov}} = \frac{12 \times 0.79}{8} = 1.19 \text{ in}^2$

$\therefore .95 \leq 1.19 < 2.64 \text{ in}^2$ ..OK

∴ #8 bars @ 8" c/c as skin reinforcement.

Design for Haunch Reinforcement:

Provide #3 @ 6" c/c as haunch reinforcement.

Student No : _____

Design of Interior Girder : Section 0-10

M_u (+ve) = 2047.8 k-ft

M_u (-ve) = -3388.6 k-ft

for +ve Moment

H = 67"

Assuming triple layer of tension bar, d = H - 2×2.5 = 67 - 2×2.5 = 62"

let, $a_{initial} = t_s = 7.5"$

$A_{s\,initial} = M_u/\phi f_y(d - \frac{a}{2}) = 2047.8\times12/.9\times60(62 - \frac{7.5}{2}) = 7.81\,in^2$

$a_{revised} = A_s f_y/.85 f'_c b_{eff} = 7.81\times60/.85\times5\times90 = 1.23" < t_s$

∴ It is a rectangular beam.

Now, $A_s = M_u/\phi f_y(d - a/2)$

$= \frac{2047.8\times12}{.9\times60\times(62 - \frac{a}{2})}$

$= 7.41\,in^2$

$a = A_s f_y/.85 f'_c b_{eff}$

$= \frac{A_s\times60}{.85\times5\times90}$

$= 1.16"$

$A_{s,min} = \frac{200}{60000} b_w d = \frac{200}{60,000}\times18\times62 = 3.72\,in^2 < A_s$

$c = \frac{a}{\beta_1} = \frac{1.16}{.8} = 1.45"$

$c\,(1.45) < \frac{3}{8}d \Rightarrow 1.45 < 23.3$

∴ Tension controlled.

∴ 14 # 8 bars as positive reinforcement $A_{s\,prov} = 10\times1 = 10\,in^2$

Student No :_____

For +ve Moment

H = 67"

Assuming double layer of tension bar, d = 67 - 4 = 63"

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

$= \frac{3388.6 \times 12}{.9 \times 60 (63 - \frac{a}{2})}$

$= 13.01 \text{ in}^2$

$a = A_s f_y / .85 f_c' b_{web}$

$= \frac{A_s 60}{.85 \times 5 \times 18}$

$= 10.2 \text{ in}^2$

$A_{s,min} = \frac{200}{60000} b_w d = \frac{200}{60000} \times 18 \times 63 = 3.78 \text{ in}^2$

$c = \frac{a}{\beta_1} = \frac{10.2}{.8} = 12.8"$

$c (12.4) < \frac{3}{8} d \left(\frac{3}{8} 63 = 23.6\right)$ ∴

∴ Tension controlled.

∴ 8 # 9 and 4 # 10 as negative Reinforcement.

$A_{sprov} = 8 \times 1 + 4 \times 1.27$

$= 13.08 \text{ in}^2$

BANGLADESH TECHNOLOGY FOR ADVANCEMENT

Student No :

Design for Shear Reinforcement:

$V_u = 19.5k$

$d = 62''$

$V_u(19.5k) < .25\phi f_c' b_w d \left(.25 \times .9 \times 5 \times 18 \times 62 = 1255.5k\right)$

∴ Concrete dimension is OK.

$\phi V_c = \phi \cdot 0316 \beta \sqrt{f_c'} b_w d = .9 \times .0316 \times 2 \times \sqrt{5} \times 18 \times 62 = 141.9k$

$V_u(13.3k) > \frac{1}{2}\phi V_c (70.9k)$. Stirrup is required.

But $V_u < \phi V_c$ ∴ S_{max} stirrup is required.

let, #3 bar - 4 legged Stirrup $A_v = 4 \times .11 = .44 in^2$

$V_u(131.1k) < .125\phi f_c' b_w d \left(.125 \times .9 \times 18 \times 62 = 629.8k\right) \rightarrow$ '8d

$$\therefore S_{max} = \min \begin{cases} \dfrac{A_v f_y}{.0316\sqrt{f_c'}\, b_w} = \dfrac{.44 \times 60}{.0316 \times \sqrt{5} \times 18} = 20.7 \approx 20.5'' \\ 8d = .8 \times 62 = 49.6 \approx 49.5'' \\ 24'' \end{cases}$$

$= 20.5''$

∴ #3 - 4 legged stirrup @ 20.5" c/c

Design of Haunch Reinforcement:

Provide #3 @ 6" c/c along the length of girder.

