Mario Aguaguiña M.

Hormigón I
Tarea #3
Paralelo 01
Resolución

Diseñar la sección T que se muestra en la figura para un momento último de 600 KN·m. La luz libre de la viga es de 4.60 m. El espaciamiento libre entre vigas es de 3m. El espesor de la losa maciza es de 100 mm, $f'_c = 21$ MPa, $f_y = 420$ MPa, $\phi_{est} = 10$ mm.

$l_n = 4.60$ m $= 4600$ mm.

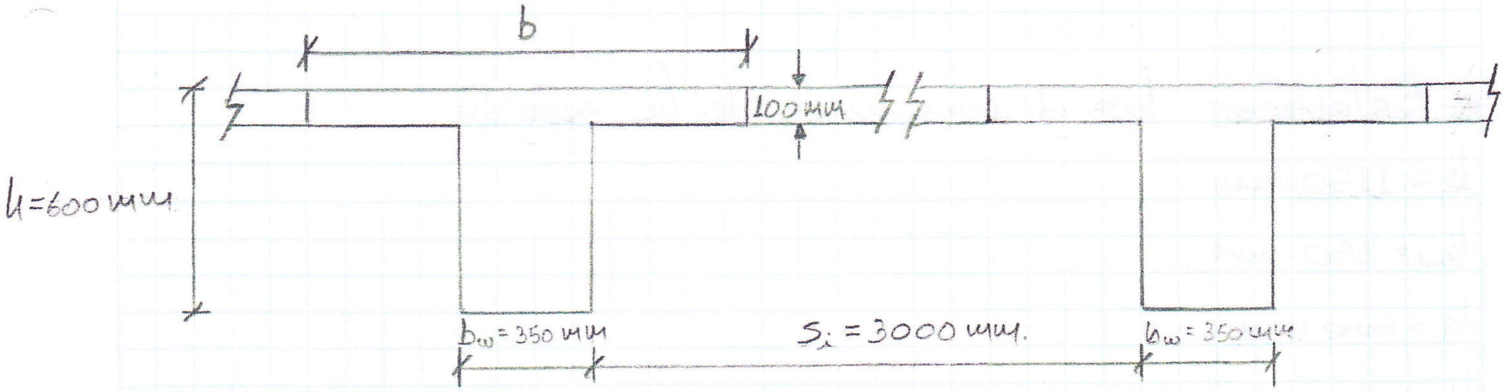
$S_i = 3.00$ m. $= 3000$ mm.

$h_f = 100$ mm.

$h = 600$ mm.

$b_w = 350$ mm

$M_u = 600$ KN·m.



* Determinar el ancho efectivo del ala (b), tal que se cumplan los requerimientos del ACI:

- $b \leq \frac{1}{4} l_n$

  $b \leq \frac{1}{4}(4600)$

  $b \leq 1150$ mm. ✓

- $b \leq b_w + \frac{(S_i + S_{i+1})}{2}$

  $b \leq 350 + \frac{(3000 + 3000)}{2}$

  $b \leq 3350$ mm.

- $b \leq b_w + 16 h_f$

  $b \leq 350 + 16(100)$

  $b \leq 1950$ mm

$\Rightarrow$ $b \leq 1150$ mm

$\therefore$ Usar $b = 1150$ mm.

$b = 1150$ mm. ≤ 1150 mm. okey

* Establecer las dimensiones de la sección:

$b = 1150$ mm.

$b_w = 350$ mm.

$h = 600$ mm.

$h_f = 100$ mm.

$S_i = 3000$ mm.

$l_n = 4600$ mm.

* Se asume que $a \leq h_f$, por lo que se analiza la viga como una sección rectangular de ancho b.

