

Diseño de Puente viga losa

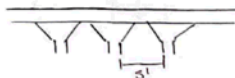
1. Diseño viga interior $L = 18m$, $f'_c = 300 \text{ kgf/cm}^2$ y $f_y = 4200 \text{ kgf/cm}^2$, usar HL-93.

- $A =$ Piedimensionamiento
 $b = 0.0157 \sqrt{S'} L$
 $L =$ longitud del puente
 $S' =$ distancia de eje.

$$b = 0.0157 \sqrt{2.10} 18$$

$$b = 0.41 \text{ m}$$

- $h \Rightarrow$ depende de la tabla
 $h = 0.070 L$
 $h = 0.070 (18)$
 $h = 1.26 \text{ m}$



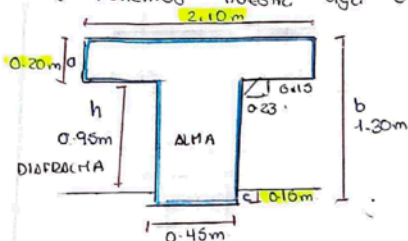
Nos conviene que sea más ancho la base para colocar las vigas de 4".

- tenemos que jugar con las opciones.

$$V = (0.40 \times 1.25) \text{ m}$$

$$V = (0.45 \times 1.30) \text{ m}$$

- tenemos nuestra viga en T



$$h = b - a - c = 1.30 - 0.15 - 0.20$$

$$h = 0.95 \text{ m}$$

- 2. Determinamos Cargas.

DC \rightarrow CM: Elementos estructurales

DW \rightarrow Carga de su rodadura

LL \rightarrow tablo de apéndice 42.

- 2.10 : es la distancia s' se supone, por la separación entre vigas

- 0.20 : es una distancia predeterminada por ser usualizado

- 0.15 : es la distancia para la viga, cajas

- VIGA DIAPHRAGMA, se supone un valor por la base de 0.20 a 0.30, en este caso el promedio 0.25 m.

* **Carga Muerta**

Carga distribuida

$$W_{\text{losa}} = 0.20 \times 2.10 \times 2400$$

$$W_{\text{losa}} = 1008$$

$$W_{\text{vigas}} = 0.45 \times 4.10 \times 2400$$

$$W_{\text{vigas}} = 4488$$

$$W_{\text{tableta}} = 2 \left[\frac{0.23 \times 0.15}{2} \right] \times 2400$$

$$W_{\text{tableta}} = 82.8$$

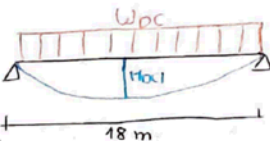
$$W_{\text{oc}} = 1008 + 4488 + 82.8 = 2278.8 \text{ kgf/m}$$

$$M_{\text{oc}} = \frac{W_{\text{oc}} \times L^2}{8}$$

$$M_{\text{oc}} = \frac{2278.8 \times 18^2}{8} = 92291.4 \text{ kgf.m}$$

$$M_{\text{oc}} = 92.29 \text{ tf.m}$$

Trasformamos a toneladas.



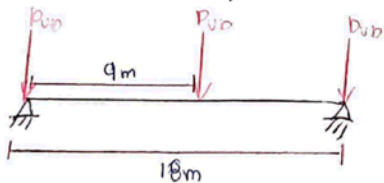
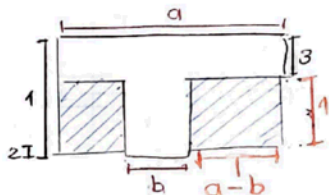
* **Carga Muerta** - Viga diafragma

$$\text{Vol} = (2.10 - 0.45) \times 0.25 \times 0.95$$

$$\text{vol} = 0.39 \text{ m}^3$$

$$P_{\text{vo}} = 0.39 \times 2400 = 940.5 \text{ kgf}$$

$$M_{\text{DC}_2} = \frac{P_{\text{vos}} \times L}{4} = \frac{940.5 \times 18}{4} = 4232.25 \Rightarrow \text{tonelada } 4.23$$



$$M_{\text{DC}} = M_{\text{oc}} + M_{\text{oc}_2}$$

$$M_{\text{DC}} = 92.29 + 4.23$$

$$M_{\text{DC}} = 96.52$$

• $D_c = \text{carga muerta} = 96.52 \text{ tnf/m}$

⇒ **Calculo de carga de rodadura** $g_{est} = 2200 \text{ Ksf/m}$

$W_{ow} = 0.05 \times 210 = 2200$

$W_{ow} = 231 \text{ Kg/m}$

M $M_{ow} = \frac{W_{ow} \times L^2}{8} = \frac{231 \times 18^2}{8} = 9356 \text{ Ksf.m} = 9.36 \text{ Tnf.m}$

