

1. CALCULO: VOLUMEN DE MOVIMIENTO TIERRA

(1)

VOLUMEN DE PRESTAMO Y DISTANCIA PROMEDIO DE TRANSPORTE

Nº 1

SECTOR	TRAMO		VOLUMEN m ³	LONGITUD m	V x L	FORMULA
	PROGRESIVA	PROGRESIVA				
I	0 + 0.00	10 + 368.9	73,230	5,200	380,796,000	10368.9 x 1/2 = 5184m
	(VxL)/ V			5,200		
II	10 + 500.00	13 + 0.00	27,844	2,200	61,256,800	(13000 - 10500) x 1/2 + (13900 - 13000) = 2150m
	15 + 0.00	18 + 800.00	40,167	3,000	120,501,000	(18800 - 15000) x 1/2 + (15000 - 13900) = 3000m
	18 + 800.00	20 + 300.00	15,575	1,600	24,920,000	(20300 - 18800) x 1/2 + (21100 - 20300) = 1550m
	21 + 200.00	22 + 363.00	12,328	700	8,629,600	(22363 - 21200) x 1/2 + (21200 - 21100) = 681.5m
	22 + 499.00	25 + 400.00	30,427	2,100	63,896,700	(25400 - 22499) x 1/2 + (26000 - 25400) = 2050m
	10 + 368.937	29 + 100.00	33,824	11,366	384,443,584	(29100 - 10368) x 1/2 + 2000 = 11,366m
	TOTAL		160,165		663,647,684	
	(VxL)/ V			4,144m		
III	32 + 600.00	33 + 600.00	12,352	1,500	18,528,000	(33600 - 32600) x 1/2 + (32600 - 31600) = 1500m
	33 + 600.00	34 + 600.00	12,339	1,700	20,976,300	(34600 - 33600) x 1/2 + (35800 - 34600) = 1700m
	47 + 350.00	48 + 400.00	6,882	1,600	11,011,200	(48400 - 47350) x 1/2 + (47350 - 46300) = 1575m
	48 + 400.00	49 + 400.00	12,157	1,500	18,235,500	(49400 - 48400) x 1/2 + (50400 - 49400) = 1500m
	TOTAL		43,730		68,751,000	
	(VxL)/ V			1,572m		
IV	53 + 500.00	54 + 500.00	2,832	1,600	4,531,200	(54500 - 53500) x 1/2 + (53500 - 52450) = 1550m
	54 + 500.00	55 + 550.00	3,959	1,500	5,938,500	(55550 - 54500) x 1/2 + (56550 - 55550) = 1525m
	59 + 650.00	60 + 700.00	7,073	1,600	11,316,800	(60700 - 59650) x 1/2 + (59650 - 58600) = 1575m
	60 + 700.00	61 + 700.00	6,794	1,500	10,191,000	(61700 - 60700) x 1/2 + (62700 - 61700) = 1500m
	67 + 950.00	69 + 0.00	11,103	1,600	17,764,800	(69000 - 67950) x 1/2 + (67950 - 66900) = 1575m
	69 + 0.00	70 + 050.00	8,928	1,600	14,284,800	(70050 - 69000) x 1/2 + (71100 - 70050) = 1575m
	80 + 400.00	82 + 200.00	10,184	1,900	19,349,600	(82200 - 80400) x 1/2 + (80400 - 79400) = 1900m
	82 + 200.00	83 + 900.00	1,282	3,400	4,358,800	(83900 - 82200) x 1/2 + (86400 - 83900) = 3350m
	TOTAL		52,155		87,735,500	
	(VxL)/ V			1,682		