- Calcular d. (asumiendo $\varnothing_b = 25$ mm. en dos capas)

$$d = 600 - (40 + 10 + 25 + 25/2)$$

$$d = 512.5 \text{ mm}$$

$$d = 51.25 \text{ cm.}$$

- Calcular As

$$\varnothing M_u \geq M_u.$$

$$\varnothing b d^2 f'_c w (1 - 0.59w) \geq M_u.$$

$$\Rightarrow M_u = \varnothing b d^2 f'_c w (1 - 0.59w)$$

$$w(1 - 0.59w) = \frac{M_u}{\varnothing b d^2 f'_c}$$

$$w - 0.59w^2 = \frac{600 \times 10^6}{(0.9)(1150)(512.5)^2(21)}$$

$$w - 0.59w^2 = 0.10510$$

$$0.59w^2 - w + 0.10510 = 0$$

$$w = 0.11258 \checkmark$$

$$w = 1.58234 \; \times$$

$$\Rightarrow w = \rho \cdot \frac{f_y}{f'_c}$$

$$w = \frac{A_s}{b \cdot d} \cdot \frac{f_y}{f'_c}$$

$$A_s = \frac{w \cdot b \cdot d \cdot f'_c}{f_y}$$

$$A_s = \frac{(0.11258)(1150)(512.5)(21)}{420}$$

$$A_s = 3317.6 \text{ mm}^2$$

- Determinar el número de barras y la cuantía.

$$\# barras = \frac{A_s}{A_{\phi b = 25 mm}} = \frac{3317.6}{491} = 6.757 \simeq 7$$

$\therefore$ Usar $7 \phi 25 mm$.

$$\Rightarrow A_s = 7(491) = 3437 \ mm^2$$

$$\Rightarrow \rho = \frac{A_s}{bd} = \frac{3437}{(1150)(512.5)} = 5.832 \times 10^{-3}$$

$$\Rightarrow \omega = \rho \cdot \frac{f_y}{f'_c} = (5.832 \times 10^{-3})\left(\frac{420}{21}\right) = 0.11663$$

* Calcular a.

$$a = \frac{A_s f_y}{0.85 f'_c b}$$

$$a = \frac{(3437)(420)}{(0.85)(21)(1150)}$$

$a = 70.3 \ mm. \leq h_f = 100 \ mm.$

$\Rightarrow$ Se verifica lo asumido anteriormente, $a \leq h_f$.

* Calcular ϕM_n.

$$\phi M_n = \phi b d^2 f'_c \omega (1 - 0.59 \omega)$$

$$\phi M_n = (0.9)(1150)(512.5)^2 (0.11663)[1 - 0.59(0.11663)]$$

$\phi M_n = 620\,004\,969$ [N.mm]

$\phi M_n = 620$ [KN.m]

$$\phi M_n \geq M_u$$

$620 \ KN.m \geq 600 \ KN.m$. <u>okey</u>

* Revisar los requerimientos de refuerzo mínimo y máximo.

- Cuantía mínima. (ala en compresión).

$$\rho_{min} = \frac{0.25\sqrt{f'c}}{fy} \qquad \rho_{min} = \frac{1.4}{fy}$$

$$\rho_{min} = \frac{(0.25)(\sqrt{21})}{420} \qquad \rho_{min} = \frac{1.4}{420}$$

$$\rho_{min} = 0.00273 \qquad \rho_{min} = 0.00333 \checkmark$$

$$\Rightarrow \rho_{min} = 0.00333$$

- Cuantía máxima

$$\rho_{máx} = 0.75\,\rho_b$$

$$\rho_b = (\bar{\rho}_b + \rho_2)\frac{bw}{b}$$

$$\bar{\rho}_b = 0.85\,\beta_1 \frac{f'c}{fy}\left(\frac{0.003Es}{0.003Es + fy}\right)$$

$$\bar{\rho}_b = (0.85)(0.85)\left(\frac{21}{420}\right)\left(\frac{0.003(2\times10^5)}{0.003(2\times10^5)+420}\right)$$

