

**U. N. I.**

# **Concreto Armado I**

**Trabajo Escalonado**

***Para Optar***

***Título de Bachiller***

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CONCRETO ARMADO I (1972)

TRABAJO ESCAFONADO

PRIMERA PARTE	ALIGERADOS
SEGUNDA PARTE	ESCALERA
TERCERA PARTE :	VIGAS
CUARTA PARTE	PLANOS

ADRIANO CISNEROS VIZQUEIRA

PRIMERA PARTE: ALIGERADOS

## ALIGERADOS

### Calculos Previos:

1.- Dimensiones: Altura = 20 cms.

$$\text{Peralte} = d = 20 - 3 = 17 \text{ cms.}$$

2.- Metrado de Cargas:

a) Cargas Muertas

-Aligerado (módulo=0.4 m.)

$$\text{Losa} = 0.4 \times 0.05 \times 1 \times 2,400 = 48 \text{ Kg/m.}$$

$$\text{Vigueta} = 0.1 \times 0.15 \times 1 \times 2,400 = 36 \text{ "}$$

$$\text{Ladrillo} = (1 / 0.3) \times \text{Ocho Kilos} = 27 \text{ "}$$

$$\underline{111 \text{ "}}$$

$$\text{Carga/ M2} = 111 \times (1 / 0.4) = 280 \text{ Kg/ M2}$$

$$\text{-Acabado} = \dots\dots\dots \approx 100 \text{ "}$$

$$\text{-Tabiqueria} = (\text{no se tomará}) \dots\dots = \underline{\hspace{2cm}}$$

$$380 \text{ "}$$

b) Cargas Vivas

$$\text{-Azotea} = 100 \text{ Kg/M2}$$

$$\text{-1ºPiso} = 200 \text{ Kg/M2}$$

3.- Carga de Rotura:

a) Azotea.

$$-W_u = \frac{380(1.5) + 100(1.8)}{2.5} = 300 \text{ Kg/ m}$$

b) 1ºPiso.

$$W_u = \frac{380(1.5) + 200(1.8)}{2.5} = 372 \text{ "}$$

4.- Momento Máximo que pueden tomar las viguetas:

$$p_x = 0.75 p_b$$

$$p_b = (0.85)^2 \times (f'_c / f_y) \times (6000 / 6000 \times f_y)$$

$$\text{Como } f'_c = 175 \text{ Kg/cm}^2 \text{ y } f_y = 2,800 \text{ Kg/ cm}^2$$

$$p_x = 0.023$$

$$a_x = (p_x \cdot f_y \cdot d) / 0.85 f'_c$$

$$a_x = 7.36 \text{ cm.}$$

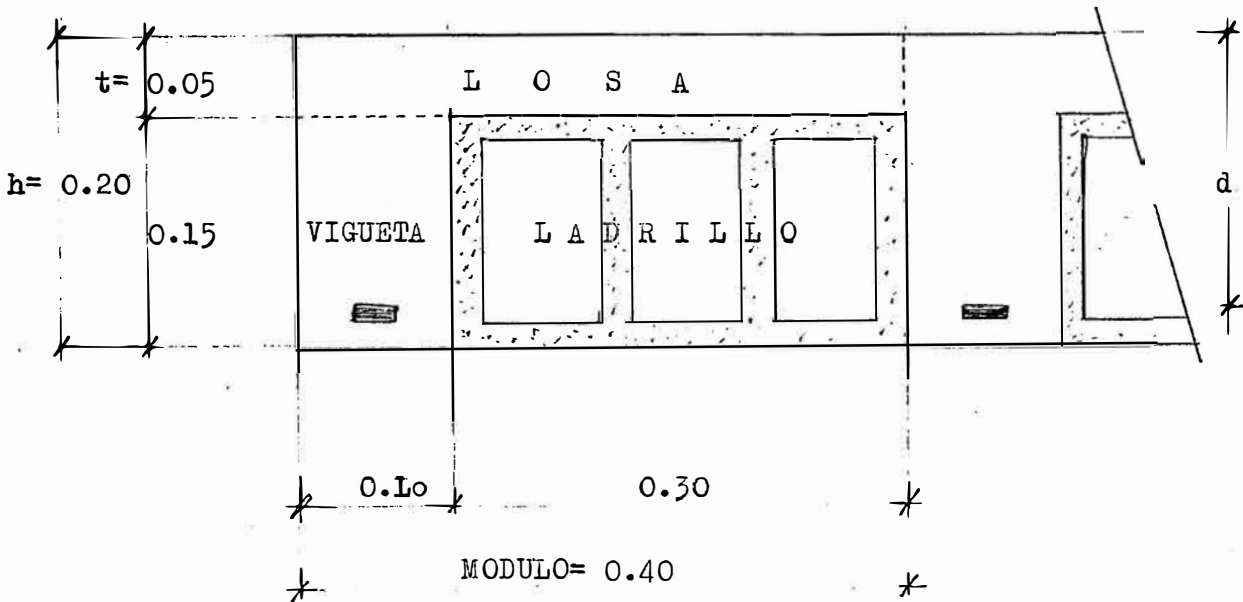
$$M'_{u_x} = 0.85 \cdot b \cdot a_x \cdot f'_c \cdot (d - \frac{a_x}{2}) \quad \text{donde } b = 10$$

$$= 1458 \text{ Kg-M}$$

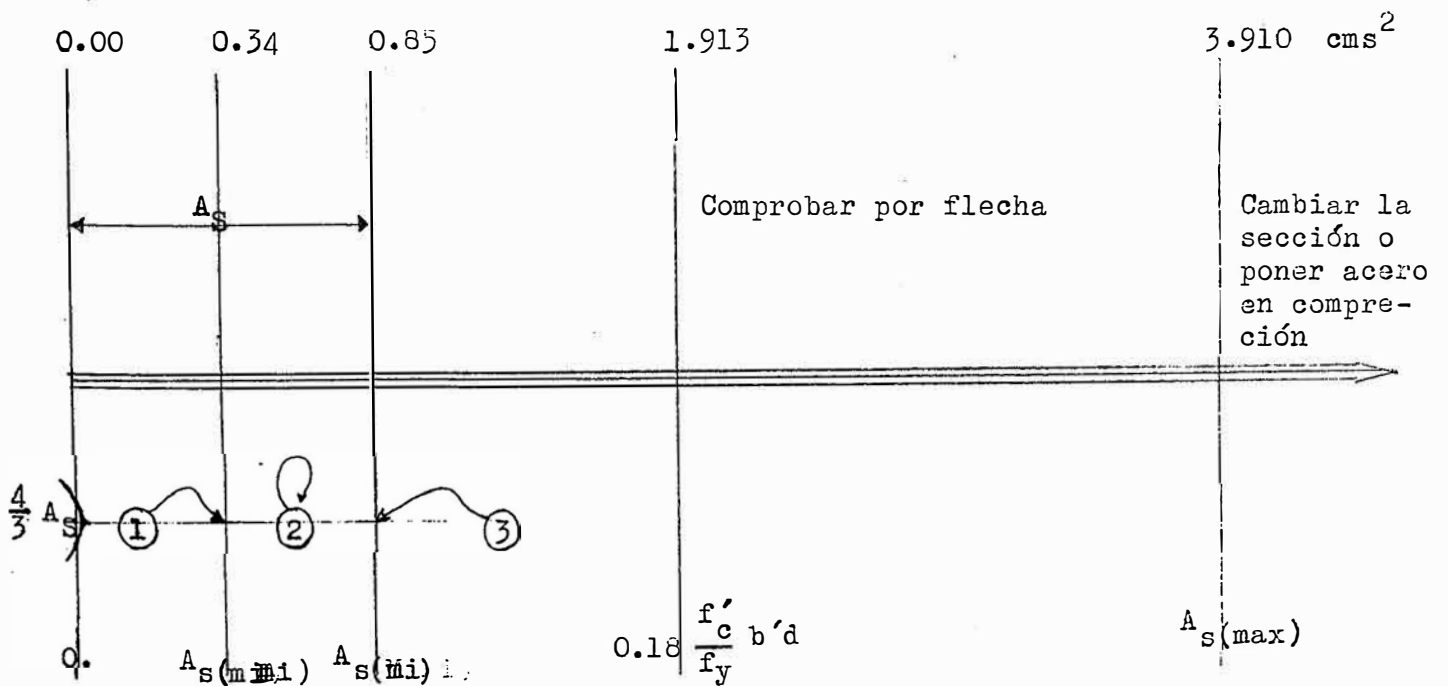
$$M_{u_x} = \phi M'_{u_x} \quad \text{donde } \phi = 0.9$$

$$= 1312 \text{ Kg-m}$$

CORTE DEL ALIGERADO



LIMITES DE ACERO ( Punto 7 )



5.- Comprobación para viga rectangular:

M = al momento máximo positivo.

$$A_s = \frac{M}{0.9 f_y (d-a/2)}$$

como a=t=5 cms. ,  $A_s = \frac{M}{36540}$

$$p = \frac{A_s}{b \cdot f_y} , \text{ como } b=40 \text{ y } d=17 ; p = \frac{M}{24847200}$$

$$q = p \frac{y}{f_c'} = 0.16M / 248472$$

$$a = 1.18q(d/0.85) = \frac{3.776 M}{248472}$$

Si a es mayor que t, se analiza como viga rectangular  
 Si a es menor que t, se analiza como viga T

6.- Comprobación por CORTE:

Tomaremos la luz mayor de todos los aligerados, si cumple con éste, cumple con todos los demás.

$$V_x = 0.575 W_u L, W_u=372 \quad L=4, V_x = 855.60 \text{ Kg.}$$

$$V_d = V_x - W_u d = 855.60 - 372(0.17) = 792.36 \text{ Kg.}$$

$$v_u = \frac{V_d}{b' d} = 4.66 \text{ Kg/cm}^2$$

$$v_{c_x} = 1.1x 0.85x 0.53 (f_c')^{1/2} = 6.56 \text{ Kg/cm}^2$$

Como 6.56 es mayor que 4.66, no es necesario anchar ninguna vigueta.

7.- Limites de acero:

$$a) A_s \text{ mínimo} = \frac{14}{f} b' d = 0.005 b' d = \dots 0.85 \text{ cm}^2$$

$$b) A_s \text{ mínimomínimo} \leq 0.002 b' d = \dots 0.34 \text{ "}$$

$$c) A_s \text{ máximo} = 0.75 p_b b' d = 0.023 b' d = 3.91 \text{ "}$$

8.- Areas de acero:

$$A_s = \frac{M}{0.9 f_y (d-a/2)}, \text{ donde } a=d/5$$

$$a) A_s = M/38556$$

$$b) A_s = M/1260(34-a)$$

$$c) a = (A_s f_y) / (0.85 f_c' b)$$

$$a(\text{positivo}) = A_s (0.471)$$

$$a(\text{negativo}) = A_s (1.882)$$

## Aligerado A-1

1.-Condicion de carga:

Unica condici~~ón~~ de carga  $W_D \downarrow L = 300 \text{ Kg/m}$

2.- Momentos negativos en los apoyos internos:

a) M. isostáticos

$$M_{AB} = M_{BA} = (WL^2)/12 = 300(3.75)^2/12 = 352 \text{ Kg-m.}$$

$$M_{BC} = M_{CB} = \quad \quad \quad = 300(3.00)^2/12 = 225 \quad \quad "$$

$$M_{CD} = M_{DC} = \quad \quad \quad = 300(4.00)^2/12 = 400 \quad \quad "$$

b) Cálculo de "K".

$$K_{AB} = (3/4)(1/L) = 0.20$$

$$K_{BC} = (1/L) = 0.33$$

$$K_{cd} = (3/4)(1/L) = 0.18$$

c) Cálculo de "C".

$$C_{BA} = K_{AB}(K_{AB} \downarrow K_{BC}) = 0.38$$

$$C_{BC} = K_{BC}(K_{AB} \downarrow K_{BC}) = 0.62$$

$$C_{CB} = K_{BC}(K_{BC} \downarrow K_{CD}) = 0.63$$

$$C_{CD} = K_{CD}(K_{BC} \downarrow K_{CD}) = 0.37$$

d) momentos (cross aparte)

$$M_B = 350 \text{ Kg-m}$$

$$M_C = 410 \quad \quad "$$

3.- Momentos negativos en los apoyos extremos:

$$M_A = (1/24) W L_1^2 = (1/24)(300)(3.50)^2 = 155 \text{ Kg-m}$$

$$M_D = (1/24) W L_2^2 = (1/24)(300)(3.75)^2 = 180 \quad \quad "$$

4.- Momentos positivos:

$$M' = (1/8) W L^2 = 37.5 L^2$$

$$M'_{AB} = 527 \quad , \quad M'_{BC} = 338 \quad , \quad M'_{CD} = 600$$

a)  $M_{AB} = 527 - 350/2 = 355 \text{ Kg-m}$

b)  $M_{BC} = 338 - 350 - (407-350)/2 = -40 \text{ Kg-m.}$

c)  $M_{CD} = 600 - 407/2 = 400 \text{ Kg-m.}$

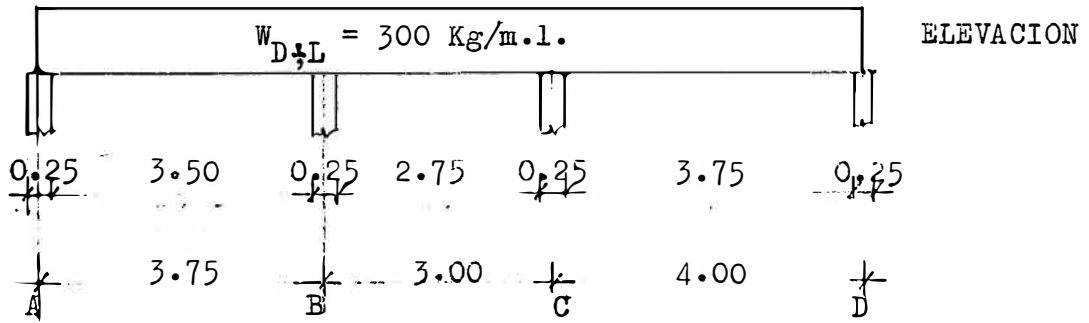
5.- Comprobaciones:

a) Momento máximo = 1312 Kg-m. es mayor que todos

b) Viga rectangular

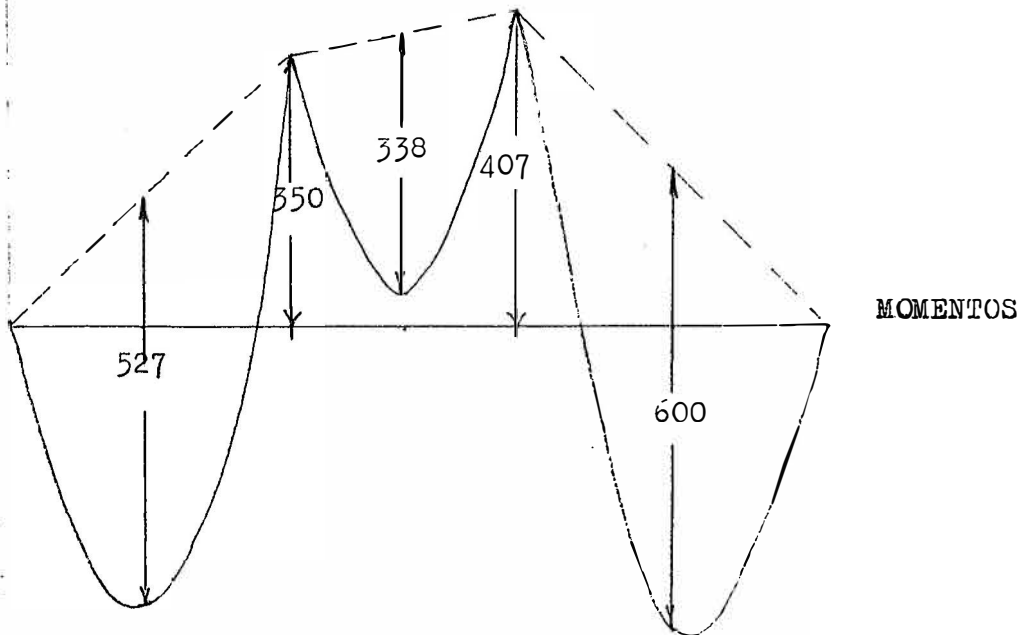
$$a = \frac{3.776(40000)}{248472} = 0.6 \text{ es menor que "t"}$$

ALIGERADO A-1



CROSS

	0.38	0.62	0.63	0.37	
-352	$\frac{1}{2}$ 352	-225	$\frac{1}{2}$ 225	-400	$\frac{1}{2}$ 400
$\frac{1}{2}$ 352	$\frac{1}{2}$ 176			-200	$\frac{1}{2}$ 400
0	$\frac{1}{2}$ 115	-188	$\frac{1}{2}$ 236	$\frac{1}{2}$ 139	0
	$\frac{1}{2}$ 350	-350	$\frac{1}{2}$ 407	-407	





6.- Areas de acero:

- a)  $M_{AB} = 35500 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 0.921$  ,  $a = A_s (0.471) = 0.43$   
 $A_s = M / 1260(34 - 0.43) = 0.839$                        $a = 0.40$   
 $A_s = M / 1260(34 - 0.40) = 0.839$                        $a = 0.40$  ok  
 Como  $A_s = 0.839$  menor que  $A_s$  (minimo) se toman los  $4/3(0.839) = 1.119$  y según el gráfico del punto 7, tomaremos  
 $A_s = \underline{0.850} = 1 \text{ } \phi \text{ } \frac{1}{2}$
- b)  $M_{CD} = 40000 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 1.037$  ,  $a = A_s (0.471) = 0.49$   
 $A_s = M / 1260(34 - 0.49) = 0.947$                        $a = 0.45$   
 $A_s = M / 1260(34 - 0.45) = 0.946$                        $a = 0.45$  ok  
 $A_s = \underline{0.946} = 1 \text{ } \phi \text{ } \frac{1}{2}$
- c)  $M_A = 15,500 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 0.402$  ,  $a = A_s (1.882) = 0.76$   
 $A_s = M / 1260(34 - 0.76) = 0.370$                        $a = 0.70$   
 $A_s = M / 1260(34 - 0.70) = 0.369$                        $a = 0.70$  ok  
 Como  $A_s = 0.369$  menor que  $A_s$  (minimo) se toman los  $4/3(0.369) = 0.492$  y según el gráfico del punto 7, tomaremos:  
 $A_s = \underline{0.492} = 1 \text{ } \phi \text{ } \frac{3}{8}$
- d)  $M_B = 35,000 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 0.908$  ,  $a = A_s (1.882) = 1.71$   
 $A_s = M / 1260(34 - 1.71) = 0.860$                        $a = 1.62$   
 $A_s = M / 1260(34 - 1.62) = 0.858$                        $a = 1.62$  ok  
 $A_s = \underline{0.858} = 1 \text{ } \phi \text{ } \frac{1}{2}$
- e)  $M_c = 41,000 \text{ kg-cms.}$   
 $A_s = M / 38556 = 1.063$  ,  $a = A_s (1.882) = 2.00$   
 $A_s = M / 1260(34 - 2.00) = 1.017$                        $a = 1.91$   
 $A_s = M / 1260(34 - 1.91) = 1.014$                        $a = 1.91$  ok  
 $A_s = \underline{1.014} = 1 \text{ } \phi \text{ } \frac{1}{2}$
- f)  $M_D = 18,000 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 0.467$  ,  $a = A_s (1.882) = 0.88$   
 $A_s = M / 1260(34 - 0.88) = 0.431$                        $a = 0.81$   
 $A_s = M / 1260(34 - 0.81) = 0.430$                        $a = 0.81$  ok  
 $A_s = 4/3(0.430) = 0.573$   
 $A_s = \underline{0.573} = 1 \text{ } \phi \text{ } \frac{3}{8}$

ALIGERADO A-2 ( AZOTEA )

1.- Condición de carga:

Unica condición de carga  $W_D; L = 300 \text{ Kg/m.}$

2.- Momentos negativos en los apoyos internos:

a) Momentos Isostáticos

$$M_{AB} = M_{BC} = (WL^2)/12 = 300(3)^2/12 = 225 \text{ Kg-m.}$$

$$M_{BC} = M_{CB} = ( \quad ) = 300(4)^2/12 = 400 \quad "$$

b) Cálculo de "K".

$$K_{AB} = (3/4)(1/L) = 0.250$$

$$K_{BC} = \quad " \quad = 0.187$$

c) Cálculo de "C".

$$C_{BA} = K_{BA} / ( K_{AB} + K_{BC} ) = 0.57$$

$$C_{BC} = K_{BC} / ( K_{AB} + K_{BC} ) = 0.43$$

d) Momentos (cross aparte)

$$M_{B_i} = 490 \text{ Kg-m.}$$

3.- Momentos negativos en los apoyos extremos:

$$M_A = (1/24) W L^2 = (1/24)(300)(2.75)^2 = 95 \text{ Kg-m.}$$

$$M_C = \quad " \quad = (1/24)(300)(3.75)^2 = 175 \quad "$$

4.- Momentos positivos:

$$M' = (1/8) W L^2 = 37.5 L^2$$

$$M'_{AB} = 337.5 \quad , \quad M'_{BC} = 600$$

$$a) M_{AB} = 337.5 - 487/2 = 95 \text{ Kg-m.}$$

$$b) M_{BC} = 600 - 487/2 = 360 \quad "$$

5.- Comprobaciones:

a) Momento máximo = 1312 Kg-m. es mayor que todos

b) Viga rectangular

$$a = \frac{3.776(36000)}{248472} = 0.55 \text{ es mayor que "t"}$$

6.- Areas de acero:

a)  $M_{AB} = 9500 \text{ Kg-cms.}$

$$A_s = M/38556 = 0.246 \quad , \quad a = A_s(0.471) = 0.12$$

$$A_s = M/1260(34-0.12) = 0.223 \quad a = 0.10$$

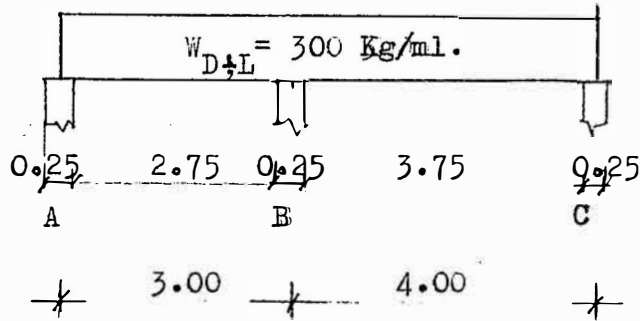
$$A_s = M/1260(34-0.10) = 0.222 \quad a = 0.10 \quad \text{ok}$$

$$A_s = 4/3(0.222) = 0.296$$

$$A_s = \underline{0.340} = 1 \text{ } \emptyset \text{ } 3/8$$

b)  $M_{BC} = 36000 \text{ Kg-cms.}$

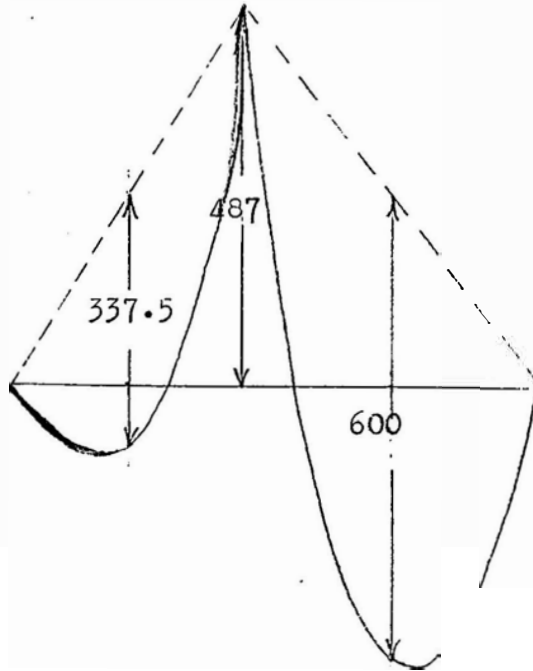
ALIGERADO A-2



ELEVACION

	0.57	0.43	
-225	$\frac{1}{3}225$	-400	$\frac{2}{3}400$
$\frac{2}{3}225$	$\frac{2}{3}113$	-200	$\frac{1}{3}400$
0	$\frac{1}{3}467$	$\frac{2}{3}113$	0
	$\frac{2}{3}467$	-487	

CROSS



MOMENTOS

e)  $A_s = M / 38556 = 0.934$  ,  $a = A_s (0.471) = 0.44$   
 $A_s = M / 1260(34 - 0.44) = 0.851$        $a = 0.40$   
 $A_s = M / 1260(34 - 0.40) = 0.850$        $a = 0.40$  ok  
 $A_s = \underline{0.850} = 1 \text{ } \phi \text{ } 1/2$

c)  $M_{A_1} = 9500 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 0.246$  ,  $a = A_s (1.882) = 0.46$   
 $A_s = M / 1260(34 - 0.46) = 0.223$        $a = 0.42$   
 $A_s = M / 1260(34 - 0.42) = 0.225$        $a = 0.42$  ok  
 $A_s = (4/3)(0.225) = 0.340$   
 $A_s = \underline{0.340} = 1 \text{ } \phi \text{ } 3/8$

d)  $M_B = 49000 \text{ Kg-cms.}$   
 $A_s = M / 38556 = 1.271$        $a = A_s (1.382) = 2.39$   
 $A_s = M / 1260(34 - 2.39) = 1.230$        $a = 2.32$   
 $A_s = M / 1260(34 - 2.32) = 1.227$        $a = 2.32$  ok  
 $A_s = \underline{1.227} = 1 \text{ } \phi \text{ } 1/2$

e)  $M_C = 17,500 \text{ kg-cms.}$   
 $A_s = M / 38556 = 0.454$        $a = A_s (1.882) = 0.85$   
 $A_s = M / 1260(34 - 0.85) = 0.419$        $a = 0.79$   
 $A_s = M / 1260(34 - 0.79) = 0.418$        $a = 0.79$  ok  
 $A_s = (4/3)(0.418) = 0.557$   
 $A_s = \underline{0.557} = 1 \text{ } \phi \text{ } 3/8$

ALIGERADO A-3 (1º PISO)

1.- Condición de carga:

A) Condición primera  $W_D = 228 \text{ Kg/m.}$

2.- Momentos negativos en los apoyos internos:

a) Momentos isostáticos

$$M_{AB} = M_{BA} = (WL^2)/12 = (228)(3.75)^2/12 = 267 \text{ Kgm}$$

$$M_{BC} = M_{CB} = ( \quad " \quad ) = (228)(3.00)^2/12 = 171 \text{ "}$$

$$M_{CD} = M_{DC} = ( \quad " \quad ) = (228)(4.00)^2/12 = 304 \text{ "}$$

b) Cálculo de "K"

$$K_{AB} = (3/4)(1/3.75) = 0.20$$

$$K_{BC} = (1/3.00) = 0.33$$

$$K_{CD} = (3/4)(1/4.00) = 0.18$$

c) Cálculo de "C"

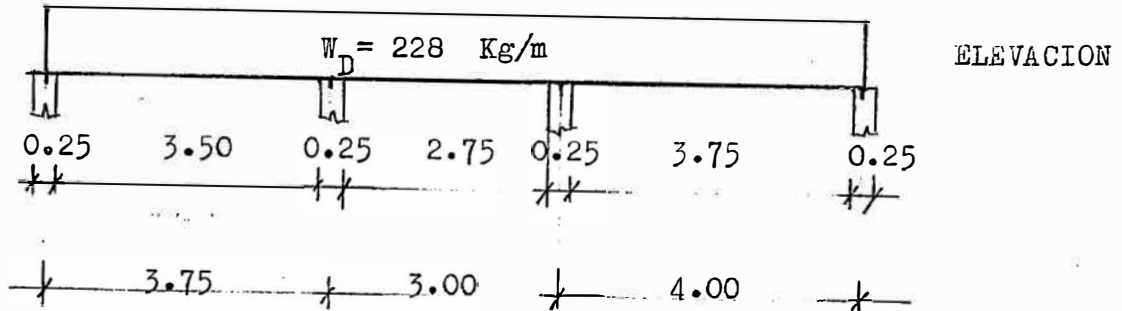
$$C_{BA} = (K_{AB}) / (K_{AB} + K_{BC}) = 0.33$$

$$C_{BC} = \quad \quad \quad = 0.62$$

$$C_{CB} = \quad \quad \quad = 0.63$$

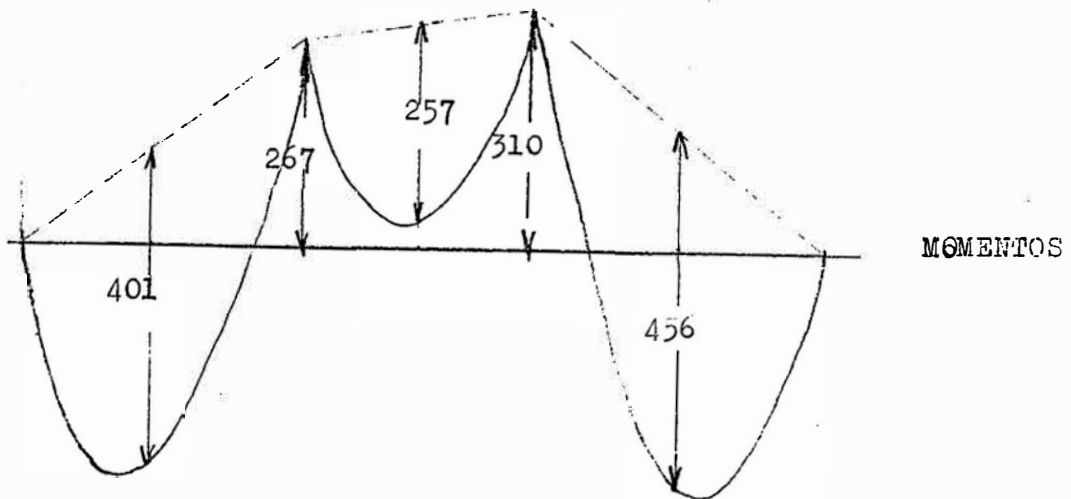
$$C_{CD} = \quad \quad \quad = 0.37$$

ALIGERADO A-3 (Condición P°)



	0.38	0.62	0.63	0.37	
267	$\frac{1}{2}267$	-171	$\frac{1}{2}171$	-304	$\frac{1}{2}304$
267	$\frac{1}{2}134$			$\frac{1}{2}152$	-304
	<u>- 87</u>	<u>-143</u>	<u><math>\frac{1}{2}180</math></u>	<u><math>\frac{1}{2}105</math></u>	
	$\frac{1}{2}90$	$\frac{1}{2}90$	- 72		
	<u>- 34</u>	<u>- 56</u>	$\frac{1}{2}45$	$\frac{1}{2}27$	
	$\frac{1}{2}23$	$\frac{1}{2}23$	- 28		
	<u>- 9</u>	<u>- 14</u>	$\frac{1}{2}18$	$\frac{1}{2}10$	
	$\frac{1}{2}9$	$\frac{1}{2}9$	- 7		
	<u>- 3</u>	<u>- 6</u>	$\frac{1}{2}4$	$\frac{1}{2}3$	
	$\frac{1}{2}2$	$\frac{1}{2}2$	- 3		
	<u>- 1</u>	<u>- 1</u>	$\frac{1}{2}2$	$\frac{1}{2}1$	
	267		310		

CROSS



d) Momentos (cross aparte)

$$M_B = 270 \text{ Kg-m}$$

$$M_C = 310 \text{ "}$$

3.- Momentos positivos.

$$M' = WL^2/8 = 28.5 L^2$$

$$M'_{AB} = 401 \quad M'_{BC} = 257 \quad M'_{CD} = 456$$

$$M_{AB} = 401 \quad 267/2 = \quad = 270 \text{ Kg-m}$$

$$M_{BC} = 310 \quad 257 - (310-267)/2 = -30 \text{ "}$$

$$M_{CD} = 456 \quad 310/2 = \quad = 305 \text{ "}$$

B) Condición segunda  $W_L = 144 \text{ Kg/m}$  en el 1º tramo

1.-M. Negativos. a) Momentos isostáticos

$$M_{AB} = M_{BA} = WL^2/12 = (144)(3.75)^2/12 = 169 \text{ Kg-m}$$

b) Momentos (cross aparte)

$$M_B = 150 \text{ Kg-m}$$

$$M_C = \frac{1}{2} 35 \text{ "}$$

2.-M. Positivos:

$$M' = (1/8)WL^2 = 18 L^2$$

$$M'_{AB} = 253 \quad M'_{BC} = 162 \quad M'_{CD} = 288$$

$$a) M_{AB} = 253 - 147/2 = \quad = 180 \text{ Kg-m}$$

$$b) M_{BC} = 162 - (147-32)/2 = 75 \text{ Kg-m}$$

$$c) M_{CD} = 288 - \frac{1}{2} 32/2 = 305 \text{ "}$$

C) Condición tercera  $W_L = 144 \text{ Kg/m}$  en el 2º tramo

1.-M. Negativos. a) Momentos isostáticos

$$M_{BC} = M_{CB} = WL^2/12 = (144)(3)^2/12 = 108 \text{ Kg-m}$$

b) Momentos (cross aparte)

$$M_B = 60 \text{ Kg-m}$$

$$M_C = 60 \text{ "}$$

2.- M. Positivos:

$$M' = (1/8)WL^2 = 18 L^2$$

$$M'_{AB} = 253 \quad M'_{BC} = 162 \quad M'_{CD} = 288$$

$$a) M_{AB} = 253 - 59/2 = \quad = 225 \text{ Kg-m}$$

$$b) M_{BC} = 162 - (59-57)/2 - 57 = 105 \text{ "}$$

$$c) M_{CD} = 288 - 57/2 = \quad = 260 \text{ "}$$

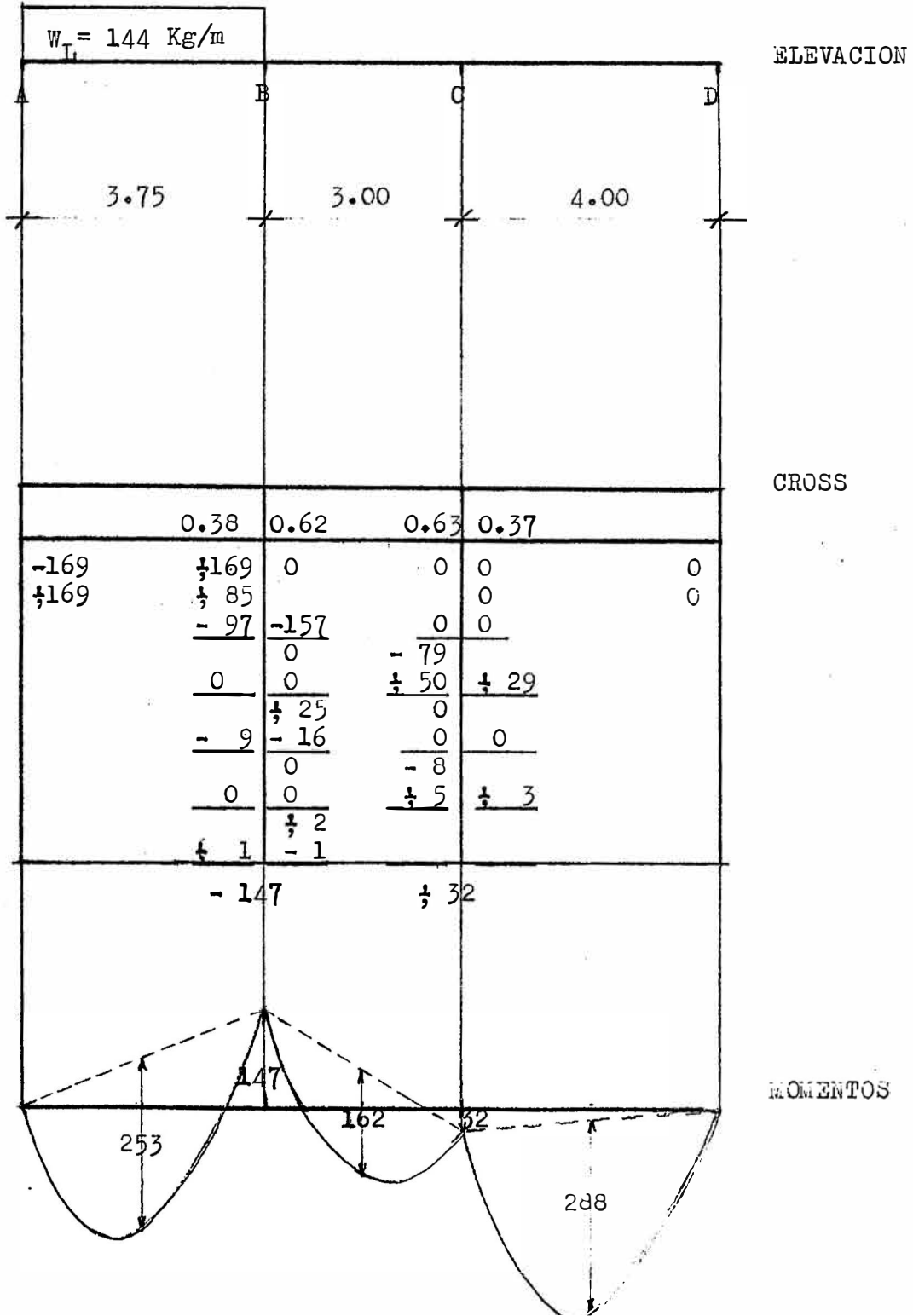
D) Condición cuarta  $W_L = 144 \text{ kg/m}$  en el tercer tramo

1.- M. Negativos

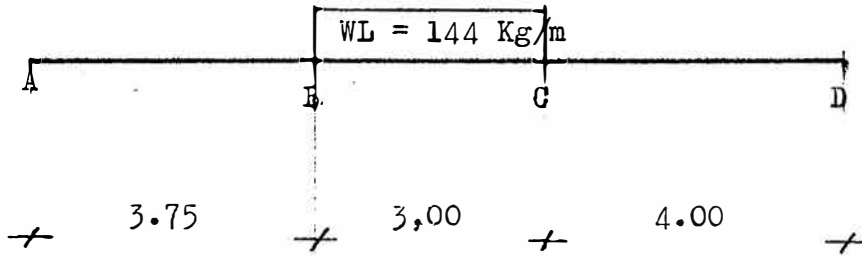
a) Momentos isostáticos

$$M_{CD} = M_{DC} = WL^2/12 = (144)(4)^2/12 = 192 \text{ Kg-m}$$

ALIGERADO A-3 (Condición 2°)



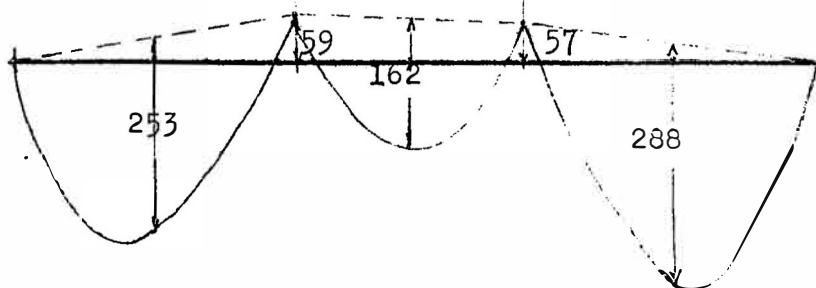
ALIGERADO A-3 (Condición 3°)