SECTOR	TRAMO		VOLUMEN m ³	LONGITUD m	V x L	FORMULA
	PROGRESIVA	PROGRESIVA				
V	93 + 400.00	94 + 400.00	3,378	1,500	5,067,000	$(94400 - 93400) \times 1/2 + (93400 - 92400)$ $= 1500m$
	94 + 400.00	95 + 400.00	3,880	1,500	5,820,000	$(95400 - 94400) \times 1/2 + (96400 - 95400)$ $= 1500m$
	TOTAL		7,258		10,887,000	
	$(V \times L) / V$		1,500			
VI	156 + 100.00	158 + 100.00	7,071	2,000	14,142,000	$(158100 - 156100) \times 1/2 + (156100 - 155100)$ $= 2000m$
	158 + 100.00	160 + 100.00	11,482	2,000	22,964,000	$(160100 - 158100) \times 1/2 + (161100 - 160100)$ $= 2000m$
	162 + 100.00	164 + 100.00	13,048	2,000	26,096,000	$(164100 - 162100) \times 1/2 + (162100 - 161100)$ $= 2000m$
	164 + 100.00	166 + 100.00	8,351	2,000	16,702,000	$(166100 - 164100) \times 1/2 + (167100 - 166100)$ $= 2000m$
	172 + 100.00	174 + 100.00	2,840	2,000	5,680,000	$(174100 - 172100) \times 1/2 + (172100 - 171100)$ $= 2000m$
	174 + 140.00	176 + 100.00	4,560	2,000	9,120,000	$(176100 - 174100) \times 1/2 + (177100 - 176100)$ $= 2000m$
	178 + 100.00	179 + 100.00	3,260	1,500	4,890,000	$(179100 - 178100) \times 1/2 + (178100 - 177100)$ $= 1500m$
	179 + 100.00	180 + 100.00	3,900	1,500	5,850,000	$(180100 - 179100) \times 1/2 + (181100 - 180100)$ $= 1500m$
	TOTAL		54,512		105,444,000	
	$(V \times L) / V$		1,934m			
VII	186 + 100.00	188 + 100.00	4,702	2,000	9,404,000	$(188100 - 186100) \times 1/2 + (186100 - 185100)$ $= 2000m$
	188 + 100.00	192 + 100.00	8,791	3,000	26,373,000	$(192100 - 188100) \times 1/2 + (193100 - 192100)$ $= 3000m$
	198 + 100.00	202 + 100.00	29,814	3,000	89,442,000	$(202100 - 198100) \times 1/2 + (198100 - 197100)$ $= 3000m$
	202 + 100.00	204 + 100.00	15,166	3,900	59,147,400	$(204100 - 202100) \times 1/2 + (207000 - 204100)$ $= 3900m$
	TOTAL		58,473		184,366,400	
	$(V \times L) / V$		3,153m			
VIII	204 + 100.00	206 + 0.00	3,340	2,000	6,680,000	$(206000 - 204100) \times 1/2 + (207000 - 206000)$ $= 1950m$
	$(V \times L) / V$		2,000m			

(2) CÁLCULO DE CANTIDADES PARA EL ACABADO DE MOVIMIENTO DE TIERRA

1) I SECTOR

$$\begin{aligned} & (1.00+0.20-0.05) \times 2 + 7.30 & = & 9.6 \text{ m}^2/\text{m} \\ & 9.6 \times 10,111.557 & = & 97,071 \text{ m}^2 \end{aligned}$$

2) II SECTOR

$$\begin{aligned} & 9.00+0.70 \times 2 & = & 10.4 \text{ m}^2/\text{m} \\ & 10.4 \times 18,533.743 & = & 192,751 \text{ m}^2 \end{aligned}$$

3) III SECTOR

$$\begin{aligned} & 9.00+0.36 \times 2 & = & 9.72 \text{ m}^2/\text{m} \\ & 9.72 \times 20,900.000 & = & 203,148 \text{ m}^2 \end{aligned}$$

4) IV SECTOR

$$9.72 \times 35,400 = 344,088 \text{ m}^2$$

5) V SECTOR

$$\begin{aligned} & 9.00+0.365 \times 2 & = & 9.73 \text{ m}^2/\text{m} \\ & 9.73 \times 70,397.04 & = & 684,963 \text{ m}^2 \end{aligned}$$

6) VI SECTOR

$$\begin{aligned} & 9.00+0.36 \times 2 & = & 9.72 \text{ m}^2/\text{m} \\ & 9.72 \times 27,970.74 & = & 271,876 \text{ m}^2 \end{aligned}$$

7) VII SECTOR

$$9.73 \times 19,979.34 = 194,399 \text{ m}^2$$

8) VIII SECTOR

$$9.72 \times 17,655.009 = 171,607 \text{ m}^2$$

2. REMOCIÓN DE TUBOS CORRUGADOS EXISTENTE

(1)