$$\bar{\rho}_b = 0.02125$$

$$\rho_2 = \frac{As_2}{bw \cdot d}$$

$$As_2 = \frac{0.85 f'c\, hf\,(b - bw)}{fy}$$

$$As_2 = \frac{(0.85)(21)(100)(1150-350)}{420}$$

$$As_2 = 3400\ mm^2$$

$$\Rightarrow \rho_2 = \frac{3400}{(350)(512.5)}$$

$$\rho_2 = 0.01895$$

$$\Rightarrow \rho_b = \left(\bar{\rho}_b + \rho_2\right)\frac{b_w}{b}$$

$$\rho_b = (0.02125 + 0.01895)\left(\frac{350}{1150}\right)$$

$$\rho_b = 0.01223$$

$$\Rightarrow \rho_{máx} = 0.75\,\rho_b = (0.75)(0.01223) = 9.176\times10^{-3}$$

$$\rho_{mín} < \rho < \rho_{máx}$$

$$3.333\times10^{-3} < 5.832\times10^{-3} < 9.176\times10^{-3}$$ okey

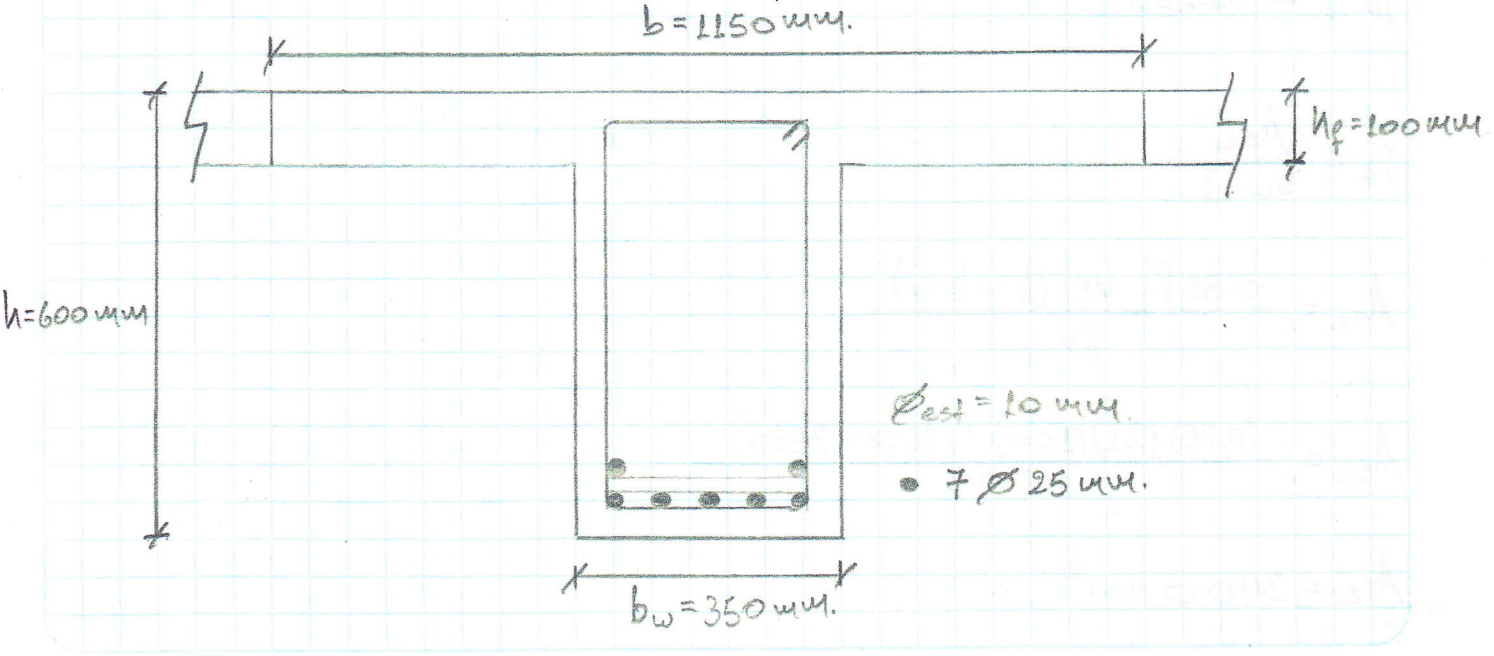
$e_{req} = 5(25) + 4(25) = 225$ mm.

$e_{disp} = 350 - 2(40+10) = 250$ mm.