ELEVACION

	0.38	0.62	0.63	0.37	
0	0	-108	108	0	0
0	0			0	0
	1/2 41	1/2 67	- 68	- 40	
		- 34	1/2 33		
	1/2 13	1/2 21	- 21	- 12	
		- 10	1/2 10		
	1/2 4	1/2 6	- 6	- 4	
		- 3	1/2 3		
	1/2 1	1/2 2	- 2	- 1	
		- 1	1/2 1		
	0	1	- 1	0	
		<u>- 59</u>	<u>- 57</u>		

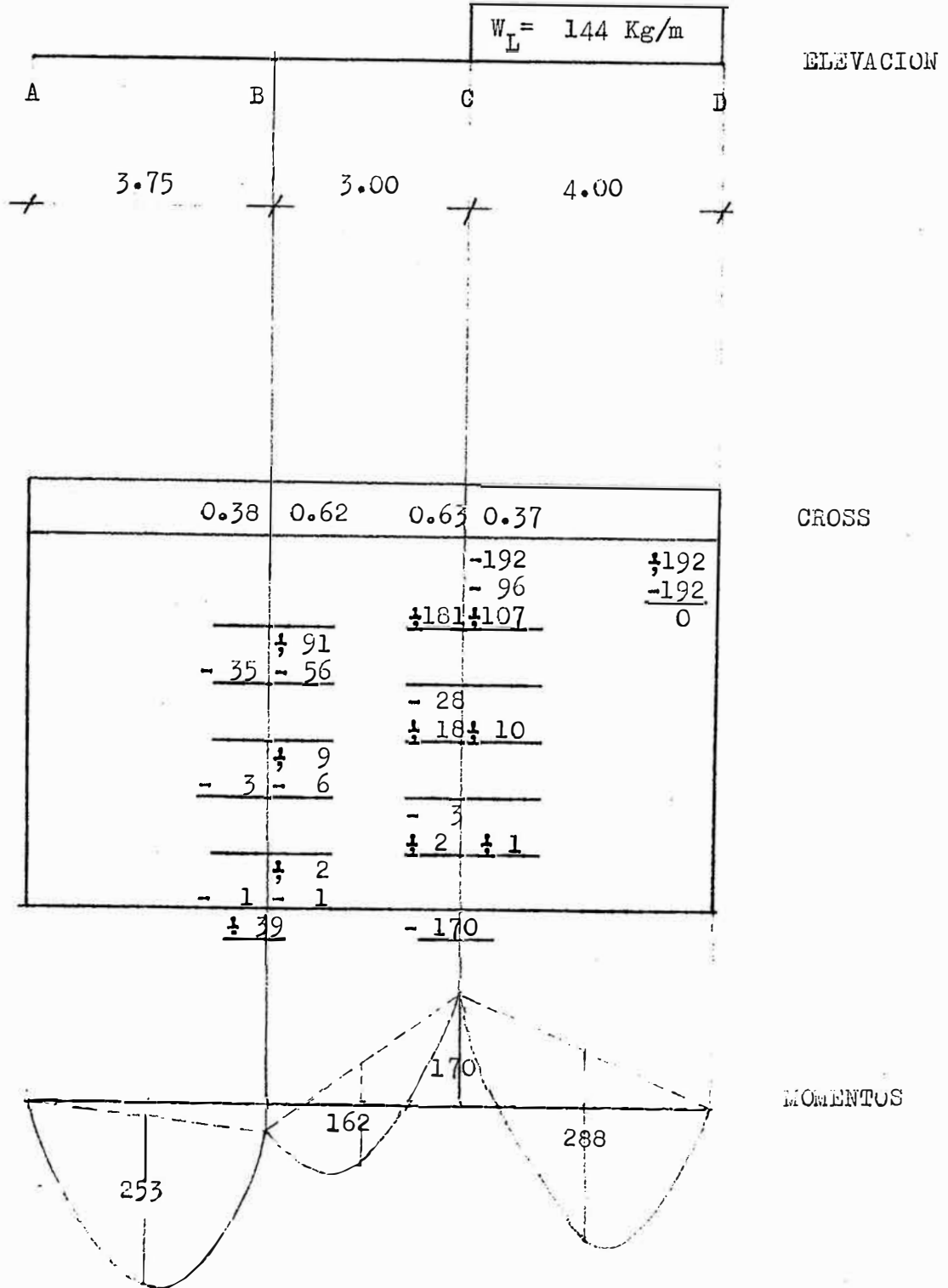
CROSS



MOMENTOS



ALIGERADO A-3 (Condición 4°)



b) momentos (cross aparte)

$$M_b = \frac{1}{2} 39 \text{ Kg-m.}$$

$$M_c = 170 \text{ "}$$

2.- M. Positivos:

$$M' = (1/8) WL^2 = 18 L^2$$

$$M'_{AB} = 253 \quad M'_{BC} = 162 \quad M'_{CD} = 288$$

$$a) M_{AB} = 253 + 39/2 = 275 \text{ Kg-m.}$$

$$b) M_{BC} = 162 - (170-39)/2 = 60 \text{ "}$$

$$c) M_{CD} = 288 - 170/2 = 205 \text{ "}$$

Momentos de cálculo

$$\text{Condición I}^\circ + 2^\circ + 4^\circ = M_{AB} = 270 + 180 + 275 = 725 \text{ Kg-m.}$$

$$M_{CD} = 305 + 305 + 205 = 815 \text{ "}$$

$$\text{Condición I}^\circ + 3^\circ = M_{BC} = 105 - 30 = 75 \text{ "}$$

$$\text{Condición I}^\circ + 2^\circ + 3^\circ = M_B = -270 - 150 - 60 = 480 \text{ "}$$

$$\text{Condición I}^\circ + 3^\circ + 4^\circ = M_C = -310 - 60 - 170 = 540 \text{ "}$$

Momentos en los apoyos extremos

$$M_A = (1/24) W_D L^2 = 372(3.5)^2/24 = 190 \text{ "}$$

$$M_D = \text{ " } = 372(3.75)^2/24 = 220 \text{ "}$$

Areas de acero;

$$a) M_{AB} = 72500 \text{ Kg-cms.}$$

$$A_S = M/38556 = 1.880, a = A_S(0.471) = 0.89$$

$$A_S = M/1260(34-0.89) = 1.738, a = 0.82$$

$$A_S = M/1260(34-0.82) = 1.734, a = 0.82 \text{ ok}$$

$$A_S = 1.734 = 1\phi \frac{1}{2} + 1\phi \frac{3}{8}$$

$$b) M_{BC} = M/38556 = 0.195, a = A_S(0.471) = 0.09$$

$$A_S = M/1260(34-0.09) = 0.176, a = 0.08$$

$$A_S = M/1260(34-0.08) = 0.175, a = 0.08 \text{ ok}$$

$$A_S = \frac{1}{3}(0.175) = 0.233$$

$$A_S = 0.340 = 1\phi \frac{3}{8}$$

$$c) M_{CD} = 81500 \text{ Kg-cms.}$$

$$A_S = M/38556 = 2.114, a = A_S(0.471) = 1.00$$

$$A_S = M/1260(34-1.00) = 1.960, a = 0.92$$

$$A_S = M/1260(34-0.92) = 1.955, a = 0.92 \text{ ok}$$

$$A_S = 1.955 = 1\phi \frac{1}{2} + 1\phi \frac{3}{8}$$

d)  $M_A = 19,000 \text{ Kg-cms.}$   
 $A_S = M/38556 = 0.493$  ,  $a = A_S(1.882) = 0.93$   
 $A_S = M/1260(34-0.93) = 0.456$        $a = 0.86$   
 $A_S = M/1260(34-0.86) = 0.455$        $a = 0.86$  ok  
 $A_S = 4/3(0.455) = 0.607$   
 $A_S = \underline{0.607} = 1 \text{ } \phi \text{ } 3/8$

e)  $M_B = 48,000 \text{ Kg-cms.}$   
 $A_S = M/38556 = 1.245$  ,  $a = A_S(1.882) = 2.34$   
 $A_S = M/1260(34-2.34) = 1.203$        $a = 2.26$   
 $A_S = M/1260(34-2.26) = 1.200$        $a = 2.26$  ok  
 $A_S = \underline{1.200} = 1 \text{ } \phi \text{ } 1/2$

f)  $M_C = 54,000 \text{ Kg-cms.}$   
 $A_S = M/38556 = 1.401$  ,  $a = A_S(1.882) = 2.64$   
 $A_S = M/1260(34-2.64) = 1.367$        $a = 2.57$   
 $A_S = M/1260(34-2.57) = 1.364$        $a = 2.57$  ok  
 $A_S = \underline{1.364} = 1 \text{ } \phi \text{ } 1/2$

g)  $M_D = 22,000 \text{ kg-cms.}$   
 $A_S = M/38556 = 0.571$  ,  $a = A_S(1.882) = 1.07$   
 $A_S = M/1260(34-1.07) = 0.530$        $a = 1.00$   
 $A_S = M/1260(34-1.00) = 0.529$        $a = 1.00$  ok  
 $A_S = 4/3(0.529) = 0.705$   
 $A_S = \underline{0.705} = 1 \text{ } \phi \text{ } 3/8$

ALIGERADO A-4 (1º PISO)

1.- Condición de carga:

A) Condición primera  $W_D = 288 \text{ Kg/m}$

2.- Momento negativo (voladizo)

$$M_B = (1/2)W L^2 = (1/2)288(1.165)^2 = 155 \text{ kgm}$$

3.- Momento positivo

$$M'_{AB} = (1/8)WL^2 = (1/8)(288)(3)^2 = 257 \text{ "}$$

$$M_{AB} = 257 - (1/2)(155) = 180 \text{ "}$$

B) Condición segunda  $W_L = 144 \text{ Kg/m}$

1.- Momento positivo

$$M_{AB} = (1/8)WL^2 = (1/8)(144)(3)^2 = 162 \text{ "}$$

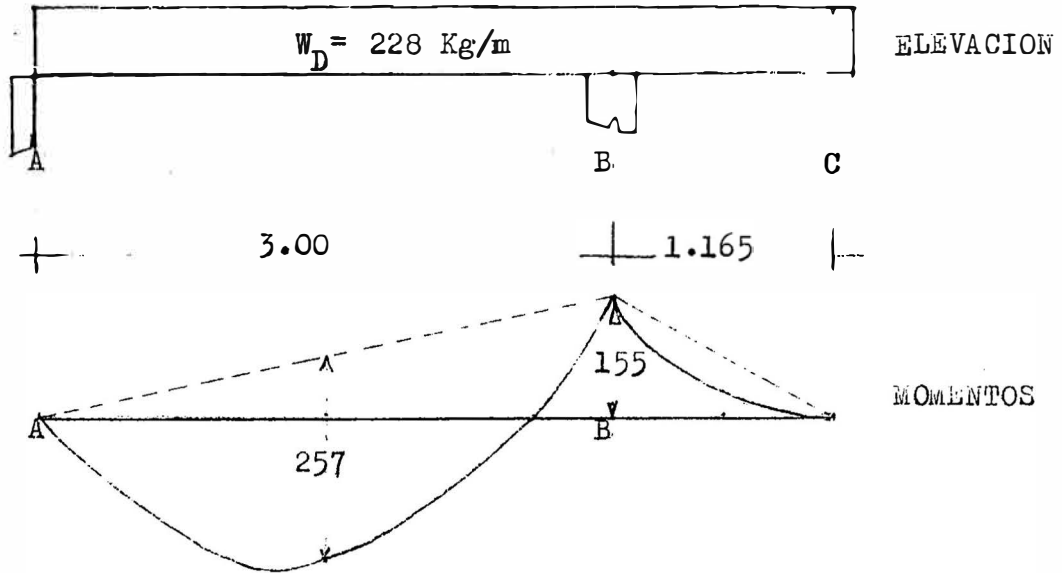
C) Condición tercera  $W_L = 144 \text{ Kg/m}$  (voladizo)

1.- Momento negativo

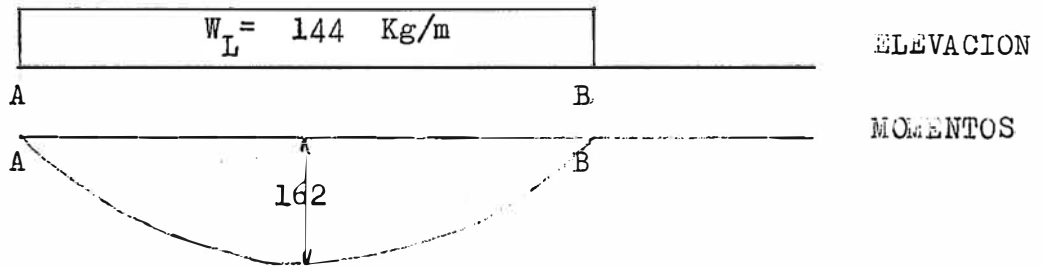
$$M_B = (1/2)WL^2 = (1/2)(144)(1.165)^2 = 98 \text{ Kg}$$

ALIGERADO A-4

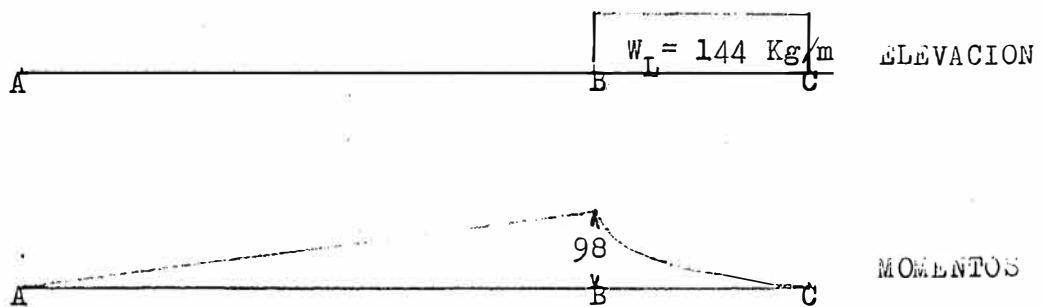
- Condición 1º



- Condición 2º



- Condición 3º



Momentos de cálculo

Condición I°  $\ddagger$  2°  $\ddagger$  3° =  $M_B = 155 \ddagger 98 = 255$  Kg-m.

Condición I°  $\ddagger$  2° =  $M_{AB} = 180 \ddagger 162 = 345$  "

Momento en el apoyo:

$$M_a = (1/24)W_{D\ddagger L} L^2 = 372(2.75)^2/24 = 120 \quad "$$

Areas de acero:

a)  $M_A = 12,000$  Kg-cms.

$$A_S = M/38556 = 0.311, \quad a = A_S(1.882) = 0.59$$

$$A_S = M/1260(34-0.59) = 0.285 \quad a = 0.54$$

$$A_S = M/1260(34-0.54) = 0.285 \quad a = 0.54 \quad \text{ok}$$

$$A_S = (4/3)(0.285) = 0.380$$

$$A_S = 0.380 = 1 \text{ } \phi \text{ } 3/8$$

b)  $M_B = 25,500$  Kg-cms.

$$A_S = M/38556 = 0.661, \quad a = A_S(1.882) = 1.24$$

$$A_S = M/1260(34-1.24) = 0.618 \quad a = 1.16$$

$$A_S = M/1260(34-1.16) = 0.616 \quad a = 1.16 \quad \text{ok}$$

$$A_S = (4/3)(0.616) = 0.821$$

$$A_S = 0.821 = 1 \text{ } \phi \text{ } 1/2$$

c)  $M_{AB} = 34,500$  Kg-cms.

$$A_S = M/38556 = 0.895, \quad a = A_S(0.471) = 0.42$$

$$A_S = M/1260(34-0.42) = 0.815 \quad a = 0.38$$

$$A_S = M/1260(34-0.38) = 0.814 \quad a = 0.38 \quad \text{ok}$$

$$A_S = (4/3)(0.814) = 1.085$$

$$A_S = 1.085 = 1 \text{ } \phi \text{ } 1/2$$

ALIGERADO A-5 (1° PISO)

1.- Condición de carga:

A) Condición única  $W_{D\ddagger L} = 372$  Kg/m

2.- Momentos. "Metodo de los coeficientes"

" Con luces iguales o menores a 3.00 m. en un solo tramo,  $K=1/12$  en ambos momentos" (PLABODY)

$$M_A = M_B = M_{AB} = (1/12)WL^2 = (1/12)(372)(3)^2 = 279 \text{ Kg-m.}$$

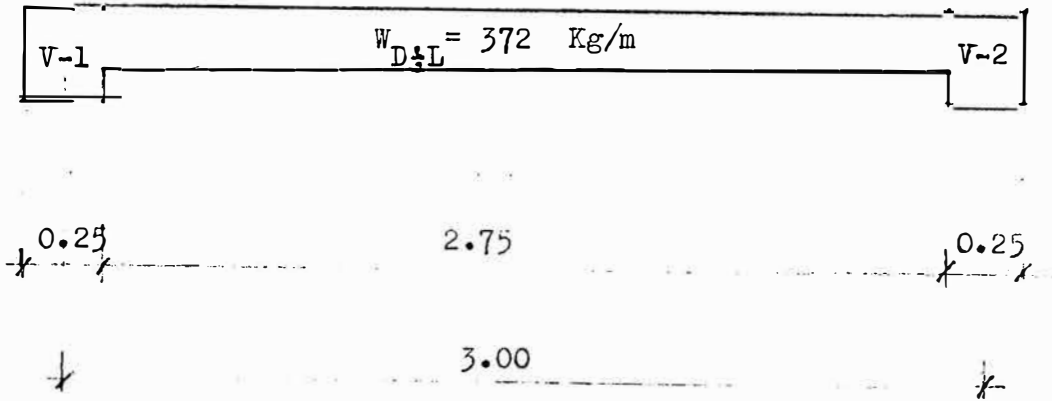
3.- Comprobaciones:

a) Momento máximo = 1312 kg-m mayor que 279 kg-m

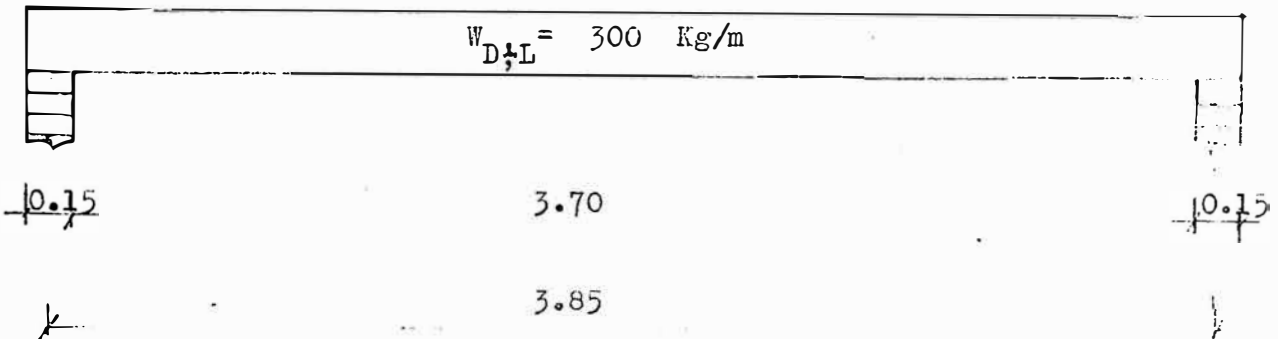
b) Viga rectangular =  $a = 3.776(M)/248472 = 0.42$  menor que "t"

ALIGERADOS A-5 y A-7

- ALIGERADO A-5



- ALIGERADO A-7



4.- Areas de acero:

a)  $M_A = 27,900 \text{ Kg-cms.}$   
 $A_S = M / 23562 = 1.184, a = A_S(1.882) = 2.23$   
 $A_S = M / 1260(34-2.23) = 0.697 \quad a = 1.31$   
 $A_S = M / 1260(34-1.31) = 0.677 \quad a = 1.27$   
 $A_S = M / 1260(34-1.27) = 0.677 \quad a = 1.27 \text{ ok}$   
 $A_S = (4/3)(0.677) = 0.903$