• $D_w = \text{w. rodadura} = 9.36 \text{ Tnf.m}$



⇒ **Calculo de carga viva LL**

Tablo A2 - Dependence $\Delta z - 2$

De la tablo: $18m = (LL + 1M) = 1.83.53$

"Se elije el mayor"

• 1 solo carril cargado

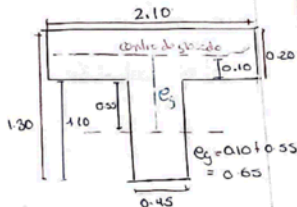
$g = 0.064 \left(\frac{S}{4.3} \right)^{0.4} \left(\frac{S}{L} \right)^{0.3} \left(\frac{K_g}{L T_s^3} \right)^{0.1}$

⇒ $n = 1$ "continuidad"

$I_{uiga} = \frac{bh^3}{12} = \frac{.45 \times 110^3}{12} = 4991250 \text{ cm}^2$

$A_{uiga} = b \cdot h = .45 \times 110 = 4950 \text{ cm}^2$

$e_g = 0.65 = 65 \text{ cm}$

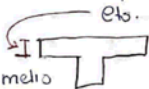


$n = \text{monolítico} = 1$

$K_g = n (I_{uiga} + A_{uiga} e_g^2) = 1 (4991250 + 4950 (65)^2)$

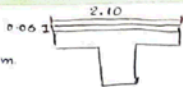
$K_g = 25903000$

⇒ $\left(\frac{K_g}{L T_s^3} \right)^{0.1} = \left(\frac{25903000}{18 \times 100 \times 20^3} \right)^{0.1} = 1.060$



en centimetro
 $0.20 = 20 \text{ cm}$

• $D_c = \text{carga muerta} = 46.52 \text{ kN/m}$



⇒ **Cálculo de carga de rodadura** $\gamma_{0.5} = 2200 \text{ kgf/m}$

$W_{DW} = 0.05 \times 210 \times 2200$

$W_{DW} = 231 \text{ kgf/m}$

$M_{How} = \frac{W_{DW} \times L^2}{8} = \frac{231 \times 18^2}{8} = 9356 \text{ kgf.m} = 936 \text{ Tm}$

• $D_w = \text{carga de rodadura} = 936 \text{ Tm}$

⇒ **Cálculo de carga viva LL**

Tubo A2 - Apéndice A2-2

De la tabla: $18\text{m} = (LL + 14) = 183.53$

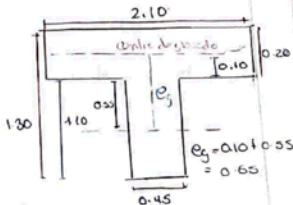
"se elige el mayor"

• 1 solo carril cargado

$g = 0.064 \left(\frac{S}{4.3} \right)^{0.4} \left(\frac{L}{L} \right)^{0.3} \left(\frac{K_g}{L^3} \right)^{0.1}$

⇒ $n = 1$ "continuidad"

$I_{viga} = \frac{bh^3}{12} = \frac{.45 \times 1.10^3}{12} = 4991250 \text{ cm}^2$



