

### Diametro y areas de barras de acero

$$d_{b\#3} := \frac{3}{8} \text{ in} = 0.95 \text{ cm}$$

$$A_{b\#3} := \frac{\pi \cdot d_{b\#3}^2}{4} = 0.71 \text{ cm}^2$$

$$d_{b\#4} := \frac{4}{8} \text{ in} = 1.27 \text{ cm}$$

$$A_{b\#4} := \frac{\pi \cdot d_{b\#4}^2}{4} = 1.27 \text{ cm}^2$$

$$d_{b\#5} := \frac{5}{8} \text{ in} = 1.59 \text{ cm}$$

$$A_{b\#5} := \frac{\pi \cdot d_{b\#5}^2}{4} = 1.98 \text{ cm}^2$$

$$d_{b\#6} := \frac{6}{8} \text{ in} = 1.91 \text{ cm}$$

$$A_{b\#6} := \frac{\pi \cdot d_{b\#6}^2}{4} = 2.85 \text{ cm}^2$$

$$d_{b\#7} := \frac{7}{8} \text{ in} = 2.22 \text{ cm}$$

$$A_{b\#7} := \frac{\pi \cdot d_{b\#7}^2}{4} = 3.88 \text{ cm}^2$$

$$d_{b\#8} := \frac{8}{8} \text{ in} = 2.54 \text{ cm}$$

$$A_{b\#8} := \frac{\pi \cdot d_{b\#8}^2}{4} = 5.07 \text{ cm}^2$$

$$d_{b\#9} := \frac{9}{8} \text{ in} = 2.86 \text{ cm}$$

$$A_{b\#9} := \frac{\pi \cdot d_{b\#9}^2}{4} = 6.41 \text{ cm}^2$$

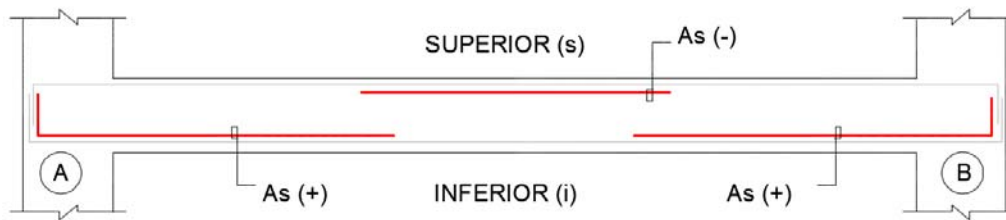
$$d_{b\#10} := \frac{10}{8} \text{ in} = 3.18 \text{ cm}$$

$$A_{b\#10} := \frac{\pi \cdot d_{b\#10}^2}{4} = 7.92 \text{ cm}^2$$

$$d_{b\#11} := \frac{11}{8} \text{ in} = 3.49 \text{ cm}$$

$$A_{b\#11} := \frac{\pi \cdot d_{b\#11}^2}{4} = 9.58 \text{ cm}^2$$

## DISEÑO DE VIGA DE CIMENTACION CON FLEXION EN CARA SUPERIOR (Eje A, entre ejes 8 y 9)



Momentos por combinación de carga (1.4 CM+1.7 CV):

Apoyo A

Centro

Apoyo B

$$Mu_{neg\_a} := 0 \text{ tonnef} \cdot m$$

$$Mu_{neg\_c} := 3.11 \text{ tonnef} \cdot m$$

$$Mu_{neg\_b} := 0 \text{ tonnef} \cdot m$$

$$Mu_{pos\_a} := 2.26 \text{ tonnef} \cdot m$$

$$Mu_{pos\_c} := 0 \text{ tonnef} \cdot m$$

$$Mu_{pos\_b} := 2.26 \text{ tonnef} \cdot m$$

Datos de viga:

Datos de concreto y acero:

$$b := 30 \text{ cm} \quad rec := 4 \text{ cm}$$

$$fc := 210 \frac{\text{kgf}}{\text{cm}^2} \quad \phi := 0.85$$

$$h := 40 \text{ cm} \quad A_{b\#5} = 1.98 \text{ cm}^2$$

$$fy := 4200 \frac{\text{kgf}}{\text{cm}^2} \quad \beta_1 := 0.85$$

$$db := d_{b\#5} = 1.59 \text{ cm}$$

Cuantía balanceada, máxima y mínima :