$A_S \neq 0.903 = 1 \emptyset \frac{1}{2}$

b)  $M_{AB} = 27,900 \text{ Kg-cms.}$   
 $A_S = M / 23562 = 1.184, a = A_S(0.471) = 0.56$   
 $A_S = M / 1260(34-0.56) = 0.662 \quad a = 0.31$   
 $A_S = M / 1260(34-0.31) = 0.657 \quad a = 0.31 \text{ ok}$   
 $A_S = (4/3)(0.657) = 0.876$

$A_S = 0.850 = 1 \emptyset \frac{1}{2}$

ALIGERADO A-6 (1° PISO)

Condición de carga:

A) Condición primera:  $W_D = 1.5 \text{ CM} = 228 \text{ Kg/m}$   
 $M_B = (\frac{1}{2})WL^2 = (\frac{1}{2})(228)(1.325)^2 = 200 \text{ Kg-m}$   
 $M'_{AB} = (1/8)WL^2 = (1/8)(228)(4)^2 = 456 \text{ "}$   
 $M_{AB} = 456 - \frac{1}{2}(200) = 360 \text{ "}$   
B) Condición segunda:  $W_L = 1.8 \text{ CV} = 144 \text{ (en el 1° tramo)}$   
 $M_{AB} = (1/8)WL^2 = (1/8)(144)(4)^2 = 290 \text{ Kg-m.}$   
C) Condición tercera:  $W_L = 144 \text{ (en el voladizo)}$   
 $M_B = \frac{1}{2} WL^2 = \frac{1}{2}(144)(1.325)^2 = 130 \text{ Kg-m}$

Momentos de cálculo

Condición 1°  $\frac{1}{2}$  2°  $\frac{1}{2}$  3° =  $M_B = 200 \frac{1}{2} 130 = 330 \text{ Kg-m}$

Condición 12  $\frac{1}{2}$  2° =  $M_{AB} = 360 \frac{1}{2} 290 = 650 \text{ "}$

Momento en el apoyo

$M_A = (1/24)W_{D+\frac{1}{2}L}L^2 = (1/24)(372)(3.75)^2 = 220 \text{ Kg-m.}$

Comprobaciones:

a) Momento máximo = 1312 mayor que todos

b) Viga rectangular:

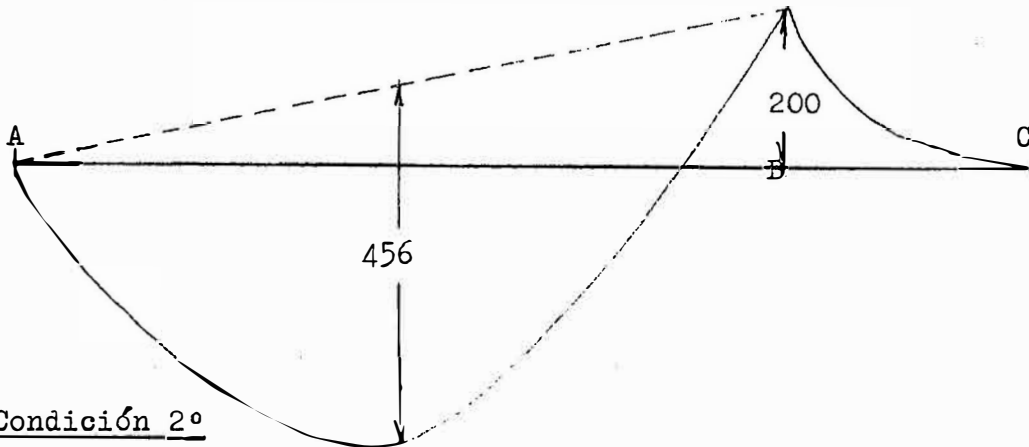
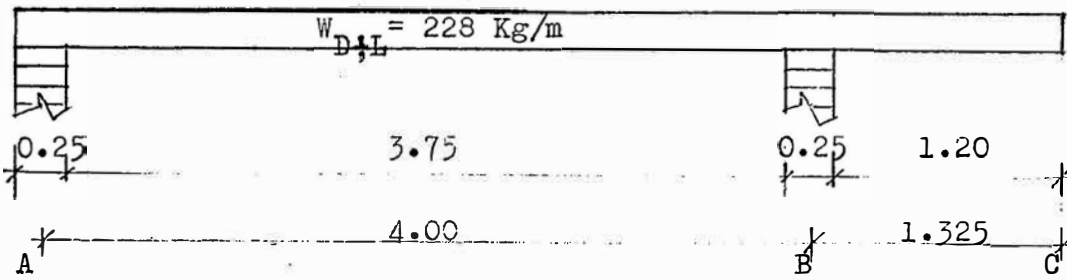
$a = (3.776)(65000) / 248472 = 0.99$  menor que "t" = 5

Areas de acero:

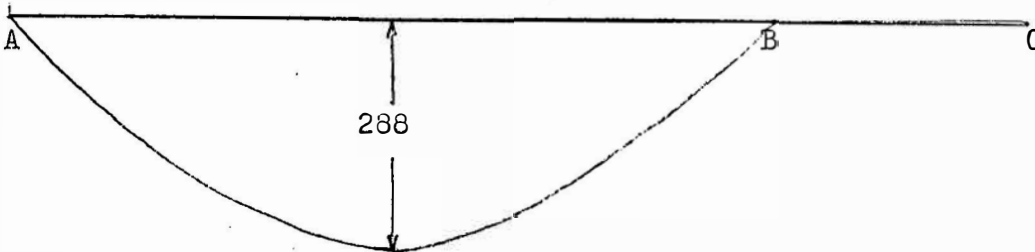
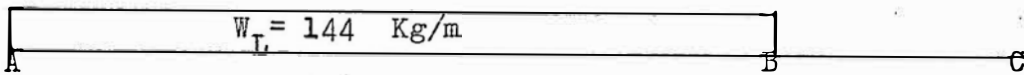
a)  $M_{AB} = 65,000 \text{ Kg-cms.}$

ALIGERADO A-6

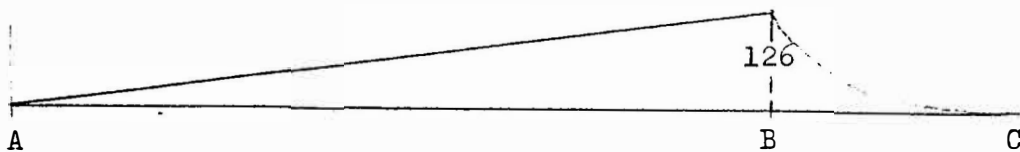
- Condición 1°



- Condición 2°



- Condición 3°





$$A_s = M / 38556 = 1.686, \quad a = A_s (0.471) = 0.79$$

$$A_s = M / 1260(34-0.79) = 1.553 \quad a = 0.73$$

$$A_s = M / 1260(34-0.73) = 1.551 \quad a = 0.73 \quad \text{ok}$$

$$A_s = \underline{1.551} = 1 \varnothing \frac{3}{8}$$

b)  $M_A = 22,000 \text{ Kg-cms.}$

$$A_s = M / 38556 = 0.571, \quad a = A_s (1.882) = 1.07$$

$$A_s = M / 1260(34-1.07) = 0.530 \quad a = 1.00$$

$$A_s = M / 1260(34-1.00) = 0.529 \quad a = 1.00 \quad \text{ok}$$

$$A_s = (4/3)(0.529) = 0.705$$

$$A_s = \underline{0.705} = 1 \varnothing \frac{3}{8}$$

c)  $M_B = 33,000 \text{ Kg-cms.}$

$$A_s = M / 38556 = 0.856, \quad a = A_s (1.882) = 1.61$$

$$A_s = M / 1260(34-1.61) = 0.809 \quad a = 1.52$$

$$A_s = M / 1260(34-1.52) = 0.806 \quad a = 1.52 \quad \text{ok}$$

$$A_s = (4/3)(0.806) = 1.075$$

$$A_s = \underline{1.075} = 1 \varnothing \frac{1}{2}$$

### ALIGERADO A-7 (Servicio)

1.- Condición de carga:

A) Condición única  $W_{D\&L} = 300 \text{ Kg/m}$

2.- Momentos! Método de los coeficientes" (PEABODY)

"Con luces mayores a 3 metros en un solo tramo;

K es igual en positivo  $1/10$ , y en negativo  $1/24$ "

$$M_A = M_B = (1/24)WL^2 = (1/24)(300)(3.85)^2 = 185 \text{ Kg-m}$$

$$M_{AB} = (1/10)WL^2 = (1/10)(300)(3.85)^2 = 445 \text{ "}$$

3.- Comprobaciones:

a) Momento máximo = 1312 mayor que todos

b) Viga rectangular  $a = 3.776(44500)/248472 = 0.68$  menor que t

4.- Areas de acero:

a)  $M_A = M_B = 18,500 \text{ Kg-cms.}$

$$A_s = M / 23562 = 0.785, \quad a = A_s (1.882) = 1.48$$

$$A_s = M / 1260(34-1.48) = 0.451 \quad a = 0.85$$

$$A_s = M / 1260(34-0.85) = 0.443 \quad a = 0.83$$

$$A_s = M / 1260(34-0.83) = 0.443 \quad a = 0.83 \quad \text{ok}$$

$$A_s = (4/3)(0.443) = 0.591$$

$$A_s = \underline{0.591} = 1 \varnothing \frac{3}{8}$$

$$b) M_{AB} = 44,500 \text{ Kg-cms.}$$

$$A_s = M / 23562 = 1.889, \quad a = A_s (0.471) = 0.89$$

$$A_s = M / 1260(34 - 0.89) = 1.067 \quad a = 0.50$$

$$A_s = M / 1260(34 - 0.50) = 1.054 \quad a = 0.50 \quad \text{ok}$$

$$A_s = \underline{1.054} = 1 \text{ } \underline{\emptyset} \text{ } \underline{\frac{1}{2}}$$

SEGUNDA PARTE: ESCALERA

## ESCALERA

### Cálculos previos:

a) Paso  $= (3.75 - 1.00 - 0.90) / 7 = 0.264 \text{ m. (p)} \approx 26.4 \text{ cms.}$

b) Contrapaso  $= (2.40 \div 0.20) / 15 = 0.173 \text{ m. (cp)} = 17.3 \text{ ''}$

c)  $t_m = \dots \quad a = (p^2 \div cp^2)^{1/2} = 31.56 \text{ cms.}$

$$t_1/h = a / p$$

$$t_1 = (31.56)(20) / 26.4 = 23.91 \text{ cms.}$$

$$t_m = t_1 \div cp/2 = 32.56 \text{ ''}$$

$$d = h - 3 = 17 \text{ cms.}$$

### Metrado de cargas

a) Rampa  $\text{Peso propio} = 0.3256 \times 1 \times 1 \times 2400 = 781.40 \text{ kg-m}$

$$\text{Piso terminado} = 100.00 \text{ ''}$$

$$\text{C.M.} = 881.40 \text{ ''}$$

$$\text{C.V.} = 400.00 \text{ ''}$$

$$W = 1.5(\text{C.M.}) \div 1.8(\text{C.V.}) = 2042 \text{ Kg-m.}$$

b) Descanso  $\text{Peso propio} = 0.20 \times 1 \times 1 \times 2400 = 480.00 \text{ ''}$

$$\text{Piso terminado} = 100.00 \text{ ''}$$

$$\text{C.M.} = 580.00 \text{ ''}$$

$$\text{C.V.} = 400.00 \text{ ''}$$

$$W_u = 1.5(\text{C.M.}) \div 1.8(\text{C.V.}) = 1590 \text{ Kg-m.}$$

c) Diferencia de cargas

$$W_u(a) - W_u(b) = 2042 - 1590 = 452 \text{ ''}$$

### PRIMER TRAMO: (Zona achurada)

Reacciones.-

$$\text{Suma de fuerzas en "Y"; } R_A \div R_B = 7080 \text{ Kg.}$$

$$\text{Suma de momentos en B ; } R_A = 3525 \text{ ''}$$

$$R_B = 3555 \text{ ''}$$

Valor de "x" cuando  $V=0$

$$0 = 3525 - 1590(1.291) - 2042(x - 1.291). \quad x = 2.012 \text{ m.}$$

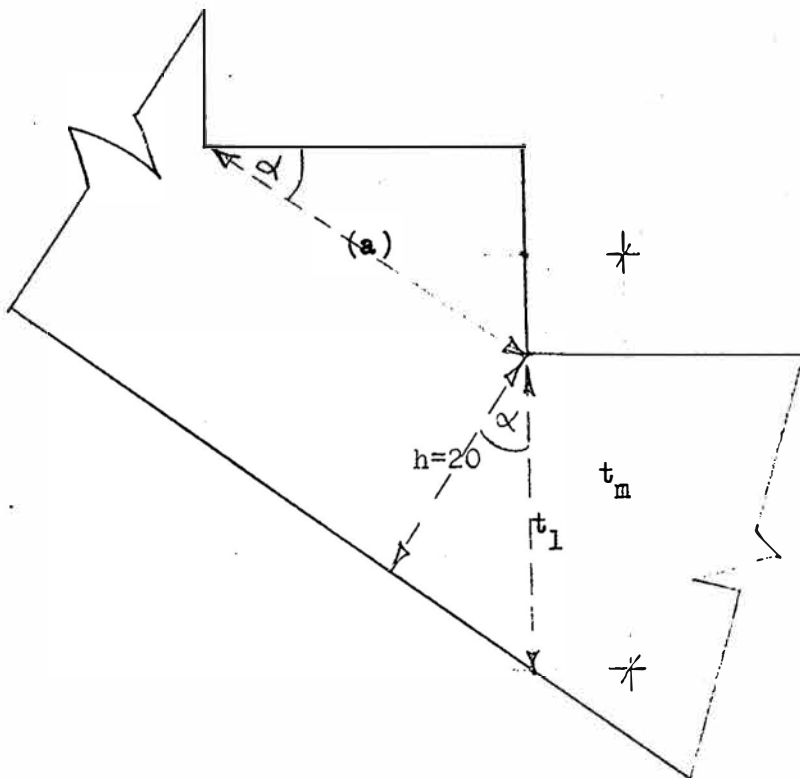
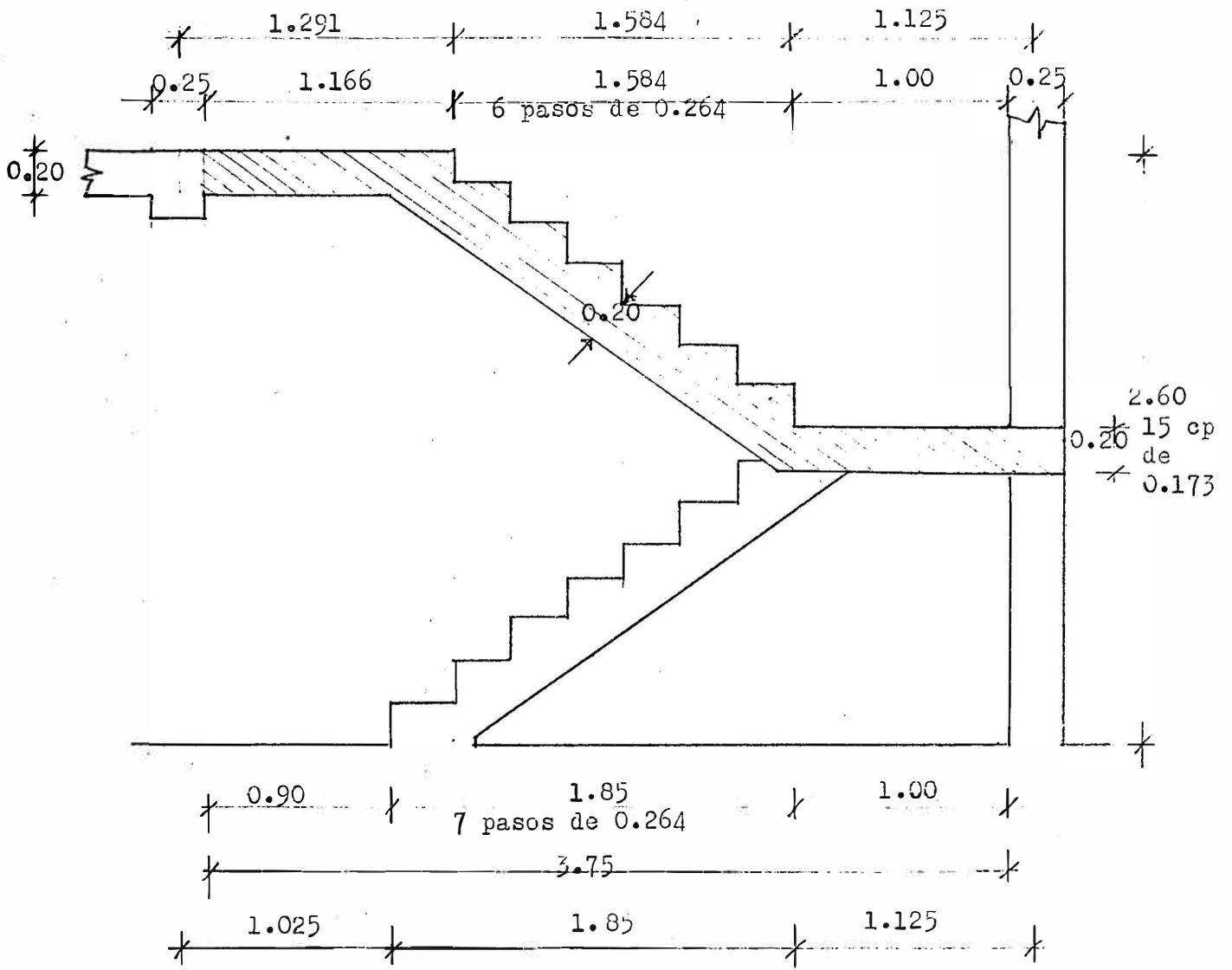
Valor del momento máximo cuando "x" = 2.012 m.

$$M_{AB} = 3525(2.012) - 1590(1.291)(2.012 - 1.291/2) - 2042(2.012 - 1.291)^2/2 = 3757 \text{ Kg-m}$$

nota: De no haber dado por conocido "d", lo obtenemos

1º-  $h = 0.04$  por metro lineal de escalera

2º-  $h = 0.9 p_f \div b d^2 (1 - 0.59 p_f / F'_c)$ . (con una cuantía supuesta del 1 o/o calculamos "d")



Valor de los momentos extremos:

$$M_A = M_B = (1/3) \text{ del Momento máximo} = 1,252 \text{ Kg-m.}$$

Valor del Momento cuando "x" = 1.291 m.

$$M = 3525(1.291) - 1590(1.291)^2/2 = 3,226 \quad "$$

Valor del momento cuando "x" = 2.875 m.

$$M = 3525(2.875) - 1590(1.291)(2.875 - 1.291/2) - 2042(1.584)^2/2 = 3,480 \quad "$$

Areas de acero. (cuando d = 17 cms. y b = 100 cms.)

