

638  
1414

# IV. MEMORIA DE CALCULO



*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. N. 154480

637  
1413

DISEÑO DE MURO DE CONTENCIÓN			
EN VOLADIZO			
PROYECTO	CONSTRUCCIÓN DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : jul-2023

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	1.20	m
h 1 =	1.400	m
t 1 =	0.15	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava	
$\gamma$ =(kg/m3)	2650
$\phi$ =(°)	30°
$\sigma$ t =(kg/cm2)	1.20

#### C DATOS DEL C° Y ACERO

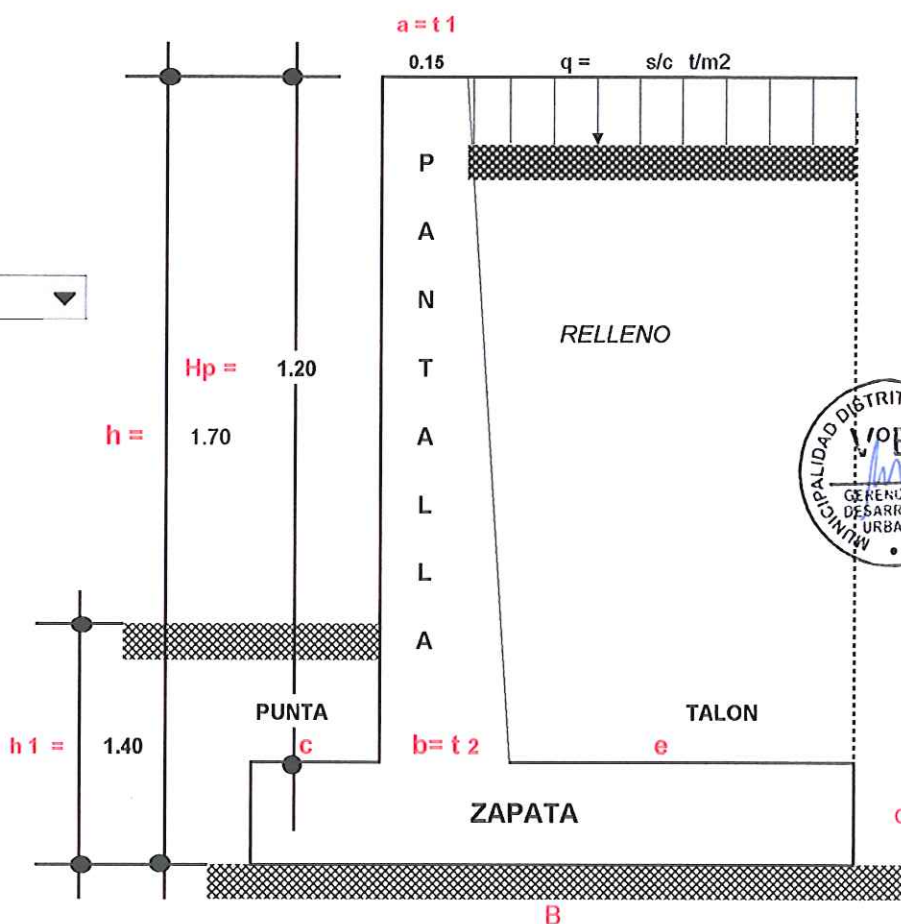
f'c=(kg/cm2)	210
f'y=(kg/cm2)	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	≥	2
F.S.D	≥	1.5

#### E SOBRECARGA

q=s/c t-m2	0.50	tn
------------	------	----



#### 1.- PREDIMENSIONAMIENTO:

$$a = 15 \text{ a } 25 \rightarrow \text{Asumido} = 0.15 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{1.70}{12} \text{ ó } \frac{1.70}{10}$$

$$b = 0.14 \text{ ó } 0.17 \rightarrow \text{Asumido} = 0.15 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 1.70 \text{ ó } 0.8 \cdot 1.70$$

$$B = 0.85 \text{ ó } 1.36 \rightarrow \text{Asumido} = 1.35 \text{ m}$$



Ing. Edgar Santos  
INGENIERO CIVIL  
REG. CIP. 144480

636  
14/12

$$\begin{aligned} B &= 0.5 \quad H \text{ a } 0.8 \quad H \\ B &= 0.5 \quad 1.70 \quad \delta \quad 0.8 \quad 1.70 \\ B &= 0.85 \quad \delta \quad 1.36 \quad \rightarrow \quad \text{Asumido} = \boxed{1.35} \text{ m} \end{aligned}$$

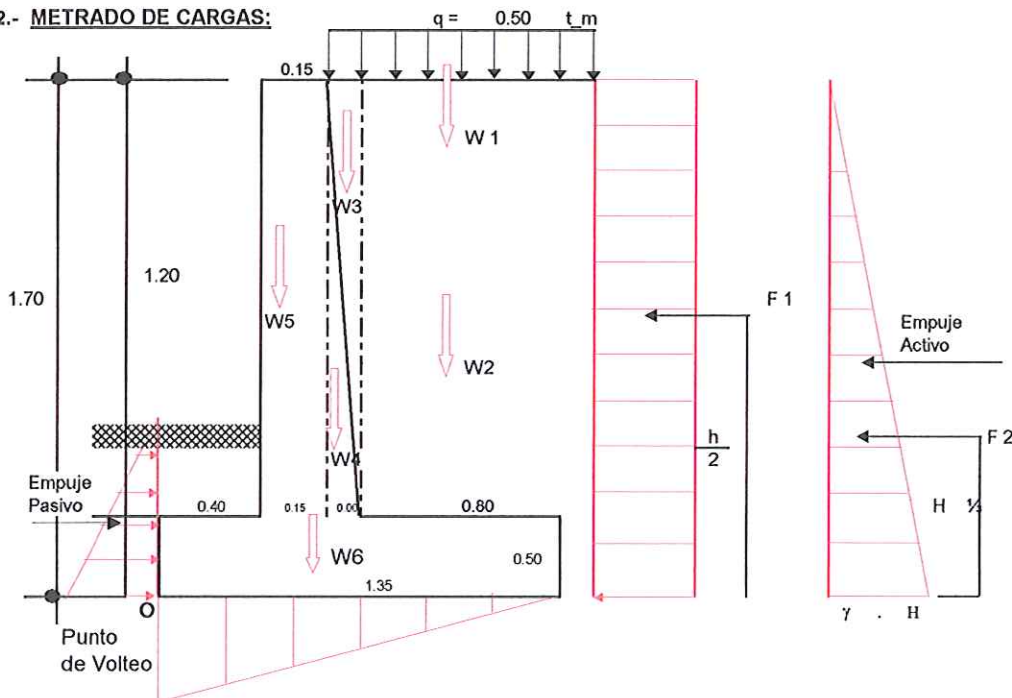
$$\begin{aligned} c &= \frac{1}{3} B - 1/2 b = 0.38 \\ c &= 0.38 \quad \rightarrow \quad \text{Asumido} = \boxed{0.40} \text{ m} \end{aligned}$$

$$\begin{aligned} d &= \begin{aligned} &= b = \\ &= b + 5 \\ &= b + 10 \quad \boxed{0.25} \rightarrow \text{Asumido} = \boxed{0.50} \text{ m} \\ &= b + 15 \\ &= b + 20 \end{aligned} \end{aligned}$$

$$e = B - c - b = 1.35 - 0.40 - 0.15$$

$$e = 0.80 \text{ m}$$

## 2.- METRADO DE CARGAS:



### a.- FUERZAS VERTICALES: 1.40 mts de Analisis

W1	=	0.50 t/m <sup>2</sup>	x	0.80	x	1.40	=	560	kg
W2	=	30 kg/cm <sup>2</sup>	x	( 0.80 x 1.20 )	x	1.40	=	40	kg
W3	=	30 kg/cm <sup>2</sup>	x	( $\frac{0.00 \times 1.20}{2}$ )	x	1.40	=	0	kg
W4	=	2,400 kg/cm <sup>2</sup>	x	( $\frac{0.00 \times 1.20}{2}$ )	x	1.40	=	0	kg
W5	=	2,400 kg/cm <sup>2</sup>	x	0.15	x	1.20	x	1.40	= 605 kg
W6	=	2400 kg/cm <sup>2</sup>	x	1.35	x	0.50	x	1.40	= 2,268 kg
$\Sigma f_y$								3,473	kg

### b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

Ing. Oscar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. 14420



635  
1411

$$F1 = [ (q) \times (H) \times 1.00 \text{ m} ] \text{ Ka}$$

$$F1 = [ 500 \text{ kg/cm}^2 \times 1.70 \times 1.00 ] \times 0.333$$

$$F1 = 283 \text{ Kg/cm}^2$$

UBICACIÓN : F 1

$$F1 = \frac{H}{2} = \frac{1.20}{2} = 0.6 \text{ m}$$

$$F2 = (\text{vol}) D \cdot P$$

$$F2 = [ \frac{1}{2} (\gamma H) (H) \times 1.00 ] \text{ Ka}$$

$$F2 = \frac{1}{2} \gamma h^2 \times 1.00 \times \text{Ka}$$

$$F2 = \frac{1}{2} 30 \text{ kg/cm}^2 \times 1.20^2 \times 1.00 \times 0.333$$

$$F2 = 7.20 \text{ Kg}$$

UBICACIÓN : F 2

$$F2 = \frac{1}{3} H$$

$$F2 = \frac{1}{3} 1.20 = 0.4 \text{ m}$$

### 3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

#### FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W1	560	0.95	532.00
W2	40	0.95	38.30
W3	0	0.550	0.00
W4	0	0.550	0.00
W5	605	0.475	287.28
W6	2,268	0.68	1,530.90
$\sum MF_f$	3,473	$\sum MoF_y$	2,388.48

#### FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F1	283	0.600	170.00
F2	7	0.40	2.88
$\sum F_h$	290.53	$\sum MF_h$	172.88

$$F_s V = \frac{2,388.48 \text{ kg/m}}{172.88 \text{ kg/m}} = 13.82 > 2 \text{ OK CUMPLE}$$

### 3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$$F_s D = \frac{u \sum F_v}{\sum F_h} \geq 1.5 = \frac{f \text{ Empuje}}{f \text{ Rozamiento}}$$

$$u = \tan \phi \leq 0.60$$

$$u = 30^\circ = 0.577 > 0.60$$

$$u = 0.58$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480



684  
1910

$F_s D$	$\frac{0.58 \cdot 3,473}{290.53}$	$=$	6.90	$>$	1.50
---------	-----------------------------------	-----	------	-----	------

OK CUMPLE

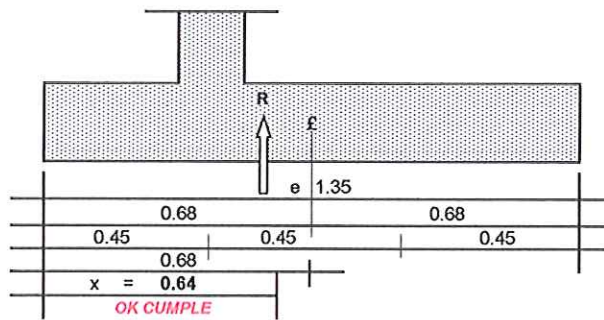
# ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

## 1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$$x = \frac{\Sigma Mo}{\Sigma Fy} \quad x = \frac{\Sigma MoFy - \Sigma MoFh}{\Sigma Fy}$$

$$x = \frac{2,388.48 - 172.88}{3,473}$$

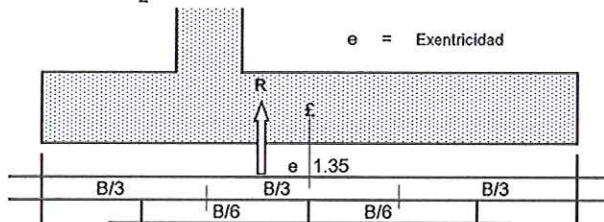
$$x = 0.64$$



OK CUMPLE

## 2ro EXENTRICIDAD

$$e = \frac{B}{2} - x$$



e = Excentricidad

$$e = \frac{1.35}{2} - 0.64 \quad e = 0.037$$

$$\frac{B}{6} = \frac{1.35}{6} = 0.23$$

## 3ro CALCULO DE LA PRESION ACTUANTE

$$q = \frac{\Sigma Fy}{A} \left( 1 \pm \frac{6e}{B} \right)$$

$$q = \frac{3,473}{1.40 \cdot 1.35} \left( 1 \pm \frac{6 \cdot 0.037}{1.35} \right)$$

$$q = 1,837.63 \quad 1 \pm 0.16476$$

$$q_{max} = 2,140.40 \quad \text{kg/m}^2 \rightarrow 0.21$$

$$q_{min} = 1,534.86 \quad \text{kg/m}^2 \rightarrow 0.15$$

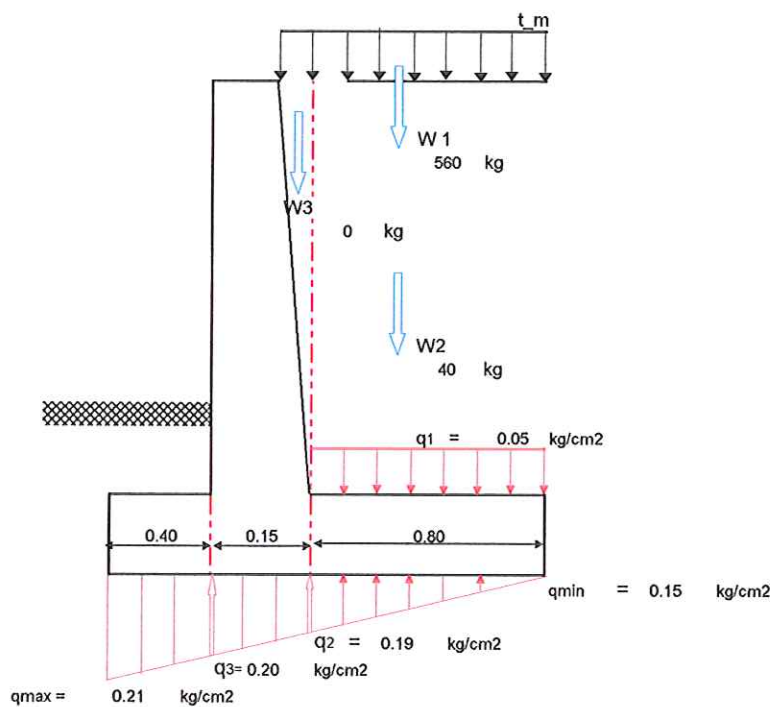
$$q_{max}, q_{min} < \sigma_t = \text{OK CUMPLE}$$

$$0.21 < 1.20$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480

683  
1409



$$q = \frac{w_1 + w_2 + w_3}{A \text{ talón}} \quad q = \frac{560 + 40 + 0}{0.80 \times 1.40}$$

$$q = 536.00 \text{ kg/m}^2 \rightarrow 0.05 \text{ kg/cm}^2$$

$$\frac{0.80}{x} = \frac{1.35}{0.06}$$

$$x = 0.036 \rightarrow q_2 = 0.15 + x$$

$$q_2 = 0.15 + 0.036$$

$$q_2 = 0.19 \text{ kg/cm}^2$$

$$\frac{0.80 + 0.15}{y} = \frac{1.35}{0.06} \quad y = 0.043$$

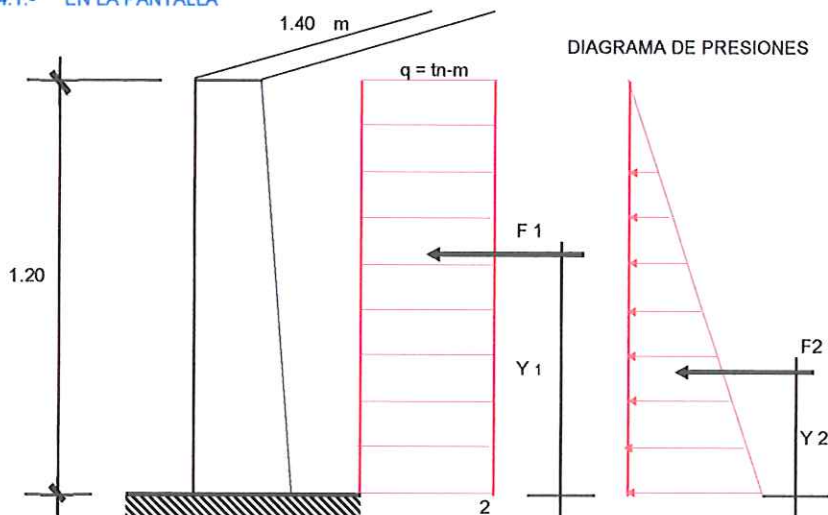
$$q_3 = 0.15 + y$$

$$q_3 = 0.15 + 0.043$$

$$q_3 = 0.20 \text{ kg/cm}^2$$

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



a) MOMENTO FLECTOR

En

$$F1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$$

$$F1 = ( 500 \text{ kg-m} \times 1.20 \text{ m} \times 1.00 \text{ m} ) \cdot 0.333$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480

632  
1408

$$F1 = 200.00 \text{ kg.}$$

$$y1 = \frac{h}{2} = \frac{1.20}{2} = 0.6$$

$$y1 = 0.6 \text{ m}$$

$$\text{En } F2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00\text{m}) K_a$$

$$F2 = \frac{1}{2} \cdot 30 \cdot \frac{1.44}{1.20} \cdot 1.00 \cdot 0.333 = 7.20 \text{ kg}$$

$$F2 = 0.01 \text{ tn-m}$$

$$y2 = \frac{1}{3} h \quad y2 = \frac{1}{3} \cdot 1.20$$

$$y2 = 0.40 \text{ m}$$

MOMENTO ULTIMO

$$M_{\max} = (F1 \cdot Y1) + (F2 \cdot Y2)$$

$$M_{\max} = (200.00 \times 0.6) + (7.20 \times 0.40)$$

$$M_{\max} = 122.88 \text{ kg-m}$$

b) FUERZA CORTANTE

\* FUERZA CORTANTE ACTUANTE

$$V = F1 + F2$$

$$V = 200.00 + 7.20$$

$$V = 207.20 \text{ kg}$$

\* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \begin{cases} V = 207.20 \\ b = 1.00 \\ d = 0.11 \end{cases}$$

$$\mu = \frac{207.20}{100 \cdot 11} = 0.19$$

$$\mu = 0.19 \text{ kg/cm}^2$$

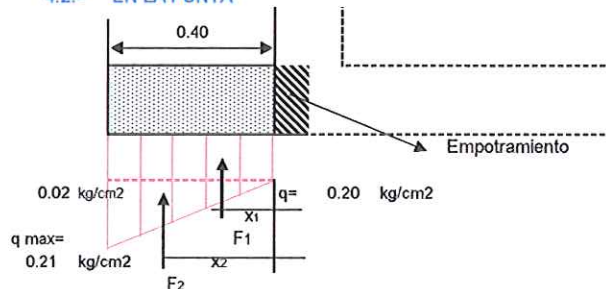
\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.19 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$

4.2.- EN LA PUNTA



a) MOMENTO FLECTOR

En:

$$F1 = 0.20 \times 0.40 \times 1.00$$

$$F1 = 784 \text{ Kg}$$



*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154420



631  
1407

$$X1 = \frac{0.40}{2} = 0.20 \text{ m}$$

$$\text{En } F2 = \frac{1}{2} \cdot 40 \cdot 0.02 \cdot 100 = 35.88 \text{ Kg}$$

$$F2 = 35.88 \text{ kg}$$

$$X2 = \frac{2}{3} \cdot 0.40 =$$

$$X2 = 0.27 \text{ mt}$$

#### MOMENTO MAXIMO

$$M_{\text{máx}} = (F1 \cdot X1) + (F2 \cdot X2)$$

$$M_{\text{máx}} = (784 \cdot 0.20) + (35.88 \cdot 0.27)$$

$$M_{\text{máx}} = -147.31 \text{ kg-m}$$

#### FUERZA CORTANTE ACTUANTE (v)

$$V = F1 + F2$$

$$V = 784 + 35.88$$

$$V = 820.28 \text{ kg}$$

#### ESFUERZO CORTANTE (u)

$$u = \frac{V}{b \cdot d}$$

$$u = \frac{820.28}{40 \cdot 11}$$

$$u = 1.86 \text{ kg/cm}^2$$

#### ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

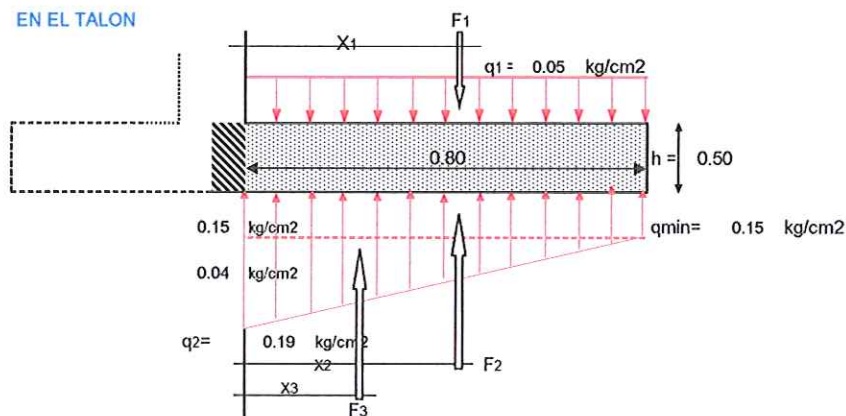
$$Vc = \emptyset \cdot 0.53 \cdot \sqrt{f'c}$$

$$Vc = 0.85 \cdot 0.53 \cdot 14.49$$

$$Vc = 6.53$$



#### 4.3.- EN EL TALON



$$F1 = 0.05 \text{ kg/cm}^2 \cdot 80 \text{ cm} \cdot 100 \text{ cm}$$

$$F1 = 428.80 \text{ kg}$$

$$X1 = \frac{0.80}{2}$$

$$X1 = 0.40 \text{ m}$$

$$F2 = 0.15 \text{ kg/cm}^2 \cdot 80 \text{ cm} \cdot 100 \text{ cm}$$

Omar Ruyman Espino  
INGENIERO CIVIL  
REG. CIP N. 154420

680  
1466

$$F2 = 1,227.89 \text{ kg}$$

$$X2 = \frac{0.80}{2}$$

$$X2 = 0.40 \text{ m}$$

$$F3 = \frac{1}{2} \cdot 0.04 \text{ kg/cm}^2 \cdot 80 \text{ cm} \cdot 100 \text{ cm}$$

$$F3 = 143.53 \text{ kg}$$

$$X3 = \frac{1}{3} \cdot 0.80$$

$$X3 = 0.27 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2 \cdot X2) + (F3 \cdot X3) - (F1 \cdot X1)$$

$$M = (1,227.89 \times 0.40) + (143.53 \times 0.27) - (429 \times 0.40)$$

$$M = 701.0 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 428.80 - 1,227.89 - 143.53$$

$$V = -942.62 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-942.62}{100 \cdot 11}$$

$$\mu = -0.86 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = 0.53 \sqrt{f'c}$$

$$V_c = 0.85 \cdot 0.53 \cdot 210$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu_{act} -0.86 \text{ kg/cm}^2 \text{ OK CUMPLE}$$

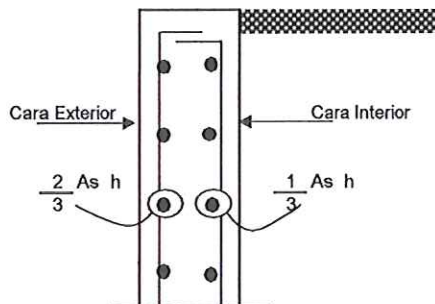
5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

- Para  $\phi \leq 5/8"$   $As_{min} \text{ (Vertical)} = 0.0012 \cdot b \cdot h$
- Para  $\phi > 5/8"$   $As_{min} \text{ (Vertical)} = 0.0015 \cdot b \cdot h$

b- Acero Mínimo Horizontal en muros:

- Para  $\phi \leq 5/8"$   $As_{min} \text{ (Horizontal)} = 0.0020 \cdot b \cdot h$
- Para  $\phi > 5/8"$   $As_{min} \text{ (Horizontal)} = 0.0025 \cdot b \cdot h$



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b \cdot d^2}$$

$$As = \rho \cdot b \cdot d$$

5.1 ACERO EN LAPANTALLA:



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

629  
MDS

a. Acero Principal Vertical

$$\mu_u = 1.6$$

$$\mu_u = 1.6 \quad 122.88 = 196.61$$

$$\mu_u = 197 \quad \text{kg/m}$$

$$K_u = \frac{197}{100} \times \frac{10^2}{121} \quad \text{kg/cm}^2$$

$$K_u = 1.62 \quad \rho =$$

$$\text{Para } \begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.62 \end{cases} \Rightarrow \rho = 0.0004$$

Acero principal:

$$A_s = \rho \quad b \quad d$$

$$A_s = 0.0004 \quad 100 \quad 11 = 0.44$$

$$A_s = 0.44 \quad \text{cm}^2$$

$$A_s = \frac{0.44}{1.27} \Rightarrow 4 \quad \emptyset \quad 1/2" = 5.07 \quad \text{OK CUMPLE}$$

+ - 0.50 CM2

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \quad \emptyset \text{ de } 1/2" @ 0.250 \text{ m}$$

b) Acero mínimo Vertical

$$A_{s\text{min}} (\text{vertical}) = 0.0015 \quad 100 \quad 11$$

$$A_{s\text{min}} = 1.65 \quad \text{cm}^2$$

$$A_{s\text{ princ}} \quad 5.07 > A_{s\text{ min}} \quad 1.65 \quad \text{OK CUMPLE}$$

5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$A_{s\text{min}} (\text{vertical}) = 0.0012 \quad 100 \quad 11$$

$$A_{s\text{min}} = 1.32 \quad \text{cm}^2$$

$$A_s = 1.32 \quad \text{cm}^2$$

$$A_s = \frac{1.32}{1.27} \Rightarrow 2 \quad \emptyset \quad 1/2" = 2.53 \quad \text{OK CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 50.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \quad \emptyset \text{ de } 1/2" @ 0.25 \text{ m}$$

5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\emptyset \leq 5/8"$





628  
1404

$$As_{min} = 0.0020 \quad b \quad d$$

1) Arriba: (h = 0.15 )

$$As_{min} = 0.0020 \quad 100 \quad 0 = 0.03$$

$$As_{min} = 3.00 \quad cm^2$$

a) Cara Interior

$$\frac{1}{3} Ash = \frac{1}{3} 3.00 = 1.00 \quad cm^2/m$$

$$As = 1.00 \quad cm^2$$

$$As = \frac{3.00}{5} \Rightarrow \frac{5}{3/8"} = 3.56 \quad OK \text{ CUMPLE}$$

$$S = \frac{0.71}{3.56} \times 100$$

$$S = 20.00 \quad \text{Asumido} \Rightarrow 0.20 \quad m$$

$$\Rightarrow \text{USAR } 5 \quad \emptyset \text{ de } 3/8" @ 0.20 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 3 = 2.00 \quad cm^2/m$$

$$As = 2.00 \quad cm^2$$

$$As = \frac{2.00}{2} \Rightarrow \frac{2}{1/2"} = 2.53 \quad OK \text{ CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 50.00 \quad \text{Asumido} \Rightarrow 0.25 \quad m$$

$$\Rightarrow \text{USAR } 2 \quad \emptyset \text{ de } 1/2" @ 0.25 \text{ m}$$

2) Cara Intermedia (h =  $\frac{15 + 15}{2}$ ) = 15 cm

$$As_{min} \text{ (Horizontal)} = 0.0020 \quad 100 \quad 15 = 3.00 \quad cm^2$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} 3.00 = 1.00 \quad cm^2/m$$

$$As = 1.00 \quad cm^2$$

$$As = \frac{3.00}{5} \Rightarrow \frac{5}{3/8"} = 3.56 \quad OK \text{ CUMPLE}$$

$$S = \frac{0.71}{3.56} \times 100$$

$$S = 20.00 \quad \text{Asumido} \Rightarrow 0.20 \quad m$$

$$\Rightarrow \text{USAR } 5 \quad \emptyset \text{ de } 3/8" @ 0.20 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 3.0 = 2.00 \quad cm^2/m$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480

627  
1403

$$A_s = 2.00 \text{ cm}^2$$

$$A_s = \frac{2.00}{2.53} \times 2 \times \frac{1}{2} = 2.53 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 50.00 \text{ Asumido } 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

3) Cara Inferior (abajo) (h = 0.15 m)

$$A_s \text{ min (Horizontal)} = 0.0020 \times 100 \times 15.00 = 3.00$$

a) Cara Interior:

$$\frac{1}{3} A_s h = \frac{1}{3} \times 3.00 = 1.00 \text{ cm}^2/\text{m}$$

$$A_s = 1.00 \text{ cm}^2$$

$$A_s = \frac{1.00}{2.53} \times 2 \times \frac{1}{2} = 2.53 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 25.00 \text{ Asumido } 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} A_s h = \frac{2}{3} \times 3.0 = 2.00 \text{ cm}^2/\text{m}$$

$$A_s = 2.00 \text{ cm}^2$$

$$A_s = \frac{2.00}{6.33} \times 5 \times \frac{1}{2} = 6.33 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \text{ Asumido } 0.200 \text{ m}$$

$$\Rightarrow \text{USAR } 5 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.20 \text{ m}$$

### Resumen

#### Acero Horizontal

1) Arriba	=	(As mín Horizontal)	=	3.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset \ 3/8 \ @ \ 0.20 \text{ m}$	
		Cara exterior	=	$\emptyset \ 1/2 \ @ \ 0.25 \text{ m}$	
2) Intermd	=	(As mín Horizontal)	=	3.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset \ 3/8 \ @ \ 0.20 \text{ m}$	
		Cara exterior	=	$\emptyset \ 1/2 \ @ \ 0.25 \text{ m}$	
3) Inferior	=	(As mín Horizontal)	=	3.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset \ 1/2 \ @ \ 0.25 \text{ m}$	
		Cara exterior	=	$\emptyset \ 1/2 \ @ \ 0.200 \text{ m}$	

Para cara Interior

C.I 2  $\emptyset \ 1/2 \ @ \ 0.25$  , 5  $\emptyset \ 3/8 \ @ \ 0.20$  Rto  $\emptyset \ 1/2 \ @ \ 0.20$

Para Exterior:

C.E 5  $\emptyset \ 1/2 \ @ \ 0.20$  , 2  $\emptyset \ 1/2 \ @ \ 0.25$  Rto  $\emptyset \ 1/2 \ @ \ 0.25$

Entonces:



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154420

626  
1402

$$\begin{array}{lcl} \text{C.I} & = & \emptyset \quad 1/2 \quad @ \quad 0.217 \quad \approx \quad \boxed{0.25} \\ \text{C.E} & = & \emptyset \quad 1/2 \quad @ \quad 0.233 \quad \approx \quad \boxed{0.25} \end{array}$$

SI UNIFORMAMOS EL ACERO  $0.217 \quad a \quad 0.233 \quad = \quad 0.225 \quad \approx \quad \boxed{0.250}$

tenemos:  $\emptyset \quad 1/2 \quad @ \quad 0.25$   
 $\emptyset \quad 1/2 \quad @ \quad 0.25$

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$Mu = 1.6 \times -147.31 \text{ kg-m} = -235.70 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = hz - \frac{(r + \emptyset \text{ vlla})}{2}$$

$$d = 50 - 7.5 + \frac{1.58}{2}$$

$$d = 41.71$$

$$Ku = \frac{-236 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$Ku = -0.14$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = -0.14 \end{cases} \Rightarrow \rho = \boxed{0.0000}$

Acero principal:

$$As = \rho \quad b \quad d$$

$$As = 0.0000 \quad 100 \quad 42 = 0.00$$

$$As = 0.00 \text{ cm}^2$$

$$As = \boxed{7.51} \Rightarrow \boxed{6 \quad \emptyset \quad 1/2"} \quad \text{OK CUMPLE}$$

+ - 0.50 CM2

$$S = \frac{1.27}{7.60} \times 100$$

$$S = 16.67 \text{ Asumido} \Rightarrow \boxed{0.17 \text{ m}}$$

$$\Rightarrow \boxed{\text{USAR } 6 \quad \emptyset \text{ de } 1/2 @ 0.17 \text{ m}}$$

Acero mínimo:

$$As_{\min} = 0.0018 \quad 100 \quad 41.71 = 7.51 \quad 0$$

$$\boxed{7.51} < \boxed{7.60} \quad \text{OK CUMPLE}$$

### ZAPATA POSTERIOR

$$Mu = 1.6 \times 701 \text{ kg-m} = 1,121.52 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = 41.71$$

$$Ku = \frac{1,122 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$Ku = 0.64$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 0.64 \end{cases} \Rightarrow \rho = \boxed{0.0002}$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. 14420



625  
1401

Acero principal:

$$A_s = \rho \cdot b \cdot d$$

$$A_s = 0.0002 \cdot 100 \cdot 42 = 0.83$$

$$A_s = 0.83 \text{ cm}^2$$

$$A_s = \frac{0.83}{\frac{1.27}{6.33}} = 6.33$$

OK CUMPLE

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \text{ Asumido } 0.20 \text{ m}$$

$$\Rightarrow \text{USAR } 5 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.20 \text{ m}$$

ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$A_{\text{stemp}} = 0.0018 \cdot b \cdot t \text{ N.T.P } t = h_z = 0.50$$

$$A_{\text{stemp}} = 0.0018 \cdot 100 \cdot 50 = 9.00 \text{ cm}^2$$

$$A_s = 9.00 \text{ cm}^2$$

$$A_s = \frac{9.00}{\frac{1.27}{10.13}} = 10.13$$

OK CUMPLE

$$S = \frac{1.27}{10.13} \times 100$$

$$S = 12.50 \text{ Asumido } 0.15 \text{ m}$$

$$\Rightarrow \text{USAR } 8 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.15 \text{ m}$$

PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:

$$s \leq \begin{cases} 0.5 & t = 0.5 \\ 45 & \text{cm} \end{cases} = 25$$

SE TOMA EL MENOR:

$$A_{\text{stemp}} = \emptyset \text{ } 1/2 \text{ @ } 0.20$$

### RESUMEN GENERAL DEL ACERO

#### 1.- PANTALLA:

##### \* ACERO VERTICAL

- Cara Interior	=	$\emptyset$	1/2	@	0.50 m	Intercalado ó a una (n) de 0.80
- Cara Exterior	=	$\emptyset$	1/2	@	0.25 m	

##### \* ACERO HORIZONTAL

- Cara Interior	=	$\emptyset$	1/2	@	0.25 m
- Cara Exterior	=	$\emptyset$	1/2	@	0.25 m

#### 2.- ZAPATA ANTERIOR (PUNTA)

* ACERO PRINCIPAL	=	$\emptyset$	1/2	@	0.20 m
* ACERO TRANSVERSAL	=	$\emptyset$	1/2	@	0.20 m

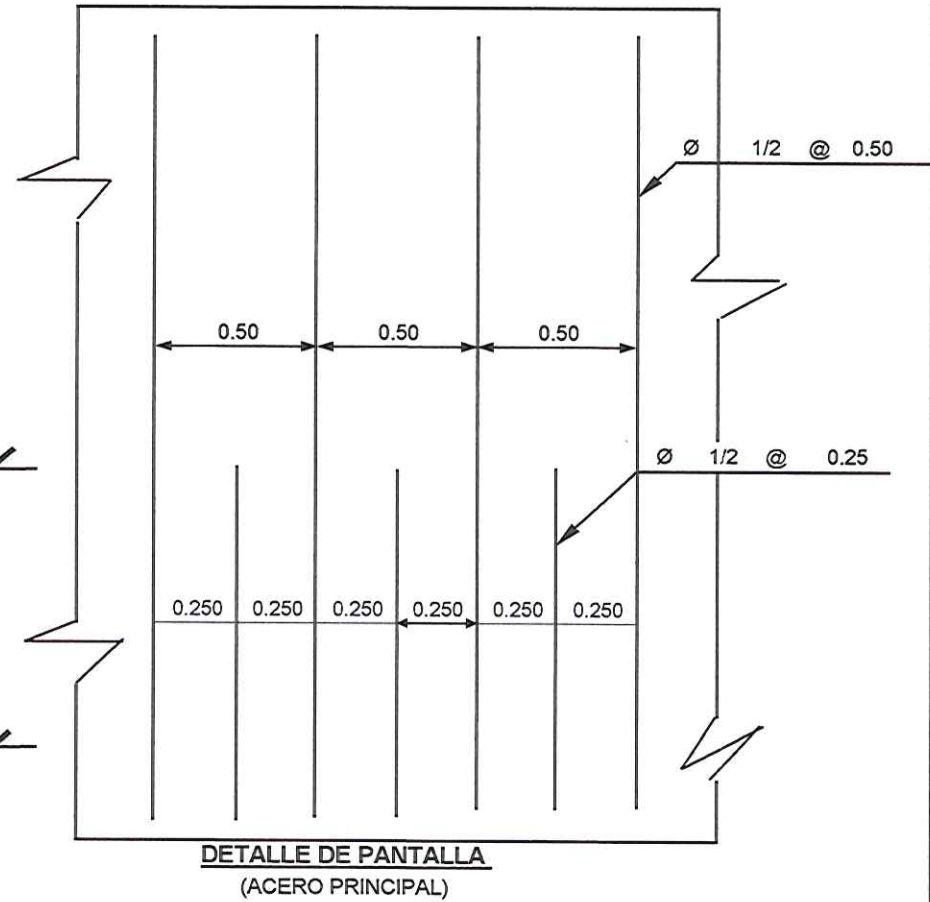
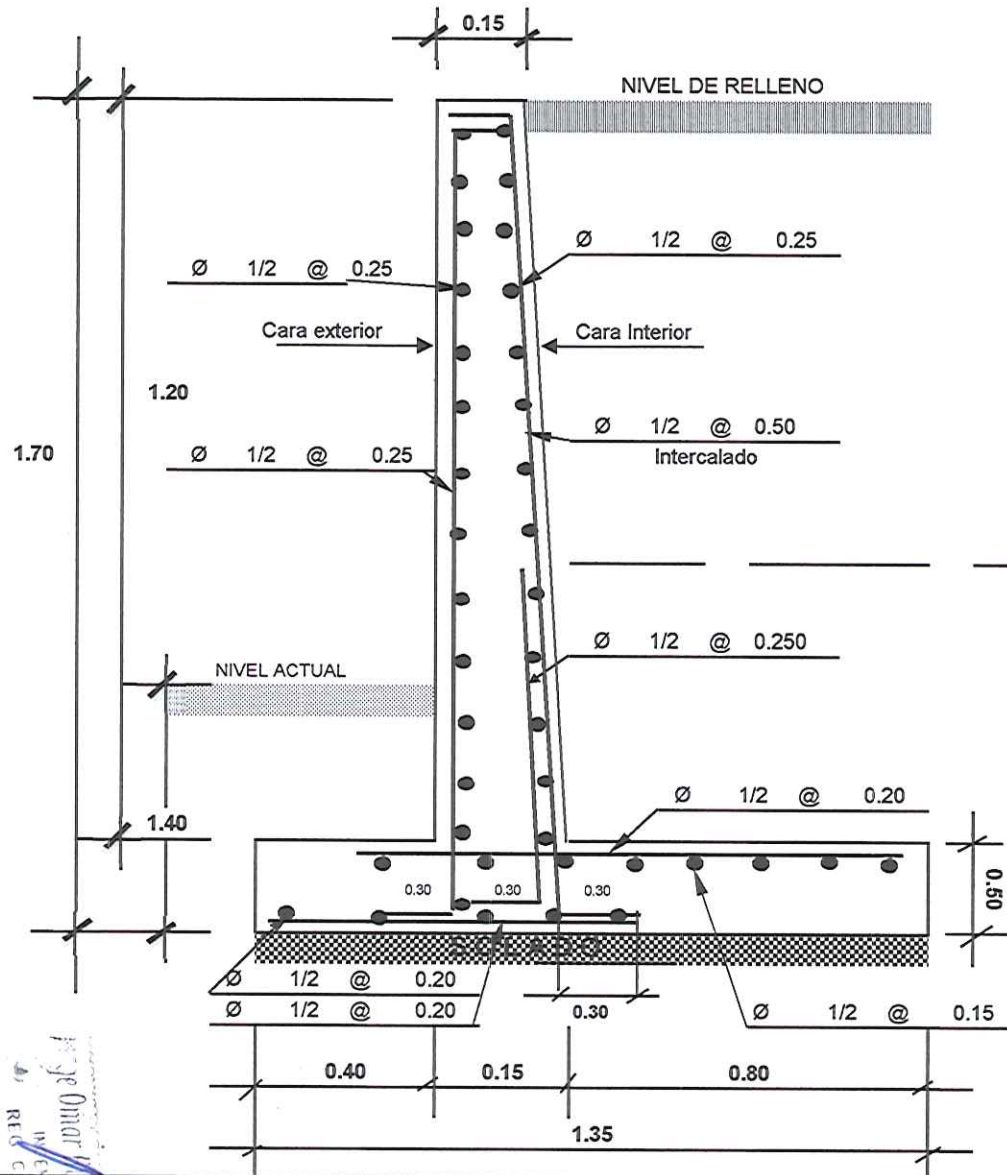
#### 3.- ZAPATA POSTERIOR (TALON)

* ACERO PRINCIPAL	=	$\emptyset$	1/2	@	0.20 m
* ACERO TRANSVERSAL	=	$\emptyset$	1/2	@	0.15 m



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. 154480

# DISEÑO DE MURO DE CONTENCION EN VOLANTE



Ing. Omar Espinoza  
 INGENIERO CIVIL  
 R.C. 14880



14880  
 624

628  
1399

DISEÑO DE MURO DE CONTENCIÓN EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : jul-2023

**DATOS:**

**A GEOMETRIA DEL MURO**

Hp =	1.70	m
h1 =	1.400	m
t1 =	0.20	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

**B DATOS DEL TERRENO**

Arena densa y grava	
$\gamma$ (kg/m <sup>3</sup> )	2650
$\phi$ (°)	30°
$\sigma$ t (kg/cm <sup>2</sup> )	1.20