Student No :_____

Design for skin Reinforcement :

For positive moment, $d_l = d = 62''$, $A_{s\,prov} = 10\ in^2$

$A_{sk} \geq .012(d_l - 30) \leq \frac{A_s}{4}$ $\Rightarrow A_{sk} \geq .012 \times (62-30) \leq \frac{10}{4}$)

$\Rightarrow A_{sk} \geq .384 \leq 2.5\ in^2$

Spacing, $S_{max} = \begin{cases} d_l/6 = 62/6 = 10.3'' \approx 10'' \\ 12'' \end{cases}$

Skin rein. should be provided to a height of $\frac{d_l}{2} = \frac{62}{2} = 31''$

Let, provide # 7 bar @ 8" c/c as skin reinforcement

$A_{sk\,prov} = \frac{12 \times A_b}{S_{prov}} = \frac{12 \times .60}{8} = 0.9\ in^2$ per ft.

$\therefore .384 \leq .9 \leq 2.5\ in^2$ $\therefore$ OK.

$\therefore$ # 7 bar @ 8" c/c as positive skin rein.

For negative moment, $d_l = d = 63''$ $A_{s\,prov} = 13.08\ in^2$

$A_{sk} \geq .012(d_l - 30) \leq \frac{A_s}{4}$ $\Rightarrow A_{sk} \geq .012(63-30) \leq \frac{13.08}{4} \Rightarrow A_{sk} \geq .4 \leq 3.3\ in^2$

Spacing, $S_{max} = \begin{cases} d_l/6 = 63/6 = 10.5'' \\ 12'' \end{cases}$

Skin Rein. should be provided to a height of $\frac{d_l}{2} = \frac{63}{2} = 31.5''$

Let provide # 7 bar @ 10" c/c

$A_{sk\,prov} = \frac{12 \times A_b}{S_{prov}} = \frac{12 \times .6}{10} = 0.72\ in^2$ per ft

$\therefore .4 < .72 < 3.3\ in^2$ $\therefore$ OK

$\therefore$ # 7 bar @ 10" c/c as negative skin reinforcement.