$$A_s (\text{minimomínimo}) = 0.002bd = 3.40 \text{ cms}^2$$

$$A_s (\text{mínimo}) = 0.005bd = 8.50 \quad "$$

$$A_s (\text{máximo}) = 0.75p_b b d = 39.10 \quad "$$

a)  $M = 375,700 \text{ Kg-cms.}$

$$A_s = M/23562 = 15.945, \quad a = A_s (0.1882) = 3.00$$

$$A_s = M/1260(34 - 3.00) = 9.619 \quad a = 1.81$$

$$A_s = M/1260(34 - 1.81) = 9.263 \quad a = 1.74$$

$$A_s = M/1260(34 - 1.74) = 9.243 \quad a = 1.74 \quad \text{ok}$$

$$A_s = 9.243 = 7 \text{ } \varnothing \frac{1}{2} \text{ a } 12.50 \text{ cms.}$$

b)  $M = 322,600 \text{ Kg-cms.}$

$$A_s = M/23562 = 13.692, \quad a = A_s (0.1882) = 2.58$$

$$A_s = M/1260(34 - 2.58) = 8.149 \quad a = 1.53$$

$$A_s = M/1260(34 - 1.53) = 7.885 \quad a = 1.48$$

$$A_s = M/1260(34 - 1.48) = 7.873 \quad a = 1.48 \quad \text{ok}$$

$$A_s = (4/3)(7.873) = 10.513$$

$$A_s = 8.500 = 7 \text{ } \varnothing \frac{1}{2} \text{ a } 12.50 \text{ cms.}$$

c)  $M = 348,000 \text{ Kg-cms.}$

$$A_s = M/23562 = 14.770, \quad a = A_s (0.1882) = 2.78$$

$$A_s = M/1260(34 - 2.78) = 8.847 \quad a = 1.66$$

$$A_s = M/1260(34 - 1.66) = 8.540 \quad a = 1.61$$

$$A_s = M/1260(34 - 1.61) = 8.527 \quad a = 1.61 \quad \text{ok}$$

$$A_s = 8.527 = 7 \text{ } \varnothing \frac{1}{2} \text{ a } 12.50 \text{ cms.}$$

d)  $M = 125,200 \text{ Kg-cms.}$

$$A_s = M/23562 = 5.314, \quad a = A_s (0.1882) = 1.00$$

$$A_s = M/1260(34 - 1.00) = 3.011 \quad a = 0.57$$

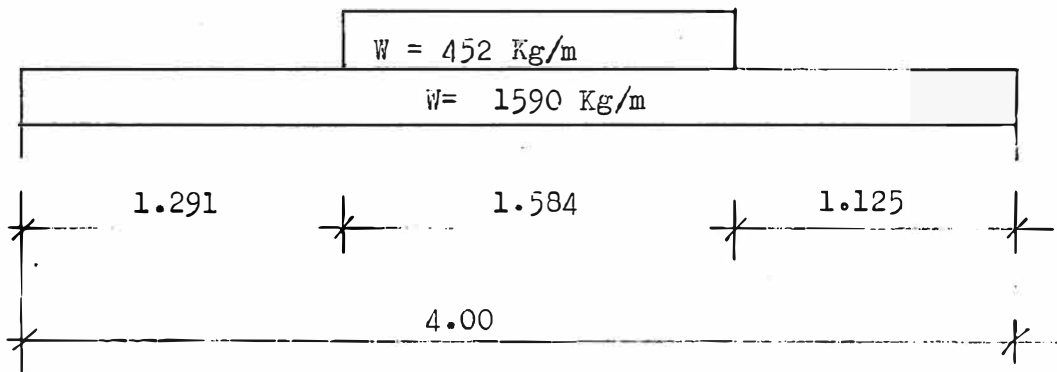
$$A_s = M/1260(34 - 0.57) = 2.972 \quad a = 0.57 \quad \text{ok}$$

$$A_s = (3/4)(2.972) = 3.960$$

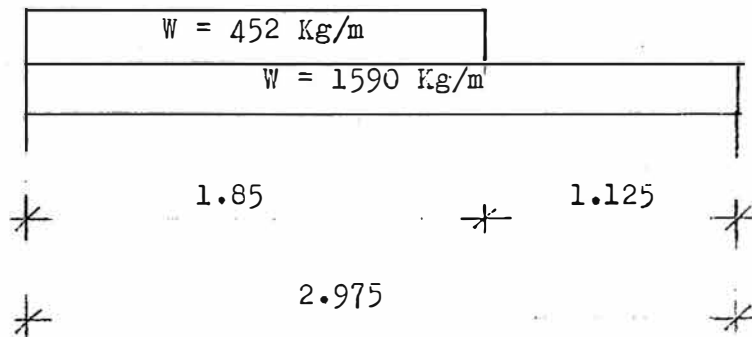
$$A_s = 3.960 = 3 \text{ } \varnothing \frac{1}{2} \text{ a } 25.00 \text{ cms.}$$

ESCALERA

- Primer Tramo ( Zona Achurada )



- Segundo Tramo



Area de acero por temperatura:

$$A_{st} = 0.002 b d = 3.40 \text{ cms.}^2$$

$$\text{Con } \phi = 3/8 = 0.713 \quad "$$

$$n = 3.400/0.713 = 4.77 \text{ varillas}$$

$$a = b/n = 100/4.77 = 21 \text{ cms.}$$

$$A_{st} = 3.40 = \phi 3/8 \text{ a } 21 \text{ cms.}$$

Comprobación por corte:

$$V_d = 3525 - 1590(0.17) = 3254.7 \text{ Kg.}$$

$$v_d = V_d / bd = 3254.7 / 100(17) = 1.91 \text{ menor } q' V_{cx} = 6.56 \text{ Kg/cms.}^2$$

Adherencia:

$$z_0 = V / \phi J d \bar{u}_u = 3525 / 0.85(7/8) 17(56.2) = 4.96 \text{ cms.}$$

### SEGUNDO TRAMO (Linea continua)

Reacciones:

$$\text{Suma de fuerzas en "Y": } R_A \uparrow R_B = 5540 \text{ Kg.}$$

$$\text{Suma de momentos en "B" } R_A = 2940 \quad "$$

$$R_B = 2600 \quad "$$

Valor de "x" cuando  $V=0$

$$0 = 2940 - 2042 x, \quad x = 1.44 \text{ m.}$$

Valor del momento máximo, cuando "x" = 1.44 m.

$$M_{AB} = 2940(1.44) - 2042(1.44)^2/2 = 2116.50 \text{ Kg-m.}$$
$$= 2120 \quad "$$

Valor de los momentos extremos:

$$M_A = M_B = (1/3) \text{ del momento máximo} = 700 \quad "$$

Valor del momento cuando "x" = 1.85 m.

$$M = 2940(1.85) - 2042(1.85)^2/2 = 1945 \quad "$$

Areas de acero: (cuando  $d=17$  cms. y  $b=100$  cms. )

$$a) M = 212,000 \text{ Kg-m.}$$

$$A_s = M / 23562 = 8.998, \quad a = A_s(0.1832) = 1.69$$

$$A_s = M / 1260(34 - 1.69) = 5.207 \quad a = 0.98$$

$$A_s = M / 1260(34 - 0.98) = 5.096 \quad a = 0.96$$

$$A_s = M / 1260(34 - 0.96) = 5.092 \quad a = 0.96 \quad \text{ok}$$

$$A_s = (4/3)(5.092) = 6.789$$

$$A_s = 6.789 = 5 \phi 2 \text{ a } 16.60 \text{ cms.}$$



$$b) M = 194,500 \text{ Kg-m.}$$

$$A_s = M / 23562 = 8.255, a = A_s (0.1882) = 1.55$$

$$A_s = M / 1260(34 - 1.55) = 4.757 \quad a = 0.90$$

$$A_s = M / 1260(34 - 0.90) = 4.664 \quad a = 0.88$$

$$A_s = M / 1260(34 - 0.88) = 4.660 \quad a = 0.88 \quad \text{ok}$$

$$A_s = (4/3)(4.660) = 6.213$$

$$A_s = \underline{6.213} = 5 \text{ } \emptyset \text{ } \frac{1}{2} \text{ a } 16.60 \text{ cms.}$$

$$c) M = 70,000 \text{ Kg-m.}$$

$$A_s = M / 23562 = 2.971, a = A_s (0.1882) = 0.56$$

$$A_s = M / 1260(34 - 0.56) = 1.661 \quad a = 0.31$$

$$A_s = M / 1260(34 - 0.31) = 1.649 \quad a = 0.31 \quad \text{ok}$$

$$A_s = (4/3)(1.649) = 2.199$$

$$A_s = \underline{3.400} = 5 \text{ } \emptyset \text{ } \frac{3}{8} \text{ a } 16.60 \text{ cms.}$$

Area de acero por temperatura:

$$A_{st} = 0.002 b d = 3.40 \text{ cms}^2$$

$$\text{Con } \emptyset = \frac{3}{8} = 0.713 \text{ "}$$

$$n = 3.40 / 0.713 = 4.77 \text{ varillas}$$

$$a = b/n = 100/4.77 = 21 \text{ cms.}$$

$$A_{st} = \underline{3.40} = \emptyset \frac{3}{8} \text{ a } 21 \text{ cms.}$$

Comprobación por corte:

$$V_d = 2940 - 2042(0.17) = 2592.86$$

$$v_d = V_d / b d = 2592.86 / 1700 = 1.53 \text{ menor q' } v_{cx} = 6.56 \text{ Kg/cms.}$$

Adherencia:

$$z_o = V / \emptyset J d \bar{U}_u = 2940 / 0.85 (7/8) 17 (56.2) = 4.14 \text{ cms.}$$

TERCERA PARTE: VIGAS

## VIGAS .

### Cálculos Previos :

- 1.- Sección -  $h = 30$  cms.  
 $b = 25$  "  
 $d = h - \text{recubrimiento} - \frac{1}{2} \text{ diámetro supuesto}$   
 $= 30 - 3 - \frac{1}{2}(\emptyset) = 26$  cms.

### 2.- Momento Máximo:

$$p_x = 0.75 p_b = 0.023$$
$$a_x = (p_x \cdot f_y \cdot d) : (0.85 f'_c) = 11.26 \text{ cms.}$$
$$M = 0.90 \times 0.85 \times b \cdot a_x \cdot f'_c \cdot (d - \frac{a_x}{2}) = 7677 \text{ kg-m.}$$

### 3.- Límites de Acero:

$$A_{s(mi.)} = 0.005 bd = 3.25 \text{ cms}^2$$
$$A_{s(mi.mi)} = 0.002 bd = 1.30 \text{ "}$$
$$A_{s(max.)} = 0.023 bd = 14.95 \text{ "}$$
$$A_{s(flecha)} = 0.18 \frac{f'_c}{f_y} bd = 7.31 \text{ "}$$

### 4.- Areas de Acero:

$$A_s = \frac{M}{0.9 f_y (d - \frac{a}{2})}, \quad a = d/5, \quad (d - a/2) = 23.4$$

$$A_s = M / 58968, \quad a = A_s (0.7529)$$

$$A_s = M / 1260(52 - a)$$

### 5.- Estribos:

$$v_c = 0.50 \emptyset (f'_c)^{2/3}, \quad \text{ACI-1701-C}$$

$$A_v = V_u s / \emptyset f_y d$$

$$v_u = \text{o mayor a } 1.6 \emptyset (f'_c)^{2/3}$$

## CALCULO DE LA VIGA V-1

Datos Previos :  $h = 30$  cms.

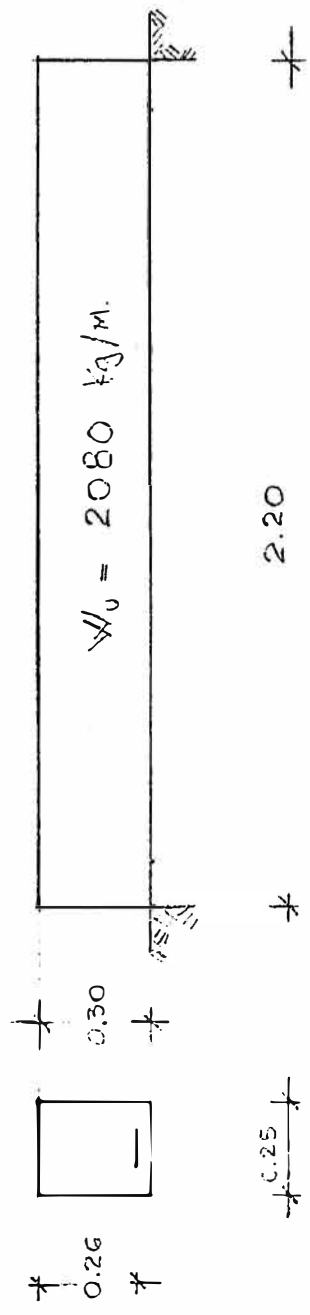
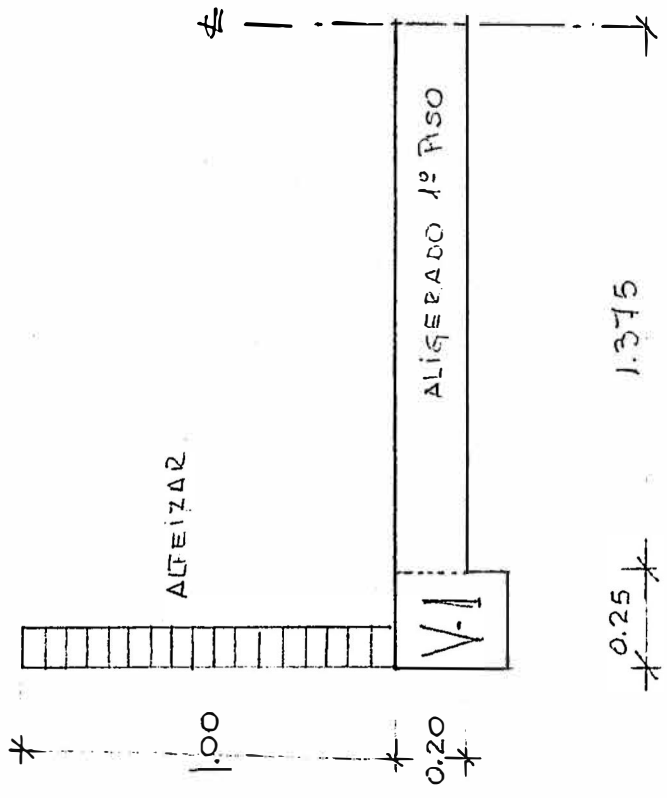
$$b = 25 \text{ "}$$

$$d = 26 \text{ "}$$

$$L = 2.20 \text{ m.}$$

Sobrecarga = Alfeizar de ladrillo perimetral  
de  $350 \text{ Kg/m}^2$ .

VIGA V-1



Metrado de Carga :

a) C.M. Aligerado =  $380 \text{ Kg/m}^2 \times 1.375 = 523 \text{ Kg/m.l.}$   
Viga =  $0.25 \times 0.30 \times 2,400 = 180 \text{ "}$   
Alfeizar =  $350 \text{ Kg/m}^2 \times 1 \approx 350 \text{ "}$   

---

1053 "

b) C.V. ( la del primer piso)  
 $200 \text{ Kg/m}^2 \times 1.375 = 275 \text{ "}$

Carga de Diseño:

$$W_u = 1.5 (\text{C.M.}) + 1.8 (\text{C.V.}) = 2080 \text{ Kg/m.l.}$$

Momentos de Cálculo:

$$M_{AB} = M_A \approx M_B = (1/12)(W_u)(L)^2 = 840 \text{ Kg-m}$$

Areas de Acero:

$$M = 84,000 \text{ Kg-cms.}$$

$$A_s = M / 58968 = 1.425, \quad a = A_s (0.7529) = 1.07$$

$$A_s = M / 1260(52-1.07) = 1.309 \quad a = 0.99$$

$$A_s = M / 1260(52-0.99) = 1.307 \quad a = 0.99 \text{ ok}$$

$$A_s = (4/3)(1.307) = 1.743$$

$$A_s = \underline{1.743} = 2 \text{ } \varnothing \frac{1}{2}$$

Estribos:

$$a) V_u = W_u \cdot \frac{L}{2} - W_u \cdot d = 2080(0.84) = 1747 \text{ Kg}$$

$$v_c = 0.50 \cdot \varnothing (f'_c)^{1/2} = 5.62 \text{ kg/cms}^2$$

$$V_c = v_c \cdot bd = 3655 \text{ Kg mayor q' } V_u, \text{ no necesita estribos}$$

$$b) v_u = V_u / bd = 2.69 \text{ menor q' } 1.6 \varnothing (f'_c)^{1/2} = 18$$

$$s = d/2 = 13 \text{ cms.}$$

$$c) s = A_v / 0.0015 b, \text{ con estribos de } 1/4$$

$$A_v = 2(0.316) \quad s = 16.8$$

$$s = 16.80 \text{ cms.}$$

$$d) s = A_v \cdot f_y / 3.5 b$$

$$s = 20.2 \text{ cms.}$$

Se escogerá el menor,  $s = 13 \text{ cms.}$

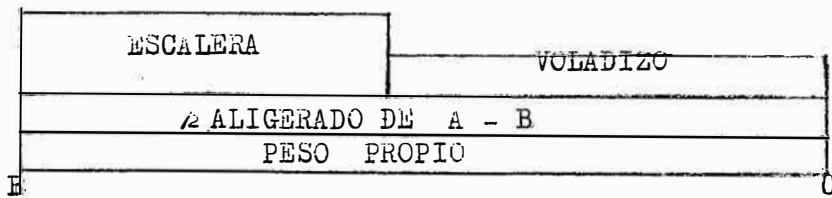
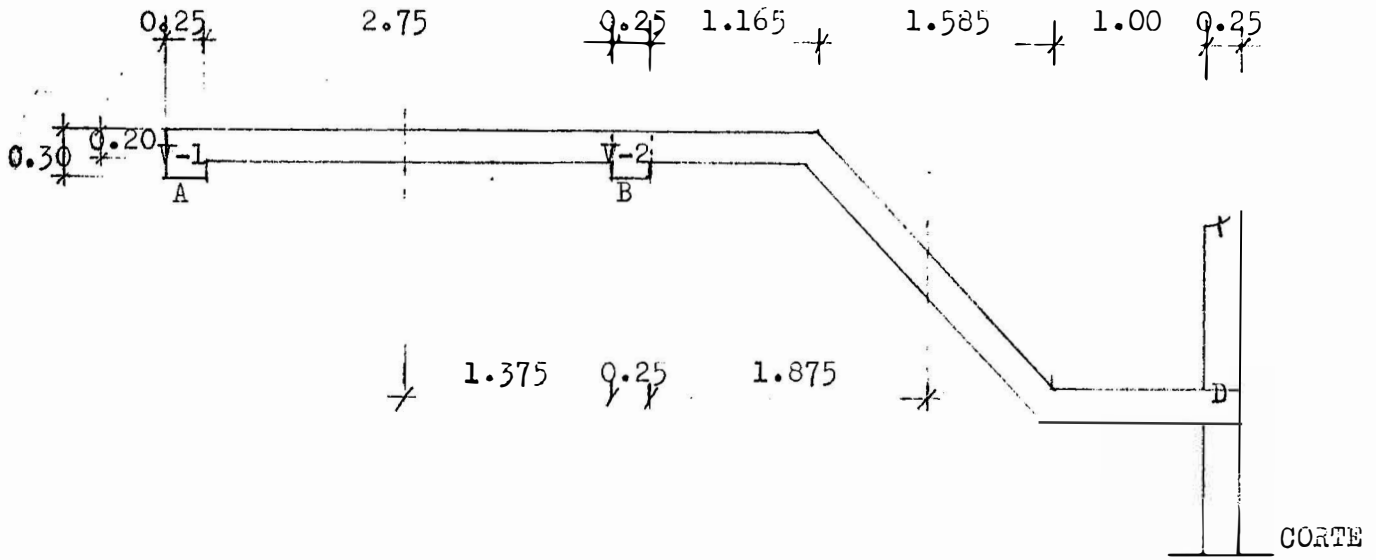
CALCULO DE LA VIGA V-2

Datos Previos:  $h = 30 \text{ cms.}$

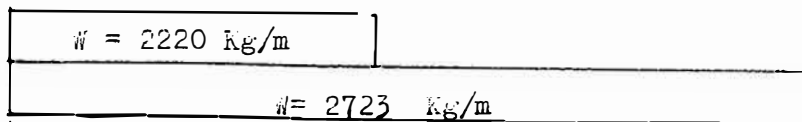
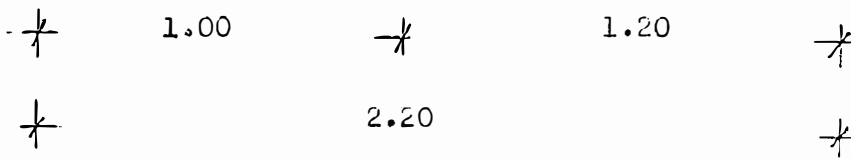
$$b = 25 \text{ "}$$

$$d = 26 \text{ "}$$

VIGA V-2



CARGAS QUE INFLUYEN



CARGA ÚTIL

$$L = 2.20 \text{ m.}$$

Cargas =  $\frac{1}{2}$  aligerado de  $L = 2.75 \text{ m.}$

= Voladizo de  $L = 1.165 \text{ m.}$

=  $\frac{1}{2}$  escalera.