**C DATOS DEL C° Y ACERO**

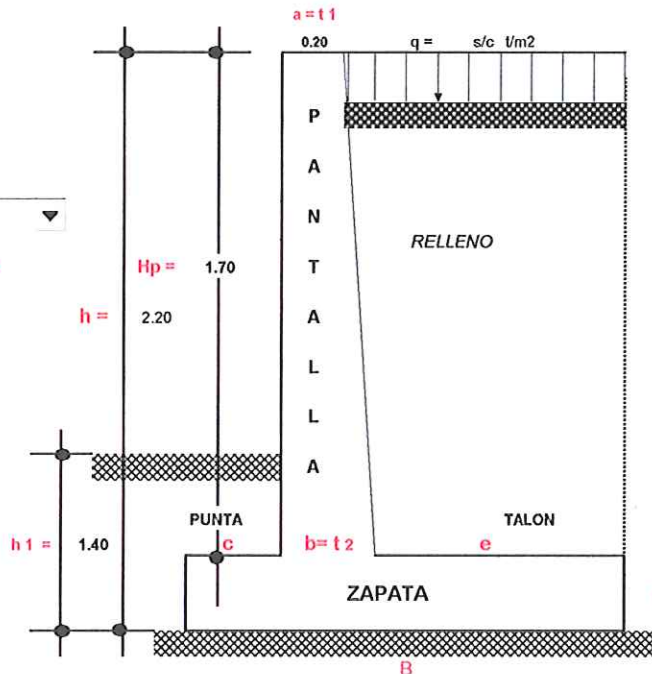
f'c (kg/cm <sup>2</sup> )	210
f'y (kg/cm <sup>2</sup> )	4,200

**D FACTOR DE SEGURIDAD**

F.S.V	≥	2
F.S.D	≥	1.5

**E SOBRECARGA**

q=s/c t-m2	0.50	tn
------------	------	----



**1.- PREDIMENSIONAMIENTO:**

$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.20 \text{ m}$

$b = \frac{H}{12} \text{ a } \frac{H}{10}$

$b = \frac{2.20}{12} \text{ ó } \frac{2.20}{10}$

$b = 0.18 \text{ ó } 0.22 \rightarrow \text{Asumido} = 0.20 \text{ m}$

$B = 0.5 \text{ H a } 0.8 \text{ H}$

$B = 0.5 \cdot 2.20 \text{ ó } 0.8 \cdot 2.20$

$B = 1.10 \text{ ó } 1.76 \rightarrow \text{Asumido} = 1.75 \text{ m}$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480



622  
1398

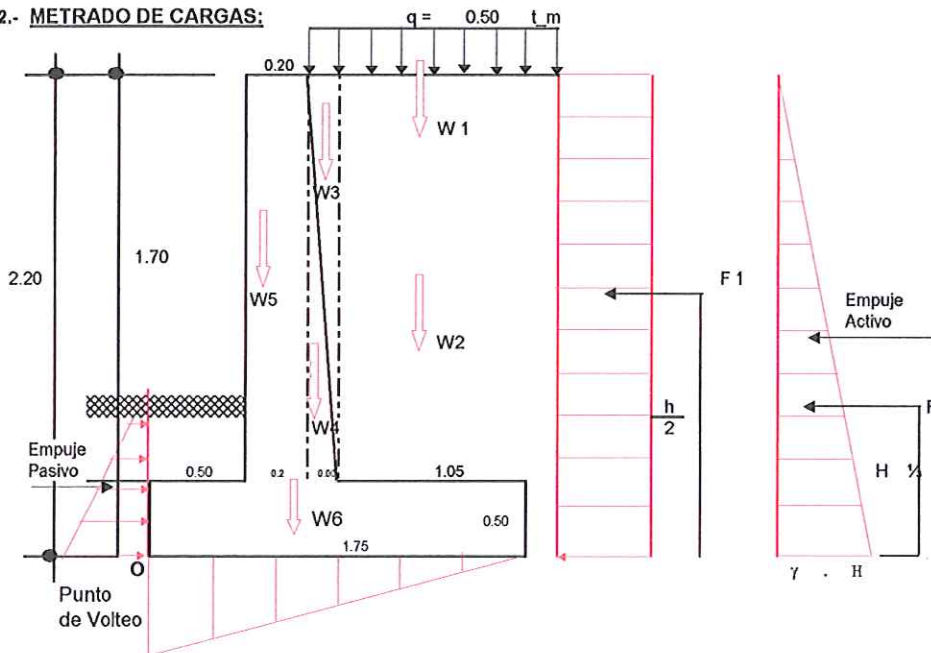
$$c = \frac{1}{3} B - \frac{1}{2} b = 0.48$$

$$c = 0.48 \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$d = \begin{matrix} = b \\ = b + 5 \\ = b + 10 \\ = b + 15 \\ = b + 20 \end{matrix} \quad \begin{matrix} 0.30 \\ 0.30 \\ 0.30 \\ 0.30 \\ 0.30 \end{matrix} \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$e = B - c - b = 1.75 - 0.50 - 0.20 = 1.05 \text{ m}$$

## 2.- METRADO DE CARGAS:



### a.- FUERZAS VERTICALES: 1.40 mts de Analisis

W1	=	0.50 t/m <sup>2</sup>	x	1.05	x	1.40	=	735	kg
W2	=	30 kg/cm <sup>2</sup>	x	(1.05 x 1.70)	x	1.40	=	75	kg
W3	=	30 kg/cm <sup>2</sup>	x	( $\frac{0.00 \times 1.70}{2}$ )	x	1.40	=	0	kg
W4	=	2,400 kg/cm <sup>2</sup>	x	( $\frac{0.00 \times 1.70}{2}$ )	x	1.40	=	0	kg
W5	=	2,400 kg/cm <sup>2</sup>	x	0.2	x	1.70	x	1.40	= 1,142 kg
W6	=	2400 kg/cm <sup>2</sup>	x	1.75	x	0.50	x	1.40	= 2,940 kg
$\Sigma fy$								4,892	kg

### b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 0.333$$

$$F1 = [(q) \times (H) \times 1.00 \text{ m}] K_a$$

$$F1 = [500 \text{ kg/cm}^2 \times 2.20 \times 1.00] \times 0.333$$

$$F1 = 367 \text{ Kg/cm}^2$$

UBICACIÓN : F1

$$F1 = \frac{H}{2} = \frac{1.70}{2} = 0.85 \text{ m}$$

$$F2 = (\text{vol}) D \cdot P$$



Omar Huaman Espino  
INGENIERO  
REG. CIP. 14480

621  
1397

$$F_2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F_2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F_2 = \frac{1}{2} \times 30 \text{ kg/cm}^2 \times 1.70^2 \times 1.00 \times 0.333$$

$$F_2 = 14.45 \text{ Kg}$$

UBICACIÓN : F 2

$$F_2 = \frac{1}{3} H$$

$$F_2 = \frac{1}{3} \times 1.70 = 0.57 \text{ m}$$

### 3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

#### FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	735	1.25	918.75
W2	75	1.25	93.71
W3	0	0.700	0.00
W4	0	0.700	0.00
W5	1,142	0.600	685.44
W6	2,940	0.88	2,572.50
$\sum MF_f$	4,892	$\sum MoF_y$	4,270.40

#### FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F 1	367	0.850	311.67
F 2	14	0.57	8.24
$\sum F_h$	381.12	$\sum MF_h$	319.90

$$F_s V = \frac{4,270.40 \text{ kg/m}}{319.90 \text{ kg/m}} = 13.35 > 2 \quad \text{OK CUMPLE}$$

### 3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$$F_s D = \frac{q \sum F_v}{\sum F_h} \geq 1.5 = \frac{f \text{ Empuje}}{f \text{ Rozamiento}}$$

$$q = \tan \phi \leq 0.60$$

$$q = 30^\circ = 0.577 > 0.60$$

$$q = 0.58$$

$$F_s D = \frac{0.58 \times 4,892}{381.12} = 7.41 > 1.50 \quad \text{OK CUMPLE}$$

### ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

#### 1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$$x = \frac{\sum Mo}{\sum F_y} \quad x = \frac{\sum MoF_y - \sum MoF_h}{\sum F_y}$$

$$x = \frac{4,270.40 - 319.90}{4,892}$$

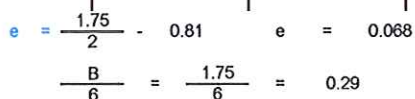
$$x = 0.81$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154488



**e = Excentricidad**



### 3ro CALCULO DE LA PRESION ACTUANTE

$$q_{mim} = 1,534.62 \text{ kg/m}^2 \rightarrow 0.15$$

$$q_{\max}, q_{\min} < \sigma_t = \text{OK CUMPLE}$$

$$0.25 < 1.20$$



*Ing Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. N. 154420

619  
1395

$$\frac{1.05}{x} = \frac{1.75}{0.09} \quad x = 0.055 \rightarrow q_2 = 0.15 + x$$

$$q_2 = 0.15 + 0.055$$

$$q_2 = 0.21 \text{ kg/cm}^2$$

$$\frac{1.05 + 0.20}{y} = \frac{1.75}{0.09} \quad y = 0.066$$

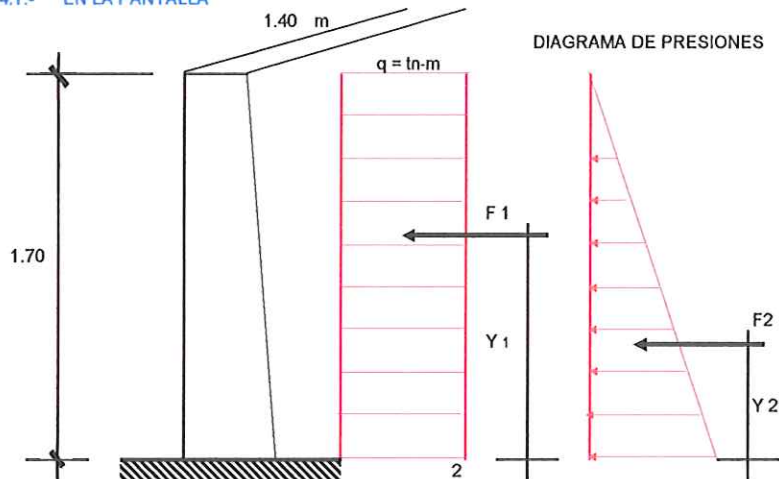
$$q_3 = 0.15 + y$$

$$q_3 = 0.15 + 0.066$$

$$q_3 = 0.22 \text{ kg/cm}^2$$

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



##### a) MOMENTO FLECTOR

En  $F_1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$

$$F_1 = (500 \text{ kg-m} \times 1.70 \text{ m} \times 1.00 \text{ m}) \cdot 0.333$$

$$F_1 = 283.33 \text{ kg}$$

$$y_1 = \frac{h}{2} = \frac{1.70}{2} = 0.85$$

$$y_1 = 0.85 \text{ m}$$

En

$$F_2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00 \text{ m}) \cdot Ka$$

$$F_2 = \frac{1}{2} \cdot 30 \cdot \frac{2.89}{1.70} \cdot 1.00 \cdot 0.333 = 14.45 \text{ kg}$$

$$F_2 = 0.01 \text{ tn-m}$$

$$y_2 = \frac{1}{3} h \quad y_2 = \frac{1}{3} \cdot 1.70$$

$$y_2 = 0.57 \text{ m}$$

##### MOMENTO ULTIMO

$$M_{\max} = (F_1 Y_1) + (F_2 Y_2)$$

$$M_{\max} = (283.33 \times 0.85) + (14.45 \times 0.57)$$

$$M_{\max} = 249.02 \text{ kg-m}$$

##### b) FUERZA CORTANTE

###### \* FUERZA CORTANTE ACTUANTE

$$V = F_1 + F_2$$

$$V = 283.33 + 14.45$$

$$V = 297.78 \text{ kg}$$

###### \* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b} \quad \left| \begin{array}{l} v = 297.78 \\ b = 1.00 \end{array} \right.$$



*Ingeniero*  
**Enrique Huaman Espino**  
INGENIERO CIVIL  
REG. CIP N° 154480



618  
1394

$$b \quad d \quad |d = 0.16$$

$$\mu = \frac{297.78}{100 \cdot 16} = 0.19$$

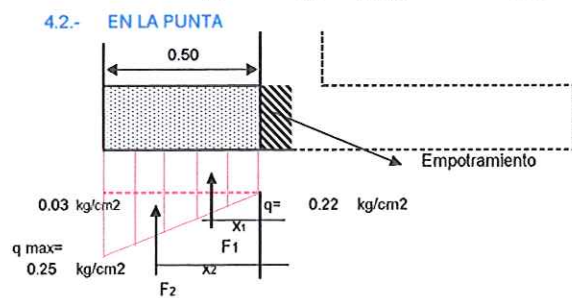
$$\mu = 0.19 \quad \text{kg/cm}^2$$

\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \quad \text{kg/cm}^2$$

$$\mu_c = 6.53 \quad \text{kg/cm}^2 > 0.19 \quad \text{kg/cm}^2 \quad \text{OK CUMPLE}$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 53380

617  
1393

a) MOMENTO FLECTOR

En:

$$F1 = 0.22 \times 0.50 \times 1.00$$

$$F1 = 1.097 \text{ Kg}$$

$$X1 = \frac{0.50}{2} = 0.25 \text{ m}$$

En

$$F2 = \frac{1}{2} \times 50 \times 0.03 \times 100 = 66.04 \text{ Kg}$$

$$F2 = 66.04 \text{ kg}$$

$$X2 = \frac{2}{3} \times 0.50 =$$

$$X2 = 0.33 \text{ mt}$$

MOMENTO MAXIMO

$$M_{\text{máx}} = (F1 \cdot X1) + (F2 \cdot X2)$$

$$M_{\text{máx}} = (1.097 \times 0.25) + (66.04 \times 0.33)$$

$$M_{\text{máx}} = -252.36 \text{ kg-m}$$

FUERZA CORTANTE ACTUANTE (v)

$$V = F1 + F2$$

$$V = 1.097 + 66.04$$

$$V = 1,163.54 \text{ kg}$$

ESFUERZO CORTANTE (q)

$$q = \frac{V}{b \cdot d}$$

$$q = \frac{1,163.54}{50 \cdot 16}$$

$$q = 1.45 \text{ kg/cm}^2$$

ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

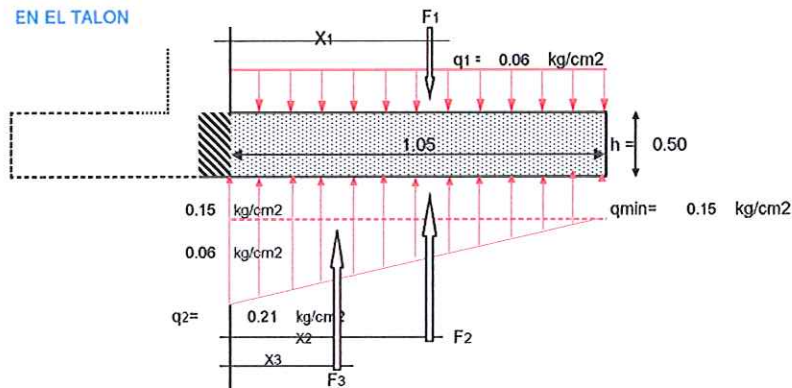
$$Vc = \emptyset \cdot 0.53 \cdot \sqrt{f'c}$$

$$Vc = 0.85 \cdot 0.53 \cdot 14.49$$

$$Vc = 6.53$$



4.3.- EN EL TALON



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

616  
1392

$$F1 = 0.06 \text{ kg/cm}^2 \cdot 105 \text{ cm} \cdot 100 \text{ cm}$$

$$F1 = 578.55 \text{ kg}$$

$$X1 = \frac{1.05}{2}$$

$$X1 = 0.53 \text{ m}$$

$$F2 = 0.15 \text{ kg/cm}^2 \cdot 105 \text{ cm} \cdot 100 \text{ cm}$$

$$F2 = 1,611.36 \text{ kg}$$

$$X2 = \frac{1.05}{2}$$

$$X2 = 0.53 \text{ m}$$

$$F3 = \frac{1}{2} \cdot 0.06 \text{ kg/cm}^2 \cdot 105 \text{ cm} \cdot 100 \text{ cm}$$

$$F3 = 291.22 \text{ kg}$$

$$X3 = \frac{1}{3} \cdot 1.05$$

$$X3 = 0.35 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2 \cdot X2) + (F3 \cdot X3) - (F1 \cdot X1)$$

$$M = (1,611.36 \times 0.53) + (291.22 \times 0.35) - (579 \times 0.53)$$

$$M = 1,251.6 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 578.55 - 1,611.36 - 291.22$$

$$V = -1,324.03 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-1,324.03}{100 \cdot 16}$$

$$\mu = -0.83 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = 0.53 \sqrt{f'c}$$

$$V_c = 0.85 \cdot 0.53 \cdot 14.49$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu_{act} -0.83 \text{ kg/cm}^2 \text{ OK CUMPLE}$$

5.- DISEÑO DEL ACERO.

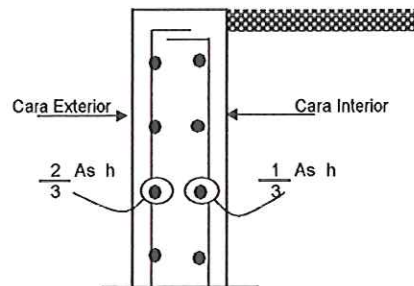
a- Acero Mínimo Vertical en muros:



*Je Onzar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

615  
1391

- Para  $\phi \leq 5/8"$   $As_{min} \text{ (Vertical)} = 0.0012 \text{ b h}$
  - Para  $\phi > 5/8"$   $As_{min} \text{ (Vertical)} = 0.0015 \text{ b h}$
- b- Acero Mínimo Horizontal en muros:
- Para  $\phi \leq 5/8"$   $As_{min} \text{ (Horizontal)} = 0.0020 \text{ b h}$
  - Para  $\phi > 5/8"$   $As_{min} \text{ (Horizontal)} = 0.0025 \text{ b h}$



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b d^2}$$

$$A_s = \rho b d$$

### 5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = 1.6$$

$$M_u = 1.6 \quad 249.02 = 398.43$$

$$M_u = 398 \text{ kg/m}$$

$$K_u = \frac{398 \times 10^2}{100 \times 256} \text{ kg/cm}^2$$

$$K_u = 1.56 \quad \rho =$$

$$\text{Para } \begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.56 \end{cases} \Rightarrow \rho = 0.0004$$



*Je Omar Huaman Espino*  
INGENIERO CIVIL  
REG CIP N. 154480



614  
1390

Acero principal:

$$A_s = \rho \cdot b \cdot d$$

$$A_s = 0.0004 \cdot 100 \cdot 16 = 0.64$$

$$A_s = 0.64 \text{ cm}^2$$

$$A_s = \frac{0.64}{\frac{1.27}{5.07}} = 5.07$$

OK CUMPLE

+ - 0.50 CM2

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.250 \text{ m}$$

b) Acero mínimo Vertical

$$A_{smin} (\text{vertical}) = 0.0015 \cdot 100 \cdot 16$$

$$A_{smin} = 2.4 \text{ cm}^2$$

$$A_{s \text{ princ}} = 5.07 > A_{s \text{ min}} = 2.4 \text{ OK CUMPLE}$$

## 5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$A_{smin} (\text{vertical}) = 0.0012 \cdot 100 \cdot 16$$

$$A_{smin} = 1.92 \text{ cm}^2$$

$$A_s = 1.92 \text{ cm}^2$$

$$A_s = \frac{1.92}{\frac{1.27}{2.53}} = 2.53$$

OK CUMPLE

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 50.00 \text{ Asumido } \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

## 5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\emptyset \leq 5/8"$

$$A_{s \text{ min}} = 0.0020 \cdot b \cdot d$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

613  
1388

1) Arriba: (h = 0.2 )

$$As_{min} = 0.0020 \cdot 100 \cdot 0 = 0.04$$

$$As_{min} = 4.00 \text{ cm}^2$$

a) Cara Interior

$$\frac{1}{3} Ash = \frac{1}{3} \cdot 4.00 = 1.33 \text{ cm}^2/\text{m}$$

$$As = 1.33 \text{ cm}^2$$

$$As = \boxed{4.00} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla = \boxed{5.07}$$

OK CUMPLE

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} \cdot 4 = 2.67 \text{ cm}^2/\text{m}$$

$$As = 2.67 \text{ cm}^2$$

$$As = \boxed{2.67} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{3/8"} \nabla = \boxed{2.85}$$

OK CUMPLE

$$S = \frac{0.71}{2.85} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \emptyset \text{ de } 3/8 \text{ @ } 0.25 \text{ m}}$$

2) Cara Intermedia (h =  $\frac{20 + 20}{2}$ ) = 20 cm

$$As_{min} \text{ (Horizontal)} = 0.0020 \cdot 100 \cdot 20 = 4.00 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} \cdot 4.00 = 1.33 \text{ cm}^2/\text{m}$$

$$As = 1.33 \text{ cm}^2$$

$$As = \boxed{4.00} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla = \boxed{5.07}$$

OK CUMPLE

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} \cdot 4.0 = 2.67 \text{ cm}^2/\text{m}$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

612  
1388

$$A_s = 2.67 \text{ cm}^2$$

$$A_s = \frac{2.67}{4} \times \frac{100}{\frac{3}{8}} = 2.85 \text{ OK CUMPLE}$$

$$S = \frac{0.71}{2.85} \times 100$$

$$S = 25.00 \text{ Asumido } 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 3/8 \text{ @ } 0.25 \text{ m}$$

3) Cara Inferior (abajo) (h = 0.20 m)

$$A_s \text{ min (Horizontal)} = 0.0020 \times 100 \times 20.00 = 4.00$$

a) Cara Interior:

$$\frac{1}{3} \text{ Ash} = \frac{1}{3} \times 4.00 = 1.33 \text{ cm}^2/\text{m}$$

$$A_s = 1.33 \text{ cm}^2$$

$$A_s = \frac{1.33}{2} \times \frac{100}{\frac{1}{2}} = 2.53 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 25.00 \text{ Asumido } 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} \text{ Ash} = \frac{2}{3} \times 4.0 = 2.67 \text{ cm}^2/\text{m}$$

$$A_s = 2.67 \text{ cm}^2$$

$$A_s = \frac{2.67}{4} \times \frac{100}{\frac{1}{2}} = 5.07 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } 0.250 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

### Resumen

#### Acero Horizontal

1) Ariba	=	(As mín Horizontal)	=	4.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 1/2 @ 0.25 m	
		Cara exterior	=	$\emptyset$ 3/8 @ 0.25 m	
2) Intermd	=	(As mín Horizontal)	=	4.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 1/2 @ 0.25 m	
		Cara exterior	=	$\emptyset$ 3/8 @ 0.25 m	
3) Inferior	=	(As mín Horizontal)	=	4.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 1/2 @ 0.25 m	
		Cara exterior	=	$\emptyset$ 1/2 @ 0.250 m	

Para cara Interior

$$C.I \quad 2 \text{ } \emptyset \text{ } 1/2 \text{ @ } 0.25, \quad 4 \text{ } \emptyset \text{ } 1/2 \text{ @ } 0.25 \quad \text{Rto } \emptyset \text{ } 1/2 \text{ @ } 0.25$$

Para Exterior:

$$C.E \quad 4 \text{ } \emptyset \text{ } 1/2 \text{ @ } 0.25, \quad 4 \text{ } \emptyset \text{ } 3/8 \text{ @ } 0.25 \quad \text{Rto } \emptyset \text{ } 1/2 \text{ @ } 0.25$$

Entonces:

$$\begin{aligned} C.I &= \emptyset \text{ } 1/2 \text{ @ } 0.250 \approx 0.25 \\ C.E &= \emptyset \text{ } 1/2 \text{ @ } 0.250 \approx 0.25 \end{aligned}$$

$$\text{SI UNIFORMAMOS EL ACERO} \quad 0.250 \text{ a } 0.250 = 0.25 \approx 0.250$$

$$\text{tenemos: } \emptyset \text{ } 1/2 \text{ @ } 0.25$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

610  
1387

Ø 1/2 @ 0.25

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$Mu = 1.6 \times -252.36 \text{ kg-m} = -403.78 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = h_z - \left( r + \frac{\phi \text{ vlla}}{2} \right)$$

$$d = 50 - 7.5 + \frac{1.58}{2}$$

$$d = 41.71$$

$$Ku = \frac{-404 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$Ku = -0.23$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = -0.23 \end{cases} \Rightarrow \rho = -0.0001$

Acero principal:

$$As = \rho \cdot b \cdot d$$

$$As = -0.0001 \cdot 100 \cdot 42 = -0.42$$

$$As = -0.42 \text{ cm}^2$$

$$As = \boxed{7.09} \Rightarrow \boxed{6} \text{ Ø } 1/2 \nabla = \boxed{7.60}$$

OK CUMPLE

+ - 0.50 CM2

$$S = \frac{1.27}{7.60} \times 100$$

$$S = 16.67 \text{ Asumido} \Rightarrow \boxed{0.20} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 6 \text{ Ø de } 1/2 @ 0.20 \text{ m}}$$

Acero mínimo:

$$As_{\min} = 0.0018 \cdot 100 \cdot 41.71 = 7.51 \quad 0$$

$$\boxed{7.51} < \boxed{7.60} \text{ OK CUMPLE}$$

### ZAPATA POSTERIOR

$$Mu = 1.6 \times 1,252 \text{ kg-m} = 2,002.61 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = 41.71$$

$$Ku = \frac{2,003 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$Ku = 1.15$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 1.15 \end{cases} \Rightarrow \rho = 0.0003$

Acero principal:

$$As = \rho \cdot b \cdot d$$

$$As = 0.0003 \cdot 100 \cdot 42 = 1.25$$

$$As = 1.25 \text{ cm}^2$$

$$As = \boxed{1.25} \Rightarrow \boxed{4} \text{ Ø } 1/2 \nabla = \boxed{5.07}$$



Omar Humán Espinoza  
INGENIERO CIVIL  
REG. CIP. N° 154480



610  
1386

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ USAR 4 Ø de 1/2 @ 0.25 m

ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$A_{temp} = 0.0018 \quad b \quad t \quad N.T.P \quad t = h_z = 0.50$$

$$A_{temp} = 0.0018 \quad 100 \quad 50 = 9.00 \text{ cm}^2$$

$$A_s = 9.00 \text{ cm}^2$$

$$A_s = 9.00 \Rightarrow 8 \quad \text{Ø} \quad 1/2 \quad \nabla = 10.13$$

OK CUMPLE

$$S = \frac{1.27}{10.13} \times 100$$

$$S = 12.50 \quad \text{Asumido} \Rightarrow 0.15 \text{ m}$$

⇒ USAR 8 Ø de 1/2 @ 0.15 m

PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:

$$S \leq \frac{0.5}{45} \quad t = 0.5 \quad 50 = 25$$

SE TOMA EL MENOR:

$$A_{temp} = \text{Ø} \quad 1/2 \quad @ \quad 0.20$$

### RESUMEN GENERAL DEL ACERO

#### 1.- PANTALLA:

##### \* ACERO VERTICAL

- Cara Interior	=	Ø	1/2	@	0.50 m	Intercalado ó
- Cara Exterior	=	Ø	1/2	@	0.25 m	a una (h) de 1.00

##### \* ACERO HORIZONTAL

- Cara Interior	=	Ø	1/2	@	0.25 m
- Cara Exterior	=	Ø	1/2	@	0.25 m

#### 2.- ZAPATA ANTERIOR (PUNTA)

* ACERO PRINCIPAL	=	Ø	1/2	@	0.20 m
* ACERO TRANSVERSAL	=	Ø	1/2	@	0.20 m

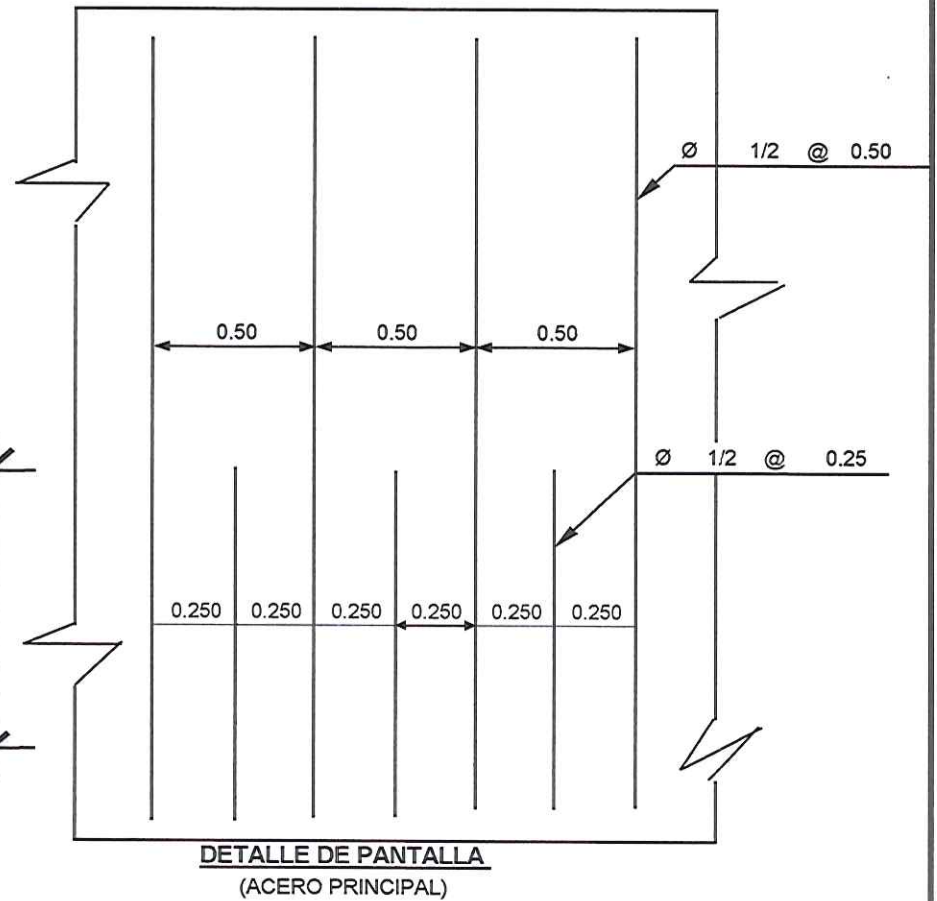
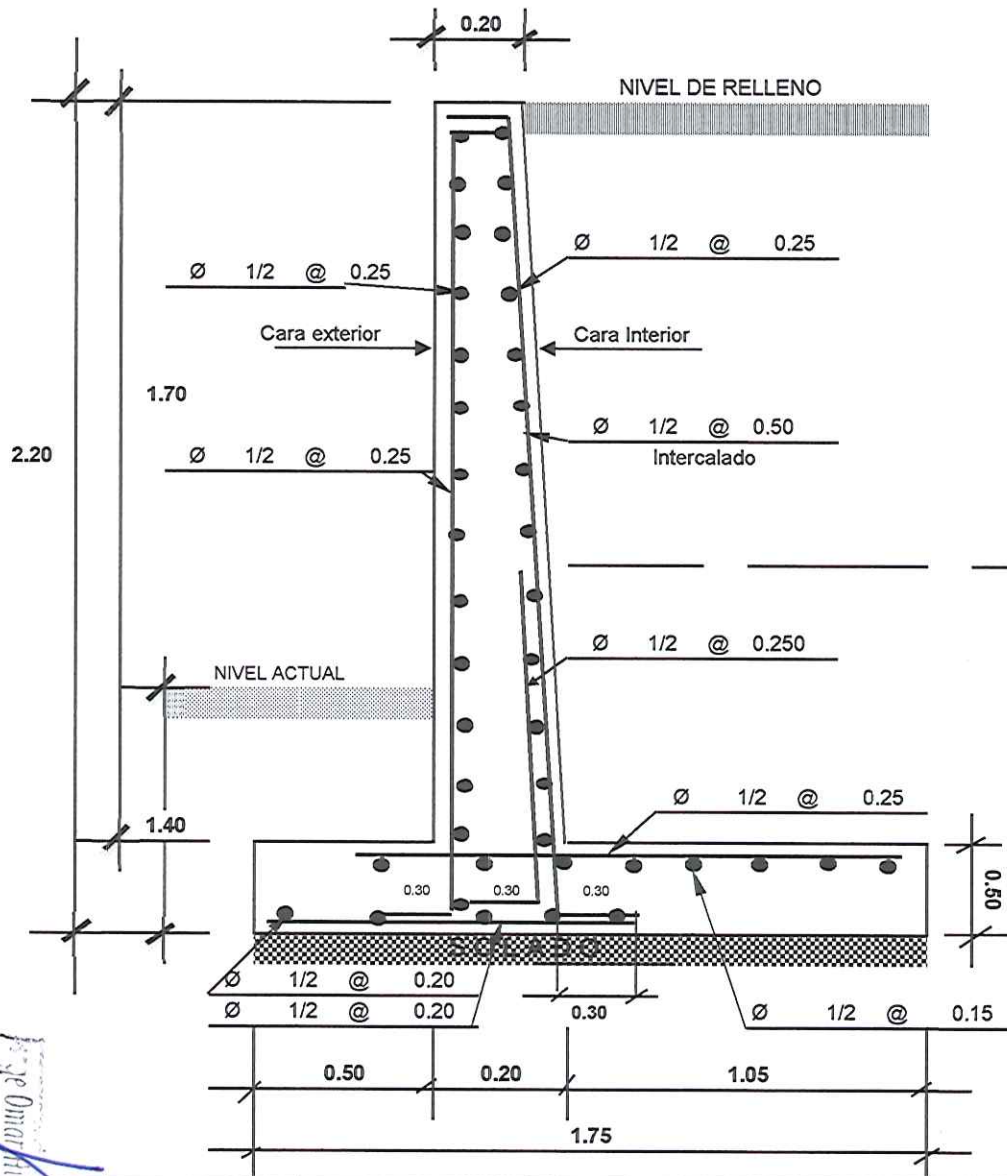
#### 3.- ZAPATA POSTERIOR (TALON)

* ACERO PRINCIPAL	=	Ø	1/2	@	0.25 m
* ACERO TRANSVERSAL	=	Ø	1/2	@	0.15 m



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. 114481

# DISEÑO DE MURO DE CONTENCION EN VOLADIZO



Ing. Omar Aguilar Espinoza  
 REVISOR CIP N. 15480



1345  
 609

608  
1384

DISEÑO DE MURO DE CONTENCIÓN EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : Marzo-2022

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	2.20	m
h 1 =	1.400	m
t 1 =	0.20	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava	
$\gamma = (\text{kg/m}^3)$	2650
$\phi = (^\circ)$	30°
$\sigma t = (\text{kg/cm}^2)$	1.20

#### C DATOS DEL C° Y ACERO

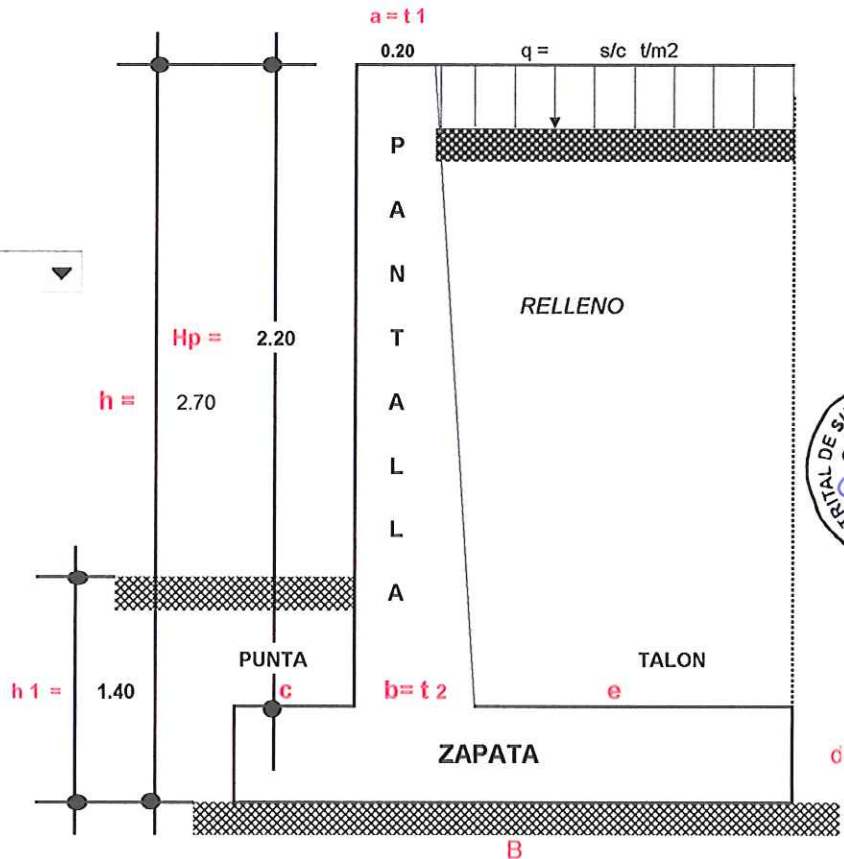
$f'c = (\text{kg/cm}^2)$	210
$f'y = (\text{kg/cm}^2)$	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	$\geq$	2
F.S.D	$\geq$	1.5

#### E SOBRECARGA

$q = \text{s/c t-m}^2$	0.50	tn
------------------------	------	----



#### 1.- PREDIMENSIONAMIENTO:

$$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.20 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{2.70}{12} \text{ ó } \frac{2.70}{10}$$

$$b = 0.23 \text{ ó } 0.27 \rightarrow \text{Asumido} = 0.25 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 2.70 \text{ ó } 0.8 \cdot 2.70$$

$$B = 1.35 \text{ ó } 2.16 \rightarrow \text{Asumido} = 2.15 \text{ m}$$



Omar Huaman Espinoza  
INGENIERO CIVIL  
REG CIP N° 154480

604  
1383

$$c = \frac{1}{3} B - \frac{1}{2} b = 0.59$$

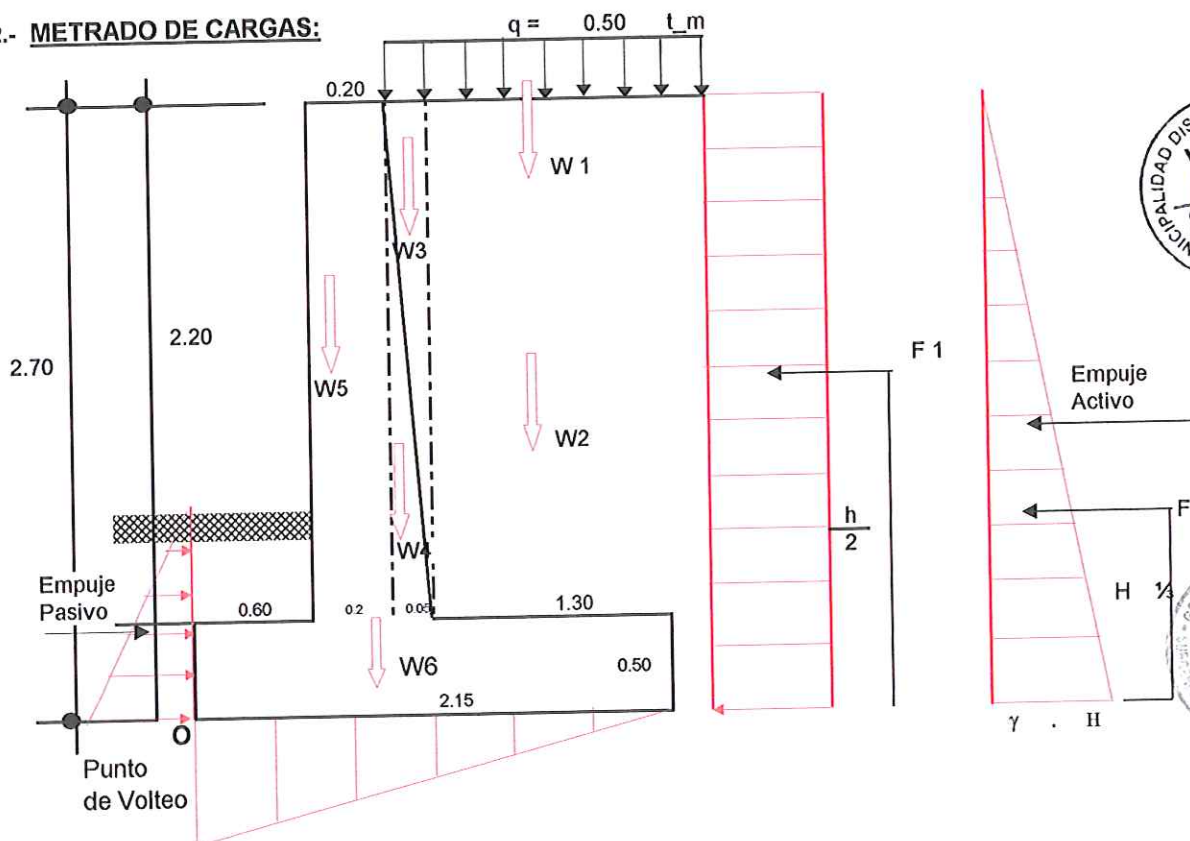
$$c = 0.59 \rightarrow \text{Asumido} = 0.60 \text{ m}$$

$$d = \begin{matrix} = b = \\ = b + 5 \\ = b + 10 \\ = b + 15 \\ = b + 20 \end{matrix} \quad 0.35 \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$e = B - c - b = 2.15 - 0.60 - 0.25$$

$$e = 1.30 \text{ m}$$

## 2.- METRADO DE CARGAS:



### a.- FUERZAS VERTICALES: 1.40 mts de Analisis

$W1$	$=$	$0.50 \text{ t/m}^2$	$\times$	$1.35$	$\times$	$1.40$	$=$	$945 \text{ kg}$
$W2$	$=$	$30 \text{ kg/cm}^2$	$\times$	$(1.30 \times 2.20)$	$\times$	$1.40$	$=$	$120 \text{ kg}$
$W3$	$=$	$30 \text{ kg/cm}^2$	$\times$	$(\frac{0.05 \times 2.20}{2})$	$\times$	$1.40$	$=$	$2 \text{ kg}$
$W4$	$=$	$2,400 \text{ kg/cm}^2$	$\times$	$(\frac{0.05 \times 2.20}{2})$	$\times$	$1.40$	$=$	$185 \text{ kg}$
$W5$	$=$	$2,400 \text{ kg/cm}^2$	$\times$	$0.2 \times 2.20$	$\times$	$1.40$	$=$	$1,478 \text{ kg}$
$W6$	$=$	$2400 \text{ kg/cm}^2$	$\times$	$2.15 \times 0.50$	$\times$	$1.40$	$=$	$3,612 \text{ kg}$
$\Sigma f_y$							$=$	$6,343 \text{ kg}$