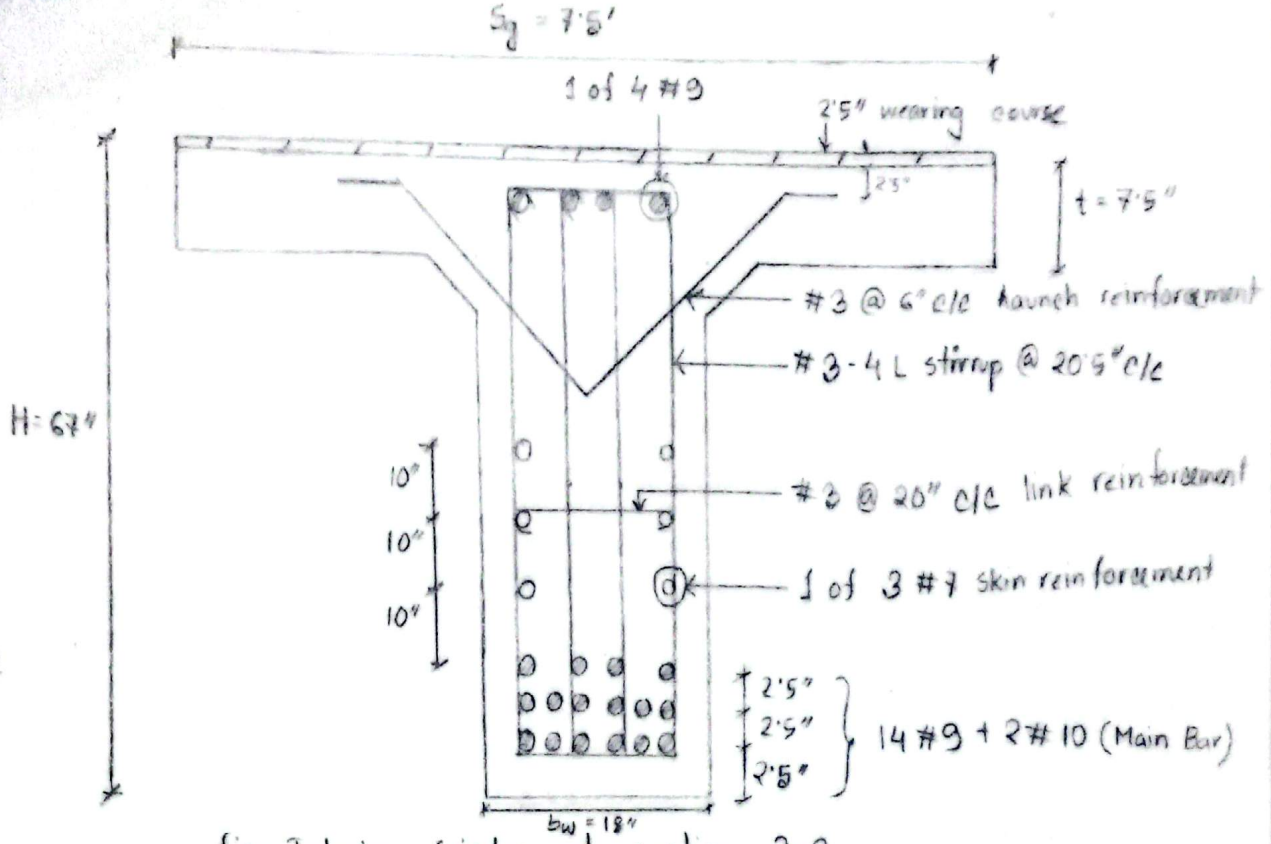


fig: Interior Girder at section 2-2
Reinforcement Detailing

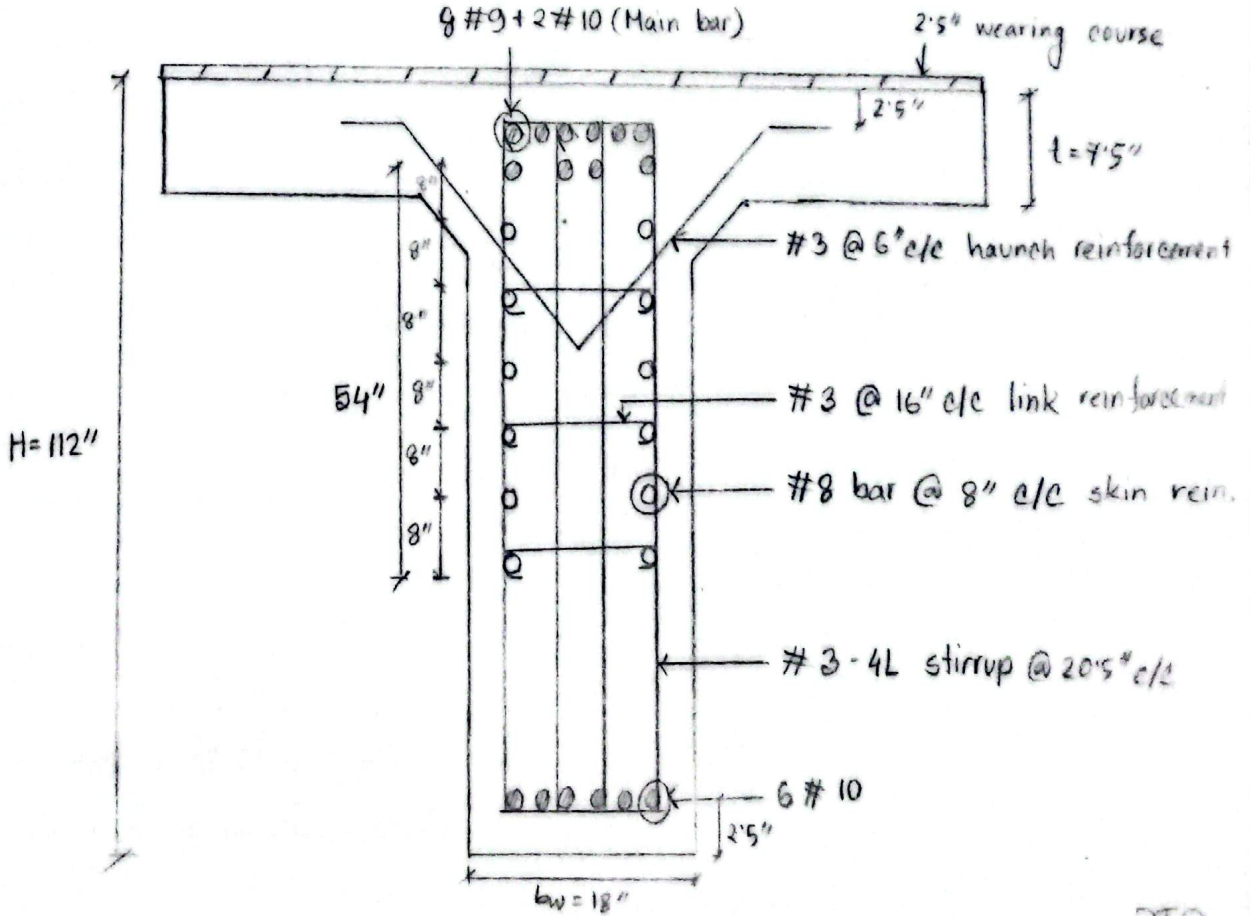