Metrado de Carga:

a) C.M.

$$1^{\text{a}} \text{Peso Propio} = 0.30 \times 0.25 \times 2400 = 180 \text{ Kg-m.}$$

$$2^{\text{a}} \text{Aligerado} = 380 \text{ Kg/m}^2 \times 1.375 = 523 \text{ "}$$

$$3^{\text{a}} \text{Voladizo} = 380 \text{ " } \times 1.165 = 443 \text{ "}$$

$$4^{\text{a}} \text{Escalera} =$$

$$\text{Rampa} = 861.4 \times 0.710 = 626$$

$$\text{Descanso} = 580.0 \times 1.155 = 676 = 1302 \text{ "}$$

$$\text{C.M.en C} = (1^{\circ} \div 2^{\circ} \div 3^{\circ} = 1146) \approx 1146 \text{ "}$$

$$\text{C.M.en B} = (1^{\circ} \div 2^{\circ} \div 4^{\circ} - \text{C.M. en C} = 859 \text{ "}$$

b) C.V.

$$1^{\text{a}} \text{Peso Propio} = 0.25 \times 200 \text{ Kg/m}^2 = 50 \text{ "}$$

$$2^{\text{a}} \text{Aligerado} = 1.375 \times \text{ " } = 275 \text{ "}$$

$$3^{\text{a}} \text{Voladizo} = 1.165 \times \text{ " } = 233 \text{ "}$$

$$4^{\text{a}} \text{Escalera} = 1.875 \times 400 \text{ " } = 750 \text{ "}$$

$$\text{C.V. en C} = (1^{\circ} \div 2^{\circ} \div 3^{\circ}) = 558 \text{ "}$$

$$\text{C.V. en B} = (1^{\circ} \div 2^{\circ} \div 4^{\circ} - \text{C.V.en C} = 517 \text{ "}$$

Carga de Diseño:

$$W_{u1} = 1.5 (1146) \div 1.8(558) = 2723 \text{ Kg-m.}$$

$$W_{u2} = 1.5 (859) \div 1.8(517) = 2220 \text{ "}$$

Momentos de Cálculo:

a) Negativos:  $M'_B = M'_C = \frac{W \cdot L^2}{12} = \frac{2723(2.2)^2}{12} = 1090 \text{ Kg-m}$   
 Según la tabla 4(a) de B.A.G. (pag 16)

$$\alpha = 1.0/1.2 = 0.455 \text{ luego } \alpha_d = 0.0206$$

$$\alpha_i = 0.0514$$

$$M = \alpha \cdot W \cdot L^2$$

$$M'_B = 0.0514(2220)(2.2)^2 = 540 \text{ Kg-m.}$$

$$M'_C = 0.0206(2220)(2.2)^2 = 215 \text{ "}$$

$$M_B = 1090 \div 540 = 1630 \text{ Kg-m.}$$

$$M_C = 1090 \div 215 = 1310 \text{ "}$$

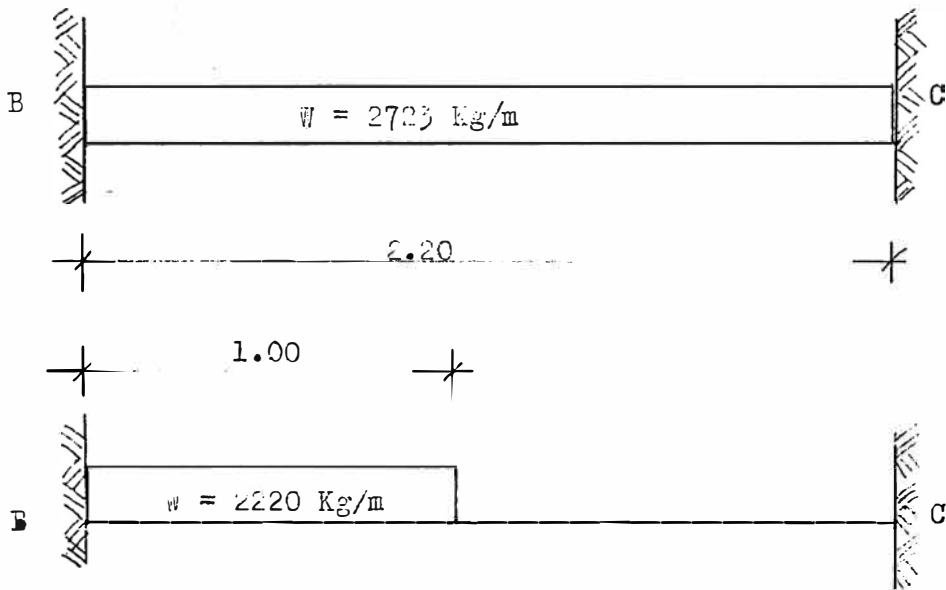
b) Positivos:  $M'_{BC} = (1/8) \cdot W \cdot L^2 = 1646 \text{ "}$

Según la tabla 4(a) de B.A.G. (pag 16)

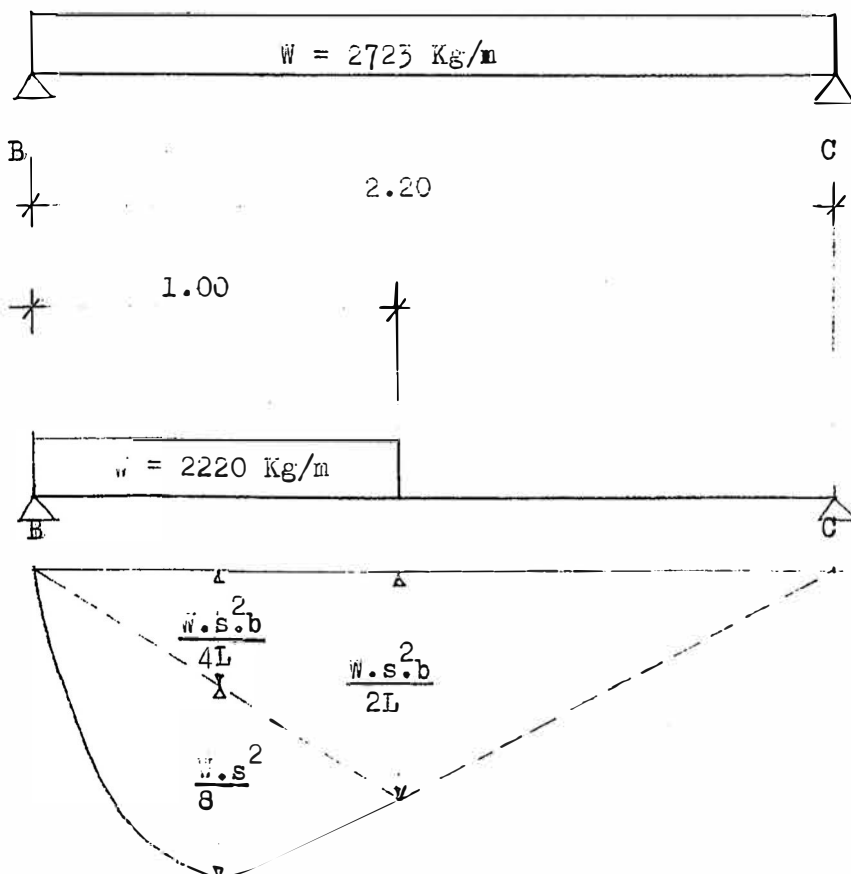
$$s = 1.0 \quad b = 1.2 \quad , \quad L = 2.2$$

VIGA V-2

MOMENTOS NEGATIVOS



MOMENTOS POSITIVOS





$$M'_{BC} = \frac{W \cdot s^2 \cdot b}{4L} \pm \frac{W s^2}{8} = \frac{W \cdot s^2}{4} \left( \frac{b}{L} \pm \frac{1}{8} \right) = 372 \text{ Kg-m.}$$

$$M_{BC} = 1646 \pm 372 = 2020 \text{ Kg-m.}$$

Areas de Acero:

a)  $M = 163000 \text{ Kg-m.}$

$$A_s = M / 58968 = 2.762, \quad a = A_s (0.7529) = 2.01$$

$$A_s = M / 1260(52 - 2.01) = 2.585 \quad a = 2.00$$

$$A_s = M / 1260(52 - 2.00) = 2.581 \quad a = 2.00 \text{ ok}$$

$$A_s = (4/3)(2.581) = 3.435$$

$$A_s = \underline{3.250} = \# \emptyset 3/8 \pm 1\emptyset/2$$

b)  $M = 131000 \text{ Kg-m.}$

$$A_s = M / 58968 = 2.246, \quad a = A_s (0.7529) = 1.52$$

$$A_s = M / 1260(52 - 1.52) = 2.064 \quad a = 1.56$$

$$A_s = M / 1260(52 - 1.56) = 2.060 \quad a = 1.56 \text{ ok}$$

$$A_s = (4/3)(2.060) = 2.755$$

$$A_s = \underline{2.755} = 2\emptyset 3/8 \pm 1\emptyset/2$$

c)  $M = 202000 \text{ Kg-m.}$

$$A_s = M / 58968 = 3.420, \quad a = A_s (0.7529) = 2.60$$

$$A_s = M / 1260(52 - 2.60) = 3.292 \quad a = 2.50$$

$$A_s = M / 1260(52 - 2.50) = 3.250 \quad a = 2.50 \text{ ok}$$

$$A_s = \underline{3.250} = 1\emptyset 3/8 \pm 2\emptyset/2$$

Estribos:

Reacciones;

$$R_B \pm R_C = 2723(2.2) \pm 2220(1) = 8211 \text{ Kg.}$$

$$\frac{2723(2.2)^2}{2} \pm 2220(1.7)$$

$$R_B = \frac{2}{2.2} = 4696 \text{ "}$$

$$R_C = 8211 - 4696 = 3514 \text{ "}$$

$$V_u = 4696 - 4943(0.26) = 3410 \text{ "}$$

$$v_c = 0.5 \cdot \emptyset \cdot (f'_c)^{1/2} = 0.5(0.35)13.23 = 5.62 \text{ Kg/cm}^2$$

$$V_c = v_c \cdot b \cdot d = 5.62 \times 25 \times 26 = 3655 \text{ Kg mayor q } V_u$$

No necesita estribos, pero:

$$v_u = \frac{V_u}{b \cdot d} = \frac{2785}{25 \times 26} = 4.25 \text{ menor q } 1.0 \emptyset (f'_c)^{1/2} = 17.09$$

$$\text{luego } s = d/2 = 13 \text{ cms.}$$

$$s = A_v / 0.0015 \cdot b, \text{ con estribos de } \emptyset 1/4, A_v = 2(0.316)$$

$$\text{luego } s = 16.8 \text{ cms.}$$

$$s = A_v \cdot f_y / 3.5 \cdot b = 20.2$$

$$\text{luego } s = 20.20 \text{ csm.}$$

Tomaremos estribos de 1/4 a 13 cms.

### CALCULO DE LA VIGA V-3

Datos Previos: h = 20 cms.

$$b = 25 \text{ "}$$

$$d = 16 \text{ "}$$

$$A_{s(mi.)} = 2.00 \text{ cms.}^2$$

$$A_{s(mimi.)} = 0.80 \text{ "}$$

Metrado de Cargas:

$$a) \text{ C.M. Aligerado} = 380 \left( \frac{3.75}{2} \div 1.20 \right) = 1169 \text{ Kg/m}$$

$$\text{Viga} = 0.25 \times 0.20 \times 2400 \times 1 = \underline{120 \text{ "}}$$

$$1290 \text{ "}$$

$$b) \text{ C.V. Aligerado} = 200 \left( 1.20 \div 0.25 \div \right.$$

$$\left. \div \frac{3.75}{2} \right) = 665 \text{ "}$$

Carga de Diseño:

$$W_u = 1.5 (1290) \div 1.8 (665) = 3132 \text{ Kg/m}$$

Momento de Cálculo (Voladizo)

$$M = \frac{1}{2} W_u L^2 = \frac{1}{2} (3132)(0.5)^2 = 392 \text{ Kg-m.}$$

Areas de Acero:

$$M = 39200 \text{ Kg-cms.}$$

$$A_s = M / 0.9 \times 2800 (16 - 1.6) = 1.08, a = A_s (0.7529) = 0.81$$

$$A_s = M / 1260 (32 - 0.81) = 0.997 \quad a = 0.75$$

$$A_s = M / 1260 (32 - 0.75) = 0.996 \quad a = 0.75 \text{ ok.}$$

$$A_s = 4/3 (0.996) = 1.328$$

$$A_s = \underline{1.328 = 2 \text{ } \emptyset \text{ } 3/8}$$

Longitud Empotrada:

$$\text{C.M./- Aligerado Azotea} = 380 \times 3.37 = 1280 \text{ kg-m}$$

$$\text{Muro} = 350 \times 2.4 = 840 \text{ "}$$

$$\text{Aligerado 1º piso} = 380 \times 3.37 = 1280 \text{ "}$$

$$\text{Viga} = 0.25 \times 0.2 \times 2400 = \underline{120 \text{ "}}$$

$$\text{C.V.- Azotea} = 100 \times 3.37 = 337 \text{ kg-m} \quad 3520 \text{ "}$$

$$\text{Alige.} = 200 \times 3.37 = \underline{674 \text{ "}}$$

$$1011 \text{ "}$$

Carga de Diseño:

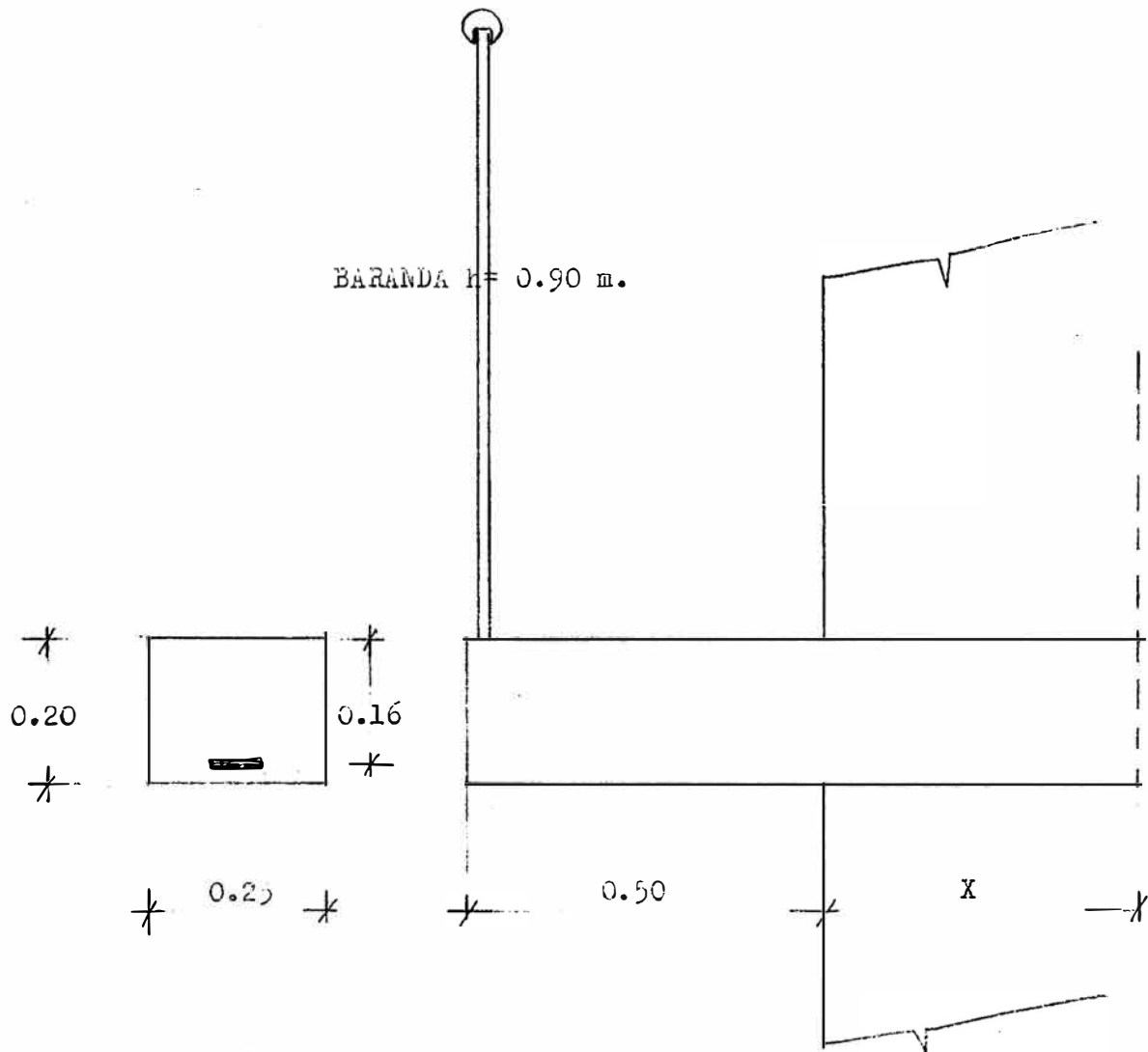
$$W = 1.5 (3520) \div 1.8 (1011) = 7100 \text{ Kg-m.}$$

Longitud:

$$3132 \left( \frac{0.50}{2} \right)^2 = 7100 \frac{x^2}{2}$$

$$\text{Longitud} = X = 54 \text{ cms.}$$

VIGA V-3



Longitud de Desarrollo:

$$L_d = A_s \cdot f_y \cdot / \phi \cdot E_o \cdot u'_u$$

$$u'_u = \frac{V_u}{\phi \cdot E_o \cdot J \cdot d} = 0 \text{ menor } \bar{u}'_u$$

$$\bar{u}'_u = 6.4 (f'_c)^{3/4} / D$$

donde:  $A_s = 2\phi 3/8 = 1.42 \text{ cms}^2$

$$\phi = 0.85$$

$$E_o = 2 \phi 3/8 = 6.00 \text{ cms.}$$

$$V_u = W_u (0.34) = 1065$$

$$J = 7/8$$

$$\bar{u}'_u = \text{menor } 56.2 \text{ Kg-cms}^2$$

luego:

$$u'_u = 14.92 \text{ Kg/cms}^2, \text{ menor, } \bar{u}'_u = 88.65 \text{ Kg/cms}^2$$

$$L_d = 52 \text{ cms.}$$

Tomaremos una longitud final de 55 cms.

Estribos:

1º-  $V_u = 1065 \text{ kg.}$

$$v_c = 0.5 \cdot \phi \cdot (f'_c)^{3/4} = 5.62 \text{ Kg/cms.}^2$$

$$V_c = v_c \cdot b \cdot d = 2249 \text{ Kg mayor q' } V_u, \text{ no necesita}$$

2º- con estribos de  $\phi 1/4$ ,  $A_v = 2(0.315) = 0.632 \text{ cms}^2$

$$s = A_v / 0.0015 \cdot b = 17 \text{ cms.}$$

3º-  $s = A_v \cdot f_y / 3.5 \cdot b = 20 \text{ ''}$

4º-  $v_u = V_u / b \cdot d = 1065 / 25 \times 16 = 2.66 \text{ Kg/cms}^2$

$$q' \text{ es menor q' } 1.6 \phi (f'_c)^{3/4} = 17.99$$

$$s = d/2 = 16/2 = 8 \text{ cms.}$$

Tomaremos estribos de 1/4 a 10 cms.