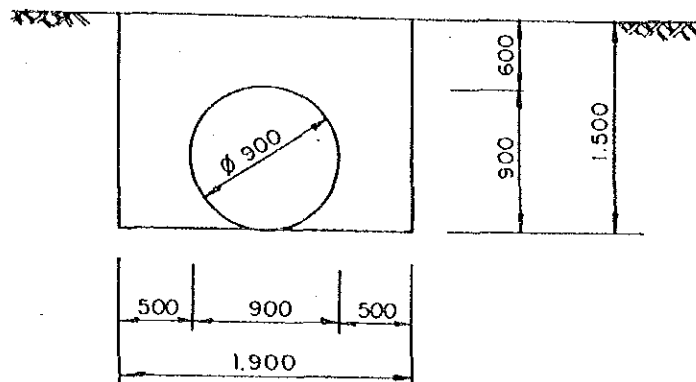
SUMARIO DE VOLUMEN DE OBRA: REMOCION DE ALCAVIARILLAS EXISTENTES

DIAMETRO	LONGITUD DE TUBOS EN CASO DE REALIZAR EXCAVACIONES				LONGITUD DE TUBOS EN CASO DE NO REALIZAR EXCAVACIONES Y RELLENADO				
	Ø0.90	Ø1.50	Ø1.80	Ø3.00	Ø0.90	Ø1.50	Ø1.80	Ø2.10	Ø2.70
PROGRESIVA									
3+242.80			29.60						
3+952.10			10.50						
4+487.15		29.60							
6+988.60		29.40							
13+654.50					13.00				
16+124.10							29.20		
18+270.50					28.00				
18+876.60		29.20							
23+900.80		52.00		26.00					
24+115.00		26.00							
26+203.00		27.00							
26+709.80			90.00						
30+264.85						50.40			
31+545.60		24.46							
31+637.20	25.00								
35+372.15		36.30							
41+886.30	13.10								
116+225.00			60.00						
116+400.00		45.00							
0+693.00						27.40	41.10		
3+446.00									73.50
6+000.00								21.40	
116+265.20			48.00						
116+292.00							45.00		
LONGITUD TOTAL	38.10	298.96	238.10	26.00	41.00	77.80	115.30	21.40	73.50
Volumen de excavación por ml de tubo (m3)	0.015	3.48	4.18	7.33					
Volumen de relleno por ml de tubo (m3)	2.85	4.20	6.72	14.40					
Volumen total de excavación	0.57	1040.38	995.26	190.58					
Volumen total de relleno	108.59	1255.63	1600.03	374.40					

(2) Cálculos de Volumen: Remoción de alcantarillas metálicas corrugadas

ALCANTARILLAS CORRUGADAS

1) ϕ 900



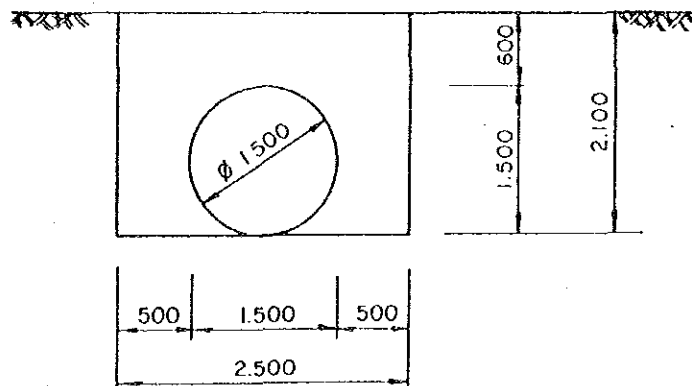
a) Excavación

$$1.90 \times 1.50 - 0.90^2 \times \pi/4 = 2.21 \text{ m}^3/\text{m}$$

b) Rellenado (material de relleno B)

$$1.90 \times 1.50 = 2.85 \text{ m}^3/\text{m}$$

2) ϕ 1500



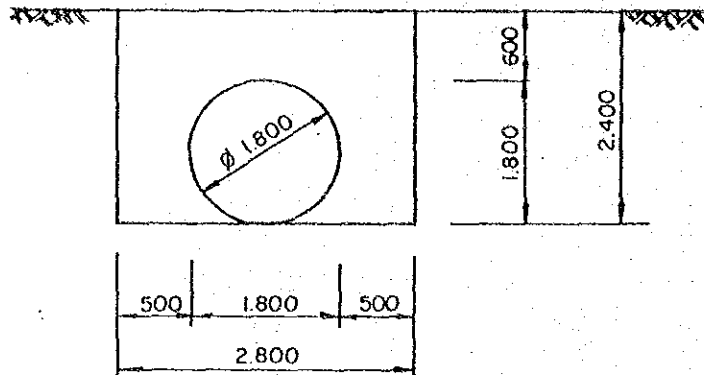
a) Excavación

$$2.50 \times 2.10 - 1.50^2 \times \pi/4 = 3.48 \text{ m}^3/\text{m}$$

b) Rellenado (Material de relleno B)