Ingeniero Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP N° 154480



6986  
1382

b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

$$F_1 = [ (q) \times (H) \times 1.00 \text{ m} ] K_a$$

$$F_1 = [ 500 \text{ kg/cm}^2 \times 2.70 \times 1.00 ] \times 0.333$$

$$F_1 = 450 \text{ Kg/cm}^2$$

UBICACIÓN : F 1

$$F_1 = \frac{H}{2} = \frac{2.20}{2} = 1.1 \text{ m}$$

$$F_2 = (\text{vol}) D \cdot P$$

$$F_2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F_2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F_2 = \frac{1}{2} 30 \text{ kg/cm}^2 \times 2.20^2 \times 1.00 \times 0.333$$

$$F_2 = 24.20 \text{ Kg}$$

UBICACIÓN : F 2

$$F_2 = \frac{1}{3} H$$

$$F_2 = \frac{1}{3} 2.20 = 0.73 \text{ m}$$

3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	945	1.55	1,464.75
W2	120	1.55	186.19
W3	2	0.825	1.91
W4	185	0.825	152.46
W5	1,478	0.700	1,034.88
W6	3,612	1.08	3,882.90
$\sum MF_f$	6,343	$\sum MoF_y$	6,723.08



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480

608  
1381

FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F 1	450	1.100	495.00
F 2	24	0.73	17.67
$\Sigma Fh$	474.20	$\Sigma MFh$	512.67

$F_s V$	$\frac{6,723.08 \text{ kg/m}}{512.67 \text{ kg/m}}$	=	13.11	>	2
---------	---	---	-------	---	---

OK CUMPLE

3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$F_s D$	=	$\frac{u \Sigma F_v}{\Sigma F_h} \geq 1.5$	=	$\frac{f \text{ Empuje}}{f \text{ Rozamiento}}$
---------	---	--	---	---

$u = \tan \phi \leq 0.60$

$u = 30^\circ = 0.577 > 0.60$

$u = 0.58$

$F_s D$	$\frac{0.58 \cdot 6,343}{474.20}$	=	7.72	>	1.50
---------	-----------------------------------	---	------	---	------

OK CUMPLE

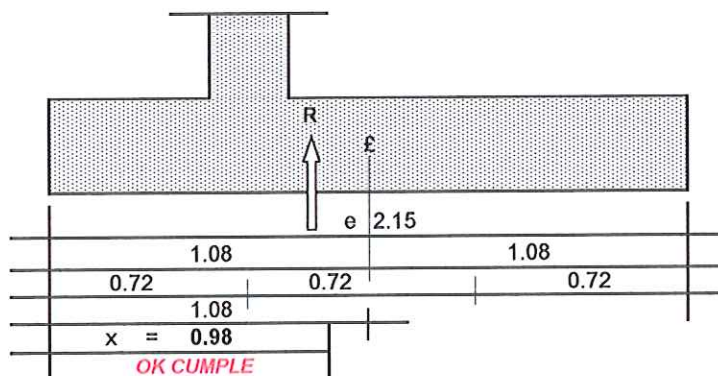
ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$x = \frac{\Sigma Mo}{\Sigma Fy} \quad x = \frac{\Sigma Mo Fy - \Sigma Mo Fh}{\Sigma Fy}$

$x = \frac{6,723.08 - 512.67}{6,343}$

$x = 0.98$



Ing. Omar Ruanan Espinoza  
INGENIERO CIVIL  
REG. CIP N. 154488

604  
1380

## 2ro EXENTRICIDAD

$$e = \frac{B}{2} - x$$

$e = \text{Exentricidad}$

$$e = \frac{2.15}{2} - 0.98 \quad e = 0.096$$

$$\frac{B}{6} = \frac{2.15}{6} = 0.36$$

## 3ro CALCULO DE LA PRESION ACTUANTE

$$q = \frac{\sum Fy}{A \cdot B} \left( 1 \pm \frac{6 \cdot e}{B} \right)$$

$$q = \frac{6,343}{1.40 \cdot 2.15} \left( 1 \pm \frac{6 \cdot 0.096}{2.15} \right)$$

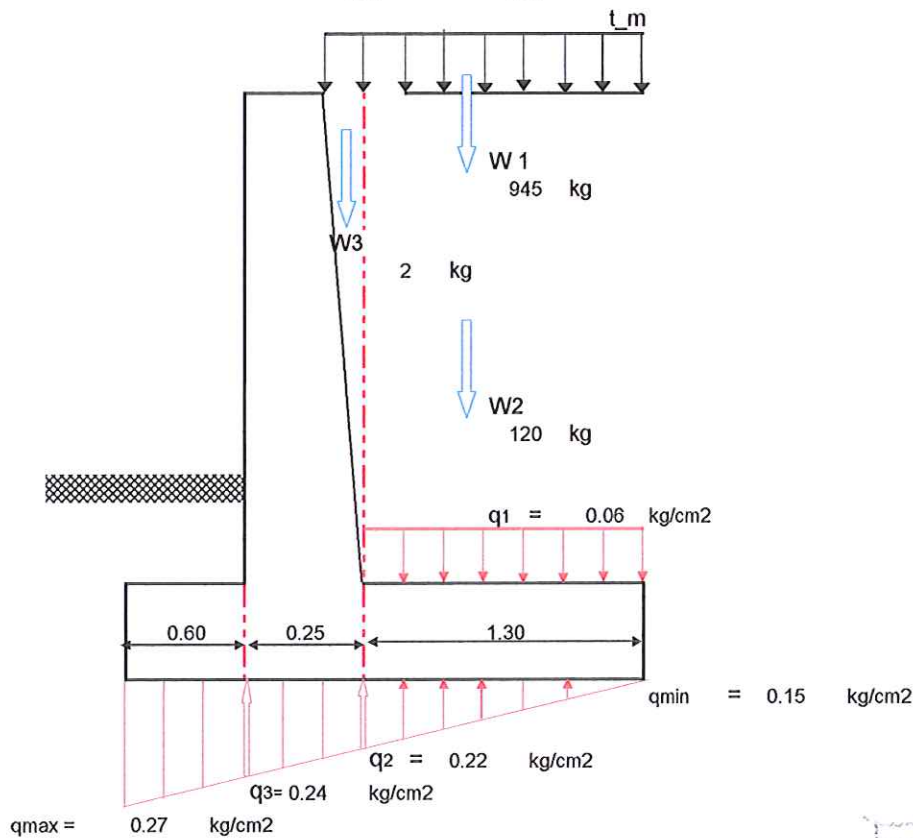
$$q = 2,107.19 \quad 1 \pm 0.2674754$$

$$q_{\max} = 2,670.81 \quad \text{kg/m}^2 \rightarrow 0.27$$

$$q_{\min} = 1,543.57 \quad \text{kg/m}^2 \rightarrow 0.15$$

$$q_{\max, q_{\min}} < \sigma_t = \text{OK CUMPLE}$$

$$0.27 < 1.20$$



Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP N° 154480

603  
1379

$$q = \frac{w_1 + w_2 + w_3}{A \text{ talón}} \quad q = \frac{945 + 120 + 2}{1.30 \times 1.40}$$

$$q = 586.50 \text{ kg/m}^2 \rightarrow 0.06 \text{ kg/cm}^2$$

$$\frac{1.30}{x} = \frac{2.15}{0.11}$$

$$x = 0.068 \rightarrow q_2 = 0.15 + x$$

$$q_2 = 0.15 + 0.068$$

$$q_2 = 0.22 \text{ kg/cm}^2$$

$$\frac{1.30 + 0.25}{y} = \frac{2.15}{0.11}$$

$$y = 0.081$$

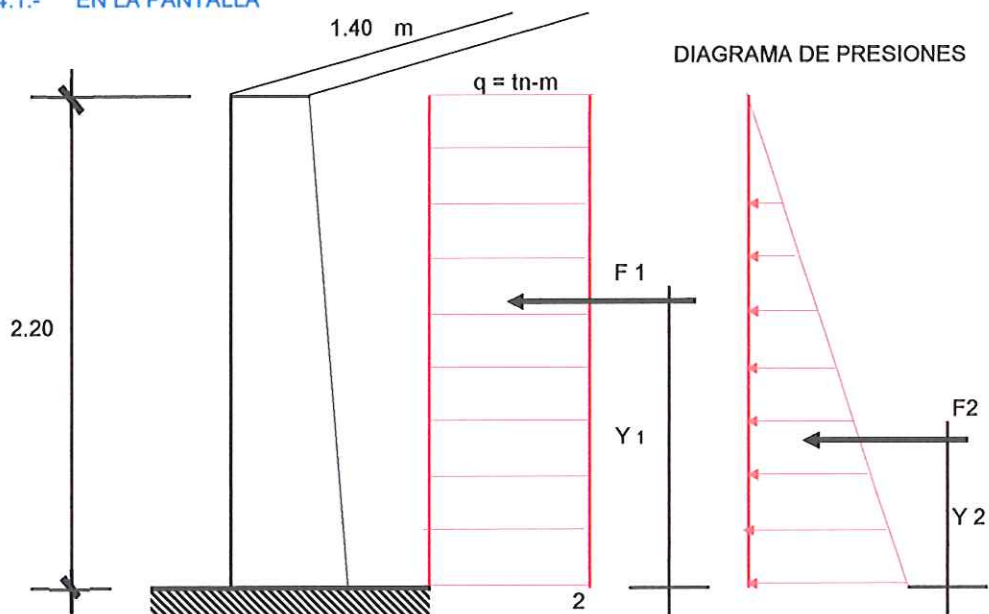
$$q_3 = 0.15 + y$$

$$q_3 = 0.15 + 0.081$$

$$q_3 = 0.24 \text{ kg/cm}^2$$

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



##### a) MOMENTO FLECTOR

En

$$F1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$$

$$F1 = (500 \text{ kg-m} \times 2.20 \text{ m} \times 1.00 \text{ m}) \cdot 0.333$$

$$F1 = 366.67 \text{ kg.}$$

$$y1 = \frac{h}{2} = \frac{2.20}{2} = 1.1$$

$$y1 = 1.1 \text{ m}$$

En

$$F2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00 \text{ m}) \cdot Ka$$

$$F2 = \frac{1}{2} \cdot 30 \cdot \frac{4.84}{2.20} \cdot 1.00 \cdot 0.333 = 24.20 \text{ kg}$$

$$F2 = 0.02 \text{ tn-m}$$

$$y2 = \frac{1}{3} h \quad y2 = \frac{1}{3} \cdot 2.20$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154488

002  
1378

$$y_2 = 0.73 \text{ m}$$

MOMENTO ULTIMO

$$M_{max} = (F_1 Y_1) + (F_2 Y_2)$$

$$M_{max} = (366.67 \times 1.1) + (24.20 \times 0.73)$$

$$M_{max} = 421.08 \text{ kg-m}$$

b) FUERZA CORTANTE

\* FUERZA CORTANTE ACTUANTE

$$V = F_1 + F_2$$

$$V = 366.67 + 24.20$$

$$V = 390.87 \text{ kg}$$

\* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \left| \begin{array}{l} V = 390.87 \\ b = 1.00 \\ d = 0.21 \end{array} \right.$$

$$\mu = \frac{390.87}{100 \cdot 21} = 0.19$$

$$\mu = 0.19 \text{ kg/cm}^2$$

\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

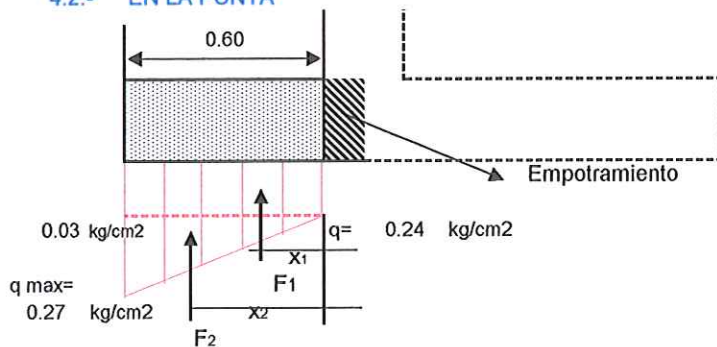
$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.19 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$



4.2.- EN LA PUNTA



a) MOMENTO FLECTOR

En:

$$F_1 = 0.24 \times 0.60 \times 1.00$$

$$F_1 = 1.414 \text{ Kg}$$

$$X_1 = \frac{0.60}{2} = 0.30 \text{ m}$$

En

$$F_2 = \frac{1}{2} \times 60 \times 0.03 \times 100 = 94.37 \text{ Kg}$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480



601

1377

$$F2 = 94.37 \text{ kg}$$

$$X2 = \frac{2}{3} \cdot 0.60 =$$

$$X2 = 0.40 \text{ mt}$$

MOMENTO MAXIMO

$$M_{\text{máx}} = (F1 \cdot X1) + (F2 \cdot X2)$$

$$M_{\text{máx}} = (1,414 \times 0.30) + (94.37 \times 0.40)$$

$$M_{\text{máx}} = -386.37 \text{ kg-m}$$

FUERZA CORTANTE ACTUANTE (v)

$$V = F1 + F2$$

$$V = 1,414 + 94.37$$

$$V = 1,508.11 \text{ kg}$$

ESFUERZO CORTANTE (u)

$$u = \frac{V}{b \cdot d}$$

$$u = \frac{1,508.11}{60 \cdot 21}$$

$$u = 1.20 \text{ kg/cm}^2$$

ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

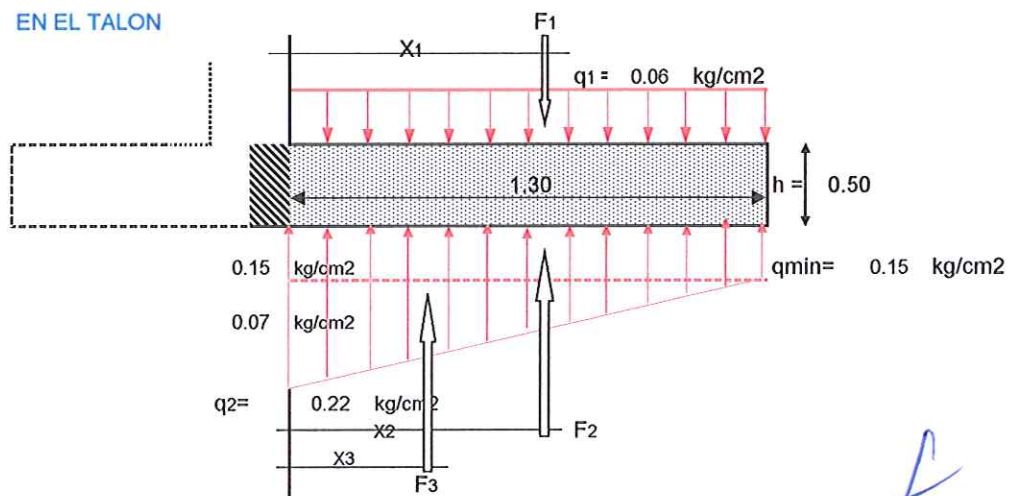
$$Vc = \phi \cdot 0.53 \cdot \sqrt{f'c}$$

$$Vc = 0.85 \cdot 0.53 \cdot 14.49$$

$$Vc = 6.53$$



#### 4.3.- EN EL TALON



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

600

1376

$$F1 = 0.06 \text{ kg/cm}^2 \quad 130 \text{ cm} \quad 100 \text{ cm}$$

$$F1 = 762.45 \text{ kg}$$

$$X1 = \frac{1.30}{2}$$

$$X1 = 0.65 \text{ m}$$

$$F2 = 0.15 \text{ kg/cm}^2 \quad 130 \text{ cm} \quad 100 \text{ cm}$$

$$F2 = 2,006.64 \text{ kg}$$

$$X2 = \frac{1.30}{2}$$

$$X2 = 0.65 \text{ m}$$

$$F3 = \frac{1}{2} \quad 0.07 \text{ kg/cm}^2 \quad 130 \text{ cm} \quad 100 \text{ cm}$$

$$F3 = 443.03 \text{ kg}$$

$$X3 = \frac{1}{3} \quad 1.30$$

$$X3 = 0.43 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2.X2) + (F3.X3) - (F1.X1)$$

$$M = (2,006.64 \times 0.65) + (443.03 \times 0.43) - (762 \times 0.65)$$

$$M = 1,991.9 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 762.45 - 2,006.64 - 443.03$$

$$V = -1,687.22 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-1,687.22}{100 \cdot 21}$$

$$\mu = -0.80 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = \emptyset \quad 0.53 \quad \sqrt{f'c}$$

$$V_c = 0.85 \quad 0.53 \quad 14.49$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu \text{ act } -0.80 \text{ kg/cm}^2 \text{ OK CUMPLE}$$

5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

- Para $\emptyset \leq 5/8"$	$A_{min} \text{ (Vertical)} = 0.0012 \quad b \quad h$
- Para $\emptyset > 5/8"$	$A_{min} \text{ (Vertical)} = 0.0015 \quad b \quad h$

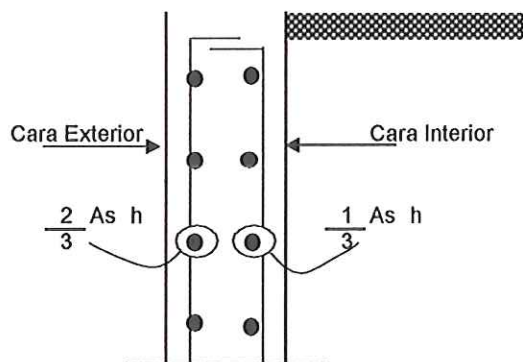
b- Acero Mínimo Horizontal en muros:

- Para $\emptyset \leq 5/8"$	$A_{min} \text{ (Horizontal)} = 0.0020 \quad b \quad h$
- Para $\emptyset > 5/8"$	$A_{min} \text{ (Horizontal)} = 0.0025 \quad b \quad h$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480

599  
1375



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b d^2}$$

$$A_s = \rho b d$$

### 5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = 1.6$$

$$M_u = 1.6 \times 421.08 = 673.73$$

$$M_u = 674 \text{ kg/m}$$

$$K_u = \frac{674 \times 10^2}{100 \times 441}$$

$$K_u = 1.53$$

$$\rho =$$

$$\text{Para } \begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.53 \end{cases}$$

$$\rho = 0.0004$$



Acero principal:

$$A_s = \rho b d$$

$$A_s = 0.0004 \times 100 \times 21 = 0.84$$

$$A_s = 0.84 \text{ cm}^2$$

$$A_s = \frac{0.84}{4} \times \frac{1.98}{1.59} \times \frac{5}{8} = 7.92$$

OK CUMPLE

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido } 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \varnothing \text{ de } 5/8 \text{ @ } 0.25 \text{ m}$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480

598  
1374

b) Acero mínimo Vertical

$$As_{min} \text{ (vertical)} = 0.0015 \cdot 100 \cdot 21$$

$$As_{min} = 3.15 \text{ cm}^2$$

As princ	7.92	>	As min	3.15	OK CUMPLE
----------	------	---	--------	------	-----------

5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$As_{min} \text{ (vertical)} = 0.0012 \cdot 100 \cdot 21$$

$$As_{min} = 2.52 \text{ cm}^2$$

$$As = 2.52 \text{ cm}^2$$

As =	2.52	⇒	2	Ø	5/8"	▼	=	3.96	OK CUMPLE
------	------	---	---	---	------	---	---	------	-----------

$$S = \frac{1.98}{3.96} \times 100$$

$$S = 50.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ 

USAR	2	Ø	de	5/8	@	0.25	ml
------	---	---	----	-----	---	------	----



5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\phi \leq 5/8"$

$$As_{min} = 0.0020 \cdot b \cdot d$$

1) Arriba: (h = 0.2 )

$$As_{min} = 0.0020 \cdot 100 \cdot 0 = 0.04$$

$$As_{min} = 4.00 \text{ cm}^2$$

a) Cara Interior

$$\frac{1}{3} As_h = \frac{1}{3} \cdot 4.00 = 1.33 \text{ cm}^2/\text{m}$$

$$As = 1.33 \text{ cm}^2$$

As =	4.00	⇒	4	Ø	1/2"	▼	=	5.07	OK CUMPLE
------	------	---	---	---	------	---	---	------	-----------

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ 

USAR	4	Ø	de	1/2	@	0.25	ml
------	---	---	----	-----	---	------	----



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. 114420

5917  
1373

b) Cara Exterior:

$$\frac{2}{3} \text{ Ash} = \frac{2}{3} \cdot 4 = 2.67 \text{ cm}^2/\text{m}$$

$$A_s = 2.67 \text{ cm}^2$$

$$A_s = \boxed{2.67} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{3/8"} \nabla \boxed{=} \boxed{2.85} \text{ OK CUMPLE}$$

$$S = \frac{0.71}{2.85} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{3/8} \text{ @ } \boxed{0.25} \text{ m}$$

2) Cara Intermedia  $(h = \frac{25 + 20}{2}) = 22.5 \text{ cm}$

$$A_s \text{ min (Horizontal)} = 0.0020 \cdot 100 \cdot 22.5 = 4.50 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} \text{ Ash} = \frac{1}{3} \cdot 4.50 = 1.50 \text{ cm}^2/\text{m}$$

$$A_s = 1.50 \text{ cm}^2$$

$$A_s = \boxed{1.50} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla \boxed{=} \boxed{5.07} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{1/2} \text{ @ } \boxed{0.25} \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} \text{ Ash} = \frac{2}{3} \cdot 4.5 = 3.00 \text{ cm}^2/\text{m}$$



*Edgar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154488



596  
1372

$$A_s = 3.00 \text{ cm}^2$$

$$A_s = \frac{3.00}{5} \Rightarrow \frac{5}{\emptyset 3/8} = 3.56 \quad \text{OK CUMPLE}$$

$$S = \frac{0.71}{3.56} \times 100$$

$$S = 20.00 \text{ Asumido} \Rightarrow 0.20 \text{ m}$$

$$\Rightarrow \text{USAR } 5 \emptyset \text{ de } 3/8 @ 0.20 \text{ m}$$

3) Cara Inferior (abajo) (h = 0.25 m)

$$A_s \text{ min (Horizontal)} = 0.0020 \times 100 \times 25.00 = 5.00$$

a) Cara Interior:

$$\frac{1}{3} A_s h = \frac{1}{3} \times 5.00 = 1.67 \text{ cm}^2/\text{m}$$

$$A_s = 1.67 \text{ cm}^2$$

$$A_s = \frac{1.67}{2} \Rightarrow \frac{2}{\emptyset 1/2} = 2.53 \quad \text{OK CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \emptyset \text{ de } 1/2 @ 0.25 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} A_s h = \frac{2}{3} \times 5.0 = 3.33 \text{ cm}^2/\text{m}$$

$$A_s = 3.33 \text{ cm}^2$$

$$A_s = \frac{3.33}{4} \Rightarrow \frac{4}{\emptyset 1/2} = 5.07 \quad \text{OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.250 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \emptyset \text{ de } 1/2 @ 0.25 \text{ m}$$

## Resumen

### Acero Horizontal

1) Ariba	=	(As mín Horizontal)	=	4.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset 1/2 @ 0.25 \text{ m}$	
		Cara exterior	=	$\emptyset 3/8 @ 0.25 \text{ m}$	
2) Intermd	=	(As mín Horizontal)	=	4.50	cm <sup>2</sup>
		Cara Interior	=	$\emptyset 1/2 @ 0.25 \text{ m}$	
		Cara exterior	=	$\emptyset 3/8 @ 0.20 \text{ m}$	
3) Inferior	=	(As mín Horizontal)	=	5.00	cm <sup>2</sup>



Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP. N. 154480

595  
1371

Cara Interior = Ø 1/2 @ 0.25 m  
Cara exterior = Ø 1/2 @ 0.250 m

Para cara Interior

C.I 2 Ø 1/2 @ 0.25 , 4 Ø 1/2 @ 0.25 Rto Ø 1/2 @ 0.25

Para Exterior:

C.E 4 Ø 1/2 @ 0.25 , 5 Ø 3/8 @ 0.20 Rto Ø 1/2 @ 0.25

Entonces:

C.I = Ø 1/2 @ 0.250 ≈ 0.25  
C.E = Ø 1/2 @ 0.233 ≈ 0.25

SI UNIFORMAMOS EL ACERO 0.250 a 0.233 = 0.242 ≈ 0.250

tenemos: Ø 1/2 @ 0.25  
Ø 1/2 @ 0.25

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$Mu = 1.6 \times -386.37 \text{ kg-m} = -618.19 \text{ kg-m}$$

$$b = 1.00 \text{ mt}$$

$$d = h_z - \frac{(r + \phi \text{ vlla})}{2}$$

$$d = 50 - 7.5 + \frac{1.58}{2}$$

$$d = 41.71$$

$$Ku = \frac{-618 \times 10^2}{100 \times 1740} \text{ kg/cm}^2$$

$$Ku = -0.36$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = -0.36 \end{cases} \Rightarrow \rho = -0.0001$

Acero principal:

$$As = \rho b d$$

$$As = -0.0001 \times 100 \times 42 = -0.42$$

$$As = -0.42 \text{ cm}^2$$

$$As = \frac{7.09}{6} \times \frac{6}{1/2} = 7.60 \text{ OK CUMPLE}$$

+ - 0.50 CM2

$$S = \frac{1.27}{7.60} \times 100$$

$$S = 16.67 \text{ Asumido } 0.20 \text{ m}$$

$$\Rightarrow \text{USAR } 6 \text{ Ø de } 1/2 @ 0.20 \text{ m}$$



Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP N° 144480

594  
1370

Acero mínimo:

$$As_{\min} = 0.0018 \times 100 \times 41.71 = 7.51$$

7.51	<	7.60	OK CUMPLE
------	---	------	-----------

ZAPATA POSTERIOR

$$Mu = 1.6 \times 1,992 \text{ kg-m} = 3,187.02 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = 41.71$$

$$Ku = \frac{3,187 \times 10^2}{100 \times 1740} \text{ kg/cm}^2$$

$$Ku = 1.83$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 1.83 \end{cases} \Rightarrow \rho = 0.0005$

Acero principal:

$$As = \rho \times b \times d$$

$$As = 0.0005 \times 100 \times 42 = 2.09$$

$$As = 2.09 \text{ cm}^2$$

As =	2.09	⇒	4	Ø	1/2"	▼	=	5.07	OK CUMPLE
------	------	---	---	---	------	---	---	------	-----------

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ **USAR 4 Ø de 1/2 @ 0.25 ml**



ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$A_{\text{temp}} = 0.0018 \times b \times t \text{ N.T.P } t = h_z = 0.50$$

$$A_{\text{temp}} = 0.0018 \times 100 \times 50 = 9.00 \text{ cm}^2$$

$$As = 9.00 \text{ cm}^2$$

As =	9.00	⇒	8	Ø	1/2"	▼	=	10.13	OK CUMPLE
------	------	---	---	---	------	---	---	-------	-----------

$$S = \frac{1.27}{10.13} \times 100$$

$$S = 12.50 \text{ Asumido} \Rightarrow 0.15 \text{ m}$$

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154488

598  
1369

→ 

USAR	8	Ø	de	1/2	@	0.15	m
------	---	---	----	-----	---	------	---

PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:

$$S \leq \left| \begin{array}{l} 0.5 \\ 45 \end{array} \right| t = 0.5 \quad 50 = 25$$

cm

SE TOMA EL MENOR:

$$Astemp = \emptyset \quad 1/2 \quad @ \quad 0.20$$

### RESUMEN GENERAL DEL ACERO

1.- PANTALLA:

\* ACERO VERTICAL

- Cara Interior	=	Ø	5/8	@	0.50 m	Intercalado ó a una (h) de 1.15
	=	Ø	5/8	@	0.25 m	
- Cara Exterior	=	Ø	5/8	@	0.25 m	

\* ACERO HORIZONTAL

- Cara Interior	=	Ø	1/2	@	0.25 m
- Cara Exterior	=	Ø	1/2	@	0.25 m

2.- ZAPATA ANTERIOR  
(PUNTA)

* ACERO PRINCIPAL	=	Ø	1/2	@	0.20 m
* ACERO TRANSVERSAL	=	Ø	1/2	@	0.20 m

3.- ZAPATA POSTERIOR  
(TALON)

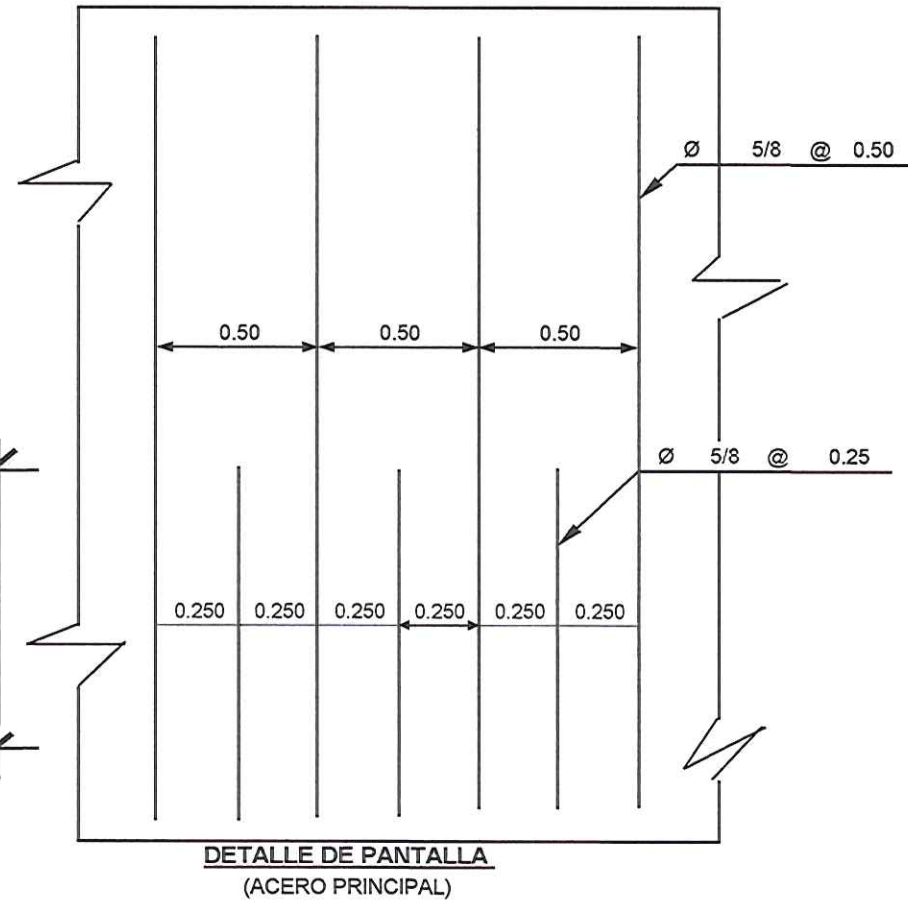
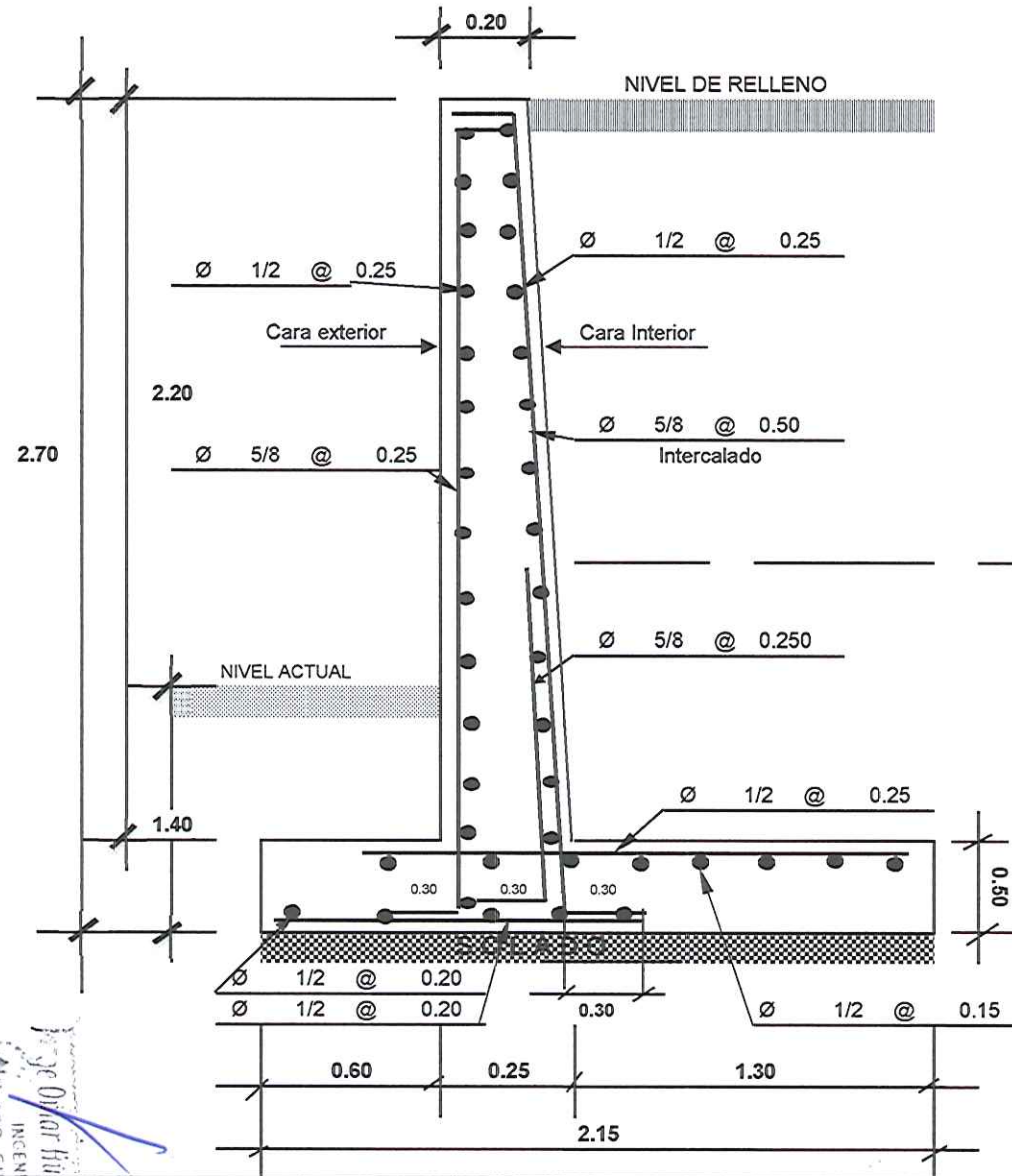
* ACERO PRINCIPAL	=	Ø	1/2	@	0.25 m
* ACERO TRANSVERSAL	=	Ø	1/2	@	0.15 m



*[Signature]*  
Ing. Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP. N° 154420



# DISEÑO DE MURO DE CONTENCION EN VOLADIZO



Ing. Oscar Huaman Espinoza  
 INGENIERO CIVIL  
 N.º 54380



1380  
 5/12



591  
1367

DISEÑO DE MURO DE CONTENCIÓN			
EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : jul-2023

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	2.70	m
h 1 =	1.400	m
t 1 =	0.25	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava		
$\gamma$ = (kg/m <sup>3</sup> )	2650	
$\phi$ = (°)	30°	30
$\sigma$ t = (kg/cm <sup>2</sup> )	1.20	

#### C DATOS DEL C° Y ACERO

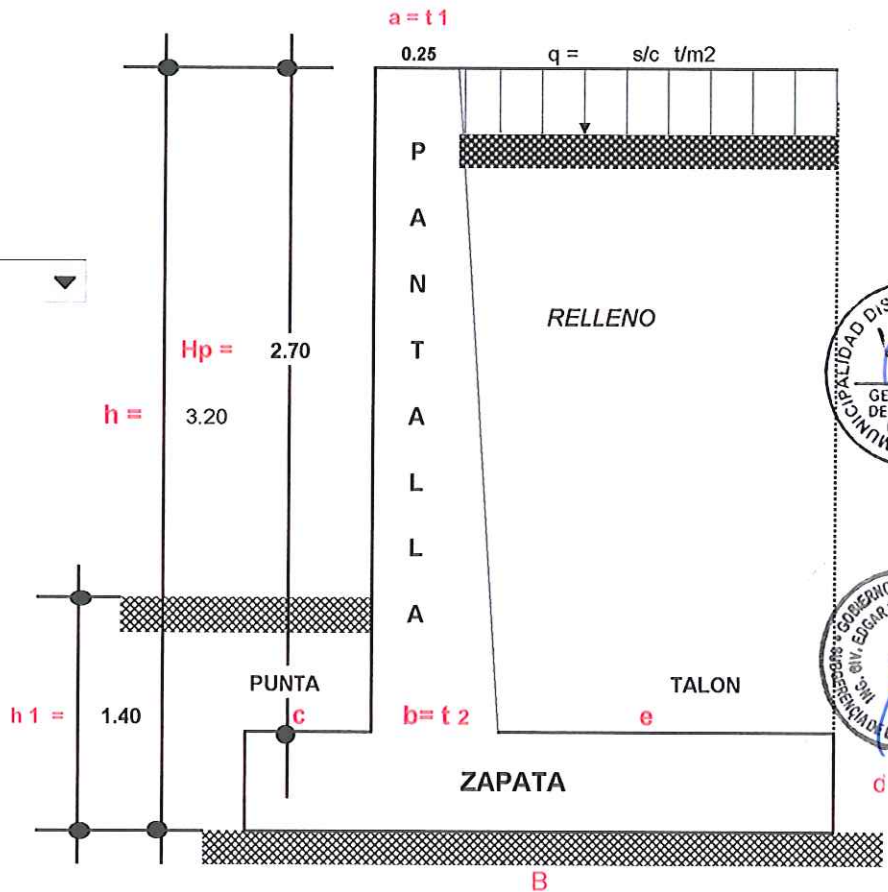
f'c = (kg/cm <sup>2</sup> )	210
f'y = (kg/cm <sup>2</sup> )	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	≥	2
F.S.D	≥	1.5

#### E SOBRECARGA

q = s/c t-m2	0.50	tn
--------------	------	----



#### 1.- PREDIMENSIONAMIENTO:

$$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.25 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{3.20}{12} \text{ ó } \frac{3.20}{10}$$

$$b = 0.27 \text{ ó } 0.32 \rightarrow \text{Asumido} = 0.30 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 3.20 \text{ ó } 0.8 \cdot 3.20$$

$$B = 1.60 \text{ ó } 2.56 \rightarrow \text{Asumido} = 2.55 \text{ m}$$

Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP N° 154480

590  
1366

$$c = \frac{1}{3} B - \frac{1}{2} b = 0.70$$

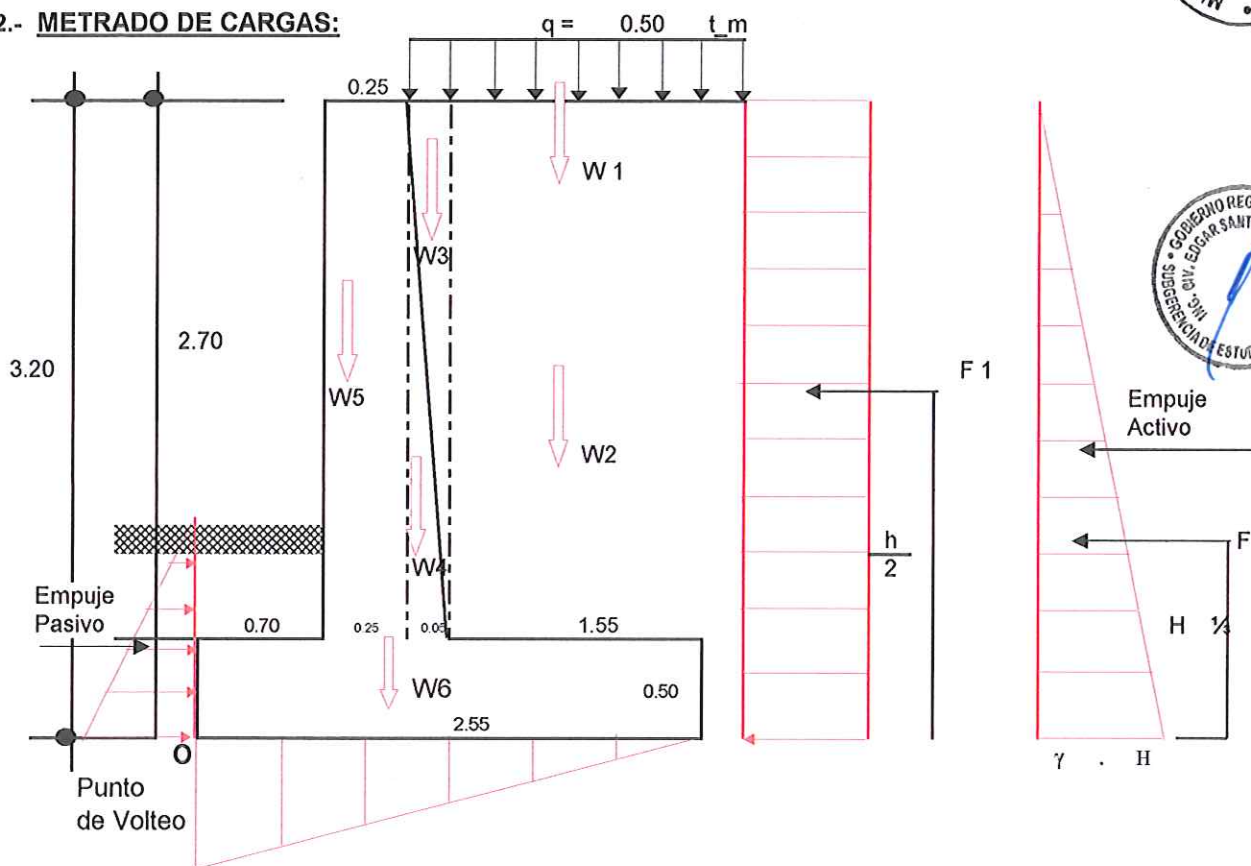
$$c = 0.70 \rightarrow \text{Asumido} = 0.70 \text{ m}$$

$$d = \begin{cases} = b \\ = b + 5 \\ = b + 10 \\ = b + 15 \\ = b + 20 \end{cases} \quad 0.40 \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$e = B - c - b = 2.55 - 0.70 - 0.30$$

$$e = 1.55 \text{ m}$$

## 2.- METRADO DE CARGAS:



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 153380

589  
1365

a.\_ FUERZAS VERTICALES: 1.40 mts de Analisis

W1	=	0.50	t/m2	x	1.60	x	1.40	=	1,120	kg
W2	=	30	kg/cm2	x	(	1.55	x	2.70	) x	1.40 = 176 kg
W3	=	30	kg/cm2	x	(	$\frac{0.05 \times 2.70}{2}$	) x	1.40	=	3 kg
W4	=	2,400	kg/cm2	x	(	$\frac{0.05 \times 2.70}{2}$	) x	1.40	=	227 kg
W5	=	2,400	kg/cm2	x	0.25	x	2.70	x	1.40	= 2,268 kg
W6	=	2400	kg/cm2	x	2.55	x	0.50	x	1.40	= 4,284 kg
$\Sigma f y$									<u>8,077</u>	kg

b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

$$F_1 = [ (q) \times (H) \times 1.00 \text{ m} ] K_a$$

$$F_1 = [ 500 \text{ kg/cm}^2 \times 3.20 \times 1.00 ] \times 0.333$$

$$F_1 = 533 \text{ Kg/cm}^2$$

UBICACIÓN : F 1

$$F_1 = \frac{H}{2} = \frac{2.70}{2} = 1.35 \text{ m}$$

$$F_2 = (vol) D \cdot P$$

$$F_2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F_2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F_2 = \frac{1}{2} 30 \text{ kg/cm}^2 \cdot 2.70^2 \cdot 1.00 \cdot 0.333$$

$$F_2 = 36.45 \text{ Kg}$$

UBICACIÓN : F 2

$$F_2 = \frac{1}{3} H$$

$$F_2 = \frac{1}{3} 2.70 = 0.9 \text{ m}$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