CALCULOS DE LA VIGA V-4

Datos Previos:  $h = 30 \text{ cms.}$

$$b = 25 \text{ ''}$$

$$d = 26 \text{ ''}$$

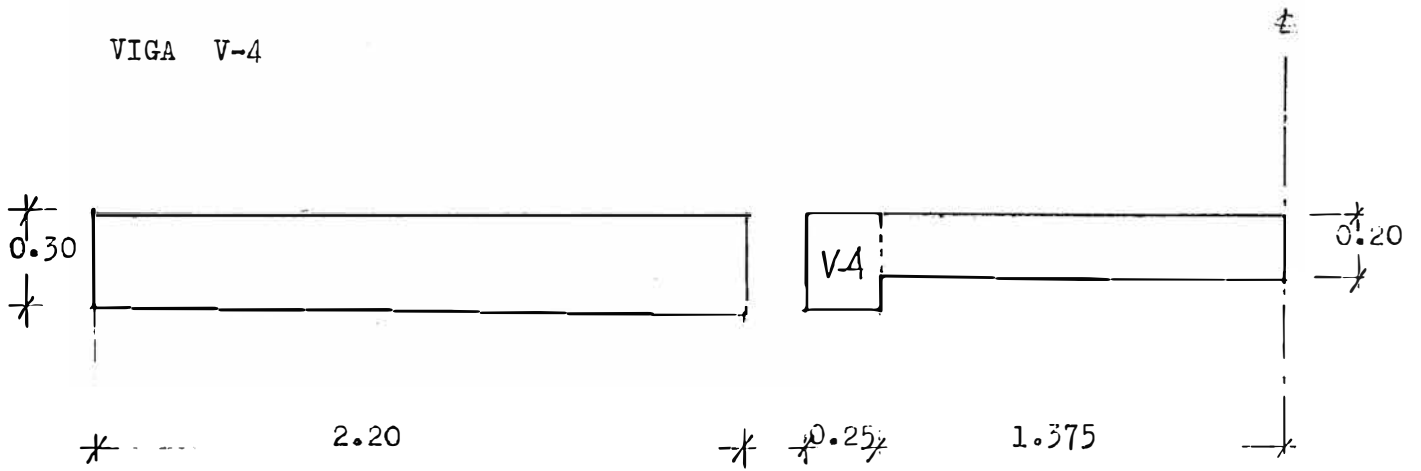
$$L = 2.20 \text{ m.}$$

Metrado de Cargas:

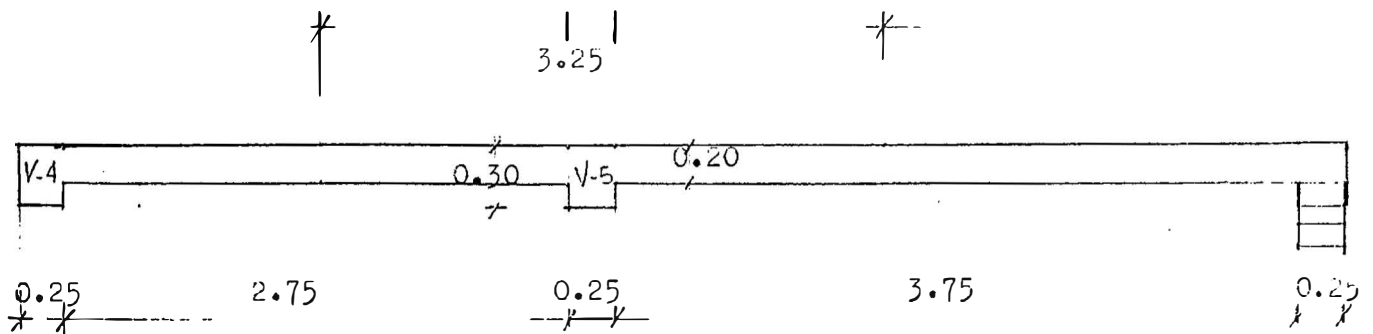
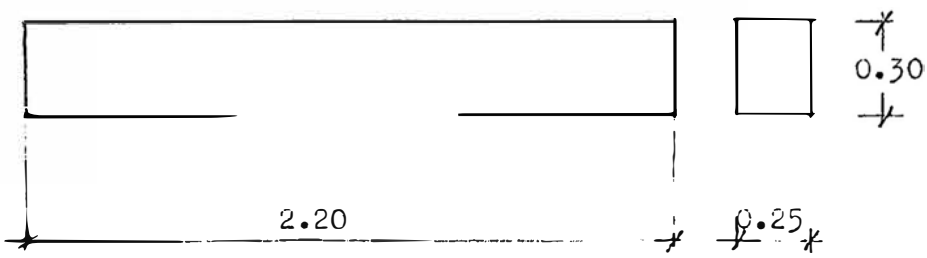
a).C.M.	Aligerado 360 x 1.375	=	523	Kg-m.
	viga 0.25 x 0.30 x 2400	=	120	"
			703	"

VIGAS V-4 y V-2

VIGA V-4



VIGA V-5



$$b) \text{ C.V. Azotea} = 100 \times 1.625 = 163 \text{ Kg-m.}$$

Carga de Diseño:

$$W_u = 1.5 (703) + 1.8 (163) = 1350 \text{ Kg/m}$$

Momentos de Cálculo:

$$M_A = M_B = M_{AB} = \frac{1}{12} (W_u L^2)$$

$$M = \frac{1}{12} (1350) (2.2)^2 = 545 \text{ Kg-m.}$$

Areas de Acero:

$$M = 54500 \text{ Kg-m.}$$

$$A_s = M / 59220 = 0.920, \quad a = A_s (0.7523) = 0.69$$

$$A_s = M / 1260(52-0.69) \quad a = 0.63$$

$$A_s = M / 1260(52-0.63) \quad a = 0.63 \text{ ok}$$

$$A_s = (4/3)(0.842) = 1.123$$

$$A_{s,i} = \frac{1.300}{1} = 2 \text{ } \phi \text{ } 3/8$$

Estribos:

$$1^\circ. v_u = \frac{W_u L}{2} = W_d = 1134 \text{ menor } q' v_c = 3655$$

luego no necesita, pero:

$$2^\circ. v_u = V_u / bd = 1.74 \text{ menor } q' 1.6 \phi (f'_c)^{1/2} = 18$$

luego  $s = 15 \text{ cms.}$

$$3^\circ. s = A_v / 0.0015 b = ( \text{ con estribos de } 1/4 = 16.8 \text{ cms.} )$$

luego  $s = 16.8 \text{ cms.}$

$$4^\circ. s = A_v f_y / 3.5 b = 20$$

Tomaremos estribos de 1/4 a 15 cms.

CALCULO DE LA VIGA V-5

Datos Previos:  $h = 30 \text{ cms.}$

$$b = 25 \text{ "}$$

$$d = 26 \text{ "}$$

$$L = 2.20 \text{ m.}$$

Metrado de Cargas:

$$\text{C.m. Aligerado} = 380 \times 3.25 = 1235 \text{ kg-m.}$$

$$\text{Viga} = 0.25 \times 0.30 \times 2400 = \underline{180} \text{ "}$$

$$1415 \text{ "}$$

$$\text{C.V. Aligerado} = 100 \times 3.25 = 325 \text{ "}$$

$$\text{Viga} = 100 \times 0.25 = \underline{25} \text{ "}$$

$$350 \text{ "}$$

Carga de Diseño:

$$W_u = 1.5 (1415) \ddagger 1.8(350) = 2753 \text{ Kg-m.}$$

Momentos de diseño:

$$M_A = M_B = M_{AB} = \frac{1}{12} \cdot W_u L^2 = 1110 \text{ Kg-m.}$$

Areas de Acero:

$$M = 111000 \text{ Kg-cms.}$$

$$A_s = M / 59220 = 1.874, a = A_s (0.752\phi) = 1.40$$

$$A = M / 1260(52 - 1.40) = 1.741 \quad a = 1.31$$

$$A_s = M / 1260(52 - 1.31) = 1.738 \quad a = 1.31 \text{ ok}$$

$$A_s = (4/3) (1.738) = 2.317$$

$$A_s = \underline{2.317} = 2 \phi 7/8$$

Estribos: Tomaremos estribos de 1/4 a 13 cms.

DINTELES:

Datos Previos: h= 15 cms.

b= 25 cms.

d= 11 "

L= 0.90 m.

Metrado de Carga:

$$\text{C.M. Aligerado } 380 \text{ Kg/m}^2 \times 2.75 \frac{1}{2} (3.75) = 1240$$

$$\text{Encimado } 350 \text{ " } \times 0.20 = 70$$

$$\text{Viga } 0.15 \times 0.25 \times 2400 = 90$$

1400 Kg/m

$$\text{C.V. (1a del 2º piso)} = 200 \times 3.25 = 650 \text{ Kg/m.}$$

Carga de Diseño:

$$W_u = 1.5(1400) \ddagger 1.8(650) = 3300 \text{ Kg/m}$$

Momento de Diseño

$$M = \frac{1}{12} W_u L^2 = (1/12)(3300)(0.9)^2 = 225 \text{ Kg-m}$$

Area de acero:

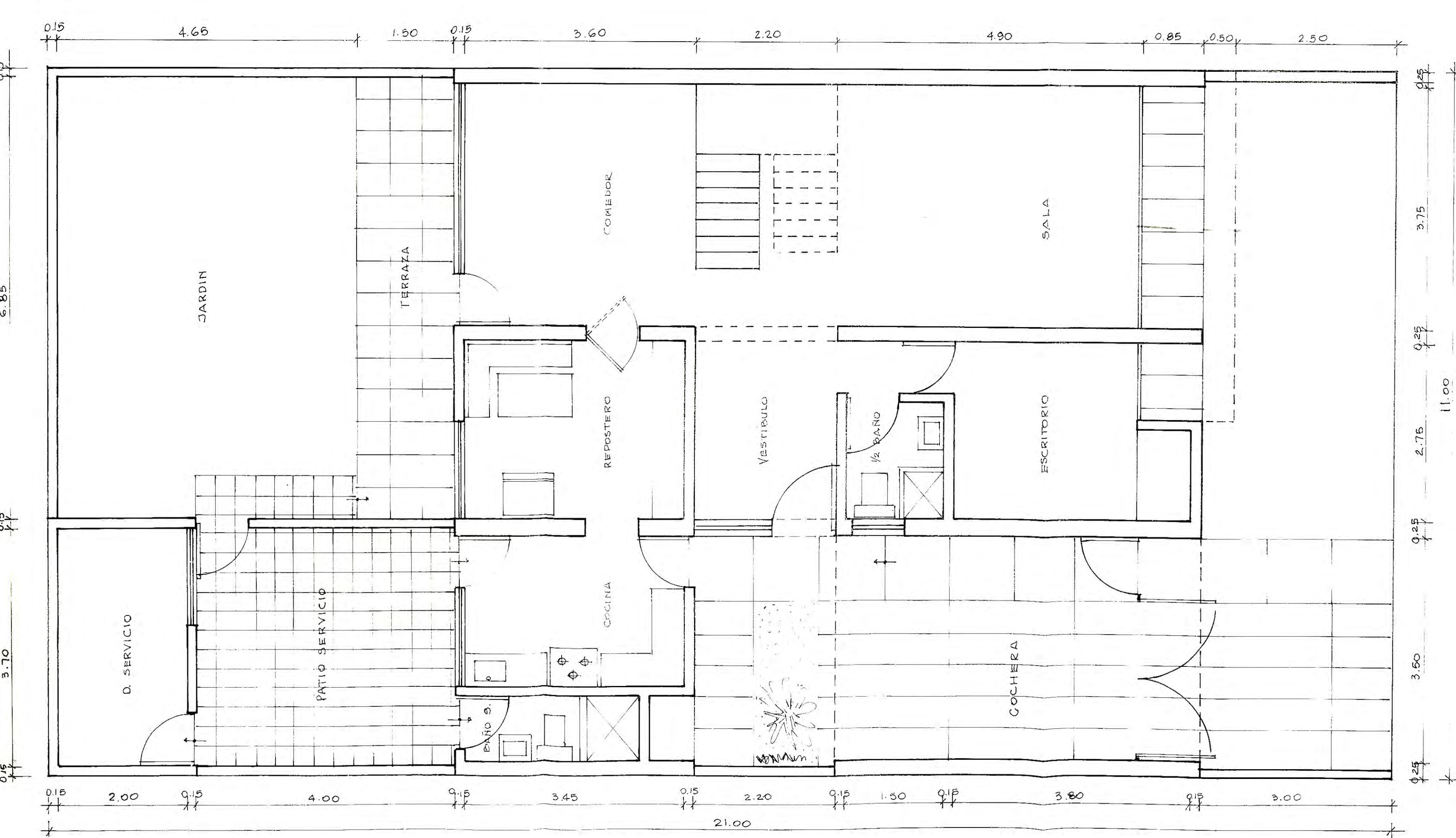
$$A_s = 0.866 \text{ menor que la mínima}$$

$$A_s = (4/3)(0.866) = 1.152$$

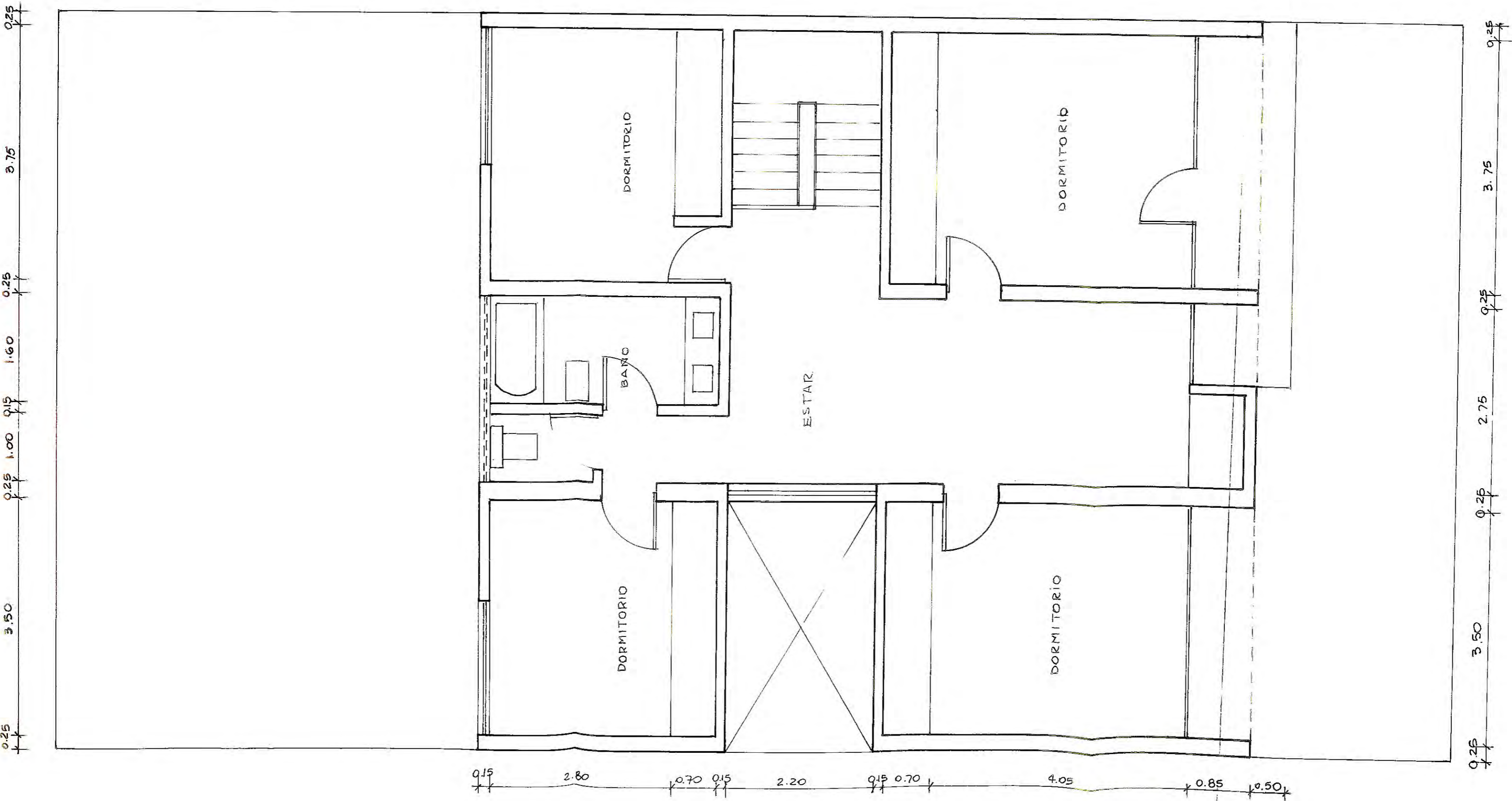
$$A_s = \underline{1.152} = 2 \phi 3/8$$

CUARTA PARTE: PLANOS

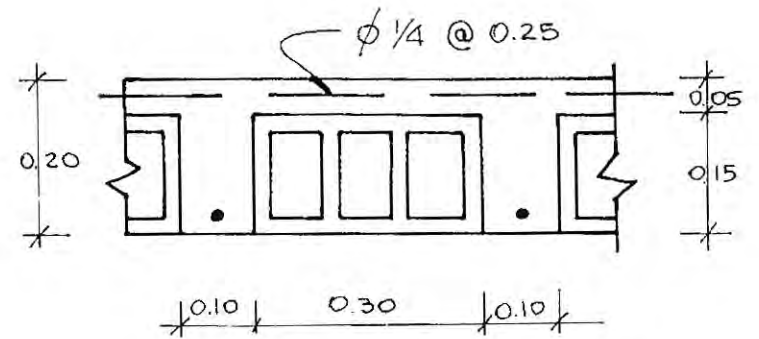
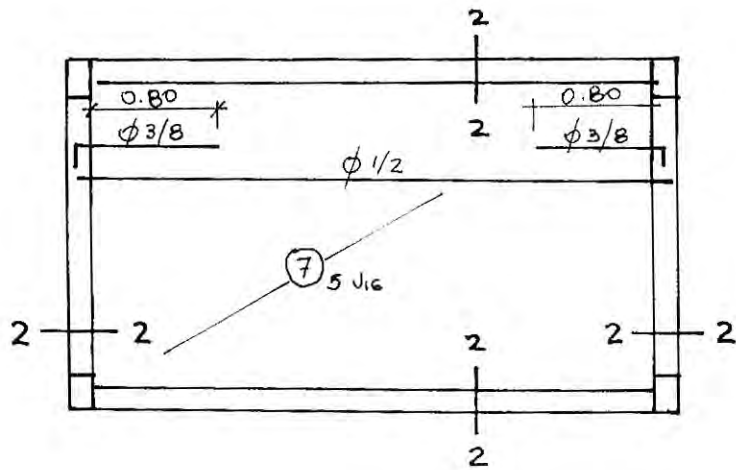