fig: Interior Girder at section 6-6
Reinforcement Detailing

PTO

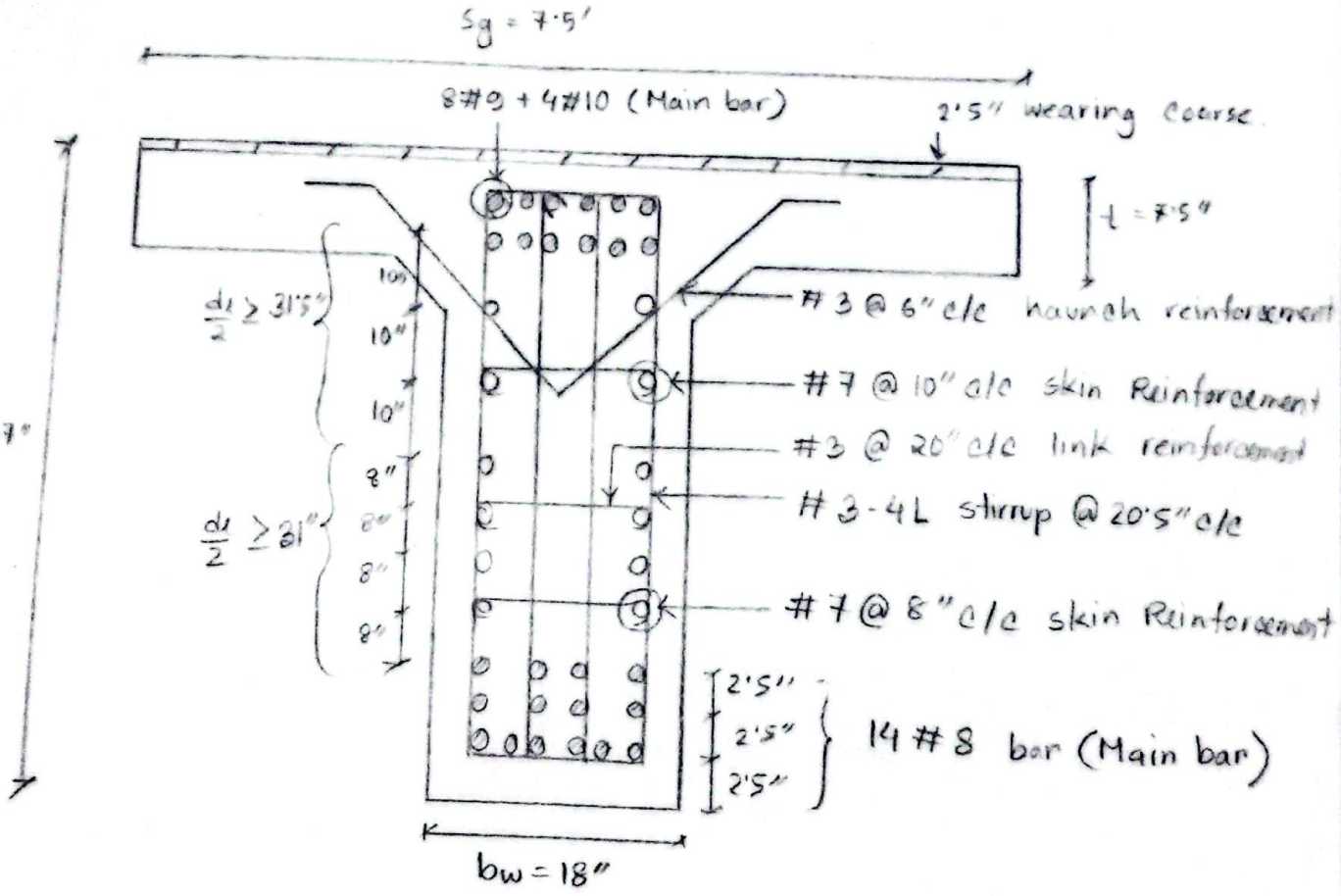


fig : Interior Girder at section 10-10

Reinforcement Detailing