$e_{req} < e_{disp}$

$225\text{ mm} < 250\text{ mm}$ okey

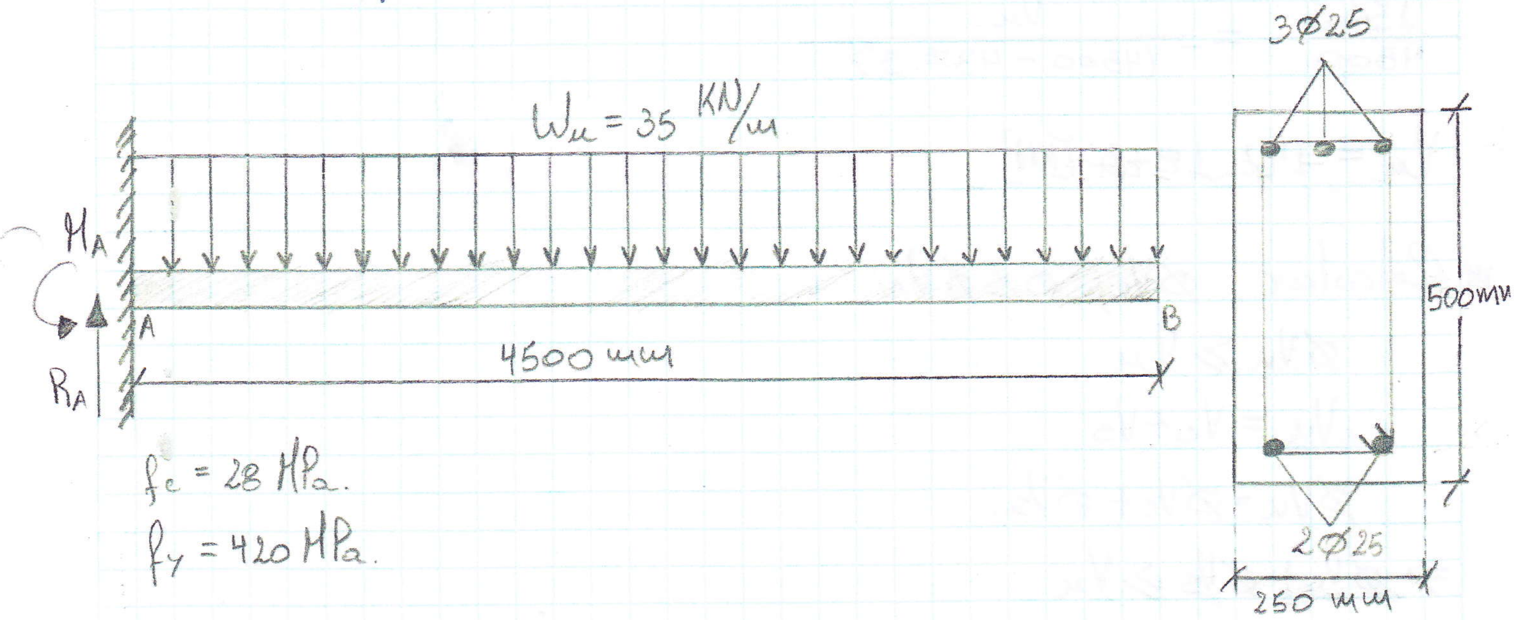
* Detalle de la sección.



Mario Aguaguiña M.