$A_{viga} = b \cdot h = .45 \times 1.10 = 4950 \text{ cm}^2$

$E_g = 0.65 = 65 \text{ cm}$

$n = \text{monolítico} = 1$

$K_g = n (I_{viga} + A_{viga} e_g^2) = 1 (4991250 + 4950 (65)^2)$

$K_g = 25905000$

⇒ $\left(\frac{K_g}{L_1 T_s^3} \right)^{0.1} = \left(\frac{25905000}{18 \times 100 \times 20^3} \right)^{0.1} = 1.060$



en centímetros
 $0.20 = 20 \text{ cm}$

⇒ hallamos g para un carril:

$$g = 0.06 + \left(\frac{5}{4.3}\right)^{0.4} \cdot \left(\frac{5}{L}\right)^{0.3} \cdot \left(\frac{k_3}{(1.7)^3}\right)^{0.1}$$

$$g = 0.06 + \left(\frac{2.1}{4.3}\right)^{0.4} \cdot \left(\frac{2.1}{18}\right)^{0.3} \cdot 1.06 = 0.478$$

⇒ hallamos g para 2 carriles:

$$g = 0.0076 + \left(\frac{5}{2.4}\right)^{0.6} \cdot \left(\frac{5}{L}\right)^{0.2} \cdot \left(\frac{k_3}{(1.7)^3}\right)^{0.1}$$

$$g = 0.0076 + \left(\frac{2.1}{2.4}\right)^{0.6} \cdot \left(\frac{2.1}{18}\right)^{0.2} \cdot 1.06 = 0.644$$

⇒ Se elige el mayor = 0.644

$$H(u+n) = 0.64 \times 183.53 = 118.19 \text{ ft. m}$$

$$\bullet H(u+n) = \text{Cotgo vivo} = 118.19 \text{ ft. m}$$

Resistencia

$$0.95 \leq n \leq 1.05$$

$$M_u = n [1.25 M_{DC} + 1.5 M_{DW} + 1.75 M(u+n)]$$

$$M_u = 1 [1.25 (96.52) + 1.5 (9.36) + 1.75 (118.19)]$$

$$M_u = 341.39 \text{ ft. m}$$

$$a = d - \sqrt{d^2 - \frac{2 M_u}{\phi \times 0.85 \times f_c \times b}}$$

$$As = \frac{M_u}{\phi f_y \left(d - \frac{a}{2}\right)}$$

$$f_c = 350 \text{ kgf/cm}^2$$

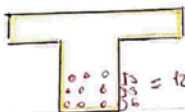
$$z = 12 \text{ cm}$$

$$d = 130 - 12 = 118 \text{ cm}$$

se trabaja en centímetros

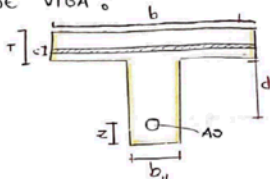
$$a = 118 - \sqrt{118^2 - \frac{2(341.39)10^5}{0.90 \times 0.85 \times 350 \times 45}}$$

⇒ No se usa



$$12 = 12 \text{ cm}$$

DISEÑO DE VIGA :



1. Suponer: $C = f$ $f = 20 \text{ cm}$

con lo que $a = 0.85 \cdot C$

$M_u = 0.90 \text{ Mn} = M_u$

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

$$a = \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b}$$

$A_s = \frac{341.39 \times 10^5}{0.90 \cdot 4200 (111 - \frac{17}{2})} = 88.12 \text{ cm}^2$ \Rightarrow con este valor voluermos a calcular "a"

$$a = \frac{88.12 \cdot 4200}{0.85 \times 350 \cdot 210} = 5.92 \text{ cm}$$

$$C = \frac{a}{0.85} = \frac{5.92}{0.85} = 6.96$$

\Rightarrow Comparamos $T > C \rightarrow$ en una direccion. $20 > 6.96 \checkmark$ se trabaja como viga \square

\Rightarrow teniendo que el modo sea en viga rectangular. $b = 210 \text{ mm}$

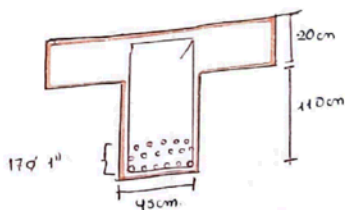
$$a = d - \sqrt{d^2 - \frac{2 M_u}{\phi \cdot 0.85 \cdot f_c \cdot b}} = 111 - \sqrt{111^2 - \frac{2 \times 341.39 \times 10^5}{0.90 \times 0.85 \times 350 \cdot 210}}$$

$$a = 5.61$$

$$A_s = \frac{M_u}{\phi \cdot f_y \cdot (d - \frac{a}{2})} = \frac{341.39 \times 10^5}{0.90 \times 4200 (111 - \frac{5.61}{2})} = 83.47 \text{ cm}^2$$

⇒ Armado:
 $A' 1'' = 5.10 \text{ cm}^2 \Rightarrow \# \text{ barras} = \frac{83.47 \text{ cm}^2}{5.10} = 16.37 \sim 17 \#$

Armado:



⇒ en este caso el número de barra lo dividimos entre 3 y usamos.