$$2.00 \times 2.10 = 4.2 \text{ m}^3/\text{m}$$

3) ϕ 1800



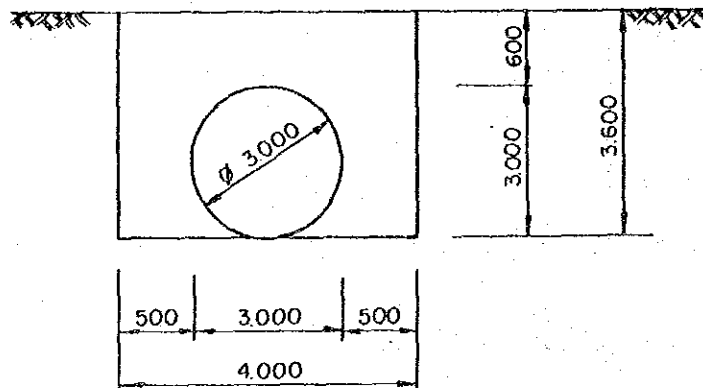
a) Excavación

$$2.80 \times 2.40 - 1.80^2 \times \pi/4 = 4.18 \text{ m}^3/\text{m}$$

b) Rellenado (Material de relleno B)

$$2.80 \times 2.40 = 6.72 \text{ m}^3/\text{m}$$

4) ϕ 3000



a) Excavación

$$4.00 \times 3.60 - 3.00^2 \times \pi/4 = 7.33 \text{ m}^3/\text{m}$$

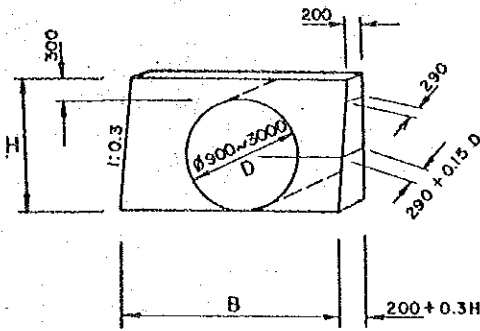
b) Rellenado (Material de relleno B)

$$4.00 \times 3.60 = 14.40 \text{ m}^3/\text{m}$$

3. CABEZALES

(1) CANTIDAD POR CABEZAL

1) Cabezal (En caso de batería de tubos simples)



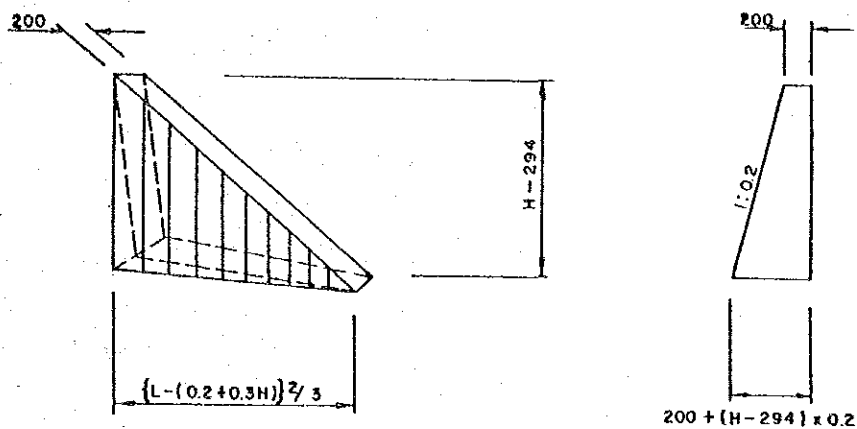
$$\begin{aligned}
 &0.30 \times 0.30 + 0.20 = 0.29 \\
 &(0.30 + D/2) \times 0.30 + 0.20 \\
 &= 0.09 + 0.15D + 0.20 \\
 &= 0.29 + 0.15D
 \end{aligned}$$

$$\begin{aligned}
 V1 &= (0.20 + 0.20 + 0.3H) \times H \times 1/2 \times B \\
 &= (0.40 + 0.3H) \times H \times 0.5B
 \end{aligned}$$

$$V2 = \pi/4 \times D^2 \times (0.29 + 0.15D)$$

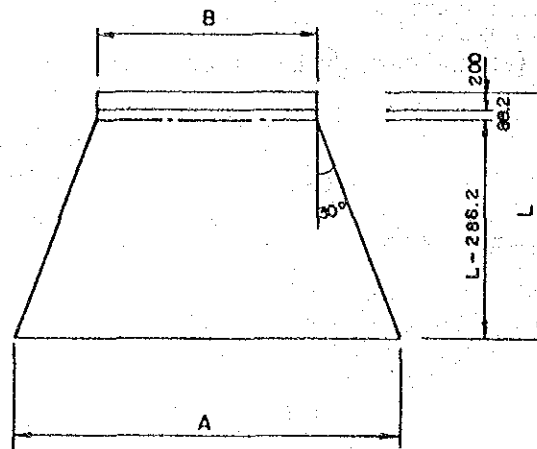
$$V3 = V1 - V2 = (0.40 + 0.3H) \times 0.5HB - \pi/4 D^2 (0.29 + 0.15D)$$