588  
1364

### 3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

#### FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	1,120	1.85	2,072.00
W2	176	1.85	325.17
W3	3	0.975	2.76
W4	227	0.975	221.13
W5	2,268	0.825	1,871.10
W6	4,284	1.28	5,462.10
$\sum MF_f$	8,077	$\sum MoF_y$	9,954.27

#### FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F 1	533	1.350	720.00
F 2	36	0.90	32.81
$\sum F_h$	569.78	$\sum MF_h$	752.81

$$F_s V = \frac{9,954.27 \text{ kg/m}}{752.81 \text{ kg/m}} = 13.22 > 2$$



OK CUMPLE

### 3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$$F_s D = \frac{q \sum F_v}{\sum F_h} \geq 1.5 = \frac{f \text{ Empuje}}{f \text{ Rozamiento}}$$

$$q = \tan \phi \leq 0.60$$

$$q = 30^\circ = 0.577 > 0.60$$

$$q = 0.58$$

$$F_s D = \frac{0.58 \cdot 8,077}{569.78} = 8.18 > 1.50$$

OK CUMPLE

### ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

#### 1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$$x = \frac{\sum Mo}{\sum F_y} \quad x = \frac{\sum MoF_y - \sum MoF_h}{\sum F_y}$$

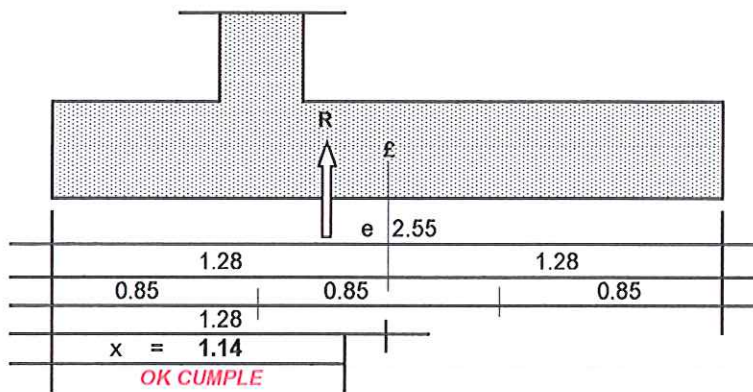
$$x = \frac{9,954.27 - 752.81}{8,077}$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480



587  
1363

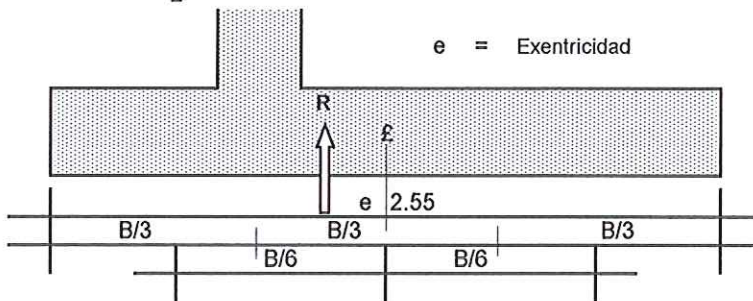
$$x = 1.14$$



## 2ro EXENTRICIDAD

$$e = \frac{B}{2} - x$$

e = Excentricidad



$$e = \frac{2.55}{2} - 1.14 = 0.136$$

$$\frac{B}{6} = \frac{2.55}{6} = 0.43$$

## 3ro CALCULO DE LA PRESION ACTUANTE

$$q = \frac{\Sigma Fy}{A \cdot B} \left( 1 \pm \frac{6 \cdot e}{B} \right)$$

$$q = \frac{8,077}{1.40 \cdot 2.55} \left( 1 \pm \frac{6 \cdot 0.136}{2.55} \right)$$

$$q = 2,262.58 \quad 1 \pm 0.3196215$$

$$q_{\max} = 2,985.75 \quad \text{kg/m}^2 \rightarrow 0.30$$

$$q_{\min} = 1,539.41 \quad \text{kg/m}^2 \rightarrow 0.15$$

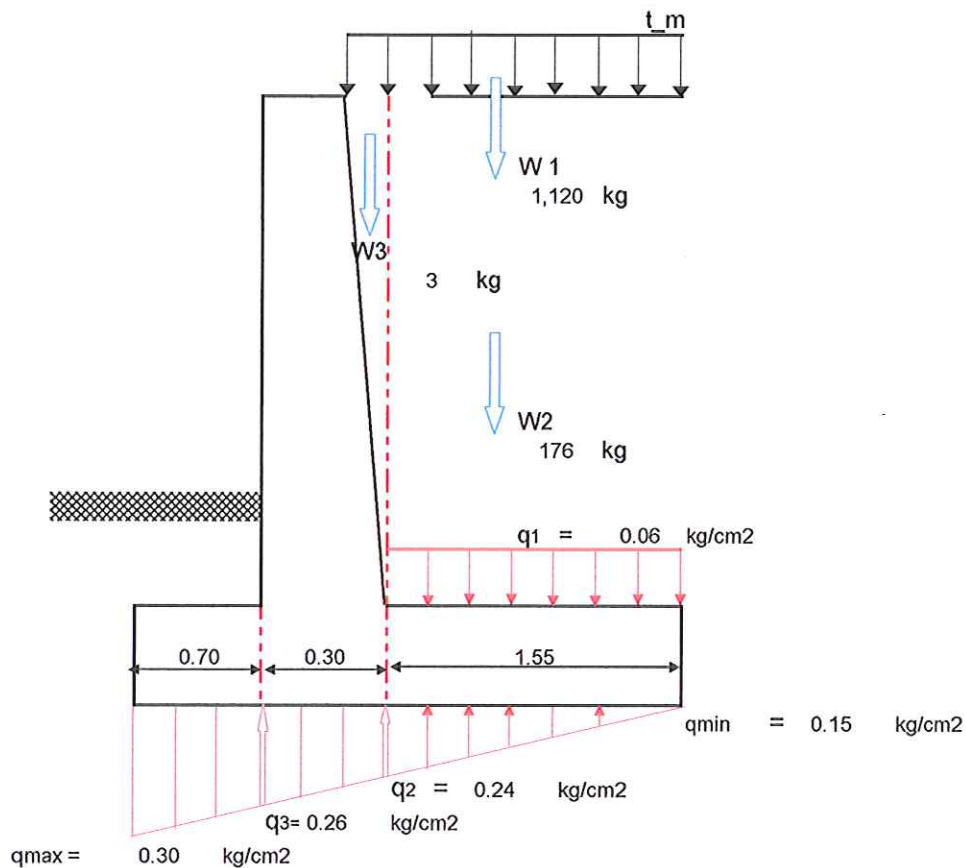
$$\begin{matrix} q_{\max}, q_{\min} < \sigma_t = \text{OK CUMPLE} \\ 0.30 < 1.20 \end{matrix}$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 153380



586  
1362



$$q = \frac{w1 + w2 + w3}{A \text{ talón}} \quad q = \frac{1,120 + 176 + 3}{1.55 \times 1.40}$$

$$q = 598.44 \text{ kg/m}^2 \rightarrow 0.06 \text{ kg/cm}^2$$

$$\frac{1.55}{x} = \frac{2.55}{0.14}$$

$$x = 0.088 \rightarrow q2 = 0.15 + x$$

$$q2 = 0.15 + 0.088$$

$$q2 = 0.24 \text{ kg/cm}^2$$

$$\frac{1.55 + 0.30}{y} = \frac{2.55}{0.14}$$

$$y = 0.105$$

$$q3 = 0.15 + y$$

$$q3 = 0.15 + 0.105$$

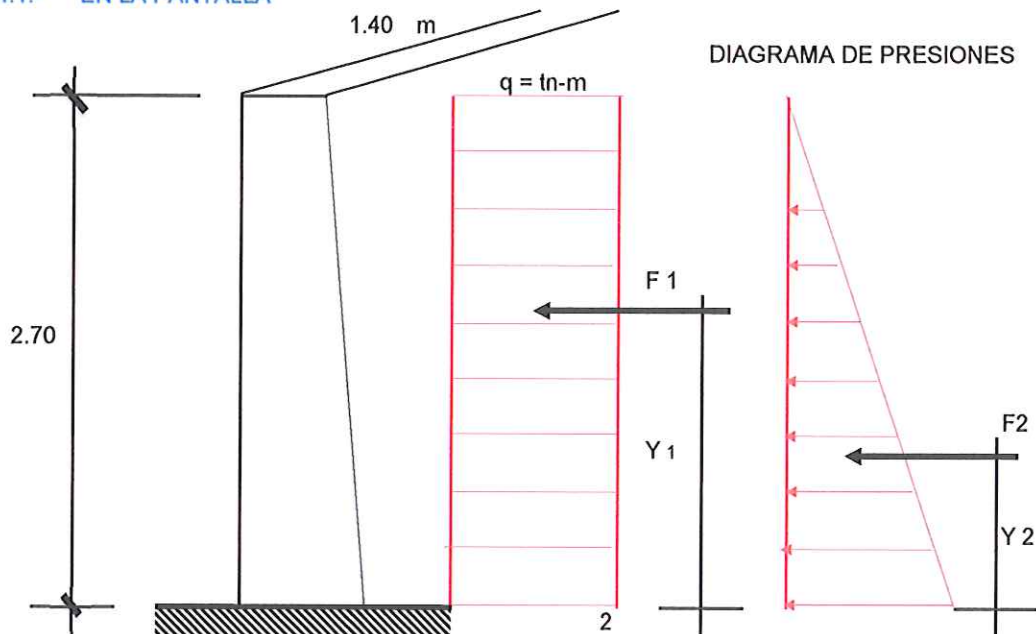
$$q3 = 0.26 \text{ kg/cm}^2$$

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

585  
1361

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



##### a) MOMENTO FLECTOR

En

$$F1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$$

$$F1 = (500 \text{ kg-m} \times 2.70 \text{ m} \times 1.00 \text{ m}) \cdot 0.333$$

$$F1 = 450.00 \text{ kg.}$$

$$y1 = \frac{h}{2} = \frac{2.70}{2} = 1.35$$

$$y1 = 1.35 \text{ m}$$

En

$$F2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00 \text{ m}) \cdot Ka$$

$$F2 = \frac{1}{2} \cdot 30 \cdot \frac{7.29}{2.70} \cdot 1.00 \cdot 0.333 = 36.45 \text{ kg}$$

$$F2 = 0.04 \text{ tn-m}$$

$$y2 = \frac{1}{3} h \quad y2 = \frac{1}{3} \cdot 2.70$$

$$y2 = 0.90 \text{ m}$$

##### MOMENTO ULTIMO

$$M_{\max} = (F1 \cdot Y1) + (F2 \cdot Y2)$$

$$M_{\max} = (450.00 \times 1.35) + (36.45 \times 0.90)$$

$$M_{\max} = 640.31 \text{ kg-m}$$

##### b) FUERZA CORTANTE

\* FUERZA CORTANTE ACTUANTE



*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

584  
1360

$$V = F_1 + F_2$$

$$V = 450.00 + 36.45$$

$$V = 486.45 \text{ kg}$$

\* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \left| \begin{array}{l} V = 486.45 \\ b = 1.00 \\ d = 0.26 \end{array} \right.$$

$$\mu = \frac{486.45}{100 \cdot 26} = 0.19$$

$$\mu = 0.19 \text{ kg/cm}^2$$

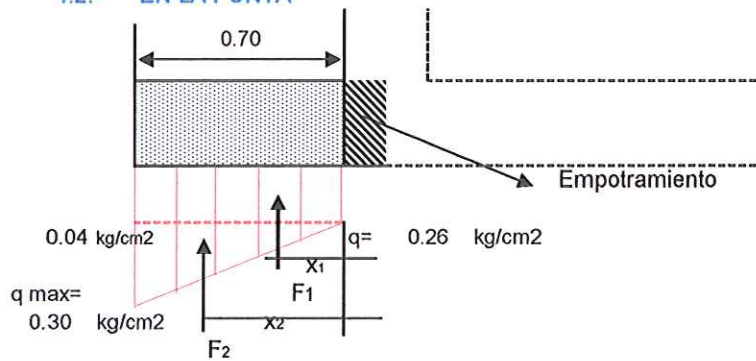
\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.19 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$

#### 4.2.- EN LA PUNTA



#### a) MOMENTO FLECTOR

En:

$$F_1 = 0.26 \times 0.70 \times 1.00$$

$$F_1 = 1.812 \text{ Kg}$$

$$X_1 = \frac{0.70}{2} = 0.35 \text{ m}$$

En

$$F_2 = \frac{1}{2} \times 70 \times 0.04 \times 100 = 138.96 \text{ Kg}$$

$$F_2 = 138.96 \text{ kg}$$

$$X_2 = \frac{2}{3} \times 0.70 =$$

$$X_2 = 0.47 \text{ mt}$$

#### MOMENTO MAXIMO

$$M_{\text{máx}} = (F_1 \cdot X_1) + (F_2 \cdot X_2)$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

583  
1359

$$M_{\max} = (1,812 \times 0.35) + (138.96 \times 0.47)$$

$$M_{\max} = -569.39 \text{ kg-m}$$

FUERZA CORTANTE ACTUANTE (v)

$$V = F_1 + F_2$$

$$V = 1,812 + 138.96$$

$$V = 1,951.06 \text{ kg}$$

ESFUERZO CORTANTE (q)

$$q = \frac{V}{b \cdot d}$$

$$q = \frac{1,951.06}{70 \cdot 26}$$

$$q = 1.07 \text{ kg/cm}^2$$

ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

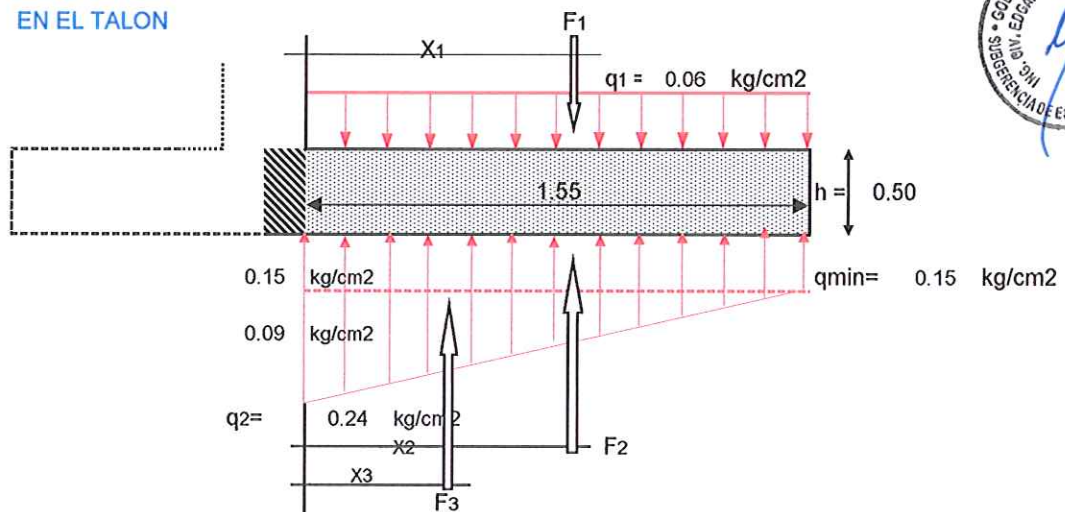
$$V_c = \phi \cdot 0.53 \cdot \sqrt{f'c}$$

$$V_c = 0.85 \cdot 0.53 \cdot 14.49$$

$$V_c = 6.53$$



#### 4.3.- EN EL TALON



$$F_1 = 0.06 \text{ kg/cm}^2 \cdot 155 \text{ cm} \cdot 100 \text{ cm}$$

$$F_1 = 927.58 \text{ kg}$$

$$X_1 = \frac{1.55}{2}$$

$$X_1 = 0.78 \text{ m}$$

$$F_2 = 0.15 \text{ kg/cm}^2 \cdot 155 \text{ cm} \cdot 100 \text{ cm}$$

$$F_2 = 2,386.09 \text{ kg}$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG CIP N° 154480

582  
1358

$$X2 = \frac{1.55}{2}$$

$$X2 = 0.78 \text{ m}$$

$$F3 = \frac{1}{2} \quad 0.09 \text{ kg/cm}^2 \quad 155 \text{ cm} \quad 100 \text{ cm}$$

$$F3 = 681.34 \text{ kg}$$

$$X3 = \frac{1}{3} \quad 1.55$$

$$X3 = 0.52 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2.X2) + (F3.X3) - (F1.X1)$$

$$M = (2,386.09 \times 0.78) + (681.34 \times 0.52) - (928 \times 0.78)$$

$$M = 2,920.1 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 927.58 - 2,386.09 - 681.34$$

$$V = -2,139.85 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-2,139.85}{100 \cdot 26}$$

$$\mu = -0.82 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = \phi \cdot 0.53 \cdot \sqrt{f'c}$$

$$V_c = 0.85 \cdot 0.53 \cdot 210$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu_{act} -0.82 \text{ kg/cm}^2 \text{ OK CUMPLE}$$



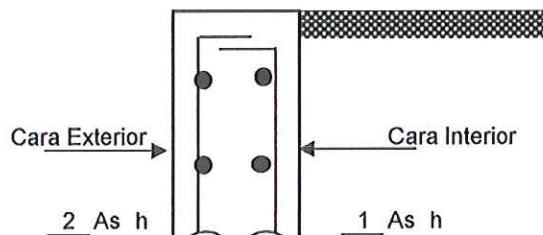
5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

- Para  $\phi \leq 5/8"$   $As_{min} \text{ (Vertical)} = 0.0012 \text{ b h}$
- Para  $\phi > 5/8"$   $As_{min} \text{ (Vertical)} = 0.0015 \text{ b h}$

b- Acero Mínimo Horizontal en muros:

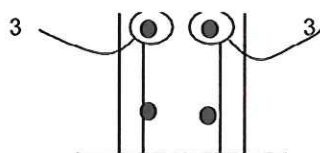
- Para  $\phi \leq 5/8"$   $As_{min} \text{ (Horizontal)} = 0.0020 \text{ b h}$
- Para  $\phi > 5/8"$   $As_{min} \text{ (Horizontal)} = 0.0025 \text{ b h}$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480



581  
1357



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b d^2}$$

$$A_s = \rho b d$$

### 5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = 1.6$$

$$M_u = 1.6 \quad 640.31 = 1,024.49$$

$$M_u = 1,024 \quad \text{kg/m}$$

$$K_u = \frac{1,024 \times 10^2}{100 \times 676} \quad \text{kg/cm}^2$$

$$K_u = 1.52$$

$$\rho =$$

$$\text{Para } \begin{cases} f'_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.52 \end{cases}$$

$$\rho = 0.0004$$

Acero principal:

$$A_s = \rho b d$$

$$A_s = 0.0004 \quad 100 \quad 26 = 1.04$$

$$A_s = 1.04 \quad \text{cm}^2$$

$$A_s = \boxed{1.04} \Rightarrow \boxed{4} \quad \emptyset \quad \boxed{5/8"} \quad \boxed{1.59} \quad \boxed{7.92} \quad \text{OK CUMPLE}$$

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \quad \boxed{4} \quad \emptyset \quad \text{de} \quad \boxed{5/8} \quad \text{@} \quad \boxed{0.250} \text{ m}$$

b) Acero mínimo Vertical

$$A_{s\text{min}} (\text{vertical}) = 0.0015 \quad 100 \quad 26$$

$$A_{s\text{mín}} = 3.9 \quad \text{cm}^2$$

$$\boxed{A_{s\text{ princ}} \quad 7.92 > A_{s\text{ min}} \quad 3.9} \quad \text{OK CUMPLE}$$



*Mar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

580  
1356

## 5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$As_{min} \text{ (vertical)} = 0.0012 \quad 100 \quad 26$$

$$As_{mín} = 3.12 \quad cm^2$$

$$As = 3.12 \quad cm^2$$

$$As = \boxed{3.12} \Rightarrow \boxed{2} \quad \emptyset \quad \boxed{5/8"} \quad \nabla \quad = \quad \boxed{3.96}$$

OK CUMPLE

$$S = \frac{1.98}{3.96} \times 100$$

$$S = 50.00 \quad \text{Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \quad \boxed{2} \quad \emptyset \quad \text{de} \quad \boxed{5/8} \quad @ \quad \boxed{0.25} \quad \boxed{m}$$

## 5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\emptyset \leq 5/8"$

$$As_{min} = 0.0020 \quad b \quad d$$

1) Arriba: (h = 0.25 )

$$As_{min} = 0.0020 \quad 100 \quad 0 = 0.05$$

$$As_{mín} = 5.00 \quad cm^2$$

a) Cara Interior

$$\frac{1}{3} As_h = \frac{1}{3} 5.00 = 1.67 \quad cm^2/m$$

$$As = 1.67 \quad cm^2$$

$$As = \boxed{5.00} \Rightarrow \boxed{4} \quad \emptyset \quad \boxed{1/2"} \quad \nabla \quad = \quad \boxed{5.07}$$

OK CMPL

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \quad \boxed{4} \quad \emptyset \quad \text{de} \quad \boxed{1/2} \quad @ \quad \boxed{0.25} \quad \boxed{m}$$

b) Cara Exterior:

$$\frac{2}{3} As_h = \frac{2}{3} 5 = 3.33 \quad cm^2/m$$

$$As = 3.33 \quad cm^2$$

$$As = \boxed{3.33} \Rightarrow \boxed{5} \quad \emptyset \quad \boxed{3/8"} \quad \nabla \quad = \quad \boxed{3.56}$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

579  
1355

OK CUMPLE

$$S = \frac{0.71}{3.56} \times 100$$

$$S = 20.00 \quad \text{Asumido} \Rightarrow 0.20 \text{ m}$$

$\Rightarrow$  USAR 5 Ø de 3/8 @ 0.20 m

2) Cara Intermedia  $(h = \frac{30 + 25}{2}) = 27.5 \text{ cm}$

$$\text{As min (Horizontal)} = 0.0020 \times 100 \times 27.5 = 5.50 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} \text{ Ash} = \frac{1}{3} \times 5.50 = 1.83 \text{ cm}^2/\text{m}$$

$$\text{As} = 1.83 \text{ cm}^2$$

$$\text{As} = 5.50 \Rightarrow 5 \text{ Ø } 1/2" = 6.33$$

OK CUMPLE

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \quad \text{Asumido} \Rightarrow 0.20 \text{ m}$$

$\Rightarrow$  USAR 5 Ø de 1/2 @ 0.20 m

b) Cara Exterior:

$$\frac{2}{3} \text{ Ash} = \frac{2}{3} \times 5.50 = 3.67 \text{ cm}^2/\text{m}$$



Inge Omar Huaman Espino  
INGENIERO  
REG. CIP. 14463

578  
1354

$$A_s = 3.67 \text{ cm}^2$$

$$A_s = \frac{3.67}{5.07} \Rightarrow 4 \text{ } \emptyset \text{ } 1/2" \text{ } \nabla = 5.07 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

3) Cara Inferior (abajo) (h = 0.30 m)

$$A_s \text{ min (Horizontal)} = 0.0020 \times 100 \times 30.00 = 6.00$$

a) Cara Interior:

$$\frac{1}{3} A_s h = \frac{1}{3} \times 6.00 = 2.00 \text{ cm}^2/\text{m}$$

$$A_s = 2.00 \text{ cm}^2$$

$$A_s = \frac{2.00}{2.53} \Rightarrow 2 \text{ } \emptyset \text{ } 1/2" \text{ } \nabla = 2.53 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{2.53} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} A_s h = \frac{2}{3} \times 6.0 = 4.00 \text{ cm}^2/\text{m}$$

$$A_s = 4.00 \text{ cm}^2$$

$$A_s = \frac{4.00}{5.07} \Rightarrow 4 \text{ } \emptyset \text{ } 1/2" \text{ } \nabla = 5.07 \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.250 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

## Resumen

### Acero Horizontal

1) Ariba	=	(A <sub>s</sub> mín Horizontal)	=	5.00	cm <sup>2</sup>
		Cara Interior	=	Ø 1/2 @ 0.25	m
		Cara exterior	=	Ø 3/8 @ 0.20	m



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154488

S78  
1353

$$\begin{aligned}
 2) \text{ Intermd} &= (\text{As mín Horizontal}) = 5.50 \text{ cm}^2 \\
 &\text{Cara Interior} = \emptyset \quad 1/2 \quad @ \quad 0.20 \text{ m} \\
 &\text{Cara exterior} = \emptyset \quad 1/2 \quad @ \quad 0.25 \text{ m} \\
 3) \text{ Inferior} &= (\text{As mín Horizontal}) = 6.00 \text{ cm}^2 \\
 &\text{Cara Interior} = \emptyset \quad 1/2 \quad @ \quad 0.25 \text{ m} \\
 &\text{Cara exterior} = \emptyset \quad 1/2 \quad @ \quad 0.250 \text{ m}
 \end{aligned}$$

Para cara Interior

$$C.I \quad 2 \quad \emptyset \quad 1/2 \quad @ \quad 0.25 \quad , \quad 5 \quad \emptyset \quad 1/2 \quad @ \quad 0.20 \quad Rto \quad \emptyset \quad 1/2 \quad @ \quad 0.25$$

Para Exterior:

$$C.E \quad 4 \quad \emptyset \quad 1/2 \quad @ \quad 0.25 \quad , \quad 4 \quad \emptyset \quad 1/2 \quad @ \quad 0.25 \quad Rto \quad \emptyset \quad 1/2 \quad @ \quad 0.20$$

Entonces:

$$\begin{aligned}
 C.I &= \emptyset \quad 1/2 \quad @ \quad 0.233 \quad \approx \quad 0.25 \\
 C.E &= \emptyset \quad 1/2 \quad @ \quad 0.233 \quad \approx \quad 0.25
 \end{aligned}$$

$$\text{SI UNIFORMAMOS EL ACERO} \quad 0.233 \quad a \quad 0.233 \quad = \quad 0.233 \quad \approx \quad 0.250$$

$$\begin{aligned}
 \text{tenemos:} \quad &\emptyset \quad 1/2 \quad @ \quad 0.25 \\
 &\emptyset \quad 1/2 \quad @ \quad 0.25
 \end{aligned}$$

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$Mu = 1.6 \times -569.39 \text{ kg-m} = -911.02 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = h_z - \frac{(r + \emptyset vlla)}{2}$$

$$d = 50 - 7.5 + \frac{1.58}{2}$$

$$d = 41.71$$

$$Ku = \frac{-911}{100} \times \frac{10^2}{1740} \text{ kg/cm}^2$$

$$Ku = -0.52$$

$$\begin{aligned}
 \text{Para} \quad &\left\{ \begin{array}{l} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = -0.52 \end{array} \right. \Rightarrow \rho = -0.0001
 \end{aligned}$$

Acero principal:

$$As = \rho \quad b \quad d$$

$$As = -0.0001 \quad 100 \quad 42 = -0.42$$

$$As = -0.42 \text{ cm}^2$$

$$As = \boxed{7.09} \Rightarrow \boxed{6} \quad \emptyset \quad 1/2" \quad \nabla \quad = \quad \boxed{7.60}$$

OK CUMPLE

+ - 0.50 CM2



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480



576  
1352

$$S = \frac{1.27}{7.60} \times 100$$

$$S = 16.67 \quad \text{Asumido} \Rightarrow 0.20 \text{ m}$$

$$\Rightarrow \text{USAR } 6 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.20 \text{ m}$$

Acero mínimo:

$$\text{Asmín} = 0.0018 \times 100 \times 41.71 = 7.51 \quad 0$$

$$7.51 < 7.60 \quad \text{OK CUMPLE}$$

ZAPATA POSTERIOR

$$Mu = 1.6 \times 2,920 \text{ kg-m} = 4,672.18 \text{ kg/m}$$

$$b = 1.00 \text{ m}$$

$$d = 41.71$$

$$Ku = \frac{4,672 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$Ku = 2.69$$

$$\text{Para } \begin{cases} f'c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 2.69 \end{cases} \Rightarrow \rho = 0.0007$$

Acero principal:

$$As = \rho \times b \times d$$

$$As = 0.0007 \times 100 \times 42 = 2.92$$

$$As = 2.92 \text{ cm}^2$$

$$As = 2.92 \Rightarrow 4 \text{ } \emptyset \text{ de } 1/2 \text{ " } = 5.07 \quad \text{OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$\text{Astemp} = 0.0018 \times b \times t \quad \text{N.T.P} \quad t = h_z = 0.50$$

$$\text{Astemp} = 0.0018 \times 100 \times 50 = 9.00 \text{ cm}^2$$

$$As = 9.00 \text{ cm}^2$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480

OK CUMPLE

⇒ 

USAR	8	Ø	de	1/2	@	0.15	ml
------	---	---	----	-----	---	------	----

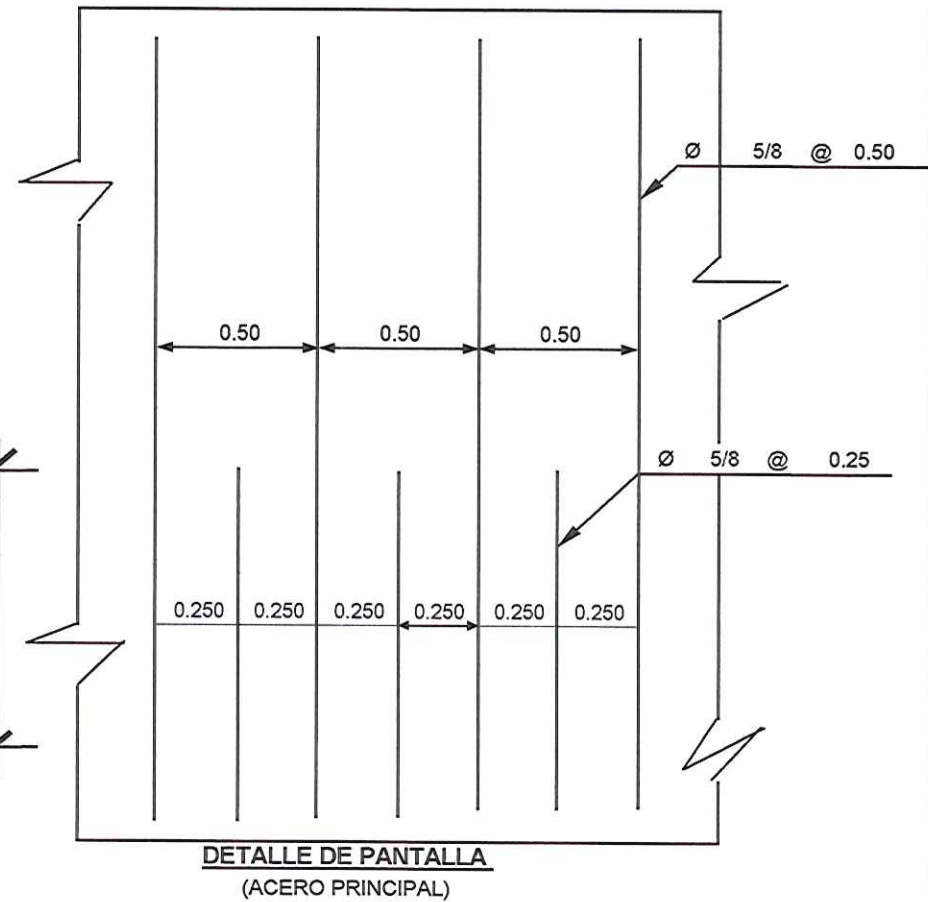
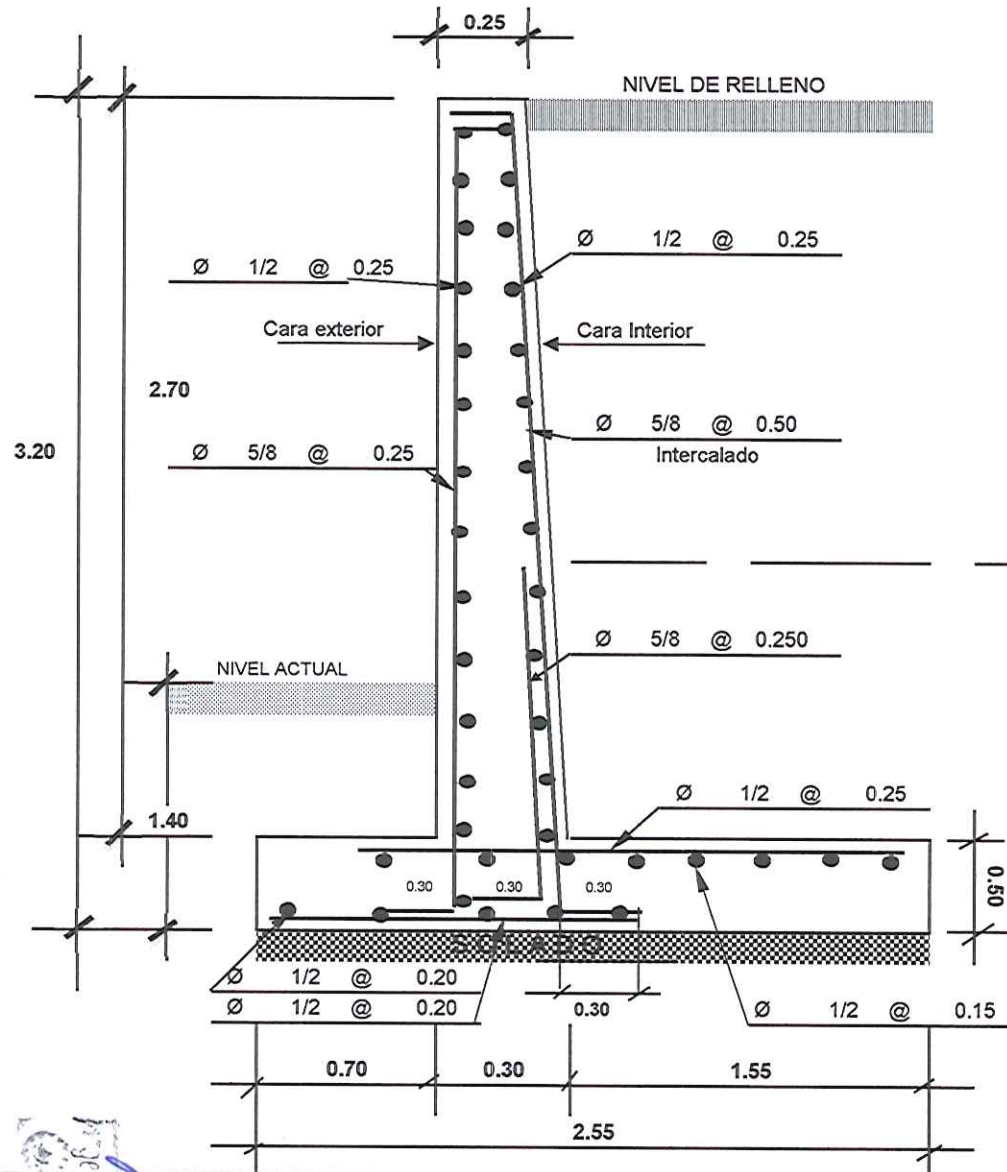
$$S \leq \frac{0.5}{45} t = \frac{0.5}{50} = 25$$
$$A_{\text{temp}} = \emptyset \quad 1/2 \quad @ \quad 0.20$$


* ACERO PRINCIPAL	=	Ø	1/2	@	0.25	m
* ACERO TRANSVERSAL	=	Ø	1/2	@	0.15	m



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480

# SEÑO DE MURO DE CONTENCION EN VOLADIZO



Ing. Omar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP N. 154480



1350  
5/8

578  
1349

DISEÑO DE MURO DE CONTENCIÓN			
EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : jul-2023

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	3.20	m
h 1 =	1.400	m
t 1 =	0.25	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava	
$\gamma = (\text{kg/m}^3)$	2650
$\phi = (^\circ)$	30°
$\sigma t = (\text{kg/cm}^2)$	1.20

#### C DATOS DEL C° Y ACERO

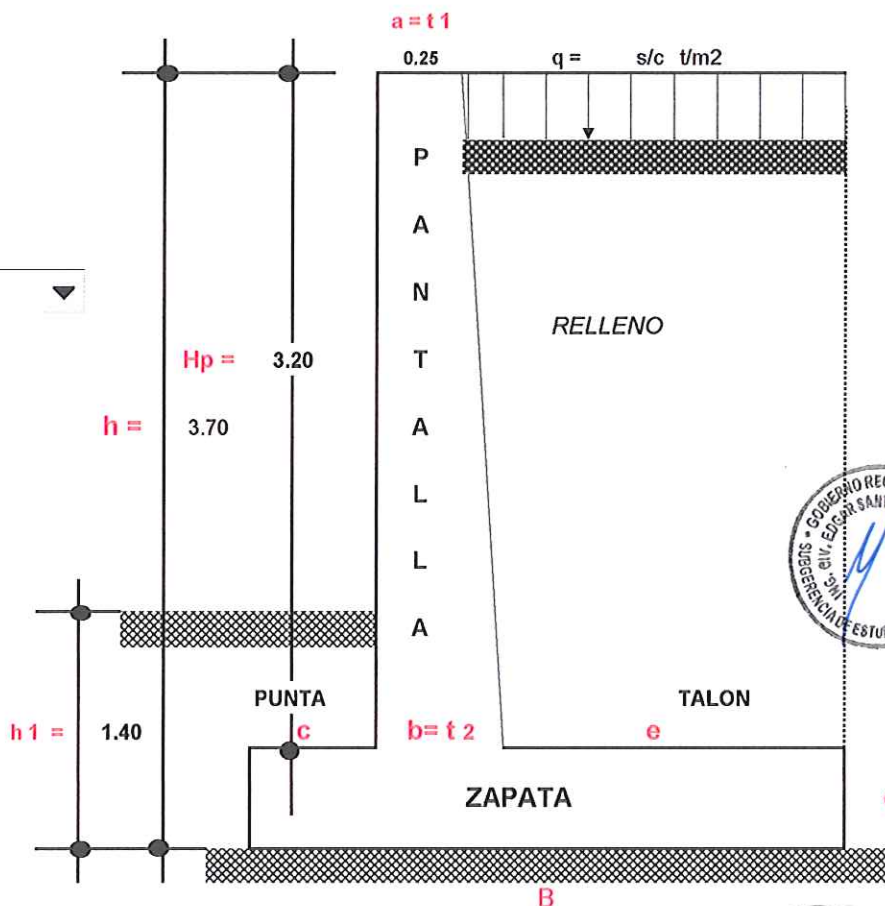
$f'c = (\text{kg/cm}^2)$	210
$f'y = (\text{kg/cm}^2)$	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	$\geq$	2
F.S.D	$\geq$	1.5