Espaciamiento:

5 espaciamientos,

Hacer a 10 barras estribos de 1/2"



$$SS = b - \text{Núcleos de rec.} - \text{recubrimiento} - 2(\text{estribos}) - \text{N}^{\circ} \text{ barras (barras)}$$

$$SS = 45 - 2 \times 4 - 2 \left(\frac{1}{2} \times 2.54 \right) - 6(1'' \times 2.54)$$

recubrimiento estribo barras

$$S = 3.84 \Rightarrow 1'' \sim 2.54 \text{ cm}$$

Acero Mínimo:

Verificación

$$\begin{aligned} A_{s \text{ max}} &\Rightarrow \text{No se tiene} \\ A_{s \text{ min}} &\Rightarrow \text{Menor valor} \end{aligned}$$

Menor valor

$$f_r = 1.15 f_r$$

$$f_r = 201 \sqrt{f_c'}$$

$$S = \frac{b \times h^2}{6} = \text{cm}$$

$$f_r = 201 \sqrt{350} = 37.60 \text{ kgf/cm}$$

$$\Rightarrow f_r = 1.15 f_r$$

$$f_r = 1.15 \times 37.60 = 43.24$$

$$M_r = 24 \times 43.24 = 1037.76 \text{ kgf.m}$$

$$\frac{1}{3} \times 10^3 \text{ para los lados}$$

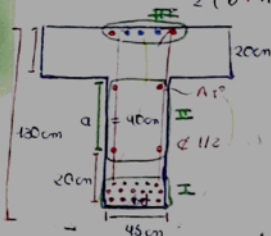
$$S = \frac{210 \times 130^2}{6} = 591500 \text{ cm}^2$$

$$M_u = 341.39 \text{ tf m} \\ = 1.33 \cdot (341.39) = 454.05 \text{ tf m}$$

donde: M_u M_{u1} M_{u2}
 $244.64 \text{ tf m} < 454.05 \text{ tf m} \rightarrow \text{se elige el menor}$

* Acero de temperatura.

$$A_{T^o} = \frac{0.18 \cdot b \cdot h}{2(b+h)} = \text{cm}^2/\text{m} = \frac{0.18 \cdot 45 \cdot 130}{2(45+130)} = 3 \text{ cm}^2/\text{m} = \phi 1/2$$



$$2.33 \text{ cm}^2/\text{m} \leq A_{T^o} \leq 17.7 \text{ cm}^2/\text{m}$$

$$d = h + h_{\text{hogar}} - h_{\text{aparcado}}$$

$$d = 130 - 20 - 20$$

$$d = 90 \text{ cm} = 0.90 \text{ m}$$

$$A_{T^o} \cdot d$$

$$A_{T^o} > 3 \text{ cm} \Rightarrow 3 > 0.90 = 2.70 \text{ cm}^2$$

$$\phi 1/2'' = 1.27 \text{ cm}^2 = \text{Area}$$

de alambros
 deben ser por

$$\# \text{ barras} = \frac{2.70}{1.27} = 2.13 \text{ barras} \approx 4 \text{ barras} = \text{deben ser por}$$

$$\frac{\sqrt{f'_c}}{f_y} b_w d = 0.7 \frac{\sqrt{350}}{4200} \cdot 45 \cdot (130 - 12) = 16.56 \text{ cm}^2$$

$$\phi 1'' \rightarrow 5.10 \text{ cm}^2 \rightarrow \# \text{ barras} = \frac{16.56}{5.10} = 3.2 \text{ barras}$$

$$\text{Jugamos: } 2\phi 1'' + 3\phi 3/4''$$

* Verificación \rightarrow Fisuración y Fatiga.