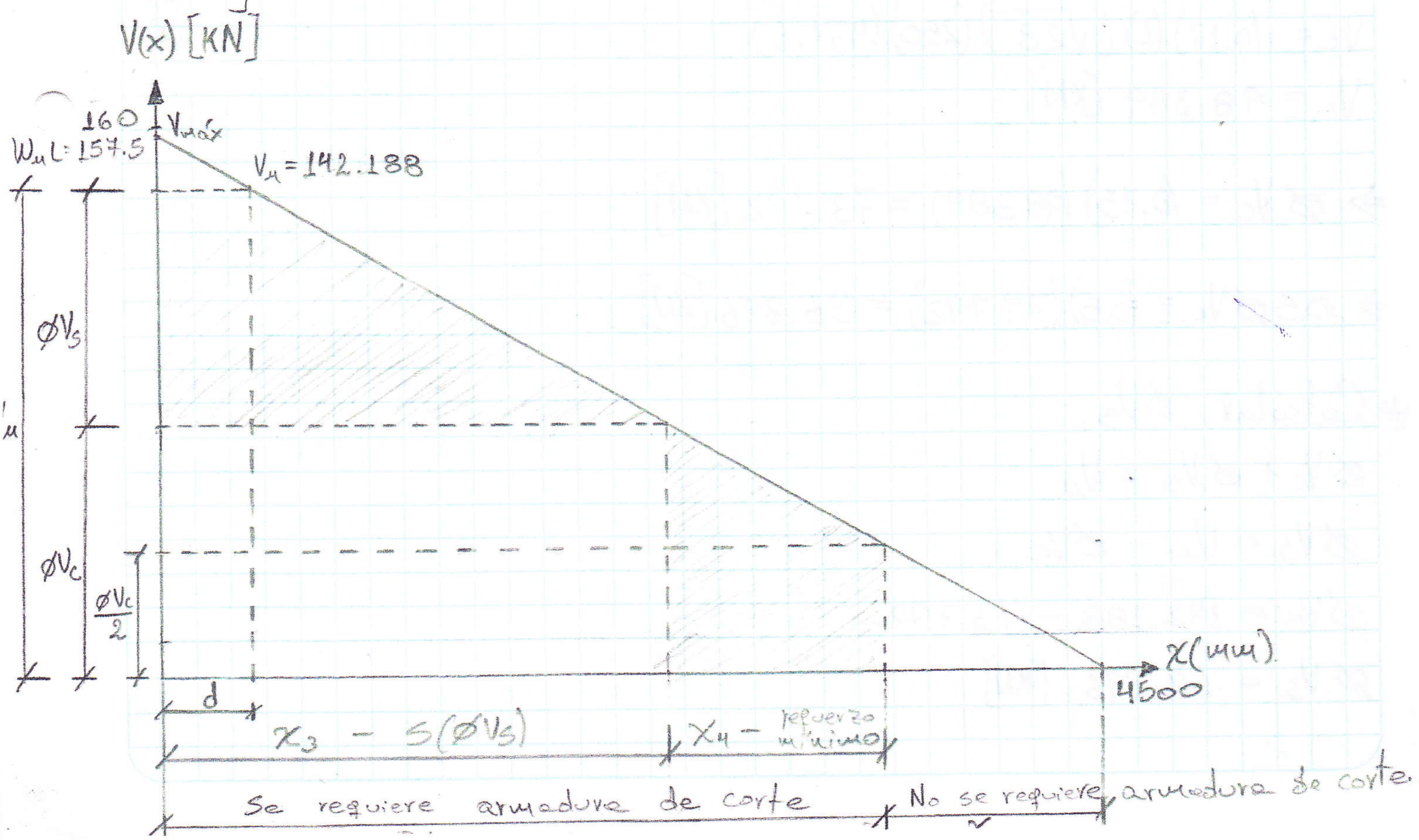
Hormigón I
Tarea #4
Paralelo 01
Resolución

Diseñe por fuerza cortante la siguiente viga en voladizo.



$f'_c = 28$ MPa.
$f_y = 420$ MPa.

* Diagrama de Fuerza Cortante



* Calcular d:

$d = h - (rec + \varnothing_{est} + \varnothing_b/2)$

$d = 500 - (40 + 10 + 25/2)$

$d = 437.5$ mm.

* Calcular V_u.

$$\frac{157.5}{4500} = \frac{V_u}{(4500 - 437.5)}$$

$V_u = 142.1875$ [KN]

* Calcular $\varnothing V_c$, $0.5\varnothing V_c$

$\varnothing V_n \geq V_u$

$V_u = V_c + V_s$

$\varnothing V_u = \varnothing V_c + \varnothing V_s$.