#### E SOBRECARGA

$q = \text{s/c t-m}^2$	0.50	tn
------------------------	------	----



#### 1.- PREDIMENSIONAMIENTO:

$$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.25 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{3.70}{12} \text{ ó } \frac{3.70}{10}$$

$$b = 0.31 \text{ ó } 0.37 \rightarrow \text{Asumido} = 0.35 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 3.70 \text{ ó } 0.8 \cdot 3.70$$

$$B = 1.85 \text{ ó } 2.96 \rightarrow \text{Asumido} = 2.95 \text{ m}$$

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480



572  
1348

$$c = \frac{1}{3} B - \frac{1}{2} b = 0.81$$

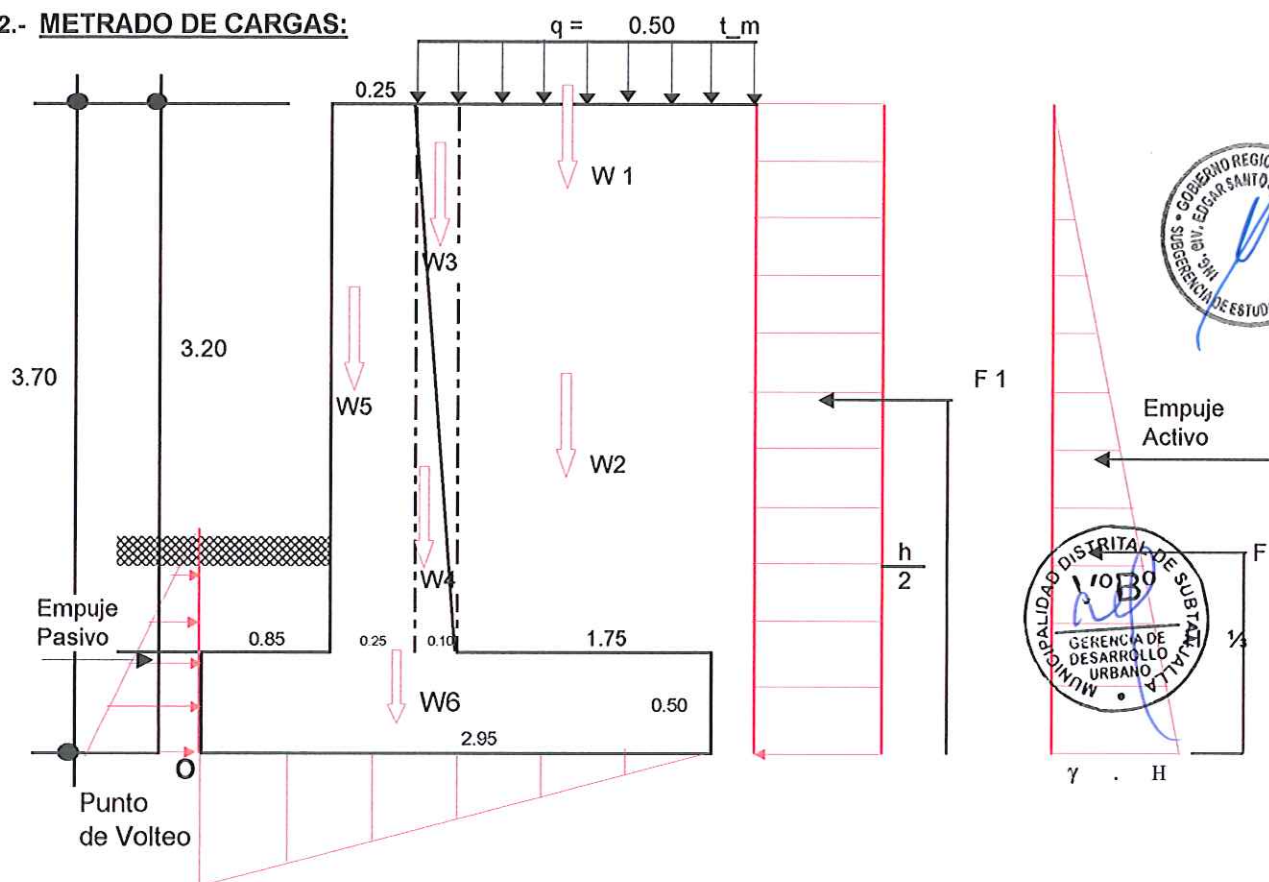
$$c = 0.81 \rightarrow \text{Asumido} = 0.85 \text{ m}$$

$$d = \begin{cases} = b = \\ = b + 5 \\ = b + 10 \\ = b + 15 \\ = b + 20 \end{cases} \quad 0.45 \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$e = B - c - b = 2.95 - 0.85 - 0.35$$

$$e = 1.75 \text{ m}$$

## 2.- METRADO DE CARGAS:



### a.\_ FUERZAS VERTICALES: 1.40 mts de Analisis

$W1$	$=$	$0.50 \text{ t/m}^2$	$\times$	$1.85$	$\times$	$1.40$	$=$	$1,295 \text{ kg}$
$W2$	$=$	$30 \text{ kg/cm}^2$	$\times$	$(1.75 \times 3.20)$	$\times$	$1.40$	$=$	$235 \text{ kg}$
$W3$	$=$	$30 \text{ kg/cm}^2$	$\times$	$(\frac{0.10 \times 3.20}{2})$	$\times$	$1.40$	$=$	$7 \text{ kg}$
$W4$	$=$	$2,400 \text{ kg/cm}^2$	$\times$	$(\frac{0.10 \times 3.20}{2})$	$\times$	$1.40$	$=$	$538 \text{ kg}$
$W5$	$=$	$2,400 \text{ kg/cm}^2$	$\times$	$0.25 \times 3.20$	$\times$	$1.40$	$=$	$2,688 \text{ kg}$

Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480



SA  
1347

$$W6 = 2400 \text{ kg/cm}^2 \times 2.95 \times 0.50 \times 1.40 = \frac{4,956 \text{ kg}}{\sum fy \quad 9,719 \text{ kg}}$$

b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

$$F_1 = [ (q) \times (H) \times 1.00 \text{ m} ] K_a$$

$$F_1 = [ 500 \text{ kg/cm}^2 \times 3.70 \times 1.00 ] \times 0.333$$

$$F_1 = 617 \text{ Kg/cm}^2$$

UBICACIÓN : F 1

$$F_1 = \frac{H}{2} = \frac{3.20}{2} = 1.6 \text{ m}$$

$$F_2 = (\text{vol}) D \cdot P$$

$$F_2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F_2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F_2 = \frac{1}{2} 30 \text{ kg/cm}^2 \times 3.20^2 \times 1.00 \times 0.333$$

$$F_2 = 51.20 \text{ Kg}$$

UBICACIÓN : F 2

$$F_2 = \frac{1}{3} H$$

$$F_2 = \frac{1}{3} 3.20 = 1.07 \text{ m}$$

3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	1,295	2.10	2,719.50
W2	235	2.10	493.92
W3	7	1.150	7.73
W4	538	1.150	618.24
W5	2,688	0.975	2,620.80
W6	4,956	1.48	7,310.10
$\sum MF_f$	9,719	$\sum MoF_y$	13,770.29



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480

570  
1346

FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F 1	617	1.600	986.67
F 2	51	1.07	54.78
$\Sigma Fh$	667.87	$\Sigma MFh$	1,041.45

$F_s V$	$\frac{13,770.29 \text{ kg/m}}{1,041.45 \text{ kg/m}}$	=	13.22	>	2	OK CUMPLE
---------	--	---	-------	---	---	-----------

3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$$F_s D = \frac{q \Sigma F_v}{\Sigma F_h} \geq 1.5 = \frac{f \text{ Empuje}}{f \text{ Rozamiento}}$$

$$q = \tan \phi \leq 0.60$$

$$q = 30^\circ = 0.577 > 0.60$$

$$q = 0.58$$

$F_s D$	$\frac{0.58 \cdot 9,719}{667.87}$	=	8.40	>	1.50	OK CUMPLE
---------	-----------------------------------	---	------	---	------	-----------



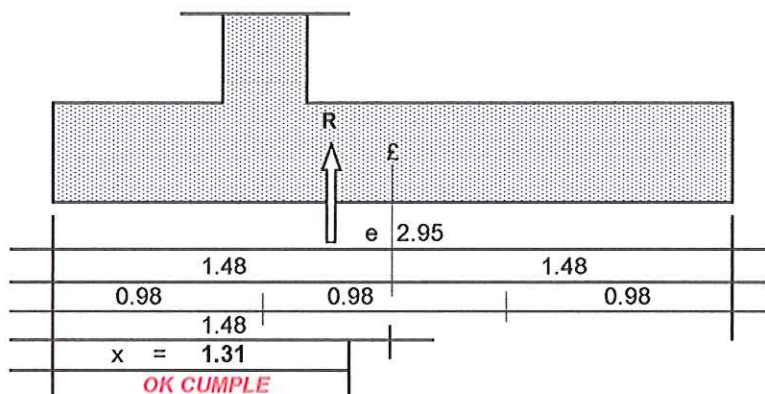
ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$$x = \frac{\Sigma Mo}{\Sigma F_y} \quad x = \frac{\Sigma Mo F_y - \Sigma Mo F_h}{\Sigma F_y}$$

$$x = \frac{13,770.29 - 1,041.45}{9,719}$$

$$x = 1.31$$

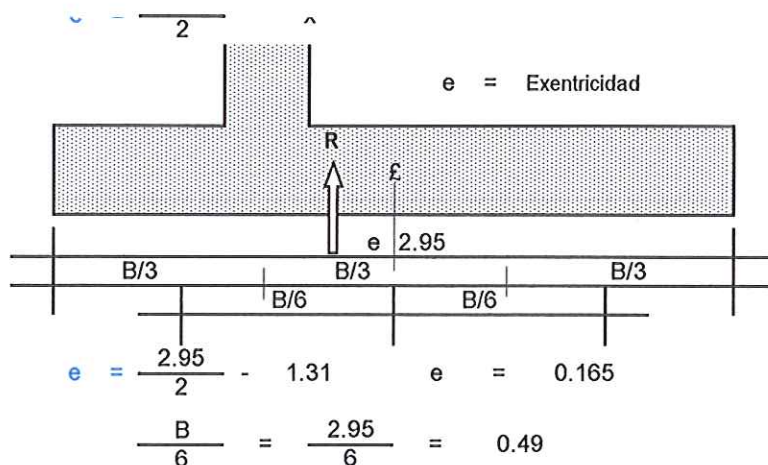


*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. N. 154480

2ro EXENTRICIDAD

$$e = \frac{B}{2} - x$$

569  
1348



### 3ro CALCULO DE LA PRESION ACTUANTE

$$q = \frac{\Sigma Fy}{A \cdot B} \left( 1 \pm \frac{6 \cdot e}{B} \right)$$

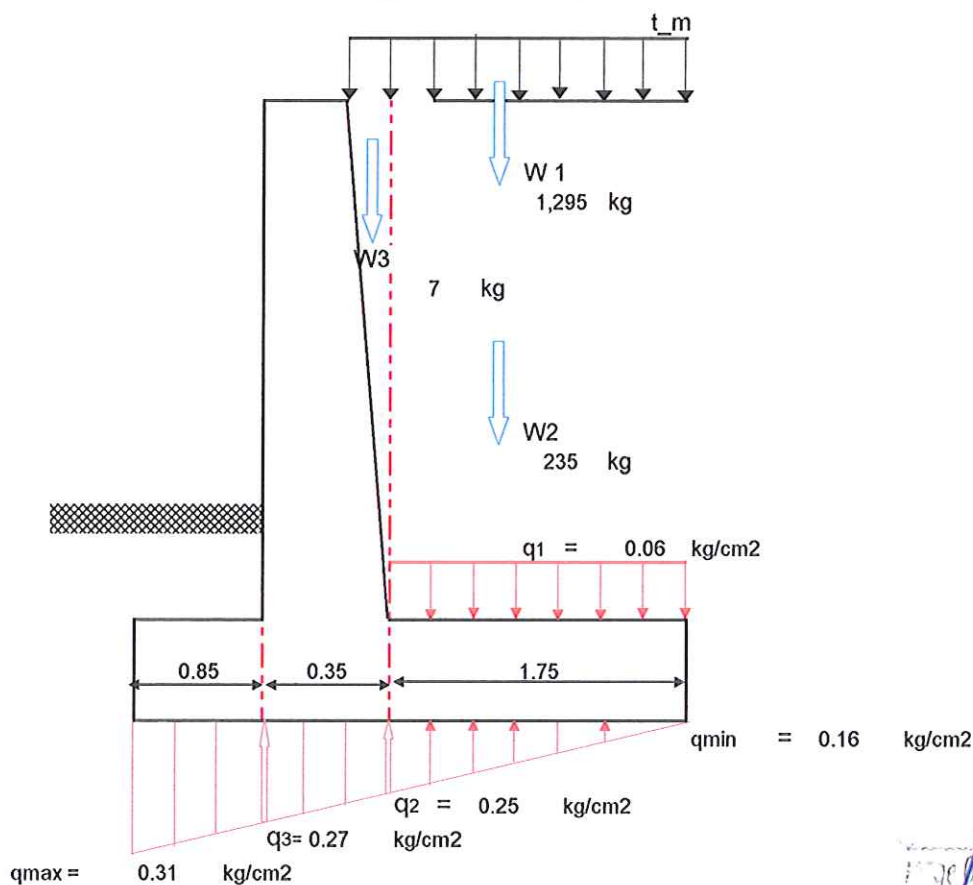
$$q = \frac{9,719}{1.40 \cdot 2.95} \left( 1 \pm \frac{6 \cdot 0.165}{2.95} \right)$$

$$q = 2,353.15 \quad 1 \pm 0.3361$$

$$q_{\max} = 3,144.05 \text{ kg/m}^2 \rightarrow 0.31$$

$$q_{\min} = 1,562.26 \text{ kg/m}^2 \rightarrow 0.16$$

$$\begin{matrix} q_{\max}, q_{\min} < \sigma_t = \text{OK CUMPLE} \\ 0.31 < 1.20 \end{matrix}$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480

568  
1344

$$q = \frac{w1 + w2 + w3}{A \text{ talón}} \quad q = \frac{1,295 + 235 + 7}{1.75 \times 1.40}$$

$$q = 627.31 \text{ kg/m}^2 \rightarrow 0.06 \text{ kg/cm}^2$$

$$\frac{1.75}{x} = \frac{2.95}{0.16}$$

$$x = 0.094 \rightarrow q2 = 0.16 + x$$

$$q2 = 0.16 + 0.094$$

$$q2 = 0.25 \text{ kg/cm}^2$$

$$\frac{1.75 + 0.35}{y} = \frac{2.95}{0.16}$$

$$y = 0.113$$

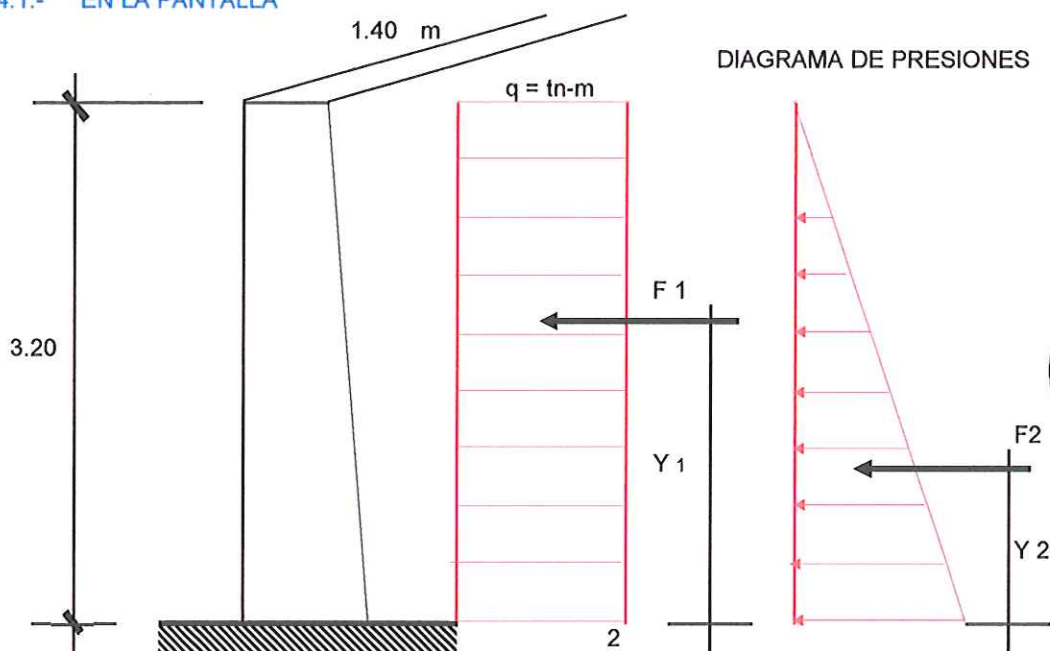
$$q3 = 0.16 + y$$

$$q3 = 0.16 + 0.113$$

$$q3 = 0.27 \text{ kg/cm}^2$$

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



##### a) MOMENTO FLECTOR

En

$$F1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$$

$$F1 = (500 \text{ kg-m} \times 3.20 \text{ m} \times 1.00 \text{ m}) \cdot 0.333$$

$$F1 = 533.33 \text{ kg}$$

$$y1 = \frac{h}{2} = \frac{3.20}{2} = 1.6$$

$$y1 = 1.6 \text{ m}$$

En

$$F2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00 \text{ m}) \cdot Ka$$

$$F2 = \frac{1}{2} \cdot 30 \cdot \frac{10.24}{3.20} \cdot 1.00 \cdot 0.333 = 51.20 \text{ kg}$$

$$F2 = 0.05 \text{ tn-m}$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 152480



567  
1343

$$y_2 = \frac{1}{3} h \quad y_2 = \frac{1}{3} 3.20$$

$$y_2 = 1.07 \text{ m}$$

#### MOMENTO ULTIMO

$$M_{\max} = (F_1 Y_1) + (F_2 Y_2)$$

$$M_{\max} = (533.33 \times 1.6) + (51.20 \times 1.07)$$

$$M_{\max} = 907.95 \text{ kg-m}$$

#### b) FUERZA CORTANTE

##### \* FUERZA CORTANTE ACTUANTE

$$V = F_1 + F_2$$

$$V = 533.33 + 51.20$$

$$V = 584.53 \text{ kg}$$

##### \* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \begin{cases} V = 584.53 \\ b = 1.00 \\ d = 0.31 \end{cases}$$

$$\mu = \frac{584.53}{100 \cdot 31} = 0.19$$

$$\mu = 0.19 \text{ kg/cm}^2$$

##### \* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

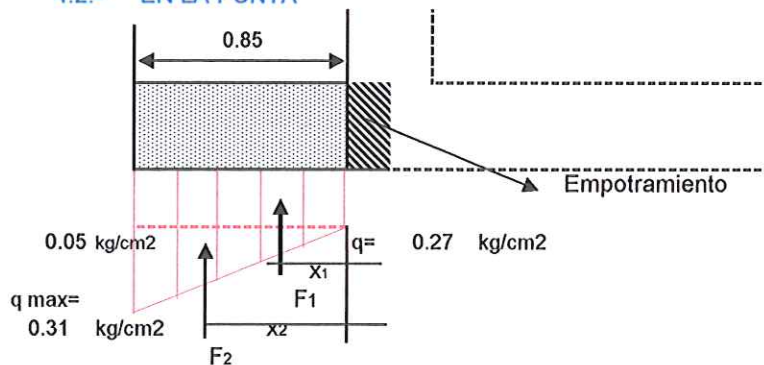
$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.19 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$



#### 4.2.- EN LA PUNTA



#### a) MOMENTO FLECTOR

En:

$$F_1 = 0.27 \times 0.85 \times 1.00$$

$$F_1 = 2,285 \text{ Kg}$$

Ing. Oscar Huaman Espinoza  
INGENIERO CIVIL  
REG. CIP N. 153380



En

F2 = 193.70 kg

$$X_2 = 0.57 \text{ mt}$$

$$M_{\text{máx}} = (F_1 \cdot X_1) + (F_2 \cdot X_2)$$

$$M_{\text{máx}} = (2,285 \times 0.43) + (193.70 \times 0.57)$$

$M_{\text{máx}} = -861.38 \text{ kg-m}$

$$V = F_1 + F_2$$

$$V = 2,285 + 193.70$$

V = 2,478.74 kg

$$u = \frac{v}{b \cdot d}$$

$$u = \frac{2,478.74}{85 \quad 31}$$

$$\eta = 0.94 \text{ kg/cm}^2$$

$$V_c = \phi \quad 0.53 \sqrt{f'_c}$$

$$V_C = \begin{matrix} 0.85 & 0.53 & 14.49 \end{matrix}$$

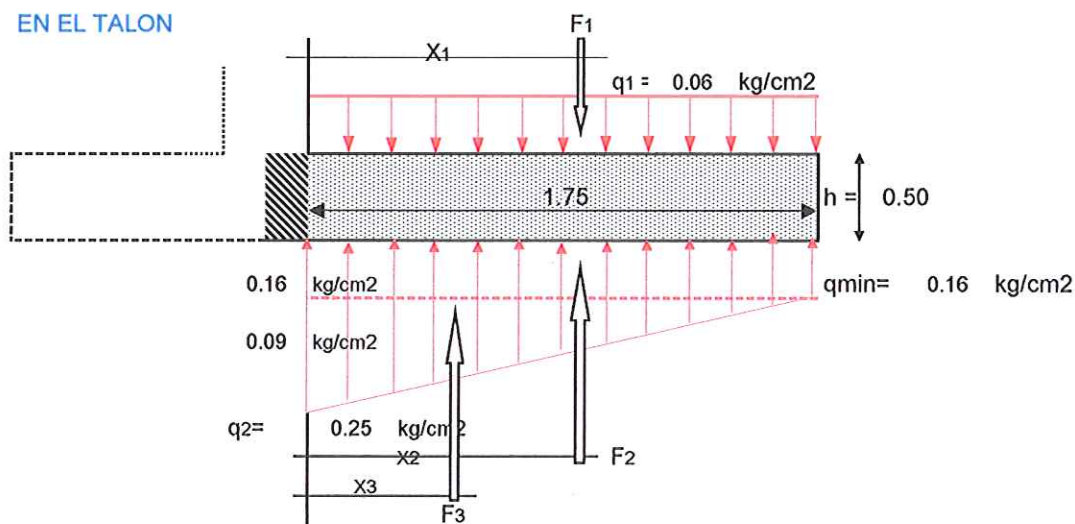
$$V_c = 6.53$$



Je Oñar Huaman Espino

865  
1341

4.3.- EN EL TALON



$$F1 = 0.06 \text{ kg/cm}^2 \cdot 175 \text{ cm} \cdot 100 \text{ cm}$$

$$F1 = 1,097.80 \text{ kg}$$

$$X1 = \frac{1.75}{2}$$

$$X1 = 0.88 \text{ m}$$

$$F2 = 0.16 \text{ kg/cm}^2 \cdot 175 \text{ cm} \cdot 100 \text{ cm}$$

$$F2 = 2,733.95 \text{ kg}$$

$$X2 = \frac{1.75}{2}$$

$$X2 = 0.88 \text{ m}$$

$$F3 = \frac{1}{2} \cdot 0.09 \text{ kg/cm}^2 \cdot 175 \text{ cm} \cdot 100 \text{ cm}$$

$$F3 = 821.06 \text{ kg}$$

$$X3 = \frac{1}{3} \cdot 1.75$$

$$X3 = 0.58 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2 \cdot X2) + (F3 \cdot X3) - (F1 \cdot X1)$$

$$M = (2,733.95 \times 0.88) + (821.06 \times 0.58) - (1,098 \times 0.88)$$

$$M = 3,831.7 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 1,097.80 - 2,733.95 - 821.06$$

$$V = -2,457.21 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{M} \quad \mu = \frac{-2,457.21}{3,831.7}$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 124460

564  
1340

b d 100 31

$$\mu = -0.79 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = \phi 0.53 \sqrt{f'_c}$$

$$V_c = 0.85 0.53 14.49$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu_{act} -0.79 \text{ kg/cm}^2 \text{ OK CUMPLE}$$

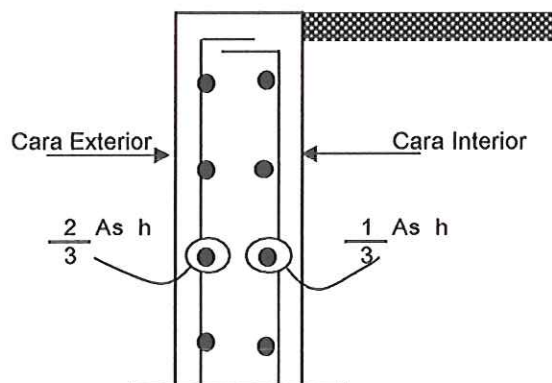
5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

$$\begin{aligned} \text{Para } \phi \leq 5/8" & \quad A_{smin} \text{ (Vertical)} = 0.0012 b h \\ \text{Para } \phi > 5/8" & \quad A_{smin} \text{ (Vertical)} = 0.0015 b h \end{aligned}$$

b- Acero Mínimo Horizontal en muros:

$$\begin{aligned} \text{Para } \phi \leq 5/8" & \quad A_{smin} \text{ (Horizontal)} = 0.0020 b h \\ \text{Para } \phi > 5/8" & \quad A_{smin} \text{ (Horizontal)} = 0.0025 b h \end{aligned}$$



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b d^2}$$

$$A_s = \rho b d$$

5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = 1.6$$

$$M_u = 1.6 \quad 907.95 = 1,452.71$$

$$M_u = 1,453 \text{ kg/m}$$

$$K_u = \frac{1,453 \times 10^2}{100 \times 961} \text{ kg/cm}^2$$

$$K_u = 1.51$$

$$\rho = \begin{aligned} & \text{Para } \left\{ \begin{array}{l} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.51 \end{array} \right. \Rightarrow \rho = 0.0004 \end{aligned}$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

863  
1339

Acero principal:

$$A_s = \rho \cdot b \cdot d$$

$$A_s = 0.0004 \cdot 100 \cdot 31 = 1.24$$

$$A_s = 1.24 \text{ cm}^2$$

$$A_s = \boxed{1.24} \Rightarrow \boxed{4} \text{ } \emptyset \boxed{3/4"} \nabla \boxed{11.40}$$

OK CUMPLE

$$S = \frac{2.85}{11.40} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \emptyset \text{ de } 3/4 @ 0.250 \text{ ml}}$$

+ - 0.50 CM2

b) Acero mínimo Vertical

$$A_{s\text{min}} (\text{vertical}) = 0.0015 \cdot 100 \cdot 31$$

$$A_{s\text{mín}} = 4.65 \text{ cm}^2$$

$$\boxed{A_s \text{ princ } 11.40} > \boxed{A_s \text{ min } 4.65} \text{ OK CUMPLE}$$



## 5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$A_{s\text{min}} (\text{vertical}) = 0.0012 \cdot 100 \cdot 31$$

$$A_{s\text{mín}} = 3.72 \text{ cm}^2$$

$$A_s = 3.72 \text{ cm}^2$$

$$A_s = \boxed{3.72} \Rightarrow \boxed{2} \text{ } \emptyset \boxed{5/8"} \nabla \boxed{3.96}$$

OK CUMPLE

$$S = \frac{1.98}{3.96} \times 100$$

$$S = 50.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 2 \text{ } \emptyset \text{ de } 5/8 @ 0.25 \text{ ml}}$$



## 5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\emptyset \leq 5/8"$

$$A_{s\text{min}} = 0.0020 \cdot b \cdot d$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N° 154480

562  
1338

1) Arriba: (h = 0.25 )

$$As_{min} = 0.0020 \cdot 100 \cdot 0 = 0.05$$

$$As_{min} = 5.00 \text{ cm}^2$$

a) Cara Interior

$$\frac{1}{3} Ash = \frac{1}{3} 5.00 = 1.67 \text{ cm}^2/\text{m}$$

$$As = 1.67 \text{ cm}^2$$

$$As = \boxed{5.00} \Rightarrow \boxed{4} \text{ Ø } \boxed{1/2"} \nabla = \boxed{5.07} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ Ø de } 1/2 @ 0.25 \text{ m}}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 5 = 3.33 \text{ cm}^2/\text{m}$$

$$As = 3.33 \text{ cm}^2$$

$$As = \boxed{3.33} \Rightarrow \boxed{5} \text{ Ø } \boxed{3/8"} \nabla = \boxed{3.56} \text{ OK CUMPLE}$$

$$S = \frac{0.71}{3.56} \times 100$$

$$S = 20.00 \text{ Asumido } \Rightarrow \boxed{0.20} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 5 \text{ Ø de } 3/8 @ 0.20 \text{ m}}$$

2) Cara Intermedia (h =  $\frac{35 + 25}{2}$ ) = 30 cm

$$As_{min} \text{ (Horizontal)} = 0.0020 \cdot 100 \cdot 30 = 6.00 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} 6.00 = 2.00 \text{ cm}^2/\text{m}$$

$$As = 2.00 \text{ cm}^2$$

$$As = \boxed{6.00} \Rightarrow \boxed{5} \text{ Ø } \boxed{1/2"} \nabla = \boxed{6.33} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \text{ Asumido } \Rightarrow \boxed{0.20} \text{ m}$$



Omar Huaman Espino  
INGENIERO  
REG. 1000



SGI  
1337

⇒ 

USAR	5	Ø	de	1/2	@	0.20	ml
------	---	---	----	-----	---	------	----

b) Cara Exterior:

$$\frac{2}{3} \text{ Ash} = \frac{2}{3} 6.0 = 4.00 \text{ cm}^2/\text{m}$$



  
Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

560  
1336

$$As = 4.00 \text{ cm}^2$$

$$As = \frac{4.00}{5.07} \Rightarrow 4 \text{ } \emptyset \text{ } 1/2" = 5.07$$

OK CUMPLE

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

3) Cara Inferior (abajo) (h = 0.35 m)

$$As \text{ min (Horizontal)} = 0.0020 \times 100 \times 35.00 = 7.00$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} \times 7.00 = 2.33 \text{ cm}^2/\text{m}$$

$$As = 2.33 \text{ cm}^2$$

$$As = \frac{2.33}{3.96} \Rightarrow 2 \text{ } \emptyset \text{ } 5/8" = 3.96$$

OK CUMPLE

$$S = \frac{1.98}{3.96} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.25 \text{ m}$$

$$\Rightarrow \text{USAR } 2 \text{ } \emptyset \text{ de } 5/8 \text{ @ } 0.25 \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} \times 7.0 = 4.67 \text{ cm}^2/\text{m}$$

$$As = 4.67 \text{ cm}^2$$

$$As = \frac{4.67}{5.07} \Rightarrow 4 \text{ } \emptyset \text{ } 1/2" = 5.07$$

OK CUMPLE

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow 0.250 \text{ m}$$

$$\Rightarrow \text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 \text{ @ } 0.25 \text{ m}$$

## Resumen

### Acero Horizontal

- |            |   |                     |   |                          |                 |
|------------|---|---------------------|---|--------------------------|-----------------|
| 1) Ariba   | = | (As mín Horizontal) | = | 5.00                     | cm <sup>2</sup> |
|            |   | Cara Interior       | = | $\emptyset$ 1/2 @ 0.25 m |                 |
|            |   | Cara exterior       | = | $\emptyset$ 3/8 @ 0.20 m |                 |
| 2) Intermd | = | (As mín Horizontal) | = | 6.00                     | cm <sup>2</sup> |



Ing. Omar Huaman Espino  
INGENIERO  
REG. CIP 1448

889  
1335

$$\begin{aligned}
 \text{Cara Interior} &= \emptyset \quad 1/2 \quad @ \quad 0.20 \quad \text{m} \\
 \text{Cara exterior} &= \emptyset \quad 1/2 \quad @ \quad 0.25 \quad \text{m} \\
 3) \text{ Inferior} &= (\text{As mín Horizontal}) = 7.00 \quad \text{cm}^2 \\
 \text{Cara Interior} &= \emptyset \quad 5/8 \quad @ \quad 0.25 \quad \text{m} \\
 \text{Cara exterior} &= \emptyset \quad 1/2 \quad @ \quad 0.250 \quad \text{m}
 \end{aligned}$$

Para cara Interior

$$C.I \quad 2 \quad \emptyset \quad 5/8 \quad @ \quad 0.25 \quad , \quad 5 \quad \emptyset \quad 1/2 \quad @ \quad 0.20 \quad \text{Rto} \quad \emptyset \quad 5/8 \quad @ \quad 0.25$$

Para Exterior:

$$C.E \quad 4 \quad \emptyset \quad 1/2 \quad @ \quad 0.25 \quad , \quad 4 \quad \emptyset \quad 1/2 \quad @ \quad 0.25 \quad \text{Rto} \quad \emptyset \quad 1/2 \quad @ \quad 0.20$$

Entonces:

$$\begin{aligned}
 C.I &= \emptyset \quad 5/8 \quad @ \quad 0.233 \quad \approx \quad 0.25 \\
 C.E &= \emptyset \quad 1/2 \quad @ \quad 0.233 \quad \approx \quad 0.25
 \end{aligned}$$

$$\text{SI UNIFORMAMOS EL ACERO} \quad 0.233 \quad \text{a} \quad 0.233 \quad = \quad 0.233 \quad \approx \quad 0.250$$

$$\begin{aligned}
 \text{tenemos:} \quad \emptyset \quad 5/8 \quad @ \quad 0.25 \\
 \emptyset \quad 1/2 \quad @ \quad 0.25
 \end{aligned}$$

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$M_u = 1.6 \times -861.38 \quad \text{kg-m} = -1,378.20 \quad \text{kg/m}$$

$$b = 1.00 \quad \text{mt}$$

$$d = h_z - \frac{(r + \emptyset \text{ vlla})}{2}$$

$$d = 50 - 7.5 + \frac{1.58}{2}$$

$$d = 41.71$$

$$K_u = \frac{-1,378 \times 10^2 \quad \text{kg/cm}^2}{100 \quad 1740}$$

$$K_u = -0.79$$

$$\begin{aligned}
 \text{Para} \quad \left\{ \begin{array}{l} f_c = 210 \quad \text{Kg/cm}^2 \\ f_y = 4,200 \quad \text{Kg/cm}^2 \\ K_u = -0.79 \end{array} \right. \Rightarrow \rho = -0.0002
 \end{aligned}$$

Acero principal:

$$A_s = \rho \quad b \quad d$$

$$A_s = -0.0002 \quad 100 \quad 42 = -0.83$$

$$A_s = -0.83 \quad \text{cm}^2$$

$$A_s = \boxed{6.67} \Rightarrow \boxed{6} \quad \emptyset \quad 1/2" \quad \nabla \quad = \quad \boxed{7.60}$$

OK CUMPLE

$$+ - 0.50 \text{ CM}^2$$



Jorge Omar Huaman Espino  
INGENIERO CIVIL  
REG CIP N° 154480

588  
1334

$$S = \frac{1.27}{7.60} \times 100$$

$$S = 16.67 \quad \text{Asumido} \Rightarrow 0.20 \text{ m}$$

$\Rightarrow$  USAR 6 Ø de 1/2 @ 0.20 ml

Acero mínimo:

$$Asmín = 0.0018 \times 100 \times 41.71 = 7.51$$

$$7.51 < 7.60 \quad \text{OK CUMPLE}$$

ZAPATA POSTERIOR

$$Mu = 1.6 \times 3,832 \text{ kg-m} = 6,130.77 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = 41.71$$

$$Ku = \frac{6,131 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$Ku = 3.52$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 3.52 \end{cases} \Rightarrow \rho = 0.0009$



Acero principal:

$$As = \rho \times b \times d$$

$$As = 0.0009 \times 100 \times 42 = 3.75$$

$$As = 3.75 \text{ cm}^2$$

$$As = 3.75 \Rightarrow 4 \text{ Ø } 1/2 \text{ } \nabla = 5.07 \quad \text{OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

$\Rightarrow$  USAR 4 Ø de 1/2 @ 0.25 ml

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$Astemp = 0.0018 \times b \times t \quad \text{N.T.P} \quad t = h_z = 0.50$$

$$Astemp = 0.0018 \times 100 \times 50 = 9.00 \text{ cm}^2$$

1333

$$A_s = 9.00 \text{ cm}^2$$

$$A_s = \frac{9.00}{\frac{8}{\frac{1}{2}}} = 10.13 \quad \text{OK CUMPLE}$$

$$S = \frac{1.27}{10.13} \times 100$$

$$S = 12.50 \text{ Asumido} \Rightarrow 0.15 \text{ m}$$

$$\Rightarrow \text{USAR } 8 \text{ de } 1/2 @ 0.15 \text{ m}$$

PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:

$$S \leq \frac{0.5}{45} t = \frac{0.5}{50} = 25$$

SE TOMA EL MENOR:

$$A_{temp} = \emptyset \quad 1/2 @ 0.20$$



### RESUMEN GENERAL DEL ACERO

#### 1.- PANTALLA:

##### \* ACERO VERTICAL

- Cara Interior	=	$\emptyset$	3/4	@	0.50 m	Intercalado ó
	=	$\emptyset$	3/4	@	0.25 m	a una (h) de 1.50
- Cara Exterior	=	$\emptyset$	5/8	@	0.25 m	

##### \* ACERO HORIZONTAL

- Cara Interior	=	$\emptyset$	5/8	@	0.25 m
- Cara Exterior	=	$\emptyset$	1/2	@	0.25 m

#### 2.- ZAPATA ANTERIOR (PUNTA)

* ACERO PRINCIPAL	=	$\emptyset$	1/2	@	0.20 m
* ACERO TRANSVERSAL	=	$\emptyset$	1/2	@	0.20 m

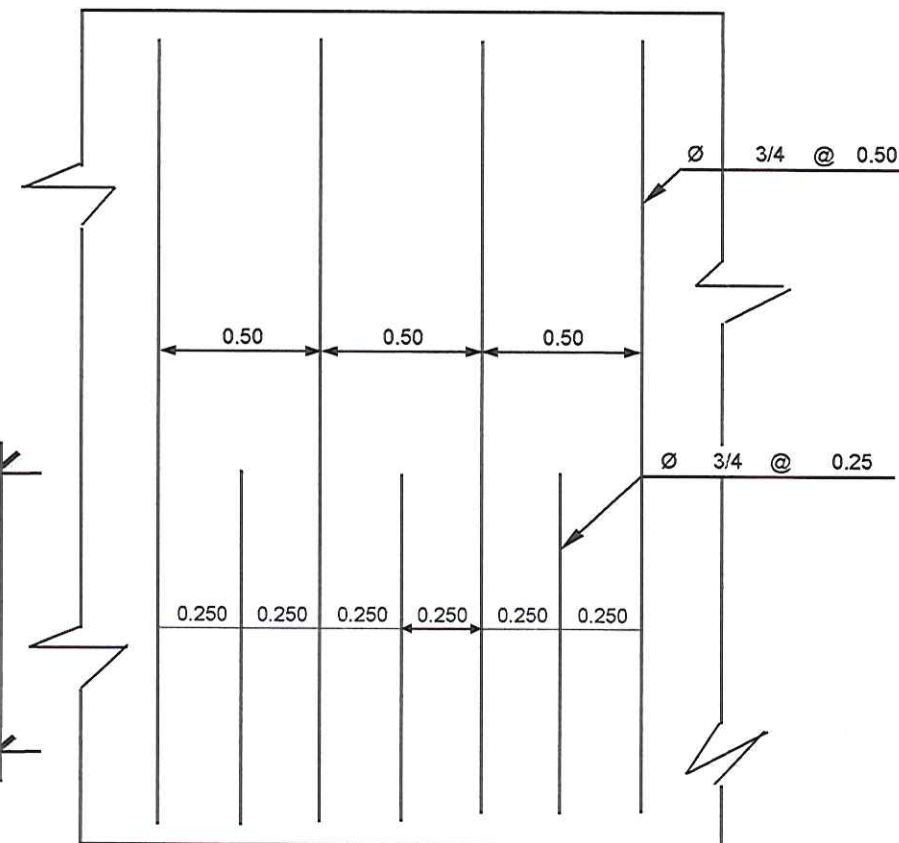
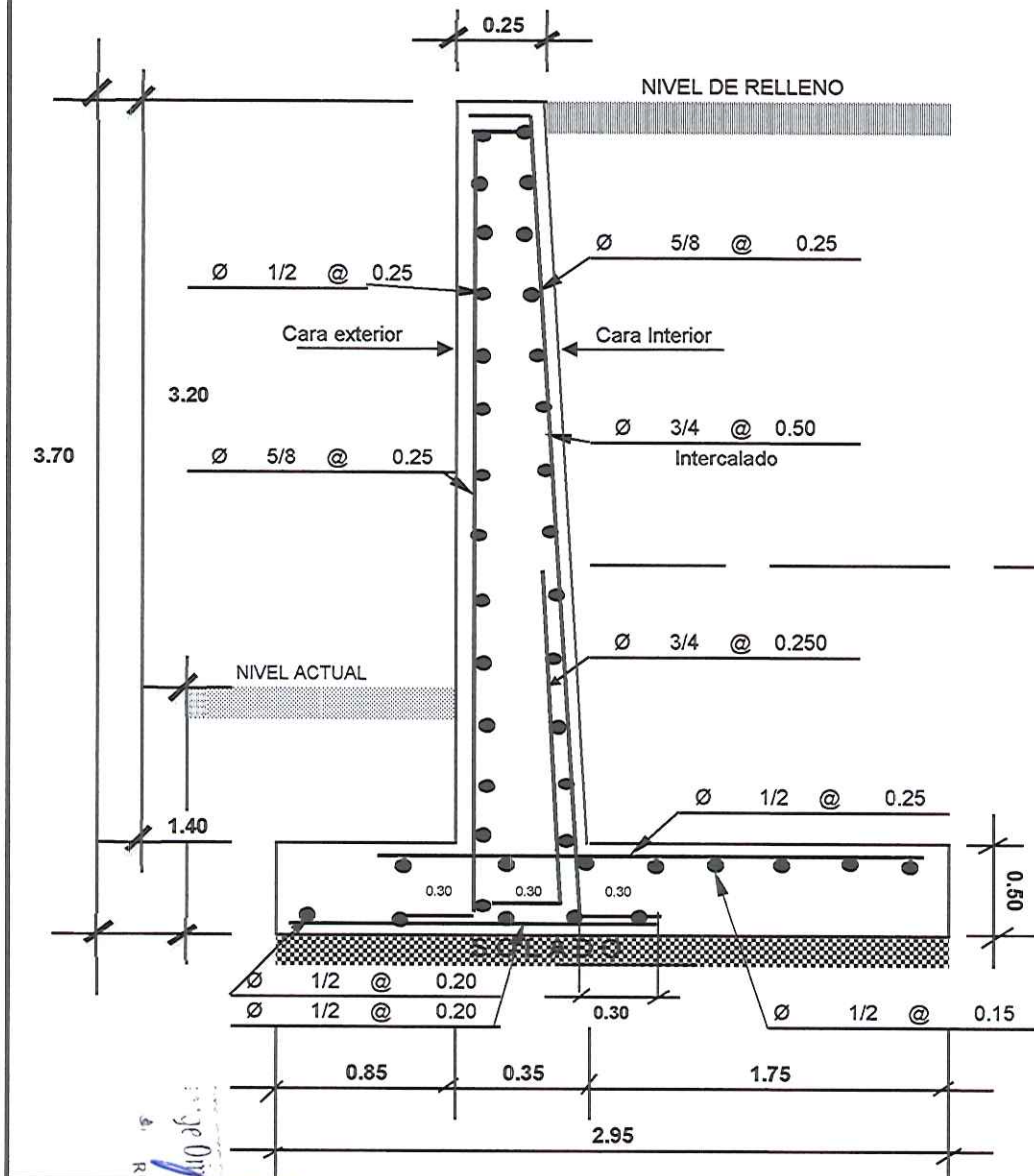
#### 3.- ZAPATA POSTERIOR (TALON)