Area de acero máximo y mínimo:

$$\rho_b := \beta_1 \cdot 0.85 \cdot \frac{fc}{fy} \left( \frac{6000 \frac{\text{kgf}}{\text{cm}^2}}{6000 \frac{\text{kgf}}{\text{cm}^2} + fy} \right) = 0.02$$

$$d := h - rec - 0.95 \text{ cm} - \frac{db}{2} = 34.26 \text{ cm}$$

$$\rho_{max} := 0.75 \cdot \rho_b = 0.0159 \quad \text{=====>}$$

$$As_{max} := \rho_{max} \cdot b \cdot d = 16.38 \text{ cm}^2$$

$$\rho_{min} := \frac{14}{fy} = 0.0033 \quad \text{=====>}$$

$$\frac{\text{kgf}}{\text{cm}^2}$$

$$As_{min} := \rho_{min} \cdot b \cdot d = 3.43 \text{ cm}^2$$

Area de acero requerido en lado A:

$$Mu := Mu_{pos\_a} = 2.26 \text{ tonnef} \cdot m$$

$$As_a := \frac{0.85 fc \cdot (b \cdot d)}{fy} \left( 1 - \sqrt{1 - \frac{2 |Mu|}{0.90 (0.85 fc \cdot b \cdot d^2)}} \right) = 1.78 \text{ cm}^2$$

if ( $As_a < As_{max}$ , "Ver Caso de refuerzo simple", "Ver Caso de refuerzo doble") = "Ver Caso de refuerzo simple"

Caso de refuerzo simple:

$$As_a := \text{if} (As_a < As_{min}, As_{min}, As_a) = 3.43 \text{ cm}^2$$

Caso de refuerzo doble:

$$p_{asumido} := p_{max}$$

$$As1 := p_{asumido} \cdot b \cdot d = 16.38 \text{ cm}^2$$

$$a := \frac{As1 \cdot f_y}{0.85 \cdot f_c \cdot b} = 12.85 \text{ cm}$$

$$Mu1 := 0.90 \cdot As1 \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 17.23 \text{ tonnef} \cdot m$$

$$Mu2 := Mu - Mu1 = -14.97 \text{ tonnef} \cdot m$$

$$d' := 6 \text{ cm}$$

$$As2 := \frac{Mu2}{0.90 \cdot f_y \cdot (d - d')} = -14.02 \text{ cm}^2$$

**Acero superior As:**

$$As := As1 + As2 = 2.36 \text{ cm}^2$$

**Acero inferior As':**

$$c := \frac{a}{\beta_1} = 15.11 \text{ cm}$$

$$f's := 6 \cdot \frac{(c - d')}{c} \frac{\text{tonnef}}{\text{cm}^2} = 3.62 \frac{\text{tonnef}}{\text{cm}^2}$$

$$f's := \text{if} (f's < f_y, f's, f_y) = 3617.95 \frac{\text{kgf}}{\text{cm}^2}$$

$$As' := \frac{Mu2}{0.90 \cdot f's \cdot (d - d')} = -16.27 \text{ cm}^2$$

$$A_{0,0} := \text{if} (As_a < As_{max}, 0 \text{ cm}^2, As')$$

$$A_{1,0} := \text{if} (As_a < As_{max}, As_a, As)$$

Area de acero requerido en lado B:

$$Mu := Mu_{pos\_b} = 2.26 \text{ tonnef} \cdot m$$

$$As_b := \frac{0.85 f_c \cdot (b \cdot d)}{f_y} \left(1 - \sqrt{1 - \frac{2 |Mu|}{0.90 (0.85 f_c \cdot b \cdot d^2)}}\right) = 1.78 \text{ cm}^2$$

if ( $As_b < As_{max}$ , "Ver Caso de refuerzo simple", "Ver Caso de refuerzo doble") = "Ver Caso de refuerzo simple"