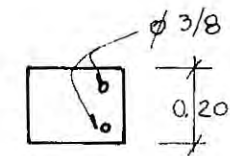
PLANTA 1er PISO ESCALA 1:50



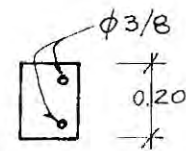
PLANTA 2º PISO ESCALA 1:50



CORTE TÍPICO ALIGERADOS



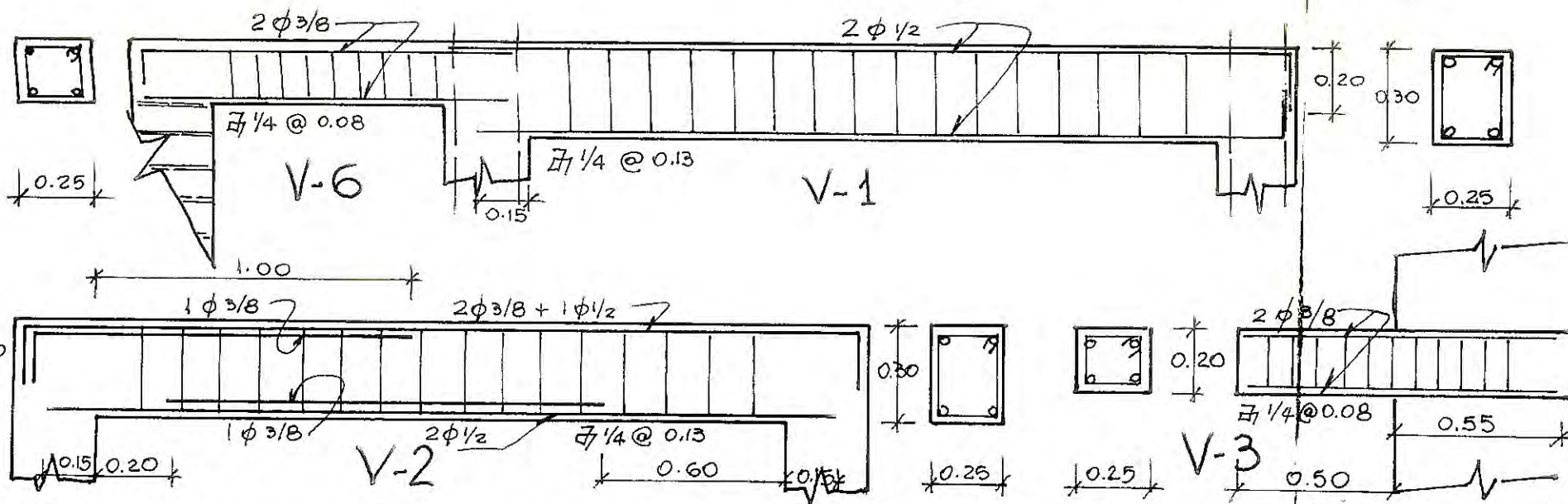
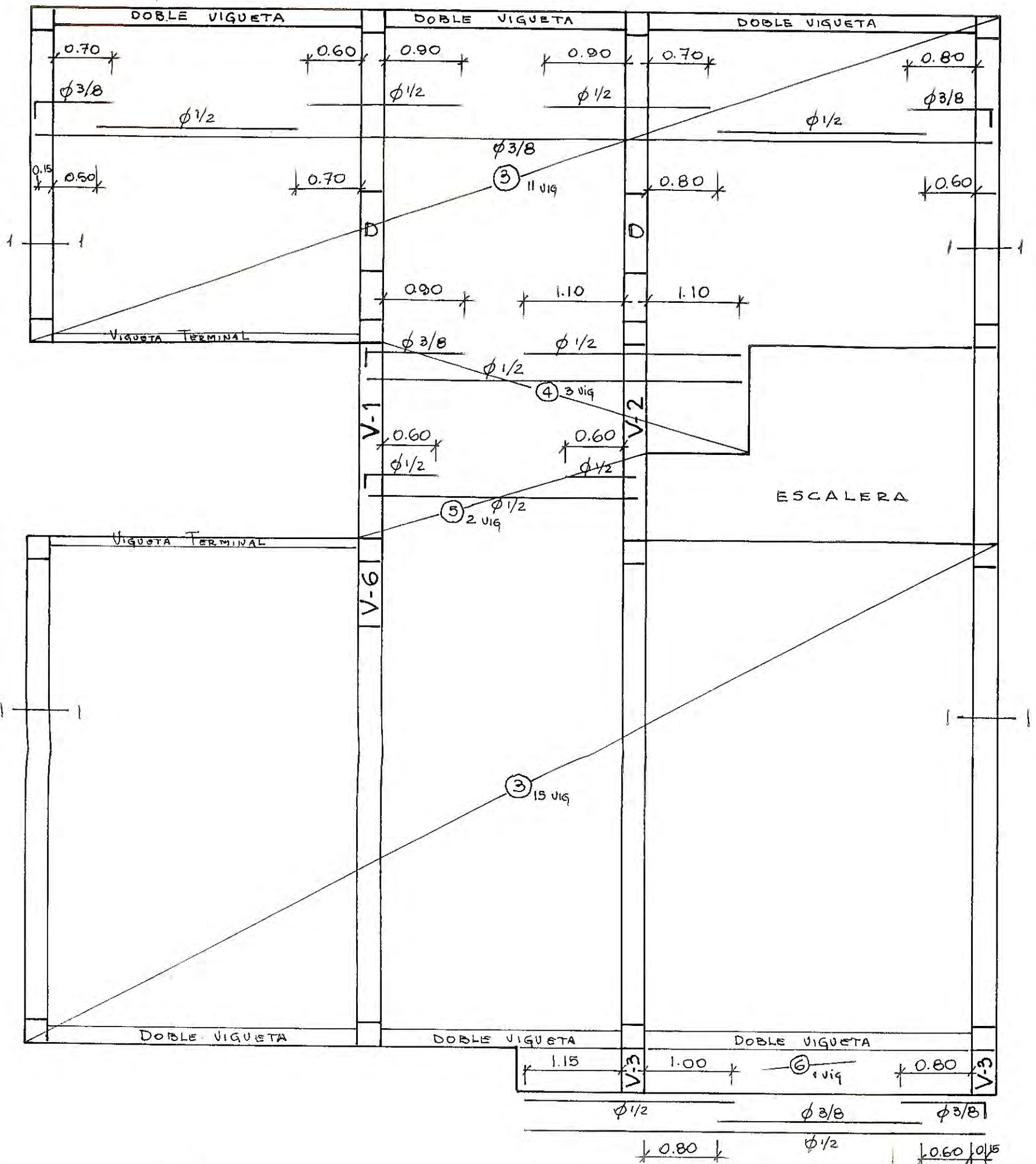
CORTE 1



CORTE 2

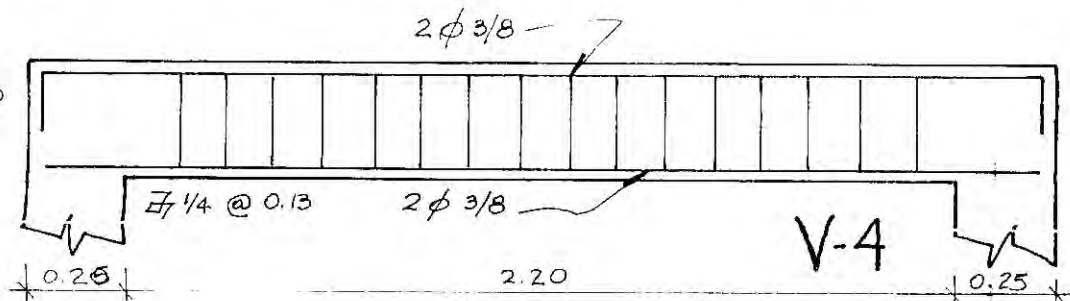
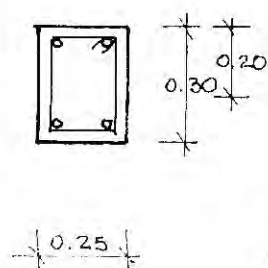
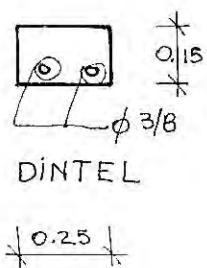
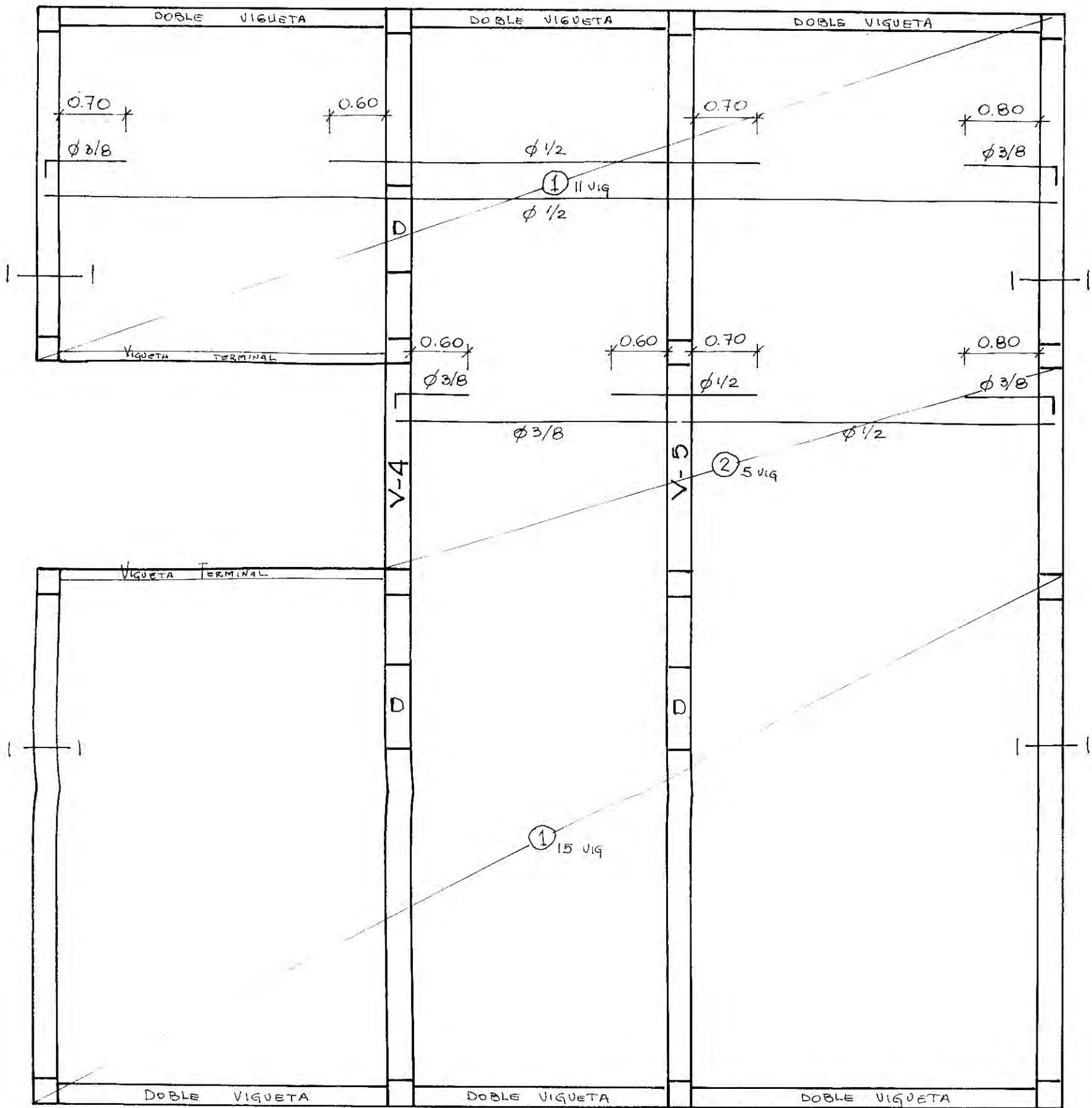
ALIGERADO SERVICIO

ESCALA 1:30, 1:20, 1:10



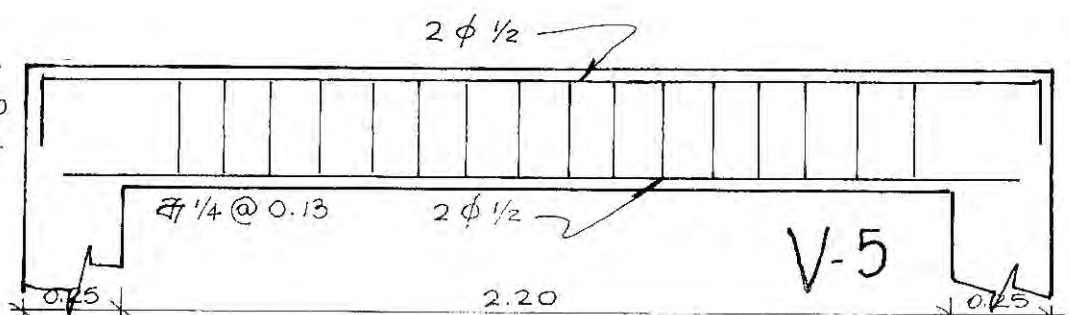
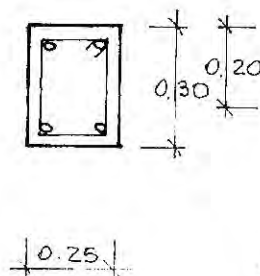
ALIGERADO 1º PISO

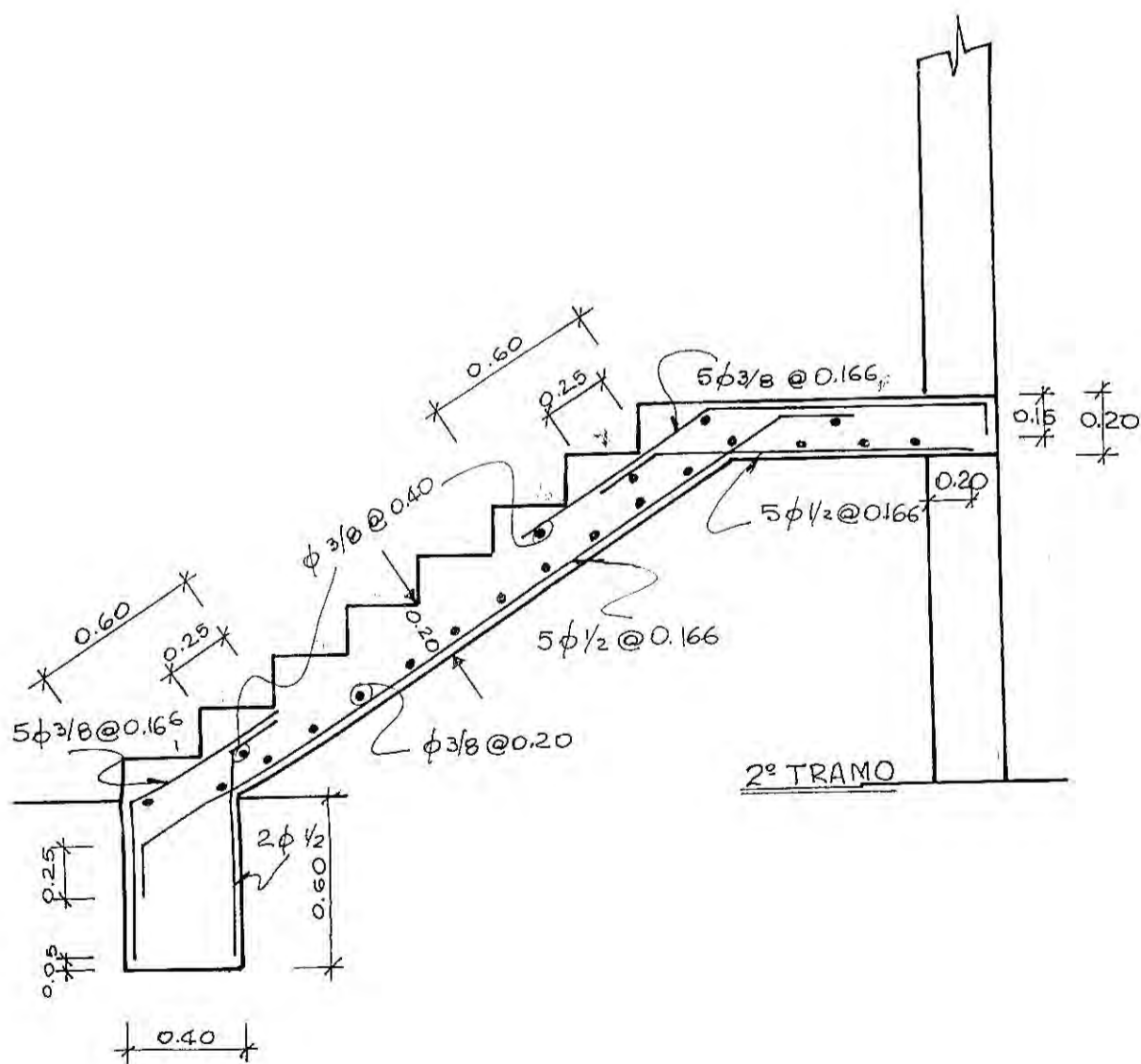
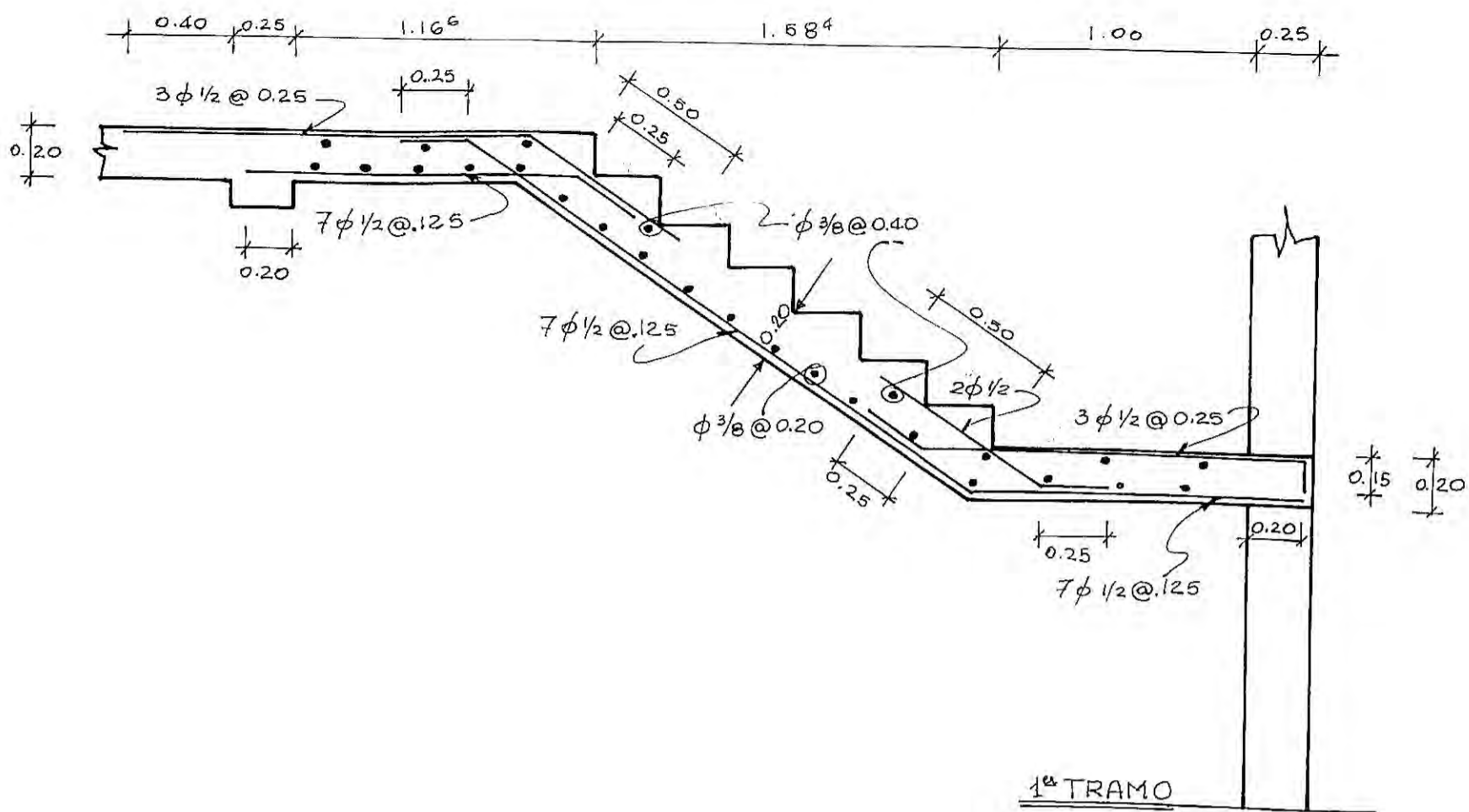
ESCALA. 1:50, 1:20



ALIGERADO  
2º PISO

ESCALA: 1:50, 1:20





ESCALERA

ESCALA 1:25