* ACERO PRINCIPAL	=	$\emptyset$	1/2	@	0.25 m
* ACERO TRANSVERSAL	=	$\emptyset$	1/2	@	0.15 m

Ing. *Mar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480



# DISEÑO DE MURO DE CONTENCION EN VOLADIZO



DETALLE DE PANTALLA  
 (ACERO PRINCIPAL)

Ing. Omar Huaman Espinoza  
 INGENIERO CIVIL  
 REG. CIP N. 15480



1332  
 S56

588  
1331

DISEÑO DE MURO DE CONTENCIÓN			
EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : Marzo-2022

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	3.70	m
h 1 =	1.400	m
t 1 =	0.30	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava		
$\gamma = (\text{kg/m}^3)$	2650	
$\phi = (^\circ)$	30°	
$\sigma t = (\text{kg/cm}^2)$	1.20	

#### C DATOS DEL C° Y ACERO

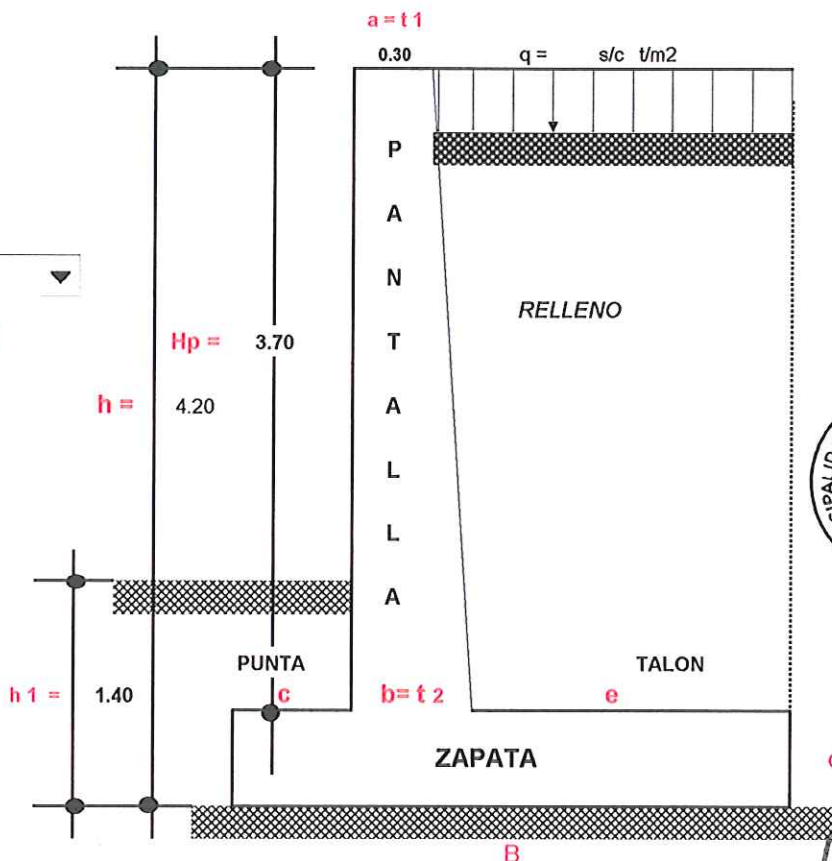
$f'c = (\text{kg/cm}^2)$	210
$f'y = (\text{kg/cm}^2)$	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	≥	2
F.S.D	≥	1.5

#### E SOBRECARGA

$q = \text{s/c t-m}^2$	0.50	tn
------------------------	------	----



#### 1.- PREDIMENSIONAMIENTO:

$$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.30 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{4.20}{12} \text{ ó } \frac{4.20}{10}$$

$$b = 0.35 \text{ ó } 0.42 \rightarrow \text{Asumido} = 0.40 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 4.20 \text{ ó } 0.8 \cdot 4.20$$

$$B = 2.10 \text{ ó } 3.36 \rightarrow \text{Asumido} = 3.35 \text{ m}$$

Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 153489

559  
1330

$$c = \frac{1}{3} B - \frac{1}{2} b = 0.92$$

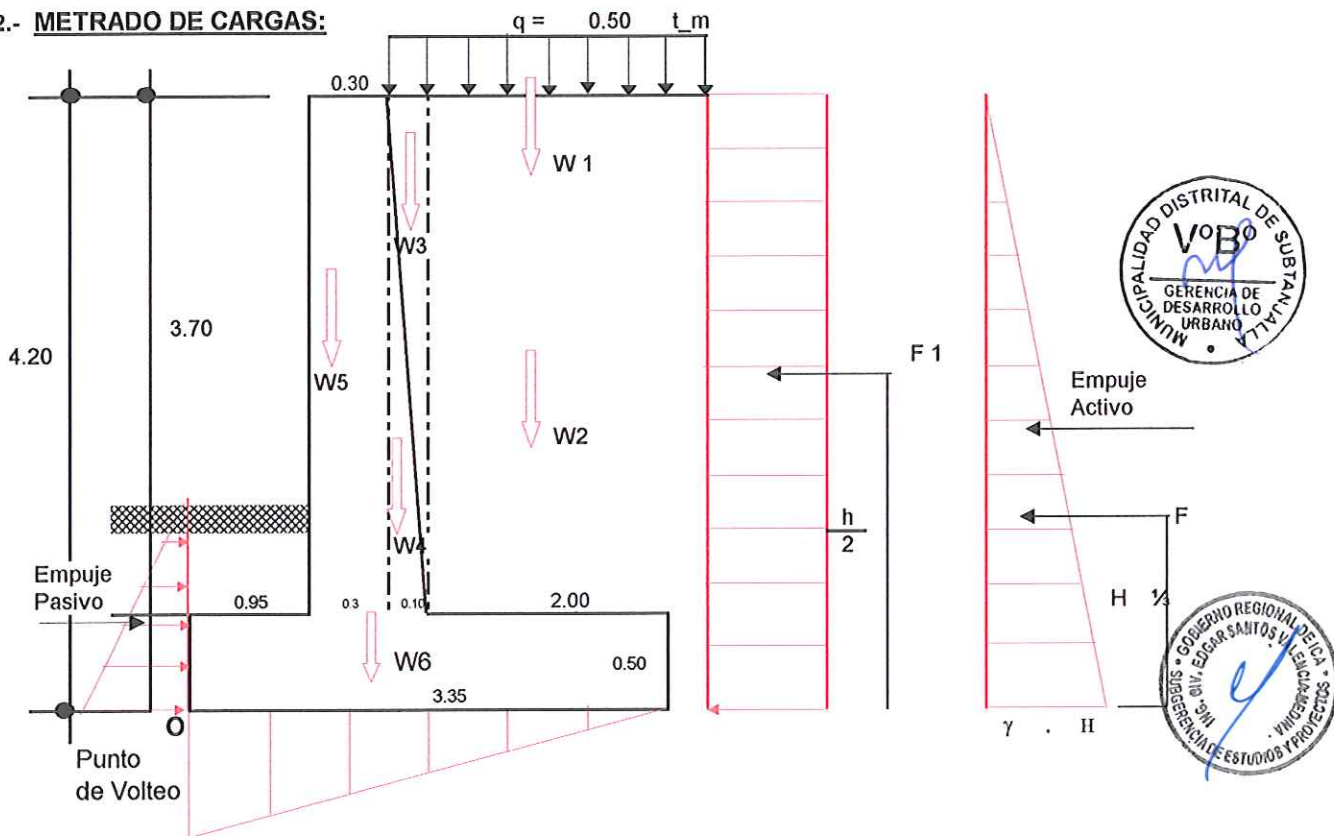
$$c = 0.92 \rightarrow \text{Asumido} = 0.95 \text{ m}$$

$$d = \begin{cases} = b = \\ = b + 5 \\ = b + 10 \\ = b + 15 \\ = b + 20 \end{cases} \quad 0.50 \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$e = B - c - b = 3.35 - 0.95 - 0.40$$

$$e = 2.00 \text{ m}$$

## 2.- METRADO DE CARGAS:



### a.\_ FUERZAS VERTICALES: 1.40 mts de Analisis

W1	=	0.50 t/m2	x	2.10	x	1.40	=	1,470	kg
W2	=	30 kg/cm2	x	( 2.00 x 3.70 )	x	1.40	=	311	kg
W3	=	30 kg/cm2	x	( $\frac{0.10 \times 3.70}{2}$ )	x	1.40	=	8	kg
W4	=	2,400 kg/cm2	x	( $\frac{0.10 \times 3.70}{2}$ )	x	1.40	=	622	kg
W5	=	2,400 kg/cm2	x	0.3 x 3.70	x	1.40	=	3,730	kg
W6	=	2400 kg/cm2	x	3.35 x 0.50	x	1.40	=	5,628	kg
$\Sigma f_y$								11,768	kg

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
R.G. CIP N° 154480

883  
1329

b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE ( $K_a$ )

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

$$F_1 = [ (q) \times (H) \times 1.00 \text{ m} ] K_a$$

$$F_1 = [ 500 \text{ kg/cm}^2 \times 4.20 \times 1.00 ] \times 0.333$$

$$F_1 = 700 \text{ Kg/cm}^2$$

UBICACIÓN : F 1

$$F_1 = \frac{H}{2} = \frac{3.70}{2} = 1.85 \text{ m}$$

$$F_2 = (vol) D \cdot P$$

$$F_2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F_2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F_2 = \frac{1}{2} 30 \text{ kg/cm}^2 \times 3.70^2 \times 1.00 \times 0.333$$

$$F_2 = 68.45 \text{ Kg}$$

UBICACIÓN : F 2

$$F_2 = \frac{1}{3} H$$

$$F_2 = \frac{1}{3} 3.70 = 1.23 \text{ m}$$

3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	1,470	2.40	3,528.00
W2	311	2.40	745.92
W3	8	1.300	10.10
W4	622	1.300	808.08
W5	3,730	1.100	4,102.56
W6	5,628	1.68	9,426.90
$\sum MF_f$	11,768	$\sum MoF_y$	18,621.56



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. 14420



582  
1328

FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F 1	700	1.850	1,295.00
F 2	68	1.23	84.19
$\Sigma Fh$	768.45	$\Sigma MFh$	1,379.19

$Fs V$	$\frac{18,621.56 \text{ kg/m}}{1,379.19 \text{ kg/m}}$	=	13.50	>	2
--------	--	---	-------	---	---

OK CUMPLE

3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$$Fs D = \frac{q \Sigma Fv}{\Sigma Fh} \geq 1.5 = \frac{f \text{ Empuje}}{f \text{ Rozamiento}}$$

$$q = \tan \phi \leq 0.60$$

$$q = 30^\circ = 0.577 > 0.60$$

$$q = 0.58$$

$Fs D$	$\frac{0.58 \cdot 11,768}{768.45}$	=	8.84	>	1.50
--------	------------------------------------	---	------	---	------

OK CUMPLE

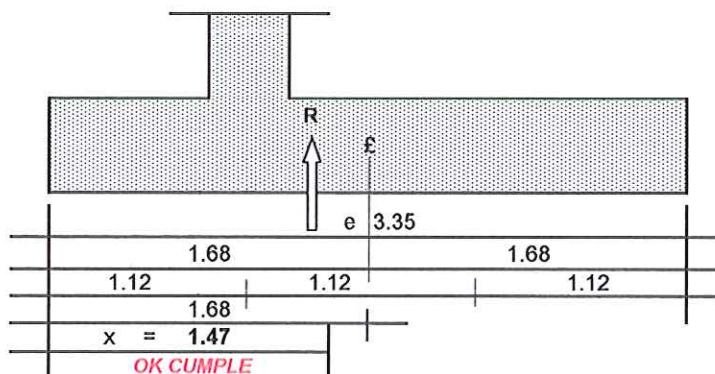
ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$$x = \frac{\Sigma Mo}{\Sigma Fy} \quad x = \frac{\Sigma MoFy - \Sigma MoFh}{\Sigma Fy}$$

$$x = \frac{18,621.56 - 1,379.19}{11,768}$$

$$x = 1.47$$



OK CUMPLE



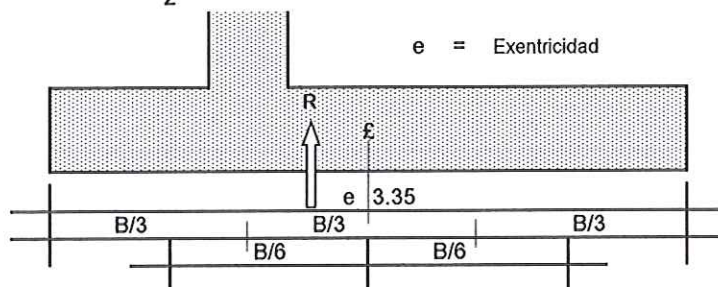
*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154380



881  
1327

## 2ro EXENTRICIDAD

$$e = \frac{B}{2} - x$$



e = Excentricidad

$$e = \frac{3.35}{2} - 1.47 \quad e = 0.210$$

$$\frac{B}{6} = \frac{3.35}{6} = 0.56$$

## 3ro CALCULO DE LA PRESION ACTUANTE

$$q = \frac{\Sigma Fy}{A \cdot B} \left( 1 \pm \frac{6e}{B} \right)$$

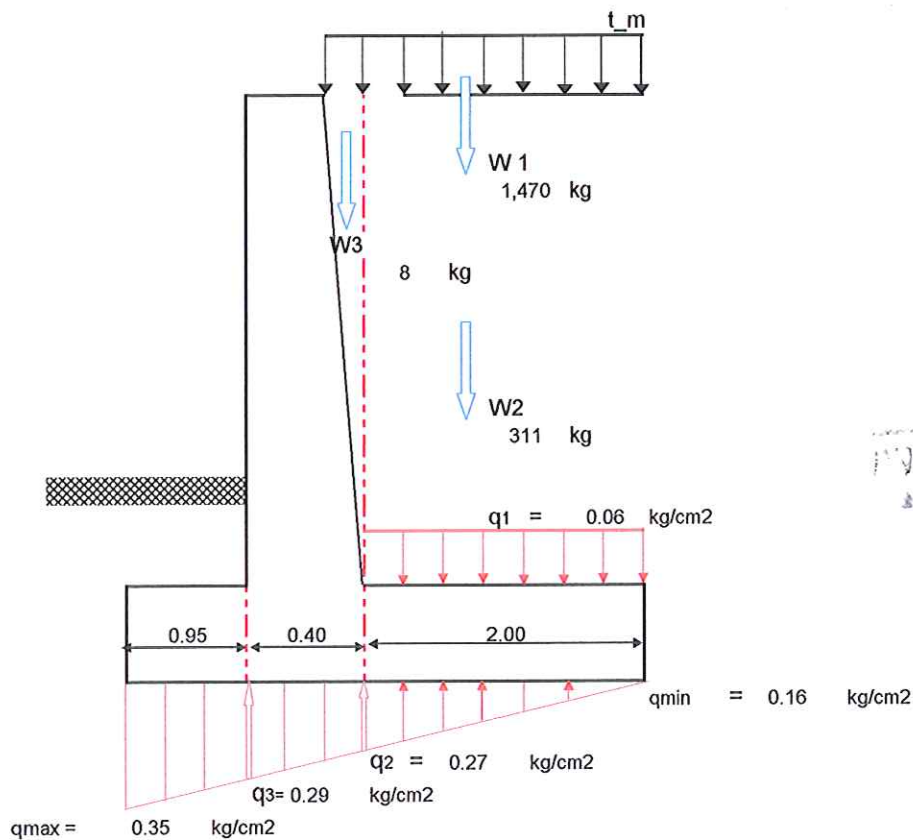
$$q = \frac{11,768}{1.40 \cdot 3.35} \left( 1 \pm \frac{6 \cdot 0.210}{3.35} \right)$$

$$q = 2,509.12 \quad 1 \pm 0.3757261$$

$$q_{\max} = 3,451.86 \quad \text{kg/m}^2 \rightarrow 0.35$$

$$q_{\min} = 1,566.38 \quad \text{kg/m}^2 \rightarrow 0.16$$

$$\begin{matrix} q_{\max}, q_{\min} < \sigma t = \text{OK CUMPLE} \\ 0.35 < 1.20 \end{matrix}$$



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

$$q = \frac{w1 + w2 + w3}{A \text{ talón}} \quad q = \frac{1,470 + 311 + 8}{2.00 \times 1.40}$$

$$q = 638.78 \text{ kg/m}^2 \rightarrow 0.06 \text{ kg/cm}^2$$

$$\frac{2.00}{x} = \frac{3.35}{0.19}$$

$$x = 0.113 \rightarrow q2 = 0.16 + x$$

$$q2 = 0.16 + 0.113$$

$$q2 = 0.27 \text{ kg/cm}^2$$

$$\frac{2.00 + 0.40}{y} = \frac{3.35}{0.19}$$

$$y = 0.135$$

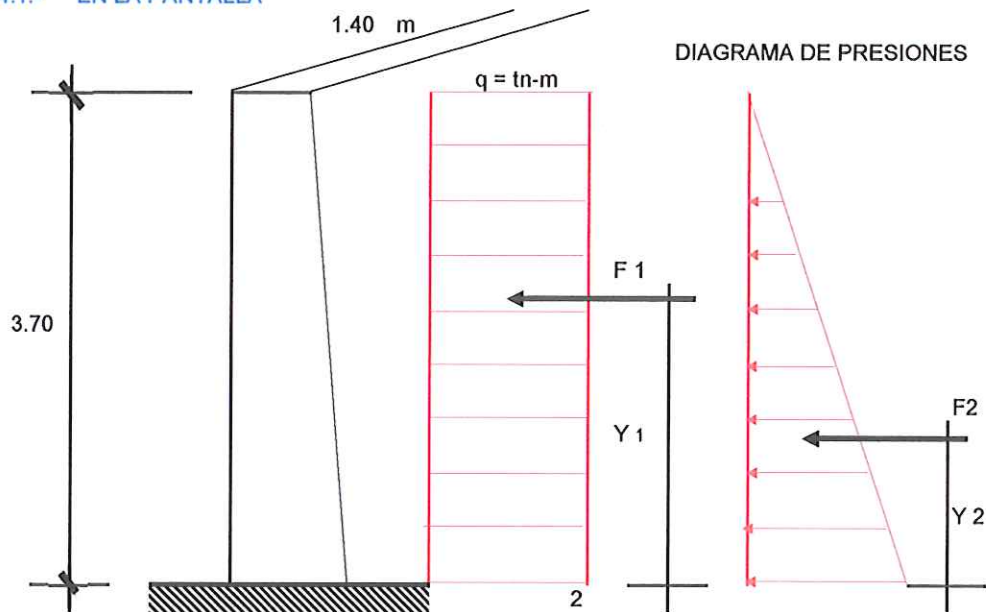
$$q3 = 0.16 + y$$

$$q3 = 0.16 + 0.135$$

$$q3 = 0.29 \text{ kg/cm}^2$$

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



##### a) MOMENTO FLECTOR

En

$$F1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$$

$$F1 = (500 \text{ kg-m} \times 3.70 \text{ m} \times 1.00 \text{ m}) \cdot 0.333$$

$$F1 = 616.67 \text{ kg.}$$

$$y1 = \frac{h}{2} = \frac{3.70}{2} = 1.85$$

$$y1 = 1.85 \text{ m}$$

En

$$F2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00 \text{ m}) \cdot Ka$$

$$F2 = \frac{1}{2} \cdot 30 \cdot \frac{13.69}{3.70} \cdot 1.00 \cdot 0.333 = 68.45 \text{ kg}$$

$$F2 = 0.07 \text{ tn-m}$$

$$y2 = \frac{1}{3} h \quad y2 = \frac{1}{3} \cdot 3.70$$

*Ing. Oscar Huaman Espino*  
INGENIERO  
REG. CIP. 148

589  
1325

$$y_2 = 1.23 \text{ m}$$

MOMENTO ULTIMO

$$M_{\max} = (F_1 Y_1) + (F_2 Y_2)$$

$$M_{\max} = (616.67 \times 1.85) + (68.45 \times 1.23)$$

$$M_{\max} = 1,225.26 \text{ kg-m}$$

b) FUERZA CORTANTE

\* FUERZA CORTANTE ACTUANTE

$$V = F_1 + F_2$$

$$V = 616.67 + 68.45$$

$$V = 685.12 \text{ kg}$$

\* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \left| \begin{array}{l} V = 685.12 \\ b = 1.00 \\ d = 0.36 \end{array} \right.$$

$$\mu = \frac{685.12}{100 \cdot 36} = 0.19$$

$$\mu = 0.19 \text{ kg/cm}^2$$

\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

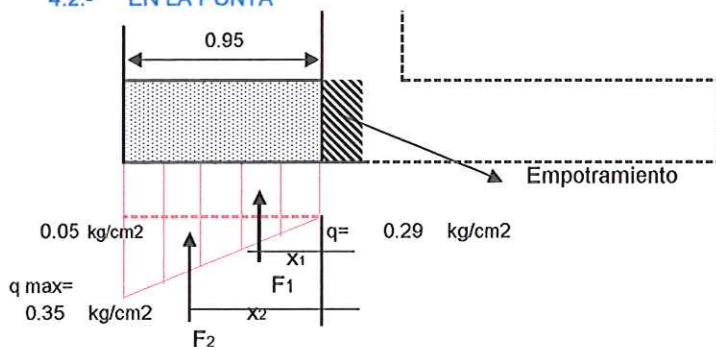
$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.19 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$



4.2.- EN LA PUNTA



a) MOMENTO FLECTOR

$$\text{En: } F_1 = 0.29 \times 0.95 \times 1.00$$

$$F_1 = 2,771 \text{ Kg}$$

$$X_1 = \frac{0.95}{2} = 0.48 \text{ m}$$

En

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

548  
1324

$$F2 = \frac{1}{2} \cdot 95 \cdot 0.05 \cdot 100 = 253.98 \text{ Kg}$$

$$F2 = 253.98 \text{ kg}$$

$$X2 = \frac{2}{3} \cdot 0.95 =$$

$$X2 = 0.63 \text{ mt}$$

#### MOMENTO MAXIMO

$$M_{\text{máx}} = (F1 \cdot X1) + (F2 \cdot X2)$$

$$M_{\text{máx}} = (2,771 \cdot 0.48) + (253.98 \cdot 0.63)$$

$$M_{\text{máx}} = -1,155.52 \text{ kg-m}$$

#### FUERZA CORTANTE ACTUANTE (v)

$$V = F1 + F2$$

$$V = 2,771 + 253.98$$

$$V = 3,025.29 \text{ kg}$$

#### ESFUERZO CORTANTE (u)

$$u = \frac{V}{b \cdot d}$$

$$u = \frac{3,025.29}{95 \cdot 36}$$

$$u = 0.88 \text{ kg/cm}^2$$

#### ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

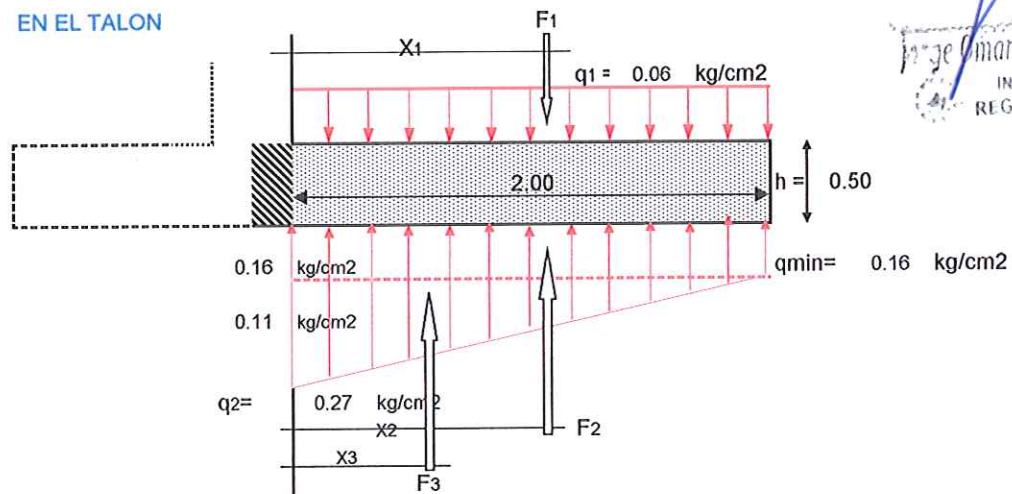
$$Vc = \phi \cdot 0.53 \cdot \sqrt{f'c}$$

$$Vc = 0.85 \cdot 0.53 \cdot 14.49$$

$$Vc = 6.53$$



#### 4.3.- EN EL TALON



*Inge Omar Huaman Espinoza*  
INGENIERO CIVIL  
REG. CIP N° 154480

547  
1323

$$F1 = 0.06 \text{ kg/cm}^2 \cdot 200 \text{ cm} \cdot 100 \text{ cm}$$

$$F1 = 1,277.55 \text{ kg}$$

$$X1 = \frac{2.00}{2}$$

$$X1 = 1.00 \text{ m}$$

$$F2 = 0.16 \text{ kg/cm}^2 \cdot 200 \text{ cm} \cdot 100 \text{ cm}$$

$$F2 = 3,132.76 \text{ kg}$$

$$X2 = \frac{2.00}{2}$$

$$X2 = 1.00 \text{ m}$$

$$F3 = \frac{1}{2} \cdot 0.11 \text{ kg/cm}^2 \cdot 200 \text{ cm} \cdot 100 \text{ cm}$$

$$F3 = 1,125.66 \text{ kg}$$

$$X3 = \frac{1}{3} \cdot 2.00$$

$$X3 = 0.67 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2 \cdot X2) + (F3 \cdot X3) - (F1 \cdot X1)$$

$$M = (3,132.76 \times 1.00) + (1,125.66 \times 0.67) - (1,278 \times 1.00)$$

$$M = 5,160.7 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 1,277.55 - 3,132.76 - 1,125.66$$

$$V = -2,980.87 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-2,980.87}{100 \cdot 36}$$

$$\mu = -0.83 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = \emptyset \cdot 0.53 \cdot \sqrt{f'c}$$

$$V_c = 0.85 \cdot 0.53 \cdot 14.49$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu_{act} -0.83 \text{ kg/cm}^2 \text{ OK CUMPLE}$$

5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

$$\begin{aligned} - \text{ Para } \emptyset \leq 5/8" & \quad A_{smin} \text{ (Vertical)} = 0.0012 \text{ b h} \\ - \text{ Para } \emptyset > 5/8" & \quad A_{smin} \text{ (Vertical)} = 0.0015 \text{ b h} \end{aligned}$$

b- Acero Mínimo Horizontal en muros:

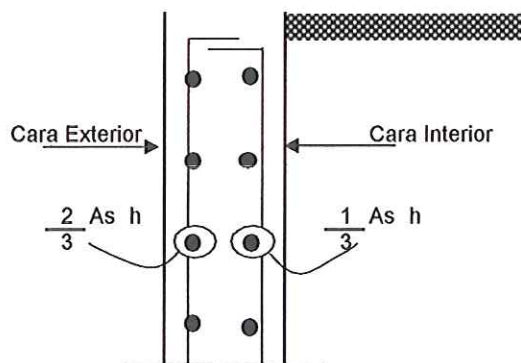
$$\begin{aligned} - \text{ Para } \emptyset \leq 5/8" & \quad A_{smin} \text{ (Horizontal)} = 0.0020 \text{ b h} \\ - \text{ Para } \emptyset > 5/8" & \quad A_{smin} \text{ (Horizontal)} = 0.0025 \text{ b h} \end{aligned}$$



*de Omar Huaman Espino*  
INGENIERO CIVIL  
REG CIP N° 154180



546  
1322



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b d^2}$$

$$A_s = \rho b d$$

### 5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = 1.6$$

$$M_u = 1.6 \times 1,225.26 = 1,960.41$$

$$M_u = 1,960 \text{ kg/m}$$

$$K_u = \frac{1,960 \times 10^2}{100 \times 1296} \text{ kg/cm}^2$$

$$K_u = 1.51$$

$$\rho =$$

$$\text{Para } \begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.51 \end{cases} \Rightarrow \rho =$$

$$\rho = 0.0004$$

Acero principal:

$$A_s = \rho b d$$

$$A_s = 0.0004 \times 100 \times 36 = 1.44$$

$$A_s = 1.44 \text{ cm}^2$$

$$A_s = \boxed{1.44} \Rightarrow \boxed{4} \text{ } \varnothing \boxed{3/4"} \Rightarrow \boxed{11.40} \text{ OK CUMPLE}$$

$$S = \frac{2.85}{11.40} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \varnothing \text{ de } 3/4 \text{ @ } 0.25 \text{ m}}$$

b) Acero mínimo Vertical

$$A_{smin} (\text{vertical}) = 0.0015 \times 100 \times 36$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. N. 154480

845  
1324

$$As_{\min} = 5.4 \text{ cm}^2$$

As princ	11.40	>	As min	5.4	OK CUMPLE
----------	-------	---	--------	-----	-----------

## 5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$As_{\min} (\text{vertical}) = 0.0012 \cdot 100 \cdot 36$$

$$As_{\min} = 4.32 \text{ cm}^2$$

$$As = 4.32 \text{ cm}^2$$

As =	4.32	⇒	2	Ø	3/4"	▼	=	5.70
------	------	---	---	---	------	---	---	------

OK CUMPLE

$$S = \frac{2.85}{5.70} \times 100$$

$$S = 50.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ 

USAR	2	Ø	de	3/4	@	0.25	ml
------	---	---	----	-----	---	------	----

## 5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\phi \leq 5/8"$

$$As_{\min} = 0.0020 \cdot b \cdot d$$

1) Arriba: (h = 0.3 )

$$As_{\min} = 0.0020 \cdot 100 \cdot 0 = 0.06$$

$$As_{\min} = 6.00 \text{ cm}^2$$

a) Cara Interior

$$\frac{1}{3} Ash = \frac{1}{3} \cdot 6.00 = 2.00 \text{ cm}^2/\text{m}$$

$$As = 2.00 \text{ cm}^2$$

As =	6.00	⇒	5	Ø	1/2"	▼	=	6.33
------	------	---	---	---	------	---	---	------

OK CUMPLE

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \text{ Asumido} \Rightarrow 0.20 \text{ m}$$

⇒ 

USAR	5	Ø	de	1/2	@	0.20	ml
------	---	---	----	-----	---	------	----

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} \cdot 6 = 4.00 \text{ cm}^2/\text{m}$$



Ing. Omar Huaman Espino  
INGENIERO  
REG. CIP. 14440

844  
1370

$$A_s = 4.00 \text{ cm}^2$$

$$A_s = \boxed{4.00} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla \boxed{=} \boxed{5.07}$$

OK CUMPLE

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{1/2} \text{ @ } \boxed{0.25} \text{ ml}$$

2) Cara Intermedia  $(h = \frac{40 + 30}{2}) = 35 \text{ cm}$

$$A_s \text{ min (Horizontal)} = 0.0020 \times 100 \times 35 = 7.00 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} A_s h = \frac{1}{3} \times 7.00 = 2.33 \text{ cm}^2/\text{m}$$

$$A_s = 2.33 \text{ cm}^2$$

$$A_s = \boxed{7.00} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{5/8"} \nabla \boxed{=} \boxed{7.92}$$

OK CUMPLE

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{5/8} \text{ @ } \boxed{0.25} \text{ ml}$$

b) Cara Exterior:

$$\frac{2}{3} A_s h = \frac{2}{3} \times 7.0 = 4.67 \text{ cm}^2/\text{m}$$



*[Signature]*  
Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

543  
1319

$$As = 4.67 \text{ cm}^2$$

$$As = \boxed{4.67} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla \boxed{=} \boxed{5.07} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{1/2} \text{ @ } \boxed{0.25} \text{ m}$$

3) Cara Inferior (abajo) (h = 0.40 m)

$$As \text{ mín (Horizontal)} = 0.0020 \times 100 \times 40.00 = 8.00$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} \times 8.00 = 2.67 \text{ cm}^2/\text{m}$$

$$As = 2.67 \text{ cm}^2$$

$$As = \boxed{2.67} \Rightarrow \boxed{2} \text{ } \emptyset \text{ } \boxed{5/8"} \nabla \boxed{=} \boxed{3.96} \text{ OK CUMPLE}$$

$$S = \frac{1.98}{3.96} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{2} \text{ } \emptyset \text{ de } \boxed{5/8} \text{ @ } \boxed{0.25} \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} \times 8.0 = 5.33 \text{ cm}^2/\text{m}$$

$$As = 5.33 \text{ cm}^2$$

$$As = \boxed{5.33} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{5/8"} \nabla \boxed{=} \boxed{7.92} \text{ OK CUMPLE}$$

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.250} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{5/8} \text{ @ } \boxed{0.25} \text{ m}$$

## Resumen

### Acero Horizontal

1) Ariba	=	(As mín Horizontal)	=	6.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 1/2 @ 0.20	m
		Cara exterior	=	$\emptyset$ 1/2 @ 0.25	m
2) Intermd	=	(As mín Horizontal)	=	7.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 5/8 @ 0.25	m
		Cara exterior	=	$\emptyset$ 1/2 @ 0.25	m
3) Inferior	=	(As mín Horizontal)	=	8.00	cm <sup>2</sup>



*Geógraf Huaman Espino*  
INGENIERO  
REG CIP

582  
1318

Cara Interior = Ø 5/8 @ 0.25 m  
Cara exterior = Ø 5/8 @ 0.250 m

Para cara Interior

C.I 2 Ø 5/8 @ 0.25 , 4 Ø 5/8 @ 0.25 Rto Ø 5/8 @ 0.20

Para Exterior:

C.E 4 Ø 5/8 @ 0.25 , 4 Ø 1/2 @ 0.25 Rto Ø 5/8 @ 0.25

Entonces:

C.I = Ø 5/8 @ 0.233 ≈ 0.25  
C.E = Ø 5/8 @ 0.250 ≈ 0.25

SI UNIFORMAMOS EL ACERO 0.233 a 0.250 = 0.242 ≈ 0.250

tenemos: Ø 5/8 @ 0.25  
Ø 5/8 @ 0.25

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$M_u = 1.6 \times -1,155.52 \text{ kg-m} = -1,848.83 \text{ kg-m}$$

$$b = 1.00 \text{ mt}$$

$$d = h_z - \left( r + \frac{\phi \text{ vlla}}{2} \right)$$

$$d = 50 - 7.5 + \frac{1.58}{2}$$

$$d = 41.71$$

$$K_u = \frac{-1,849 \times 10^2 \text{ kg/cm}^2}{100 \times 1740}$$

$$K_u = -1.06$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = -1.06 \end{cases} \Rightarrow \rho = -0.0003$

Acero principal:

$$A_s = \rho \cdot b \cdot d$$

$$A_s = -0.0003 \cdot 100 \cdot 42 = -1.25$$

$$A_s = -1.25 \text{ cm}^2$$

$$A_s = \boxed{6.26} \Rightarrow \boxed{6} \text{ Ø } 1/2" \nabla = \boxed{7.60}$$

OK CUMPLE

+ - 0.50 CM2

$$S = \frac{1.27}{7.60} \times 100$$

$$S = 16.67 \text{ Asumido} \Rightarrow \boxed{0.20} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 6 \text{ Ø de } 1/2 @ 0.20 \text{ m}}$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480



13/7

Acero mínimo:

$$\text{Asmín} = 0.0018 \times 100 \times 41.71 = 7.51$$

7.51	<	7.60	OK CUMPLE
------	---	------	-----------

ZAPATA POSTERIOR

$$M_u = 1.6 \times 5,161 \text{ kg-m} = 8,257.19 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = 41.71$$

$$K_u = \frac{8,257}{100} \times \frac{10^2}{1740} \text{ kg/cm}^2$$

$$K_u = 4.75$$

Para

$f_c = 210 \text{ Kg/cm}^2$	$\Rightarrow \rho = 0.0013$
$f_y = 4,200 \text{ Kg/cm}^2$	
$K_u = 4.75$	

Acero principal:

$$A_s = \rho \times b \times d$$

$$A_s = 0.0013 \times 100 \times 42 = 5.42$$

$$A_s = 5.42 \text{ cm}^2$$

As =	5.42	$\Rightarrow$	4	$\emptyset$	5/8"	$\nabla$	=	7.92
OK CUMPLE								

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

$\Rightarrow$	USAR	4	$\emptyset$	de	5/8	@	0.25	m
---------------	------	---	-------------	----	-----	---	------	---

ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$A_{stemp} = 0.0018 \times b \times t \text{ N.T.P} \quad t = h_z = 0.50$$

$$A_{stemp} = 0.0018 \times 100 \times 50 = 9.00 \text{ cm}^2$$

$$A_s = 9.00 \text{ cm}^2$$

As =	9.00	$\Rightarrow$	5	$\emptyset$	5/8"	$\nabla$	=	9.90
OK CUMPLE								

$$S = \frac{1.98}{9.90} \times 100$$

$$S = 20.00 \text{ Asumido} \Rightarrow 0.20 \text{ m}$$



*Ing. Omar Huaman Espinoza*  
INGENIERO CIVIL  
REG. CIP. N. 154380

590  
1316

⇒ 

USAR	5	Ø	de	5/8	@	0.20	ml
------	---	---	----	-----	---	------	----

PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:

$$S \leq \left| \begin{array}{l} 0.5 \\ 45 \end{array} \right| t = 0.5 \quad 50 = 25 \text{ cm}$$

SE TOMA EL MENOR:

Astemp = Ø 5/8 @ 0.20

### RESUMEN GENERAL DEL ACERO

#### 1.- PANTALLA:

##### \* ACERO VERTICAL

- Cara Interior	=	Ø	3/4	@	0.50 m	Intercalado ó a una (h) de 1.65
	=	Ø	3/4	@	0.25 m	
- Cara Exterior	=	Ø	3/4	@	0.25 m	