Caso de refuerzo simple:

$$As_b := \text{if} (As_b < As_{min}, As_{min}, As_b) = 3.43 \text{ cm}^2$$

Caso de refuerzo doble:

$$p_{asumido} := p_{max}$$

$$As1 := p_{asumido} \cdot b \cdot d = 16.38 \text{ cm}^2$$

$$a := \frac{As1 \cdot f_y}{0.85 \cdot f_c \cdot b} = 12.85 \text{ cm}$$

$$Mu1 := 0.90 \cdot As1 \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 17.23 \text{ tonnef} \cdot m$$

$$Mu2 := Mu - Mu1 = -14.97 \text{ tonnef} \cdot m$$

$$d' := 6 \text{ cm}$$

$$As2 := \frac{Mu2}{0.90 \cdot f_y \cdot (d - d')} = -14.02 \text{ cm}^2$$

Acero superior As:

$$As := As1 + As2 = 2.36 \text{ cm}^2$$

Acero inferior As':

$$c := \frac{a}{\beta_1} = 15.11 \text{ cm}$$

$$f's := 6 \cdot \frac{(c - d')}{c} \frac{\text{tonnef}}{\text{cm}^2} = 3.62 \frac{\text{tonnef}}{\text{cm}^2}$$

$$f's := \text{if}(f's < f_y, f's, f_y) = 3617.95 \frac{\text{kgf}}{\text{cm}^2}$$

$$As' := \frac{Mu2}{0.90 \cdot f's \cdot (d - d')} = -16.27 \text{ cm}^2$$

$$A_{0,2} := \text{if}(As_b < As_{max}, 0 \text{ cm}^2, As')$$

$$A_{1,2} := \text{if}(As_b < As_{max}, As_b, As)$$

Area de acero requerido en centro:

$$Mu := Mu_{neg\_c} = 3.11 \text{ tonnef} \cdot m$$

$$As_c := \frac{0.85 f_c \cdot (b \cdot d)}{f_y} \left(1 - \sqrt{1 - \frac{2 |Mu|}{0.90 (0.85 f_c \cdot b \cdot d^2)}}\right) = 2.47 \text{ cm}^2$$

if ( $As_c < As_{max}$ , "Ver Caso de refuerzo simple", "Ver Caso de refuerzo doble") = "Ver Caso de refuerzo simple"

Caso de refuerzo simple:

$$As_c := \text{if}(As_c < As_{min}, As_{min}, As_c) = 3.43 \text{ cm}^2$$

Caso de refuerzo doble:

$$p_{asumido} := p_{max}$$

$$As1 := p_{asumido} \cdot b \cdot d = 16.38 \text{ cm}^2$$

$$a := \frac{As1 \cdot fy}{0.85 \cdot fc \cdot b} = 12.85 \text{ cm}$$

$$Mu1 := 0.90 \cdot As1 \cdot fy \cdot \left(d - \frac{a}{2}\right) = 17.23 \text{ tonnef} \cdot m$$

$$Mu2 := Mu - Mu1 = -14.12 \text{ tonnef} \cdot m$$

$$d' := 6 \text{ cm}$$

$$As2 := \frac{Mu2}{0.90 \cdot fy \cdot (d - d')} = -13.22 \text{ cm}^2$$

**Acero superior As:**

$$As := As1 + As2 = 3.16 \text{ cm}^2$$

**Acero inferior As':**

$$c := \frac{a}{\beta_1} = 15.11 \text{ cm}$$

$$fs := 6 \cdot \frac{(c - d')}{c} \frac{\text{tonnef}}{\text{cm}^2} = 3617.95 \frac{\text{kgf}}{\text{cm}^2}$$

$$fs := \text{if}(fs < fy, fs, fy) = 3617.95 \frac{\text{kgf}}{\text{cm}^2}$$

$$As' := \frac{Mu2}{0.90 \cdot fs \cdot (d - d')} = -15.35 \text{ cm}^2$$

$$A_{0,1} := \text{if}(As_c < As_{max}, As_c, As) = 3.43 \text{ cm}^2 \quad A_{1,1} := \text{if}(As_c < As_{max}, 0 \text{ cm}^2, As')$$

Matriz de area de acero calculado:

$$A = \begin{bmatrix} 0 & 3.43 & 0 \\ 3.43 & 0 & 3.43 \end{bmatrix} \text{ cm}^2$$

$$As_{min} = 3.43 \text{ cm}^2$$

$$As_{max} = 16.38 \text{ cm}^2$$

$$f(As1, As2) := \text{if}(As1 \geq As2, \text{"Cumple"}, \text{"No cumple"})$$

Resumen final:

**Seccion A:**

**Centro:**

**Seccion B:**

$$A_{0,0} = 0 \text{ cm}^2$$

$$A_{0,1} = 3.43 \text{ cm}^2$$

$$A_{0,2} = 0 \text{ cm}^2$$

As superior

$$A_{1,0} = 3.43 \text{ cm}^2$$

$$A_{1,1} = 0 \text{ cm}^2$$

$$A_{1,2} = 3.43 \text{ cm}^2$$

As inferior

$$As_{col\_a} := 2 A_{b\#5} + 0 A_{b\#4}$$

$$As_{col\_c} := 3 A_{b\#5} + 0 A_{b\#4}$$

$$As_{col\_b} := 2 A_{b\#5} + 0 A_{b\#4}$$

Barra colocado

$$As_{col\_a} = 3.96 \text{ cm}^2$$

$$As_{col\_c} = 5.94 \text{ cm}^2$$

$$As_{col\_b} = 3.96 \text{ cm}^2$$

As colocado

$$p := \frac{As_{col\_a}}{b \cdot d} = 0.0039$$

$$p := \frac{As_{col\_c}}{b \cdot d} = 0.0058$$

$$p := \frac{As_{col\_b}}{b \cdot d} = 0.0039$$

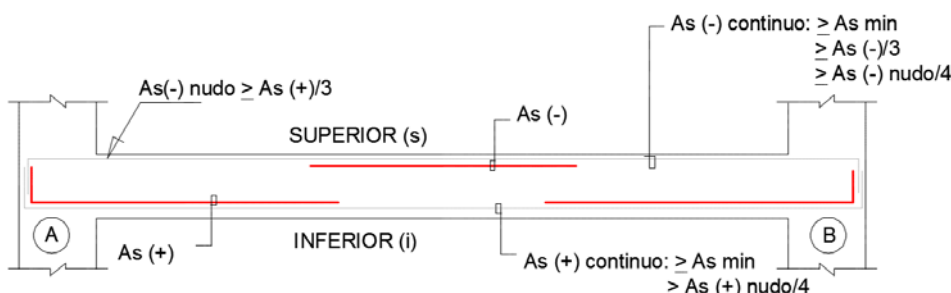
Cuantia

$$f(As_{col\_a}, A_{1,0}) = \text{"Cumple"}$$

$$f(As_{col\_c}, A_{0,1}) = \text{"Cumple"}$$

$$f(As_{col\_b}, A_{1,2}) = \text{"Cumple"}$$

Por lo tanto, se colocara acero corrugado: 03 varillas de 5/8" en el centro de cara superior y 02 varillas de 5/8" entre los apoyos de cara inferior. Estas varillas seran corridas en ambas caras para el amarre de estribos.



#### Verificacion de acero corrido colocado en zona de flexion (Superior):

$$As_{nudo\_compresion} := \max(A_{0,0}, A_{1,0}, A_{0,2}, A_{1,2}) = 3.43 \text{ cm}^2 \quad As_{flexion} := \max(A_{0,1}, A_{1,1}) = 3.43 \text{ cm}^2$$

$$As_{nudo\_flexion} := \frac{As_{nudo\_compresion}}{3} = 1.14 \text{ cm}^2$$

$$As_{corrido\_flexion} := \max\left(As_{min}, \frac{As_{flexion}}{3}, \frac{As_{nudo\_flexion}}{4}\right) = 3.43 \text{ cm}^2$$

$$As_{corrido\_flexion\_asumido} := 3 A_{b\#5} + 0 A_{b\#4} = 5.94 \text{ cm}^2$$

if ( $As_{corrido\_flexion\_asumido} \geq As_{corrido\_flexion}$ , "Cumple", "No cumple") = "Cumple"

#### Verificacion de acero corrido colocado en zona de compresion (inferior):

$$As_{nudo\_compresion} := \max(A_{0,0}, A_{1,0}, A_{0,2}, A_{1,2}) = 3.43 \text{ cm}^2$$

$$As_{corrido\_compresion} := \max\left(As_{min}, \frac{As_{nudo\_compresion}}{4}\right) = 3.43 \text{ cm}^2$$

$$As_{corrido\_compresion\_asumido} := 2 A_{b\#5} + 0 A_{b\#4} = 3.96 \text{ cm}^2$$

if ( $As_{corrido\_compresion\_asumido} \geq As_{corrido\_compresion}$ , "Cumple", "No cumple") = "Cumple"

Finalmente , las varillas de acero corrugado corrido colocado en la viga cumplen con las exigencias de norma ACI 2014.

CUADRO DE VIGA DE CIMENTACIÓN			
TIPO	SECCION	VARILLAS	ESTRIBOS
VC		5 Ø 5/8"	Ø 3/8" 1 @ 0.05 m, 8 @ 0.10, Rto @ 0.20 m. A.E.