$\Rightarrow \varnothing V_c + \varnothing V_s \geq V_u$

$V_c = 0.17 \lambda \sqrt{f'c} \cdot b_w \cdot d$

$V_c = (0.17)(1)(\sqrt{28})(250)(437.5)$

$V_c = 98.389$ [KN]

$\Rightarrow \varnothing V_c = (0.75)(98.389) = 73.792$ [KN]

$\Rightarrow 0.5\varnothing V_c = (0.5)(79.792) = 36.896$ [KN]

* Calcular $\varnothing V_s$.

$\varnothing V_c + \varnothing V_s = V_u$

$\varnothing V_s = V_u - \varnothing V_c$

$\varnothing V_s = 142.188 - 73.792$

$\varnothing V_s = 68.396$ [KN]

$\phi V_{s\,máx} = \phi\, 0.66 \sqrt{f'c}\; b_w \cdot d$

$\phi V_{s\,máx} = (0.75)(0.66)(\sqrt{28})(250)(437.5)$

$\phi V_{s\,máx} = 286.485$ [KN]

$\phi V_s < \phi V_{s\,máx}$

68.396 KN < 286.485 KN **okey**

* No se requiere armadura de corte.

$$\frac{4500}{157.5} = \frac{x_1}{36.896}$$

$x_1 = 1054.17$ mm

* Se requiere armadura de corte.

$x_2 = 4500 - x_1$

$x_2 = 4500 - 1054.17$

$x_2 = 3445.83$ mm.

* Determinar $x_3 \Rightarrow S(\phi V_s)$

$$\frac{4500}{157.5} = \frac{x_3}{157.5 - 73.792}$$

$x_3 = 2391.66$ mm.

* Determinar $x_4 \Rightarrow$ refuerzo mínimo

$x_2 = x_3 + x_4$

$x_4 = x_2 - x_3$.

$x_4 = 3445.83 - 2391.66$

$x_4 = 1054.17$ mm

* Cuando $V_u > \phi V_c$

$$0.33\sqrt{f'_c}\, b_w \cdot d = (0.33)(\sqrt{28})(250)(437.5) = 190.990\ [KN]$$

$$V_s = \frac{\phi V_s}{\phi} \qquad \Rightarrow \qquad V_s \leq 0.33\sqrt{f'_c}\cdot b_w \cdot d$$

$$V_s = \frac{68.396}{0.75} \qquad 91.195\ KN \leq 190.990\ KN \quad \underline{\underline{\text{okey}}}$$

$$V_s = 91.195\ [KN]$$

- Separación de estribos

→ Requerido:

$$S = \frac{\phi A_v f_y \cdot d}{V_u - \phi V_c} = \frac{\phi \cdot A_v \cdot f_y \cdot d}{\phi V_s} = \frac{A_v \cdot f_y \cdot d}{V_s}$$

$$S = \frac{2(78.54)(420)(437.5)}{91.195 \times 10^3}$$

$$S = 316.5\ mm$$

→ Máxima:

$$S = \frac{d}{2} \qquad S = 600\ mm.$$

$$S = \frac{437.5}{2}$$

$$S = 218.75\ mm. ✓$$

⇒ Usar $S = 200\ mm$

* Cuando $0.5\phi V_c < V_u \leq \phi V_c$.

- Separación de estribos

→ Requerida

$$S = \frac{Av \cdot fyt}{0.062\sqrt{f'c}\ bw}$$

$$S = \frac{(2)(78.54)(420)}{(0.062)(\sqrt{28})(250)}$$

$S = 804.38$ mm.

$$S = \frac{Av \cdot fyt}{0.35\ bw}$$

$$S = \frac{(2)(78.54)(420)}{(0.35)(250)}$$

$S = 753.98$ mm ✓

⇒ $S = 753.98$ mm.

→ Máximo:

$$S = \frac{d}{2}$$

$$S = \frac{437.5}{2}$$

$S = 218.75$ mm ✓

$S = 600$ mm.

⇒ $S = 218.75$ mm. ✓

⇒ Usar $S = 200$ mm.

* Detallamiento de la viga.