$$M_{oc} = 46.52 \text{ tf m}$$

$$M_{ov} = 9.36 \text{ tf m}$$

$$M_{u1} = 118.11 \text{ tf m}$$

M_s = momento de servicio

$$M_o = 1.0 M_{oc} + 1.0 M_{ov} + 1.0 M_{u1} + m_1$$

$$M_s = 96.52 + 9.36 + 118.11$$

$$M_s = 223.99 \text{ tf m}$$

$$E_s = 2 \times 10^6 \text{ kg/cm}^2$$

$$E_c = 45000 \sqrt{f'_c}$$

$$E_c = 280624.30 \text{ kg/cm}^2$$

$$E_{comp} = E_c = 280624.30$$

$$n = \frac{E_s}{E_c} = \frac{2 \times 10^6}{280624.30} = 8$$

$$n = \text{relación modular}$$

$$d_c = \text{rec. A} + \phi \text{ estribo} + \phi \text{ r/2}$$

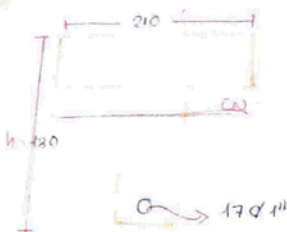
$$d_c = \text{recubrimiento} + \text{diámetro} + \text{Pulgado / 2}$$

$$d_c = 4 + (\frac{1}{2} \cdot 2.54) + (2.54/2) = 6.54 \text{ cm}$$

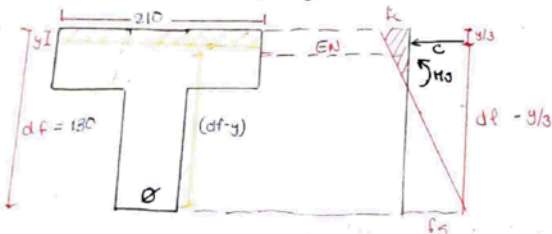
$$d_l = 130 - 6.54 = 123.46 \text{ cm}$$

$$\text{Área de tracción} = n \cdot A_s$$

$$\text{acción transformada} = 8 \times 17 \times 5.10 = 693.6 \text{ cm}^2$$



• Cálculo de f_c' y f_y .



$$A_s \times (d_l - y) = 210 \times y \times (y/2)$$

$$693.6 \times (123.46 - y) = 210 \times y^2 / 2$$

$$y = 25.44 \text{ cm}$$

$$E_s = 2 \times 10^6 \text{ kgf/cm}^2$$

$$E_c = 13000 \sqrt{350}$$

$$C_c = 280.624 \text{ 30 kgf/cm}^2$$

$$E_{\text{conc}} = E_s = 13000 \sqrt{350}$$

$$n = \frac{E_s}{E_c} = \frac{2 \times 10^6}{280.624 \cdot 30} = 8$$

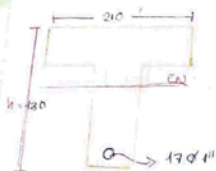
$n = 8$ = relación modular

$$d_c = \text{rec} + p \text{ estribo} + \phi \text{ p/2}$$

$$d_c = \text{recubrimiento} + \text{diámetro de estribo} + \text{fulgado} / 2$$

$$d_c = 4 + (1/2 \cdot 2.54) + (1 \cdot 2.54 / 2) = 6.34 \text{ cm}$$

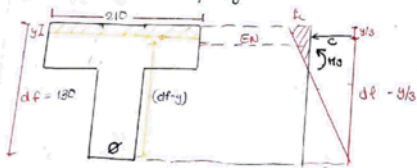
$$d_l = 130 - 6.34 = 123.66 \text{ m}$$



$$\text{Area de tracción} = n \cdot A_s$$

$$\text{sección transformada} = 8 \times 17.5 \cdot 10 = 693.6 \text{ cm}^2$$

* Cálculo de A_s y f_y .



$$A_s \cdot y \cdot (d_l - y) = 210 \cdot y \cdot (y/2)$$

$$693.6 \cdot (123 - 46.7 \cdot y) = 210 \cdot y^2 / 2$$

$$y = 25.44 \text{ cm}$$