##### \* ACERO HORIZONTAL

- Cara Interior	=	Ø	5/8	@	0.25 m
- Cara Exterior	=	Ø	5/8	@	0.25 m

#### 2.- ZAPATA ANTERIOR (PUNTA)

* ACERO PRINCIPAL	=	Ø	5/8	@	0.20 m
* ACERO TRANSVERSAL	=	Ø	5/8	@	0.20 m

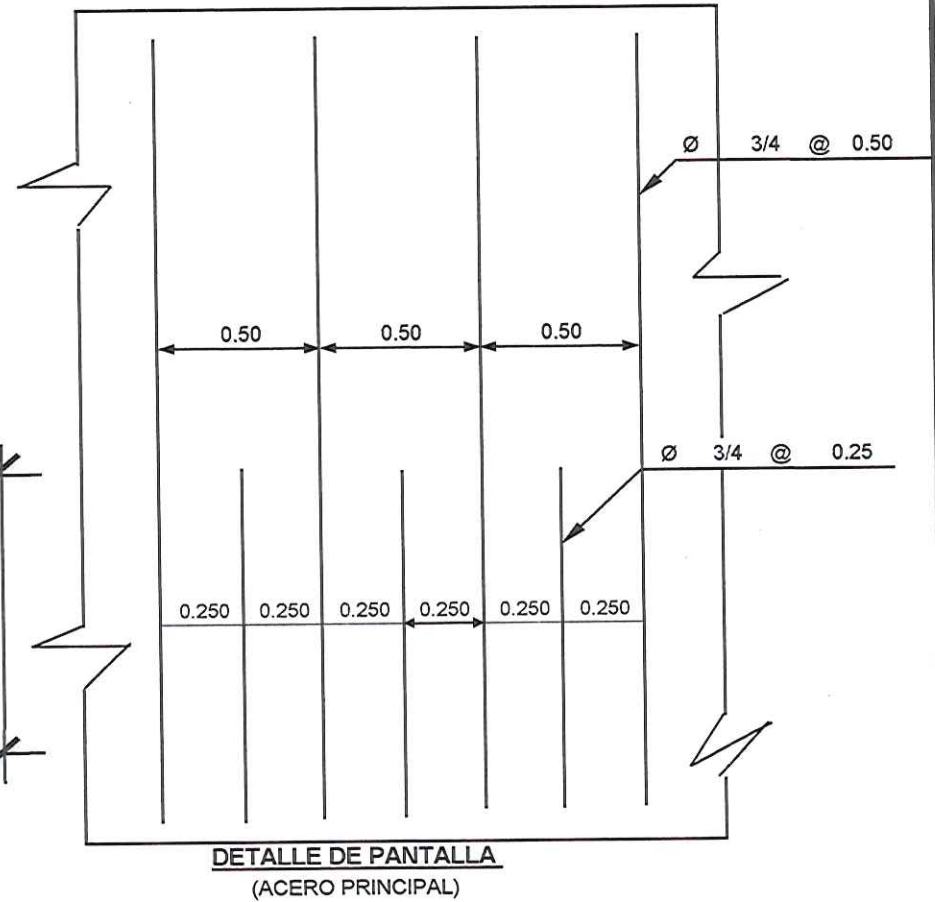
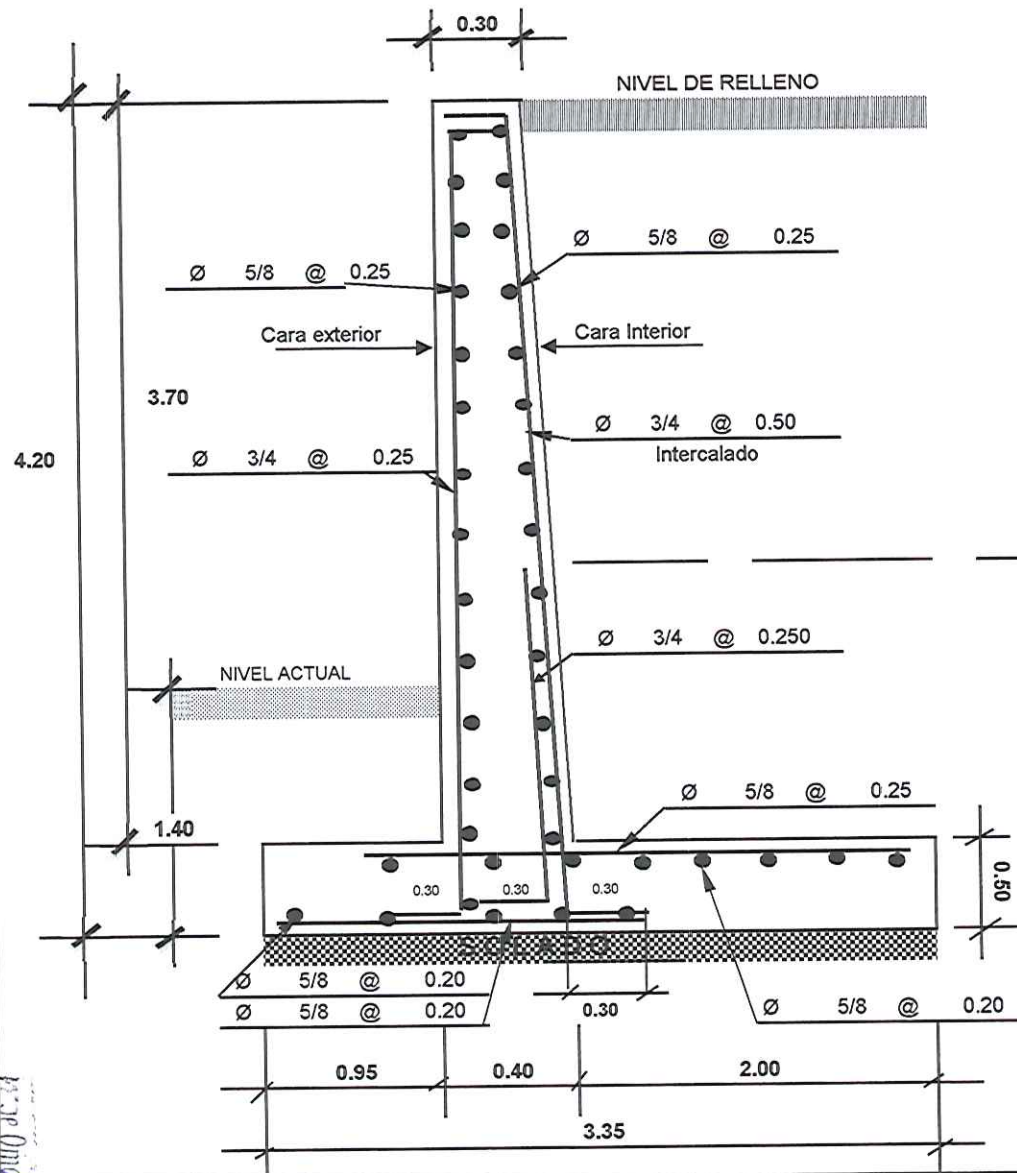
#### 3.- ZAPATA POSTERIOR (TALON)

* ACERO PRINCIPAL	=	Ø	5/8	@	0.25 m
* ACERO TRANSVERSAL	=	Ø	5/8	@	0.20 m



*Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

# DISEÑO DE MURO DE CONTENCION EN VOLANTE



Ing. Omar Huaman Espinoza  
 INGENIERO CIVIL  
 REG. CIP. 54480



1315

280  
1314

DISEÑO DE MURO DE CONTENCIÓN EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : jul-2023

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	3.90	m
h 1 =	1.400	m
t 1 =	0.30	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava	
$\gamma$ (kg/m <sup>3</sup> )	2650
$\phi$ (°)	30°
$\sigma$ t (kg/cm <sup>2</sup> )	1.20

#### C DATOS DEL C° Y ACERO

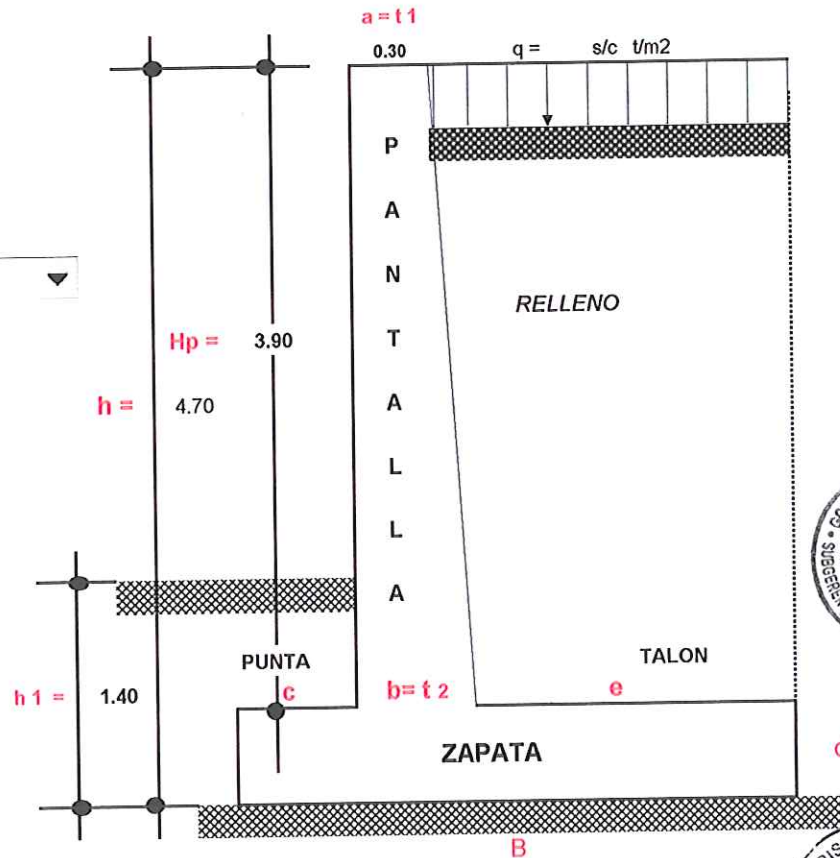
f'c (kg/cm <sup>2</sup> )	210
f'y (kg/cm <sup>2</sup> )	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	≥	2
F.S.D	≥	1.5

#### E SOBRECARGA

q=s/c t-m2	0.50	tn
------------	------	----



#### 1.- PREDIMENCIONAMIENTO:

$$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.30 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{4.70}{12} \text{ ó } \frac{4.70}{10}$$

$$b = 0.39 \text{ ó } 0.47 \rightarrow \text{Asumido} = 0.45 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 4.70 \text{ ó } 0.8 \cdot 4.70$$

$$B = 2.35 \text{ ó } 3.76 \rightarrow \text{Asumido} = 3.75 \text{ m}$$

Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154488



S36  
1312

b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

$$F_1 = [ (q) \times (H) \times 1.00 \text{ m} ] K_a$$

$$F_1 = [ 500 \text{ kg/cm}^2 \times 4.70 \times 1.00 ] \times 0.333$$

$$F_1 = 783 \text{ Kg/cm}^2$$

UBICACIÓN : F 1

$$F_1 = \frac{H}{2} = \frac{3.90}{2} = 1.95 \text{ m}$$

$$F_2 = (\text{vol}) D \cdot P$$

$$F_2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F_2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F_2 = \frac{1}{2} 30 \text{ kg/cm}^2 \times 3.90^2 \times 1.00 \times 0.333$$

$$F_2 = 76.05 \text{ Kg}$$

UBICACIÓN : F 2

$$F_2 = \frac{1}{3} H$$

$$F_2 = \frac{1}{3} 3.90 = 1.3 \text{ m}$$

3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	1,680	2.70	4,536.00
W2	369	2.70	995.09
W3	12	1.425	17.51
W4	983	1.425	1,400.49
W5	3,931	1.200	4,717.44
W6	10,080	1.88	18,900.00
$\sum MF_f$	17,055	$\sum MoF_y$	30,566.52



*Arge Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. 153480



532  
1308

MOMENTO ULTIMO

$$M_{max} = (F_1 Y_1) + (F_2 Y_2)$$

$$M_{max} = ( 650.00 \times 1.95 ) + ( 76.05 \times 1.30 )$$

$$M_{max} = 1,366.37 \text{ kg-m}$$

b) FUERZA CORTANTE

\* FUERZA CORTANTE ACTUANTE

$$V = F_1 + F_2$$

$$V = 650.00 + 76.05$$

$$V = 726.05 \text{ kg}$$

\* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \left| \begin{array}{l} V = 726.05 \\ b = 1.00 \\ d = 0.41 \end{array} \right.$$

$$\mu = \frac{726.05}{100 \cdot 41} = 0.18$$

$$\mu = 0.18 \text{ kg/cm}^2$$

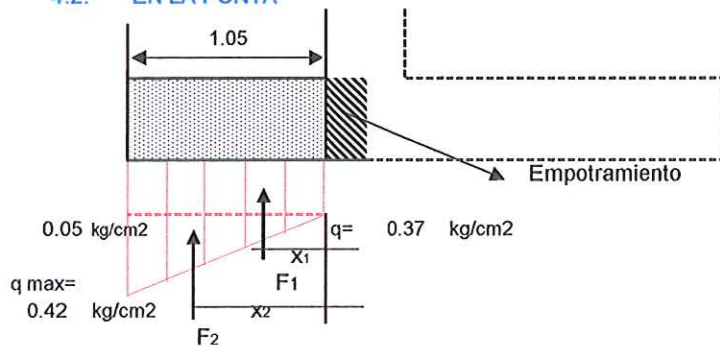
\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

$$\mu_c = 0.53 \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.18 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$

4.2.- EN LA PUNTA



a) MOMENTO FLECTOR

En:

$$F_1 = 0.37 \times 1.05 \times 1.00$$

$$F_1 = 3,839 \text{ Kg}$$

$$X_1 = \frac{1.05}{2} = 0.53 \text{ m}$$

En

$$F_2 = \frac{1}{2} \times 105 \times 0.05 \times 100 = 272.17 \text{ Kg}$$



*Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. N° 154480

831  
1307

$$F2 = 272.17 \text{ kg}$$

$$X2 = \frac{2}{3} \cdot 1.05 =$$

$$X2 = 0.70 \text{ mt}$$

MOMENTO MAXIMO

$$M_{\text{máx}} = (F1 \cdot X1) + (F2 \cdot X2)$$

$$M_{\text{máx}} = (3,839 \times 0.53) + (272.17 \times 0.70)$$

$$M_{\text{máx}} = -1,824.78 \text{ kg-m}$$

FUERZA CORTANTE ACTUANTE (v)

$$V = F1 + F2$$

$$V = 3,839 + 272.17$$

$$V = 4,110.84 \text{ kg}$$

ESFUERZO CORTANTE (u)

$$u = \frac{V}{b \cdot d}$$

$$u = \frac{4,110.84}{105 \cdot 41}$$

$$u = 0.95 \text{ kg/cm}^2$$

ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

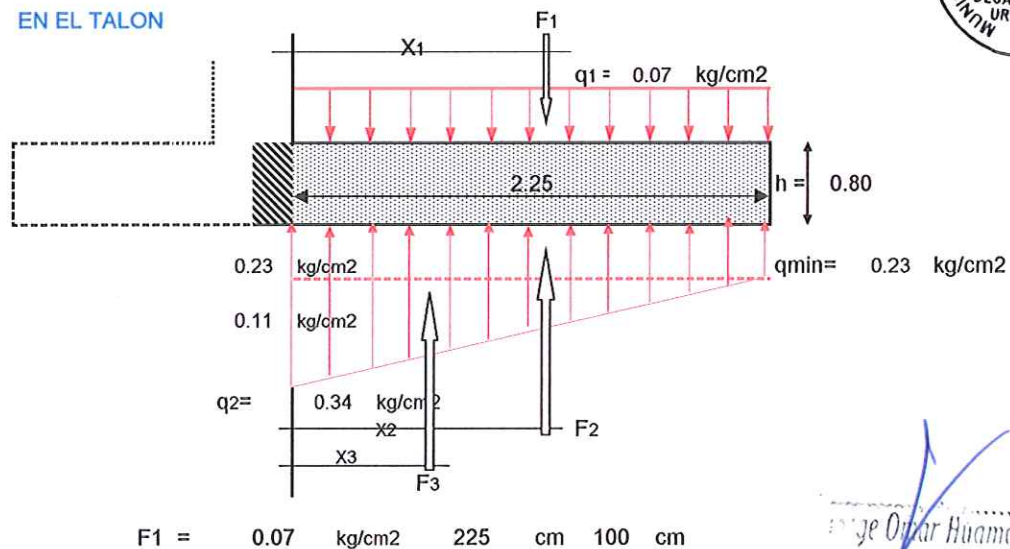
$$Vc = 0.53 \sqrt{f'c}$$

$$Vc = 0.85 \cdot 0.53 \cdot 14.49$$

$$Vc = 6.53$$



#### 4.3.- EN EL TALON



$$F1 = 0.07 \text{ kg/cm}^2 \cdot 225 \text{ cm} \cdot 100 \text{ cm}$$

*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

530  
1308

$$F1 = 1,472.03 \text{ kg}$$

$$X1 = \frac{2.25}{2}$$

$$X1 = 1.13 \text{ m}$$

$$F2 = 0.23 \text{ kg/cm}^2 \cdot 225 \text{ cm} \cdot 100 \text{ cm}$$

$$F2 = 5,226.25 \text{ kg}$$

$$X2 = \frac{2.25}{2}$$

$$X2 = 1.13 \text{ m}$$

$$F3 = \frac{1}{2} \cdot 0.11 \text{ kg/cm}^2 \cdot 225 \text{ cm} \cdot 100 \text{ cm}$$

$$F3 = 1,249.78 \text{ kg}$$

$$X3 = \frac{1}{3} \cdot 2.25$$

$$X3 = 0.75 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2 \cdot X2) + (F3 \cdot X3) - (F1 \cdot X1)$$

$$M = (5,226.25 \times 1.13) + (1,249.78 \times 0.75) - (1,472 \times 1.13)$$

$$M = 8,472.9 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 1,472.03 - 5,226.25 - 1,249.78$$

$$V = -5,004.00 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-5,004.00}{100 \cdot 41}$$

$$\mu = -1.22 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )

$$V_c = \emptyset \cdot 0.53 \cdot \sqrt{f'c}$$

$$V_c = 0.85 \cdot 0.53 \cdot 14.49$$

$$V_c = 6.53 \text{ kg/cm}^2 > \mu \text{ act } -1.22 \text{ kg/cm}^2 \text{ OK CUMPLE}$$

5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

- Para $\emptyset \leq 5/8"$	Asmin (Vertical) = 0.0012 b h
- Para $\emptyset > 5/8"$	Asmin (Vertical) = 0.0015 b h

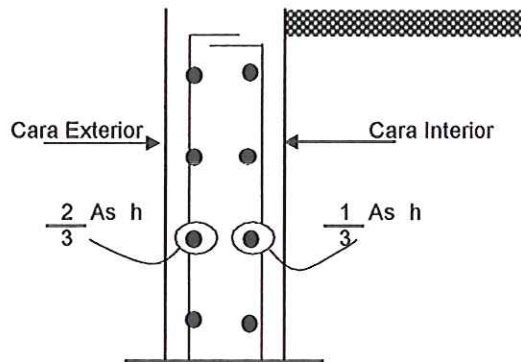
b- Acero Mínimo Horizontal en muros:

- Para $\emptyset \leq 5/8"$	Asmin (Horizontal) = 0.0020 b h
- Para $\emptyset > 5/8"$	Asmin (Horizontal) = 0.0025 b h



*Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

S29  
1305



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b d^2}$$

$$A_s = \rho b d$$

### 5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = 1.6$$

$$M_u = 1.6 \times 1,366.37 = 2,186.18$$

$$M_u = 2,186 \text{ kg/m}$$

$$K_u = \frac{2,186 \times 10^2}{100 \times 1681} \text{ kg/cm}^2$$

$$K_u = 1.30$$

$$\rho =$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = 1.30 \end{cases}$

$$\rho = 0.0003$$



Acero principal:

$$A_s = \rho b d$$

$$A_s = 0.0003 \times 100 \times 41 = 1.23$$

$$A_s = 1.23 \text{ cm}^2$$

$$A_s = \boxed{1.23} \Rightarrow \boxed{4} \text{ } \varnothing \boxed{1"} \Rightarrow \boxed{20.27} \text{ cm}$$

5.07  
2.54  
OK CUMPLE

$$S = \frac{5.07}{20.27} \times 100$$

$$S = 25.00 \text{ Asumido } \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \varnothing \text{ de } 1 \text{ @ } 0.250 \text{ m}}$$

+ - 0.50 CM2



b) Acero mínimo Vertical

$$A_{smin} \text{ (vertical)} = 0.0015 \times 100 \times 41$$

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

528  
1304

$$As_{\min} = 6.15 \text{ cm}^2$$

$$As_{\text{princ}} \quad 20.27 > As_{\min} \quad 6.15 \quad \text{OK CUMPLE}$$

## 5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$As_{\min} (\text{vertical}) = 0.0012 \quad 100 \quad 41$$

$$As_{\min} = 4.92 \text{ cm}^2$$

$$As = 4.92 \text{ cm}^2$$

$$As = \boxed{4.92} \Rightarrow \boxed{2} \quad \emptyset \quad \boxed{3/4"} \quad \nabla \quad = \quad \boxed{5.70}$$

OK CUMPLE

$$S = \frac{2.85}{5.70} \times 100$$

$$S = 50.00 \quad \text{Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \quad \boxed{2} \quad \emptyset \text{ de } \boxed{3/4} \quad @ \quad \boxed{0.25} \text{ m}$$



## 5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\emptyset \leq 5/8"$

$$As_{\min} = 0.0020 \quad b \quad d$$

1) Arriba: (h = 0.3 )

$$As_{\min} = 0.0020 \quad 100 \quad 0 = 0.06$$

$$As_{\min} = 6.00 \text{ cm}^2$$

a) Cara Interior

$$\frac{1}{3} Ash = \frac{1}{3} 6.00 = 2.00 \text{ cm}^2/\text{m}$$

$$As = 2.00 \text{ cm}^2$$

$$As = \boxed{6.00} \Rightarrow \boxed{5} \quad \emptyset \quad \boxed{1/2"} \quad \nabla \quad = \quad \boxed{6.33}$$

OK CUMPLE

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \quad \text{Asumido} \Rightarrow \boxed{0.20} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \quad \boxed{5} \quad \emptyset \text{ de } \boxed{1/2} \quad @ \quad \boxed{0.20} \text{ m}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 6 = 4.00 \text{ cm}^2/\text{m}$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480



S27  
133

$$A_s = 4.00 \text{ cm}^2$$

$$A_s = \boxed{4.00} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla \boxed{=} \boxed{5.07}$$

OK CUMPLE

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{1/2} \text{ @ } \boxed{0.25} \text{ m}$$



2) Cara Intermedia  $(h = \frac{45 + 30}{2}) = 37.5 \text{ cm}$

$$A_{s \text{ min (Horizontal)}} = 0.0020 \times 100 \times 37.5 = 7.50 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} A_{sh} = \frac{1}{3} 7.50 = 2.50 \text{ cm}^2/\text{m}$$

$$A_s = 2.50 \text{ cm}^2$$

$$A_s = \boxed{7.50} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{5/8"} \nabla \boxed{=} \boxed{7.92}$$

OK CUMPLE

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{5/8} \text{ @ } \boxed{0.25} \text{ m}$$



b) Cara Exterior:

$$\frac{2}{3} A_{sh} = \frac{2}{3} 7.5 = 5.00 \text{ cm}^2/\text{m}$$

*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 54480

526  
1302

$$As = 5.00 \text{ cm}^2$$

$$As = \boxed{5.00} \Rightarrow \boxed{4} \text{ } \emptyset \boxed{1/2"} \nabla = \boxed{5.07} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{1/2} \text{ @ } \boxed{0.25} \text{ ml}$$

3) Cara Inferior (abajo) (h = 0.45 m)

$$As \text{ min (Horizontal)} = 0.0020 \times 100 \times 45.00 = 9.00$$

a) Cara Interior:

$$\frac{1}{3} As_h = \frac{1}{3} 9.00 = 3.00 \text{ cm}^2/\text{m}$$

$$As = 3.00 \text{ cm}^2$$

$$As = \boxed{3.00} \Rightarrow \boxed{2} \text{ } \emptyset \boxed{3/4"} \nabla = \boxed{5.70} \text{ OK CUMPLE}$$

$$S = \frac{2.85}{5.70} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{2} \text{ } \emptyset \text{ de } \boxed{3/4} \text{ @ } \boxed{0.25} \text{ ml}$$

b) Cara Exterior:

$$\frac{2}{3} As_h = \frac{2}{3} 9.0 = 6.00 \text{ cm}^2/\text{m}$$

$$As = 6.00 \text{ cm}^2$$

$$As = \boxed{6.00} \Rightarrow \boxed{4} \text{ } \emptyset \boxed{5/8"} \nabla = \boxed{7.92} \text{ OK CUMPLE}$$

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.250} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{5/8} \text{ @ } \boxed{0.25} \text{ ml}$$

## Resumen

### Acero Horizontal

1) Arriba	=	(As mín Horizontal)	=	6.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 1/2 @ 0.20	m
		Cara exterior	=	$\emptyset$ 1/2 @ 0.25	m
2) Interm	=	(As mín Horizontal)	=	7.50	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 5/8 @ 0.25	m
		Cara exterior	=	$\emptyset$ 1/2 @ 0.25	m
3) Inferior	=	(As mín Horizontal)	=	9.00	cm <sup>2</sup>



*Je Onar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154420

S25  
1301

Cara Interior = Ø 3/4 @ 0.25 m  
Cara exterior = Ø 5/8 @ 0.250 m

Para cara Interior

C.I 2 Ø 3/4 @ 0.25 , 4 Ø 5/8 @ 0.25 Rto Ø 3/4 @ 0.20

Para Exterior:

C.E 4 Ø 5/8 @ 0.25 , 4 Ø 1/2 @ 0.25 Rto Ø 5/8 @ 0.25

Entonces:

C.I = Ø 3/4 @ 0.233 ≈ 0.25  
C.E = Ø 5/8 @ 0.250 ≈ 0.25

SI UNIFORMAMOS EL ACERO 0.233 a 0.250 = 0.242 ≈ 0.250

tenemos: Ø 3/4 @ 0.25  
Ø 5/8 @ 0.25



## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$Mu = 1.6 \times -1,824.78 \text{ kg-m} = -2,919.65 \text{ kg-m}$$

$$b = 1.00 \text{ mt}$$

$$d = h_z - \left( r + \frac{\phi \text{ vlla}}{2} \right)$$

$$d = 80 - 7.5 + \frac{1.58}{2}$$

$$d = 71.71$$

$$Ku = \frac{-2,920}{100} \times \frac{10^2}{5142} \text{ kg/cm}^2$$

$$Ku = -0.57$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = -0.57 \end{cases} \Rightarrow \rho = -0.0001$



Acero principal:

$$As = \rho b d$$

$$As = -0.0001 \times 100 \times 72 = -0.72$$

$$As = -0.72 \text{ cm}^2$$

$$As = \frac{12.19}{13.86} \times 7 \times \frac{\phi}{5/8} = 13.86$$

OK CUMPLE

+ - 0.50 CM2

$$S = \frac{1.98}{13.86} \times 100$$

$$S = 14.29 \text{ Asumido } \Rightarrow 0.15 \text{ m}$$

$$\Rightarrow \text{USAR } 7 \text{ Ø de } 5/8 @ 0.15 \text{ m}$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154488

524  
1300

Acero mínimo:

$$As_{\min} = 0.0018 \times 100 \times 71.71 = 12.91$$

12.91	<	13.86	OK CUMPLE
-------	---	-------	-----------

ZAPATA POSTERIOR

$$Mu = 1.6 \times 8,473 \text{ kg-m} = 13,556.63 \text{ kg-m}$$

$$b = 1.00 \text{ mt}$$

$$d = 71.71$$

$$Ku = \frac{13,557}{100} \times \frac{10^2}{5142} \text{ kg/cm}^2$$

$$Ku = 2.64$$

Para  $\left\{ \begin{array}{l} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 2.64 \end{array} \right. \Rightarrow \rho = 0.0007$

Acero principal:

$$As = \rho \times b \times d$$

$$As = 0.0007 \times 100 \times 72 = 5.02$$

$$As = 5.02 \text{ cm}^2$$

As =	5.02	⇒	4	Ø	5/8"	▼	=	7.92	OK CUMPLE
------	------	---	---	---	------	---	---	------	-----------

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ **USAR 4 Ø de 5/8 @ 0.25 m**

ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$A_{\text{temp}} = 0.0018 \times b \times t \text{ N.T.P } t = h_z = 0.80$$

$$A_{\text{temp}} = 0.0018 \times 100 \times 80 = 14.40 \text{ cm}^2$$

$$As = 14.40 \text{ cm}^2$$

As =	14.40	⇒	8	Ø	5/8"	▼	=	15.83	OK CUMPLE
------	-------	---	---	---	------	---	---	-------	-----------

$$S = \frac{1.98}{15.83} \times 100$$

$$S = 12.50 \text{ Asumido} \Rightarrow 0.15 \text{ m}$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

⇒ 

USAR	8	Ø	de	5/8	@	0.15	ml
------	---	---	----	-----	---	------	----

**PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:**

$$S \leq \left| \frac{0.5}{45} t \right| = \frac{0.5}{45} \cdot 80 = 40$$

SE TOMA EL MENOR:

As<sub>temp</sub> = Ø 5/8 @ 0.20

## RESUMEN GENERAL DEL ACERO

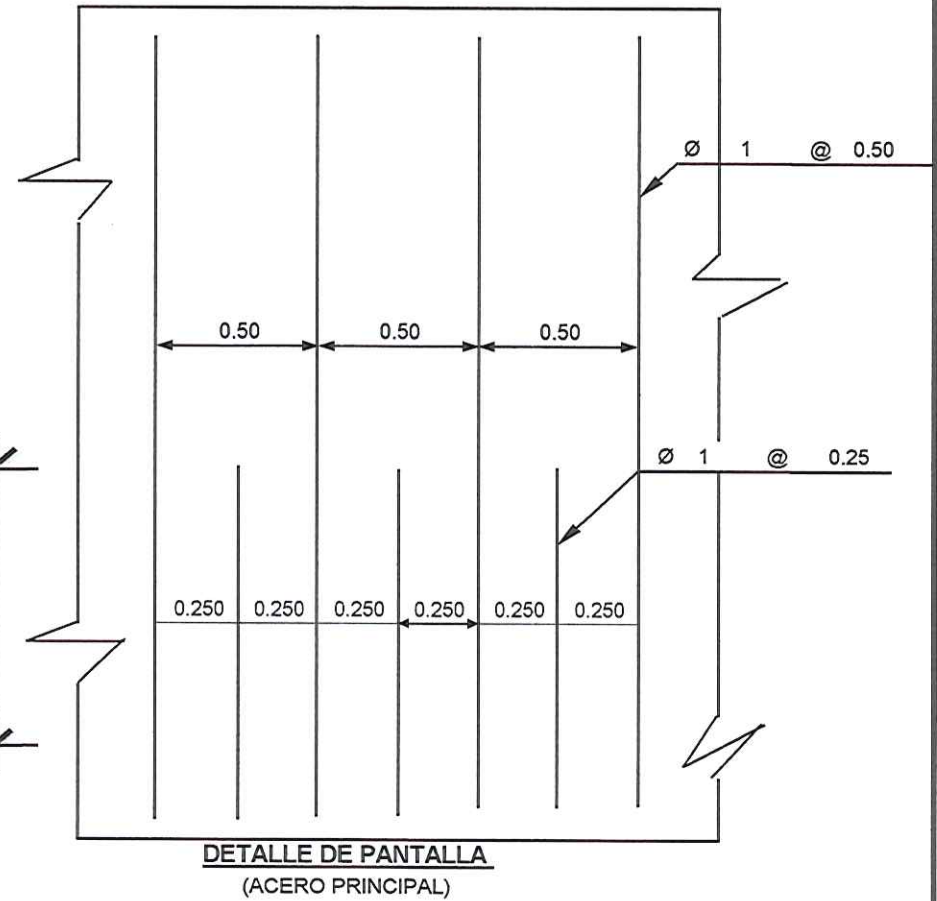
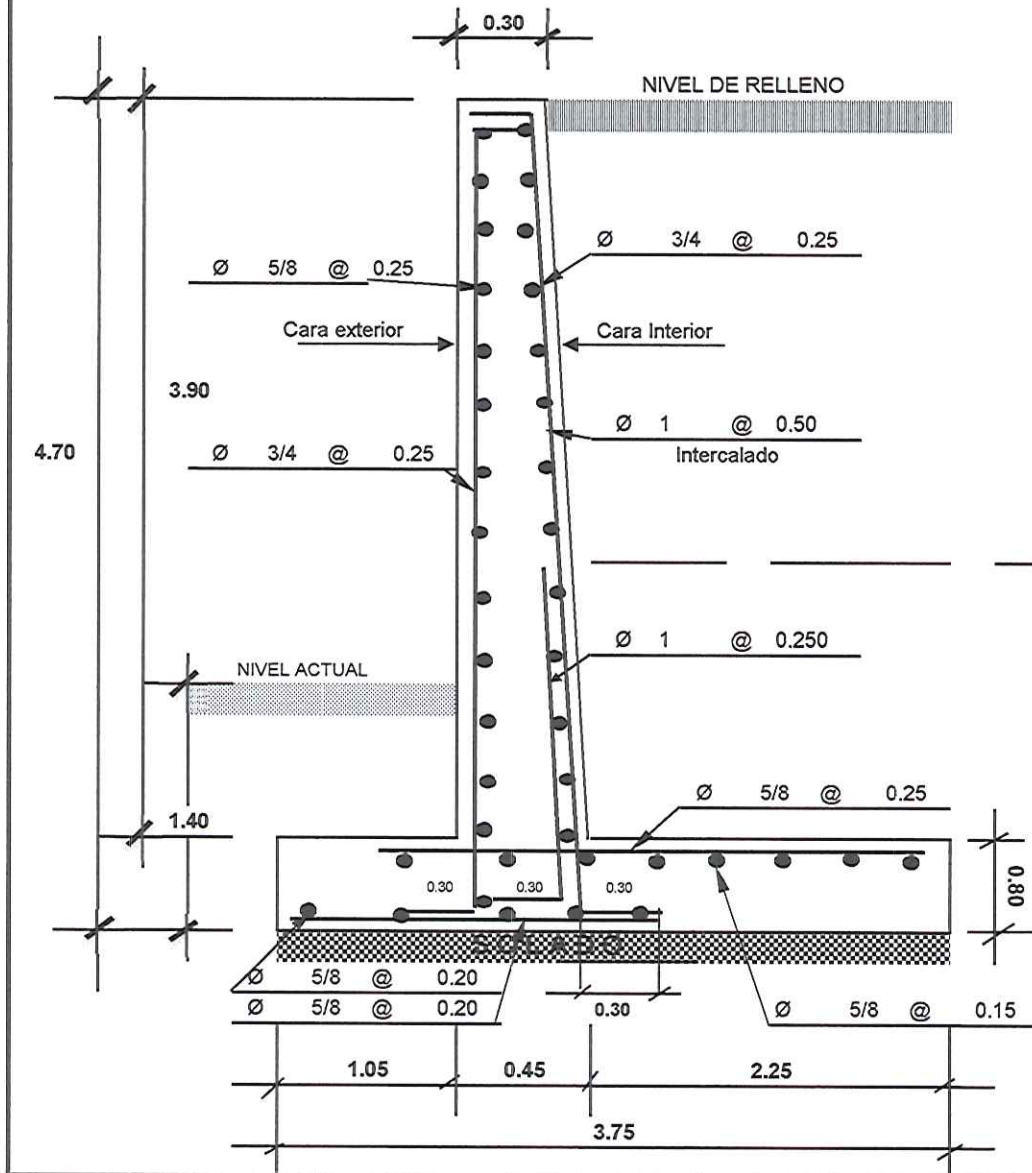
- |            |                         |                  |                   |   |     |     |      |      |               |      |
|------------|-------------------------|------------------|-------------------|---|-----|-----|------|------|---------------|------|
| <b>1.-</b> | <b>PANTALLA:</b>        |                  |                   |   |     |     |      |      |               |      |
|            | *                       | ACERO VERTICAL   |                   |   |     |     |      |      |               |      |
|            | -                       | Cara Interior    | =                 | Ø | 1   | @   | 0.50 | m    | Intercalado ó |      |
|            |                         |                  | =                 | Ø | 1   | @   | 0.25 | m    | a una (h) de  | 2.00 |
|            | -                       | Cara Exterior    | =                 | Ø | 3/4 | @   | 0.25 | m    |               |      |
|            | *                       | ACERO HORIZONTAL |                   |   |     |     |      |      |               |      |
|            | -                       | Cara Interior    | =                 | Ø | 3/4 | @   | 0.25 | m    |               |      |
|            | -                       | Cara Exterior    | =                 | Ø | 5/8 | @   | 0.25 | m    |               |      |
| <b>2.-</b> | <b>ZAPATA ANTERIOR</b>  |                  |                   |   |     |     |      |      |               |      |
|            | (PUNTA)                 | *                | ACERO PRINCIPAL   | = | Ø   | 5/8 | @    | 0.20 | m             |      |
|            |                         | *                | ACERO TRANSVERSAL | = | Ø   | 5/8 | @    | 0.20 | m             |      |
| <b>3.-</b> | <b>ZAPATA POSTERIOR</b> |                  |                   |   |     |     |      |      |               |      |
|            | (TALON)                 | *                | ACERO PRINCIPAL   | = | Ø   | 5/8 | @    | 0.25 | m             |      |
|            |                         | *                | ACERO TRANSVERSAL | = | Ø   | 5/8 | @    | 0.15 | m             |      |



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480



# SEÑO DE MURO DE CONTENCION EN VOLADO



1298  
502

528  
1297

DISEÑO DE MURO DE CONTENCIÓN			
EN VOLADIZO			
PROYECTO	CONSTRUCCION DE MURO DE CONTENCIÓN		
PROPIETARIO	MUNICIPALIDAD DISTRITAL DE SUBTANJALLA	DEPART.	ICA
PROVINCIA	ICA	SUBTANJALLA	FECHA : Marzo-2022

### DATOS:

#### A GEOMETRIA DEL MURO

Hp =	4.40	m
h 1 =	1.400	m
t 1 =	0.30	m
Rec Muro	4	cm
Rec Zpta	7.5	cm

#### B DATOS DEL TERRENO

Arena densa y grava		
$\gamma$ =(kg/m3)	2650	
$\phi$ =(°)	30°	
$\sigma$ t =(kg/cm2)	1.20	

#### C DATOS DEL C° Y ACERO

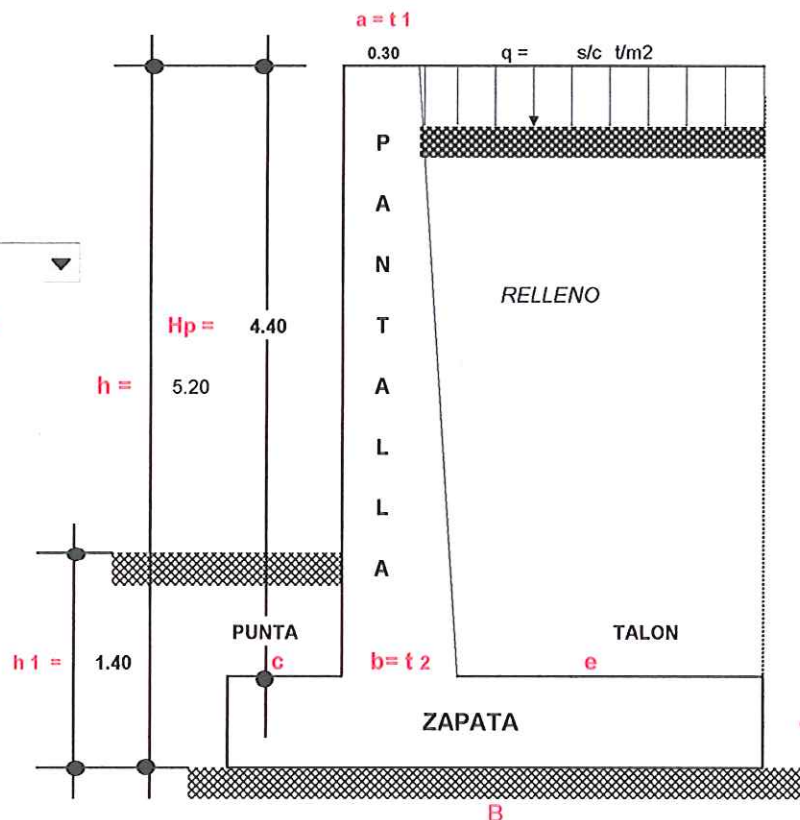
f'c=(kg/cm2)	210
f'y=(kg/cm2)	4,200

#### D FACTOR DE SEGURIDAD

F.S.V	≥	2
F.S.D	≥	1.5

#### E SOBRECARGA

q=s/c t-m2	0.50	tn
------------	------	----



#### 1.- PREDIMENSIONAMIENTO:

$$a = 20 \text{ a } 30 \rightarrow \text{Asumido} = 0.30 \text{ m}$$

$$b = \frac{H}{12} \text{ a } \frac{H}{10}$$

$$b = \frac{5.20}{12} \text{ ó } \frac{5.20}{10}$$

$$b = 0.43 \text{ ó } 0.52 \rightarrow \text{Asumido} = 0.50 \text{ m}$$

$$B = 0.5 \text{ H a } 0.8 \text{ H}$$

$$B = 0.5 \cdot 5.20 \text{ ó } 0.8 \cdot 5.20$$

$$B = 2.60 \text{ ó } 4.16 \rightarrow \text{Asumido} = 4.15 \text{ m}$$

Ing. Omar Huaman Espino  
INGENIERO CIVIL  
R.G. CIP N° 154480

520  
1796

$$c = \frac{1}{3} B - \frac{1}{2} b = 1.13$$

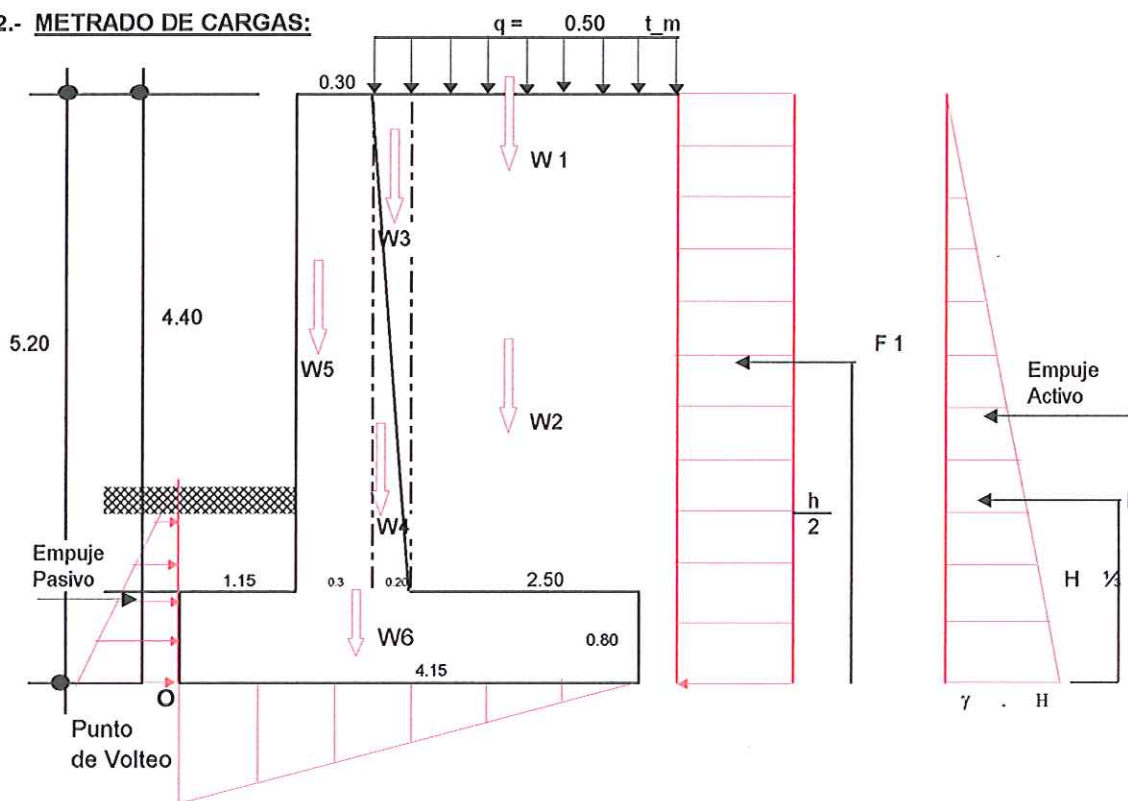
$$c = 1.13 \rightarrow \text{Asumido} = 1.15 \text{ m}$$

$$d = \begin{matrix} = b = \\ = b + 5 \\ = b + 10 \\ = b + 15 \\ = b + 20 \end{matrix} \quad \begin{matrix} 0.60 \\ 0.60 \\ 0.60 \\ 0.60 \\ 0.60 \end{matrix} \rightarrow \text{Asumido} = 0.80 \text{ m}$$

$$e = B - c - b = 4.15 - 1.15 - 0.50$$

$$e = 2.50 \text{ m}$$

## 2.- METRADO DE CARGAS:



### a.\_ FUERZAS VERTICALES: 1.40 mts de Analisis

W1	=	0.50	t/m2	x	2.70	x	1.40	=	1,890	kg		
W2	=	30	kg/cm2	x	(	2.50	x	4.40	) x	1.40 =	462	kg
W3	=	30	kg/cm2	x	(	$\frac{0.20 \times 4.40}{2}$	) x	1.40	=	18	kg	
W4	=	2,400	kg/cm2	x	(	$\frac{0.20 \times 4.40}{2}$	) x	1.40	=	1,478	kg	
W5	=	2,400	kg/cm2	x	0.3	x	4.40	x	1.40	=	4,435	kg

*Inge Omar Huaman Espino*  
INGENIERO CIVIL  
REG CIP N° 154480

519  
1298

$$W6 = 2400 \text{ kg/cm}^2 \times 4.15 \times 0.80 \times 1.40 = \frac{11,155 \text{ kg}}{\sum fy \quad 19,439 \text{ kg}}$$

b.- FUERZAS HORIZONTALES O FUERZAS DE EMPUJE DEL TERRENO

CALCULO DEL COEFICIENTE ACTIVO DE RANKINE (Ka)

$$K_a = \tan^2 \left( 45^\circ - \frac{\phi}{2} \right)$$

$$K_a = \tan^2 \left( 45^\circ - \frac{30}{2} \right) = 30.00$$

$$K_a = 0.333$$

$$F1 = [ (q) \times (H) \times 1.00 \text{ m} ] K_a$$

$$F1 = [ 500 \text{ kg/cm}^2 \times 5.20 \times 1.00 ] \times 0.333$$

$$F1 = 867 \text{ Kg/cm}^2$$

**UBICACIÓN : F 1**

$$F1 = \frac{H}{2} = \frac{4.40}{2} = 2.2 \text{ m}$$

$$F2 = (vol) D \cdot P$$

$$F2 = \left[ \frac{1}{2} (\gamma H) (H) \times 1.00 \right] K_a$$

$$F2 = \frac{1}{2} \gamma h^2 \times 1.00 \times K_a$$

$$F2 = \frac{1}{2} 30 \text{ kg/cm}^2 \cdot 4.40^2 \cdot 1.00 \cdot 0.333$$

$$F2 = 96.80 \text{ Kg}$$

**UBICACIÓN : F 2**

$$F2 = \frac{1}{3} H$$

$$F2 = \frac{1}{3} 4.40 = 1.47 \text{ m}$$

### 3.- ESTABILIDAD DEL MURO AL VOLTEO

$$F_s V = \frac{\sum MF_y}{\sum MF_h} \geq 2$$

FUERZAS VERTICALES ESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
W 1	1,890	3.00	5,670.00
W2	462	3.00	1,386.00
W3	18	1.550	28.64
W4	1,478	1.550	2,291.52
W5	4,435	1.300	5,765.76
W6	11,155	2.08	23,147.04
$\sum MF_f$	19,439	$\sum MoF_y$	38,288.96



Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP. N. 154480



518  
1294

FUERZAS HORIZONTALES DESESTABILIZADORAS

PESO	W (Kg)	BRAZO (m)	MOMENTO(kg-m)
F 1	867	2.200	1,906.67
F 2	97	1.47	142.30
$\Sigma Fh$	963.47	$\Sigma MFh$	2,048.96

$F_s V$	$\frac{38,288.96 \text{ kg/m}}{2,048.96 \text{ kg/m}}$	=	18.69	>	2	OK CUMPLE
---------	--	---	-------	---	---	-----------

3.- ESTABILIDAD DEL MURO POR DESLIZAMIENTO

$F_s D$	=	$\frac{u \Sigma F_v}{\Sigma F_h}$	$\geq$	1.5	=	$\frac{f \text{ Empuje}}{f \text{ Rozamiento}}$
---------	---	-----------------------------------	--------	-----	---	---

$$u = \tan \phi \leq 0.60$$

$$u = 30^\circ = 0.577 > 0.60$$

$$u = 0.58$$

$F_s D$	$\frac{0.58 \cdot 19,439}{963.47}$	=	11.64	>	1.50	OK CUMPLE
---------	------------------------------------	---	-------	---	------	-----------

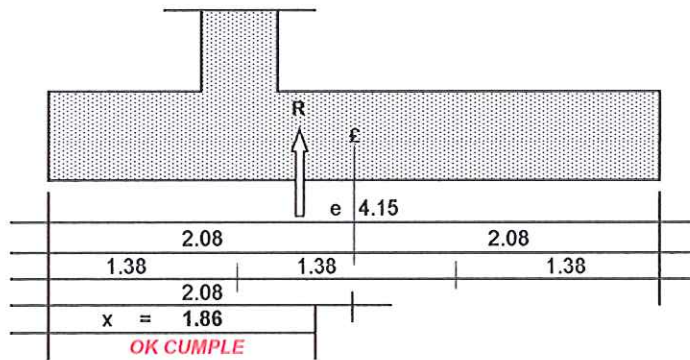
ESTABILIDAD PARA CAPACIDAD PORTANTE DEL TERRENO DE CIMENTACIÓN

1ro CALCULO DE LA UBICACIÓN DE LA RESULTANTE:

$$x = \frac{\Sigma M_o}{\Sigma F_y} \quad x = \frac{\Sigma M_o F_y - \Sigma M_o F_h}{\Sigma F_y}$$

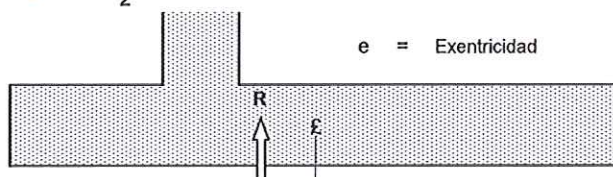
$$x = \frac{38,288.96 - 2,048.96}{19,439}$$

$$x = 1.86$$



2ro EXENTRICIDAD

$$e = \frac{B}{2} - x$$



*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. 1294



SA  
1793

$$\begin{array}{c}
 \begin{array}{|c|c|c|c|}
 \hline
 & e & 4.15 & \\
 \hline
 B/3 & B/3 & B/3 & \\
 \hline
 & B/6 & B/6 & \\
 \hline
 \end{array} \\
 e = \frac{4.15}{2} - 1.86 \quad e = 0.211 \\
 \frac{B}{6} = \frac{4.15}{6} = 0.69
 \end{array}$$

### 3ro CALCULO DE LA PRESION ACTUANTE

$$q = \frac{\sum Fy}{A \cdot B} \left( 1 \pm \frac{6 \cdot e}{B} \right)$$

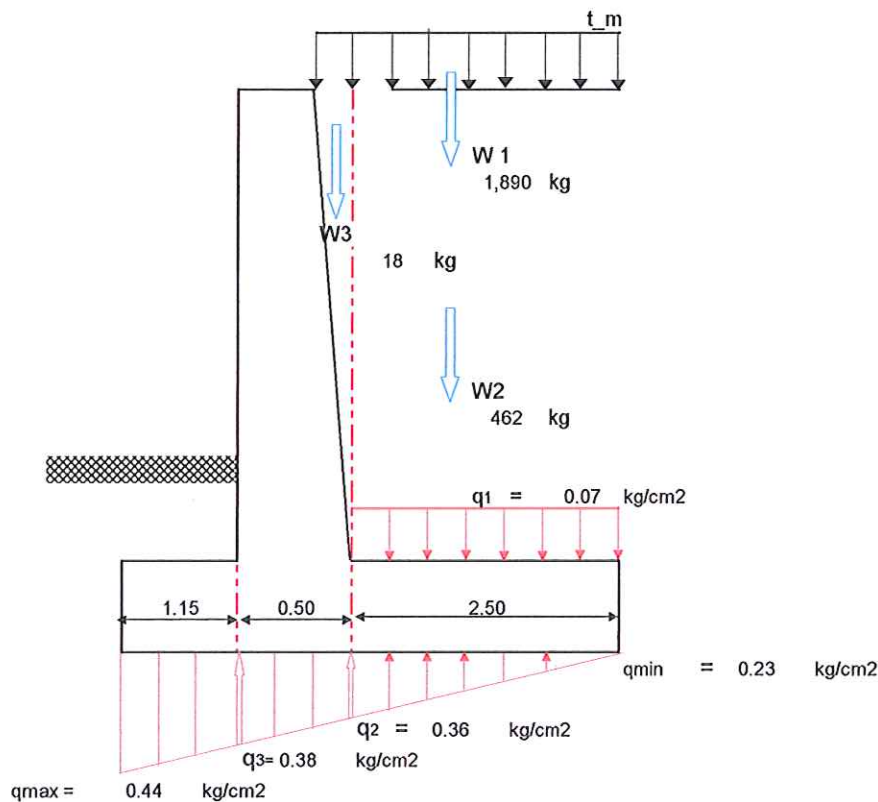
$$q = \frac{19,439}{1.40 \cdot 4.15} \left( 1 \pm \frac{6 \cdot 0.211}{4.15} \right)$$

$$q = 3,345.83 \quad 1 \pm 0.3046747$$

$$q_{\max} = 4,365.22 \text{ kg/m}^2 \rightarrow 0.44$$

$$q_{\min} = 2,326.44 \text{ kg/m}^2 \rightarrow 0.23$$

$$\begin{array}{lcl}
 q_{\max}, q_{\min} & < & \sigma_t = \text{OK CUMPLE} \\
 0.44 & < & 1.20
 \end{array}$$



$$q = \frac{w_1 + w_2 + w_3}{A \text{ talón}} \quad q = \frac{1,890 + 462 + 18}{2.50 \times 1.40}$$

$$q = 677.28 \text{ kg/m}^2 \rightarrow 0.07 \text{ kg/cm}^2$$

$$\frac{2.50}{x} = \frac{4.15}{0.20} \quad x = 0.123 \rightarrow q_2 = 0.23 + x$$

$$\begin{array}{l}
 q_2 = 0.23 + 0.123 \\
 q_2 = 0.36 \text{ kg/cm}^2
 \end{array}$$

$$\frac{2.50 + 0.50}{y} = \frac{4.15}{0.20} \quad y = 0.147 \quad q_3 = 0.23 + y$$



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 54480

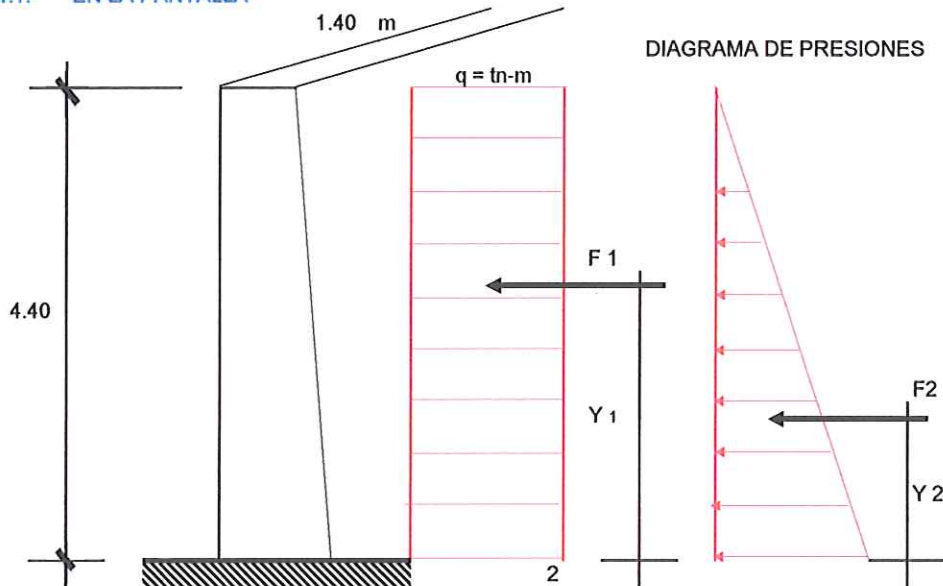
816  
1292

$$q_3 = 0.23 + 0.147$$

$$q_3 = 0.38 \text{ kg/cm}^2$$

#### 4.- CALCULO DE LOS MOMENTOS FLECTORES Y FUERZAS CORTANTES

##### 4.1.- EN LA PANTALLA



##### a) MOMENTO FLECTOR

En

$$F1 = (q \cdot h \cdot 1.00 \text{ m}) \cdot ka$$

$$F1 = (500 \text{ kg-m} \times 4.40 \text{ m} \times 1.00 \text{ m}) \cdot 0.333$$

$$F1 = 733.33 \text{ kg}$$

$$y1 = \frac{h}{2} = \frac{4.40}{2} = 2.2$$

$$y1 = 2.2 \text{ m}$$

En

$$F2 = \frac{1}{2} (\gamma \cdot h^2 \cdot 1.00 \text{ m}) \cdot Ka$$

$$F2 = \frac{1}{2} \cdot 30 \cdot \frac{19.36}{4.40} \cdot 1.00 \cdot 0.333 = 96.80 \text{ kg}$$

$$F2 = 0.10 \text{ tn-m}$$

$$y2 = \frac{1}{3} h \quad y2 = \frac{1}{3} \cdot 4.40$$

$$y2 = 1.47 \text{ m}$$

##### MOMENTO ULTIMO

$$M_{\max} = (F1 \cdot Y1) + (F2 \cdot Y2)$$

$$M_{\max} = (733.33 \times 2.2) + (96.80 \times 1.47)$$

$$M_{\max} = 1,755.31 \text{ kg-m}$$

##### b) FUERZA CORTANTE

##### \* FUERZA CORTANTE ACTUANTE

$$V = F1 + F2$$

$$V = 733.33 + 96.80$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 154480

518  
1291

$$V = 830.13 \text{ kg}$$

\* ESFUERZO CORTANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \left| \begin{array}{l} V = 830.13 \\ b = 1.00 \\ d = 0.46 \end{array} \right.$$

$$\mu = \frac{830.13}{100 \cdot 46} = 0.18$$

$$\mu = 0.18 \text{ kg/cm}^2$$

\* ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $\mu_c$ )

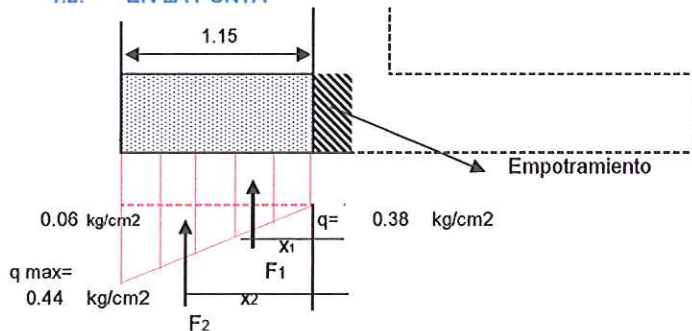
$$\mu_c = \phi \cdot 0.53 \cdot \sqrt{f'c}$$

$$\mu_c = 0.85 \times 0.53 \cdot \sqrt{210} = 6.53 \text{ kg/cm}^2$$

$$\mu_c = 6.53 \text{ kg/cm}^2 > 0.18 \text{ kg/cm}^2 \quad \text{OK CUMPLE}$$



4.2.- EN LA PUNTA



a) MOMENTO FLECTOR

En:

$$F1 = 0.38 \times 1.15 \times 1.00$$

$$F1 = 4,370 \text{ Kg}$$

$$X1 = \frac{1.15}{2} = 0.58 \text{ m}$$

En

$$F2 = \frac{1}{2} \times 115 \times 0.06 \times 100 = 324.85 \text{ Kg}$$

$$F2 = 324.85 \text{ kg}$$

$$X2 = \frac{2}{3} \times 1.15 =$$

$$X2 = 0.77 \text{ mt}$$

MOMENTO MAXIMO

$$M_{\text{máx}} = (F1 \cdot X1) + (F2 \cdot X2)$$

$$M_{\text{máx}} = (4,370 \times 0.58) + (324.85 \times 0.77)$$

$$M_{\text{máx}} = -2,263.87 \text{ kg-m}$$

FUERZA CORTANTE ACTUANTE ( $v$ )

$$V = F1 + F2$$

Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 10448

SH  
1290

$$V = 4,370 + 324.85$$

$$V = 4,695.15 \text{ kg}$$

ESFUERZO CORTANTE (q)

$$q = \frac{V}{b \cdot d}$$

$$q = \frac{4,695.15}{115 \cdot 46}$$

$$q = 0.89 \text{ kg/cm}^2$$

ESFUERZO CORTANTE RESISTENTE DEL CONCRETO (Vc)

$$Vc = \emptyset \quad 0.53 \quad \sqrt{f'c}$$

$$Vc = 0.85 \quad 0.53 \quad 14.49$$

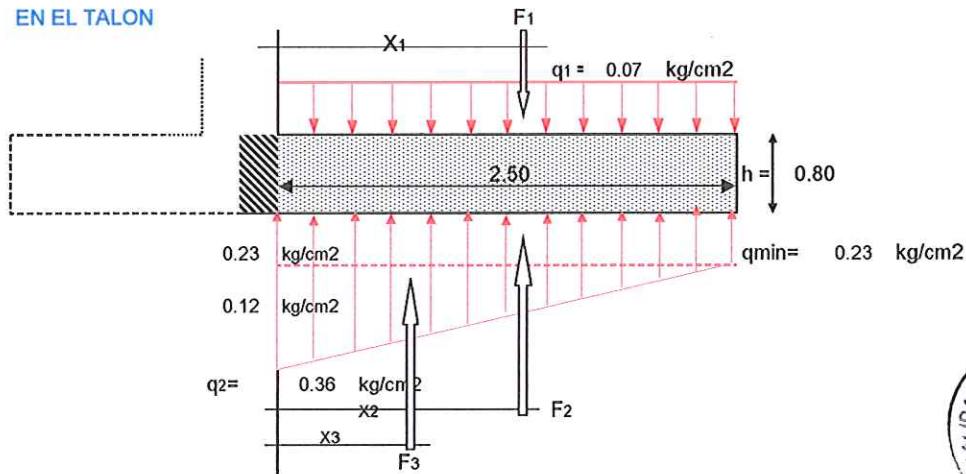
$$Vc = 6.53$$



Ing. Omar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N° 54461

513  
1289

4.3.- EN EL TALON



$$F1 = 0.07 \text{ kg/cm}^2 \cdot 250 \text{ cm} \cdot 100 \text{ cm}$$

$$F1 = 1,693.20 \text{ kg}$$

$$X1 = \frac{2.50}{2}$$

$$X1 = 1.25 \text{ m}$$

$$F2 = 0.23 \text{ kg/cm}^2 \cdot 250 \text{ cm} \cdot 100 \text{ cm}$$

$$F2 = 5,816.10 \text{ kg}$$

$$X2 = \frac{2.50}{2}$$

$$X2 = 1.25 \text{ m}$$

$$F3 = \frac{1}{2} \cdot 0.12 \text{ kg/cm}^2 \cdot 250 \text{ cm} \cdot 100 \text{ cm}$$

$$F3 = 1,535.23 \text{ kg}$$

$$X3 = \frac{1}{3} \cdot 2.50$$

$$X3 = 0.83 \text{ m}$$

a. MOMENTO FLECTOR

$$M = (F2 \cdot X2) + (F3 \cdot X3) - (F1 \cdot X1)$$

$$M = (5,816.10 \times 1.25) + (1,535.23 \times 0.83) - (1,693 \times 1.25)$$

$$M = 10,666.0 \text{ kg/cm}^2$$

b. FUERZA CORTANTE

$$V = F1 - F2 - F3$$

$$V = 1,693.20 - 5,816.10 - 1,535.23$$

$$V = -5,658.13 \text{ kg/cm}^2$$

c. ESFUERZO CORTANTE ACTUANTE ( $\mu$ )

$$\mu = \frac{V}{b \cdot d} \quad \mu = \frac{-5,658.13}{100 \cdot 46}$$

$$\mu = -1.23 \text{ kg/cm}^2$$

d. ESFUERZO CORTANTE RESISTENTE DEL CONCRETO ( $V_c$ )



*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP. N. 154464



512  
1288

$$V_c = \emptyset \quad 0.53 \quad \sqrt{f'_c} \quad 210$$

$$V_c = \quad 0.85 \quad 0.53 \quad 14.49$$

$$V_c = \quad 6.53 \quad \text{kg/cm}^2 > \mu \text{ act } -1.23 \quad \text{kg/cm}^2 \quad \text{OK CUMPLE}$$

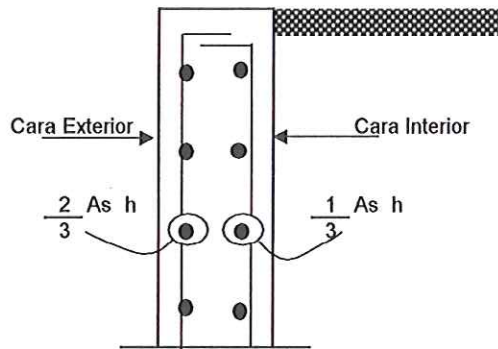
## 5.- DISEÑO DEL ACERO.

a- Acero Mínimo Vertical en muros:

- Para  $\emptyset \leq 5/8"$   $A_{smin} \text{ (Vertical)} = 0.0012 \quad b \quad h$
- Para  $\emptyset > 5/8"$   $A_{smin} \text{ (Vertical)} = 0.0015 \quad b \quad h$

b- Acero Mínimo Horizontal en muros:

- Para  $\emptyset \leq 5/8"$   $A_{smin} \text{ (Horizontal)} = 0.0020 \quad b \quad h$
- Para  $\emptyset > 5/8"$   $A_{smin} \text{ (Horizontal)} = 0.0025 \quad b \quad h$



Para elementos sometidos a Flexocompresión (Losas, vigas, escaleras, muros)

$$K_u = \frac{M_u}{b \quad d^2}$$

$$A_s = \rho \quad b \quad d$$

### 5.1 ACERO EN LAPANTALLA:

a. Acero Principal Vertical

$$M_u = \quad 1.6$$

$$M_u = \quad 1.6 \quad 1,755.31 = \quad 2,808.49$$

$$M_u = \quad 2,808 \quad \text{kg/m}$$

$$K_u = \frac{2,808 \quad \times \quad 10^2 \quad \text{kg/cm}^2}{100 \quad 2116}$$

$$K_u = \quad 1.33 \quad \rho =$$

$$\text{Para } \begin{cases} f_c = 210 \quad \text{Kg/cm}^2 \\ f_y = 4,200 \quad \text{Kg/cm}^2 \\ K_u = 1.33 \end{cases} \Rightarrow \rho = \quad 0.0004$$

Acero principal:

$$A_s = \rho \quad b \quad d$$

$$A_s = \quad 0.0004 \quad 100 \quad 46 = \quad 1.84$$

$$A_s = \quad 1.84 \quad \text{cm}^2$$

$$A_s = \quad 1.84 \quad \Rightarrow \quad 4 \quad \emptyset \quad 1" \quad \nabla \quad = \quad 20.27$$

OK CUMPLE

+ - 0.50 CM2



Ing. Omar Huaman Espino  
INGENIERO  
REG. CIP. 14448

SH  
1287

$$S = \frac{5.07}{20.27} \times 100$$

$$S = 25.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

$\Rightarrow$ 

USAR	4	Ø	de	1	@	0.250	ml
------	---	---	----	---	---	-------	----

b) Acero mínimo Vertical

$$As_{min} \text{ (vertical)} = 0.0015 \quad 100 \quad 46$$

$$As_{mín} = 6.9 \quad \text{cm}^2$$

As princ	20.27	>	As min	6.9
----------	-------	---	--------	-----

 OK CUMPLE



5.2 ACERO SECUNDARIO PRINCIPAL:

a) Acero Vertical en la cara exterior:

$$As_{min} \text{ (vertical)} = 0.0012 \quad 100 \quad 46$$

$$As_{mín} = 5.52 \quad \text{cm}^2$$

$$As = 5.52 \quad \text{cm}^2$$

$As =$ 

5.52	$\Rightarrow$	2	Ø	3/4"	$\nabla$	=	5.70
------	---------------	---	---	------	----------	---	------

 OK CUMPLE

$$S = \frac{2.85}{5.70} \times 100$$

$$S = 50.00 \quad \text{Asumido} \Rightarrow 0.25 \text{ m}$$

$\Rightarrow$ 

USAR	2	Ø	de	3/4	@	0.25	ml
------	---	---	----	-----	---	------	----



5.2 ACERO SECUNDARIO PRINCIPAL:

Asumimos un  $\varnothing \leq 5/8"$

$$As_{min} = 0.0020 \quad b \quad d$$

Omar Huaman Espino  
INGENIERO CIVIL  
R.O.C. CIP N° 55448

S/D  
1286

1) Arriba: (h = 0.3 )

$$As_{min} = 0.0020 \cdot 100 \cdot 0 = 0.06$$

$$As_{min} = 6.00 \text{ cm}^2$$

a) Cara Interior

$$\frac{1}{3} Ash = \frac{1}{3} 6.00 = 2.00 \text{ cm}^2/\text{m}$$

$$As = 2.00 \text{ cm}^2$$

$$As = \boxed{6.00} \Rightarrow \boxed{5} \text{ } \emptyset \boxed{1/2"} \nabla = \boxed{6.33} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \text{ Asumido} \Rightarrow \boxed{0.20} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 5 \text{ } \emptyset \text{ de } 1/2 @ 0.20 \text{ m}}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 6 = 4.00 \text{ cm}^2/\text{m}$$

$$As = 4.00 \text{ cm}^2$$

$$As = \boxed{4.00} \Rightarrow \boxed{4} \text{ } \emptyset \boxed{1/2"} \nabla = \boxed{5.07} \text{ OK CUMPLE}$$

$$S = \frac{1.27}{5.07} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 4 \text{ } \emptyset \text{ de } 1/2 @ 0.25 \text{ m}}$$

2) Cara Intermedia (h =  $\frac{50 + 30}{2}$ ) = 40 cm

$$As_{min} (\text{Horizontal}) = 0.0020 \cdot 100 \cdot 40 = 8.00 \text{ cm}^2$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} 8.00 = 2.67 \text{ cm}^2/\text{m}$$

$$As = 2.67 \text{ cm}^2$$

$$As = \boxed{8.00} \Rightarrow \boxed{3} \text{ } \emptyset \boxed{3/4"} \nabla = \boxed{8.55} \text{ OK CUMPLE}$$

$$S = \frac{2.85}{8.55} \times 100$$

$$S = 33.33 \text{ Asumido} \Rightarrow \boxed{0.35} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR } 3 \text{ } \emptyset \text{ de } 3/4 @ 0.35 \text{ m}}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 8.0 = 5.33 \text{ cm}^2/\text{m}$$



*Ing. Oscar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N° 454488

509  
1285

$$As = 5.33 \text{ cm}^2$$

$$As = \boxed{5.33} \Rightarrow \boxed{5} \text{ } \emptyset \text{ } \boxed{1/2"} \nabla \boxed{=} \boxed{6.33}$$

OK CUMPLE

$$S = \frac{1.27}{6.33} \times 100$$

$$S = 20.00 \text{ Asumido} \Rightarrow \boxed{0.20} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{5} \text{ } \emptyset \text{ de } \boxed{1/2} \text{ @ } \boxed{0.20} \text{ ml}$$

3) Cara Inferior (abajo) (h = 0.50 m)

$$As \text{ min (Horizontal)} = 0.0020 \times 100 \times 50.00 = 10.00$$

a) Cara Interior:

$$\frac{1}{3} Ash = \frac{1}{3} 10.00 = 3.33 \text{ cm}^2/\text{m}$$

$$As = 3.33 \text{ cm}^2$$

$$As = \boxed{3.33} \Rightarrow \boxed{2} \text{ } \emptyset \text{ } \boxed{3/4"} \nabla \boxed{=} \boxed{5.70}$$

OK CUMPLE

$$S = \frac{2.85}{5.70} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.25} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{2} \text{ } \emptyset \text{ de } \boxed{3/4} \text{ @ } \boxed{0.25} \text{ ml}$$

b) Cara Exterior:

$$\frac{2}{3} Ash = \frac{2}{3} 10.0 = 6.67 \text{ cm}^2/\text{m}$$

$$As = 6.67 \text{ cm}^2$$

$$As = \boxed{6.67} \Rightarrow \boxed{4} \text{ } \emptyset \text{ } \boxed{5/8"} \nabla \boxed{=} \boxed{7.92}$$

OK CUMPLE

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow \boxed{0.250} \text{ m}$$

$$\Rightarrow \boxed{\text{USAR}} \boxed{4} \text{ } \emptyset \text{ de } \boxed{5/8} \text{ @ } \boxed{0.25} \text{ ml}$$

### Resumen

#### Acero Horizontal

1) Ariba	=	(As mín Horizontal)	=	6.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 1/2 @ 0.20	m
		Cara exterior	=	$\emptyset$ 1/2 @ 0.25	m
2) Intermd	=	(As mín Horizontal)	=	8.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 3/4 @ 0.35	m
		Cara exterior	=	$\emptyset$ 1/2 @ 0.20	m
3) Inferior	=	(As mín Horizontal)	=	10.00	cm <sup>2</sup>
		Cara Interior	=	$\emptyset$ 3/4 @ 0.25	m
		Cara exterior	=	$\emptyset$ 5/8 @ 0.250	m



*Ing. Omar E. Espino*  
INGENIERO CIVIL  
REG. CIP N° 154480

508  
1284

Para cara Interior

C.I 2 Ø 3/4 @ 0.25 , 3 Ø 3/4 @ 0.35 Rto Ø 3/4 @ 0.20

Para Exterior:

C.E 4 Ø 5/8 @ 0.25 , 5 Ø 1/2 @ 0.20 Rto Ø 5/8 @ 0.25

Entonces:

C.I = Ø 3/4 @ 0.267 ≈ 0.3  
C.E = Ø 5/8 @ 0.233 ≈ 0.25

SI UNIFORMAMOS EL ACERO 0.267 a 0.233 = 0.25 ≈ 0.250

tenemos: Ø 3/4 @ 0.25  
Ø 5/8 @ 0.25

## 5 DISEÑO DE LA ZAPATA.

### a) MOMENTO ULTIMO

$$M_u = 1.6 \times -2,263.87 \text{ kg-m} = -3,622.19 \text{ kg-m}$$

$$b = 1.00 \text{ mt}$$

$$d = h_z - \frac{(r + \phi \text{ vlla})}{2}$$

$$d = 80 - 7.5 + \frac{1.58}{2}$$

$$d = 71.71$$

$$K_u = \frac{-3,622}{100} \times \frac{10^2}{5142} \text{ kg/cm}^2$$

$$K_u = -0.70$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ K_u = -0.70 \end{cases} \Rightarrow \rho = -0.0002$

Acero principal:

$$A_s = \rho \cdot b \cdot d$$

$$A_s = -0.0002 \cdot 100 \cdot 72 = -1.43$$

$$A_s = -1.43 \text{ cm}^2$$

$$A_s = \frac{11.47}{13.86} \Rightarrow 7 \text{ Ø } 5/8 = 13.86$$

OK CUMPLE

+ - 0.50 CM2

$$S = \frac{1.98}{13.86} \times 100$$

$$S = 14.29 \text{ Asumido } \Rightarrow 0.15 \text{ m}$$

$$\Rightarrow \text{USAR } 7 \text{ Ø de } 5/8 @ 0.15 \text{ m}$$

Acero mínimo:

$$A_{s\text{mín}} = 0.0018 \cdot 100 \cdot 71.71 = 12.91$$



Ing. Oscar Huaman Espino  
INGENIERO CIVIL  
REG. CIP N. 154480



507  
1783

12.91	<	13.86	OK CUMPLE
-------	---	-------	-----------

#### ZAPATA POSTERIOR

$$Mu = 1.6 \times 10,666 \text{ kg-m} = 17,065.57 \text{ kg/m}$$

$$b = 1.00 \text{ mt}$$

$$d = 71.71$$

$$Ku = \frac{17,066 \times 10^2 \text{ kg/cm}^2}{100 \times 5142}$$

$$Ku = 3.32$$

Para  $\begin{cases} f_c = 210 \text{ Kg/cm}^2 \\ f_y = 4,200 \text{ Kg/cm}^2 \\ Ku = 3.32 \end{cases} \Rightarrow \rho = 0.0009$



#### Acero principal:

$$As = \rho \cdot b \cdot d$$

$$As = 0.0009 \cdot 100 \cdot 72 = 6.45$$

$$As = 6.45 \text{ cm}^2$$

As =	6.45	⇒	4	Ø	5/8"	▼	=	7.92
------	------	---	---	---	------	---	---	------

OK CUMPLE

$$S = \frac{1.98}{7.92} \times 100$$

$$S = 25.00 \text{ Asumido} \Rightarrow 0.25 \text{ m}$$

⇒ **USAR 4 Ø de 5/8 @ 0.25 ml**



#### ACERO TRANSVERSAL (PARA PUNTA Y TALON)

$$Astemp = 0.0018 \cdot b \cdot t \quad \text{N.T.P} \quad t = h_z = 0.80$$

$$Astemp = 0.0018 \cdot 100 \cdot 80 = 14.40 \text{ cm}^2$$

$$As = 14.40 \text{ cm}^2$$

As =	14.40	⇒	8	Ø	5/8"	▼	=	15.83
------	-------	---	---	---	------	---	---	-------

OK CUMPLE

$$S = \frac{1.98}{15.83} \times 100$$

$$S = 12.50 \text{ Asumido} \Rightarrow 0.15 \text{ m}$$

⇒ **USAR 8 Ø de 5/8 @ 0.15 ml**

*Ing. Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 154480

506  
1282

PARA ACERO DE TEMPERATURA, NO DEBE DE EXCEDER:

$$S \leq \left| \frac{0.5}{45} t \right| = \frac{0.5}{80} = 40$$

SE TOMA EL MENOR:

$$Astemp = \emptyset \quad 5/8 \quad @ \quad 0.20$$



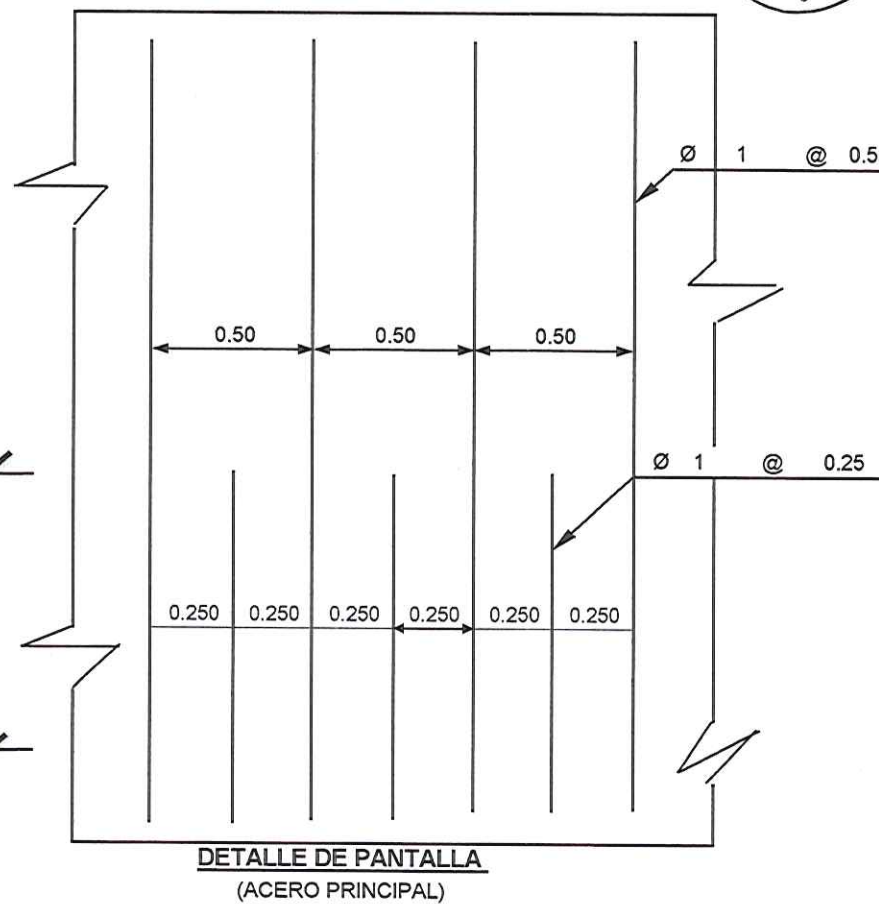
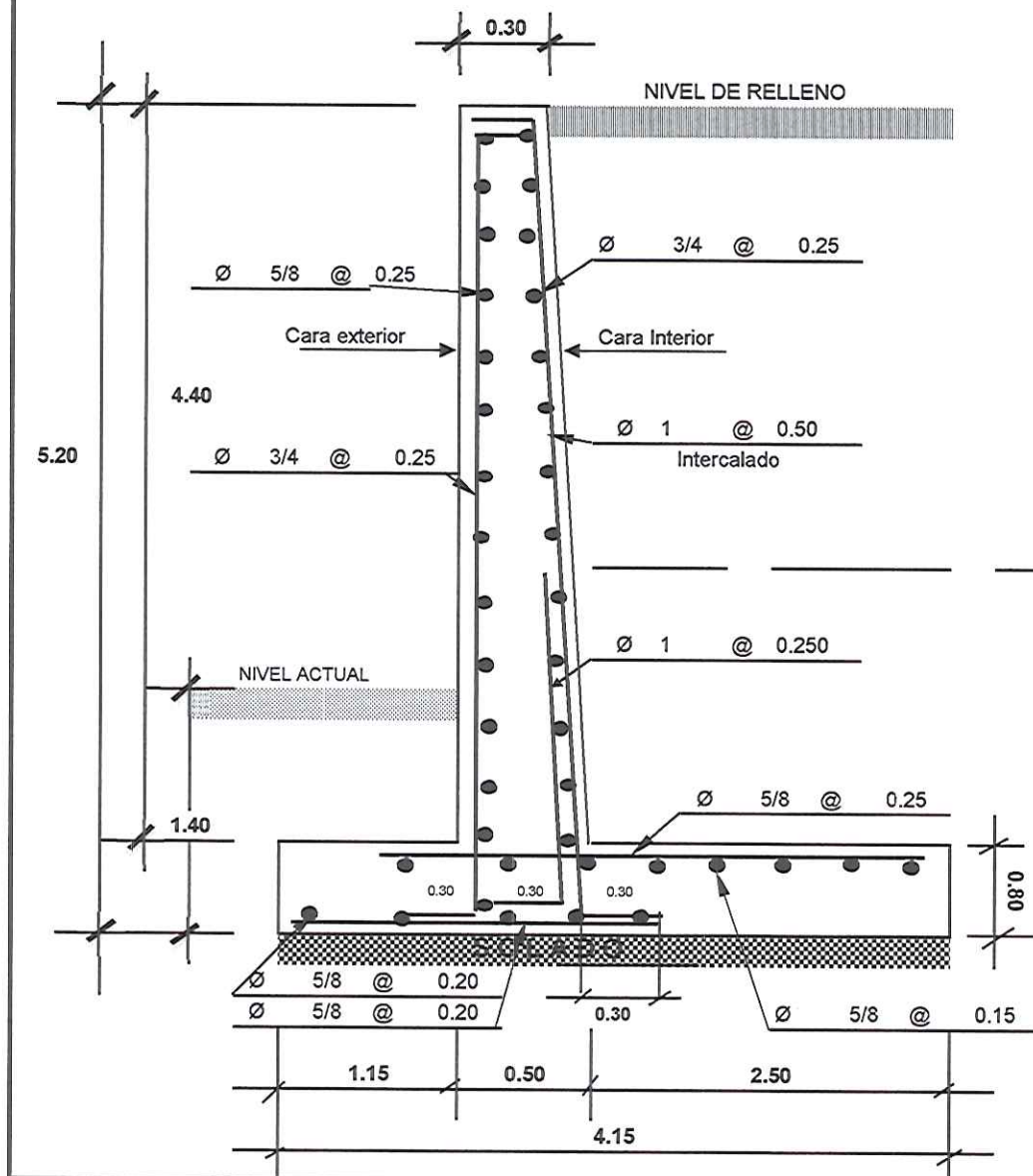
### RESUMEN GENERAL DEL ACERO

1.-	PANTALLA:								
	*	ACERO VERTICAL							
		-	Cara Interior	=	$\emptyset$	1	@	0.50 m	Intercalado ó
				=	$\emptyset$	1	@	0.25 m	a una (h) de 2.20
		-	Cara Exterior	=	$\emptyset$	3/4	@	0.25 m	
	*	ACERO HORIZONTAL							
		-	Cara Interior	=	$\emptyset$	3/4	@	0.25 m	
		-	Cara Exterior	=	$\emptyset$	5/8	@	0.25 m	
2.-	ZAPATA ANTERIOR (PUNTA)								
	*	ACERO PRINCIPAL	=	$\emptyset$	5/8	@	0.20 m		
	*	ACERO TRANSVERSAL	=	$\emptyset$	5/8	@	0.20 m		
3.-	ZAPATA POSTERIOR (TALON)								
	*	ACERO PRINCIPAL	=	$\emptyset$	5/8	@	0.25 m		
	*	ACERO TRANSVERSAL	=	$\emptyset$	5/8	@	0.15 m		



*Omar Huaman Espino*  
INGENIERO CIVIL  
REG. CIP N. 153480

# DISEÑO DE MURO DE CONTENCION EN VOLADIZO



Inge Omar Huaman Espino  
 INGENIERO CIVIL  
 REC. CIP N° 154480

128  
 505