2) Alero (2 Aleros por un cabezal)



$$\begin{aligned}
 V4 &= \left\{ 0.20 + 0.20 + (H - 0.294) \times 0.2 \right\} \times (H - 0.294) \times 1/2 \times \\
 &\quad \left\{ L - (0.20 + 0.3H) \right\} \times 2 / \sqrt{3} \times 1/2 \times 2 \\
 &= (0.3412 + 0.2H) (H - 0.294) (L - 0.20 - 0.3H) \times 1/\sqrt{3} \times 2
 \end{aligned}$$

3) Recubrimiento Inferior



$$\begin{aligned}
 V5 &= 0.2882 \times B \times 0.12 \\
 V6 &= (B+A) \times (L-0.2882) \times \frac{1}{2} \times 0.12 \\
 V7 &= A \times (P-0.12) \times C \\
 V8 &= V5 + V6 + V7
 \end{aligned}$$

4) Revestimiento de Mortero

$$\begin{aligned}
 V5' &= 0.2882 \times B \times 0.03 \\
 V6' &= (B+A) \times (L-0.2882) \times \frac{1}{2} \times 0.03 \\
 V8' &= V5' + V6'
 \end{aligned}$$

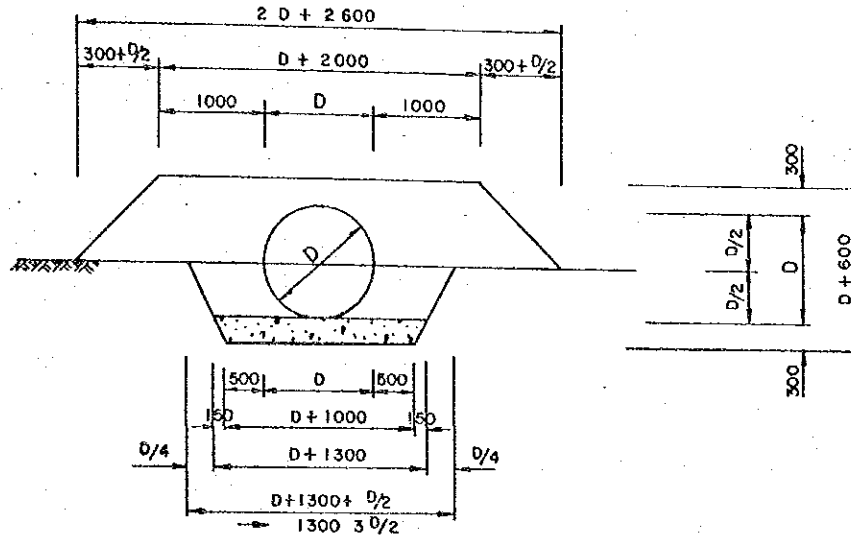
5) Cálculo para encofrado de cabezal (Por un cabezal)

$$\begin{aligned}
 A1 &= (0.20+0.20+0.3H) \times H \times \frac{1}{2} \times 2 \\
 A2 &= \sqrt{H^2+(0.3H)^2} \times B \times 2 \\
 A3 &= \pi D \times (0.29+0.15D) \\
 A4 &= \frac{\pi/4 D^2 \times 2 \times \sqrt{H^2+(0.3H)^2}}{H} \\
 A5 &= A1+A2+A3-A4 \\
 &= (0.40+0.3H) \times H + 2B \sqrt{H^2+(0.3H)^2} + \pi D(0.29+0.15D) + \\
 &\quad \frac{\pi/2 \times D^2 \times \sqrt{H^2+(0.3H)^2}}{H}
 \end{aligned}$$

6) Encofrado de Alero (2 Aleros por un cabezal)

$$\begin{aligned}
 A7 &= \left\{ L - (0.2 + 0.3H) \right\} \times 2 / \sqrt{3} \times (H - 0.294) \times \sqrt{2} \times 2 \\
 &\quad + \left\{ L - (0.2 + 0.3H) \right\} \times (H - 0.294) \times \sqrt{2} \times 2 \\
 &= (L - 0.2 - 0.3H) \times 2 / \sqrt{3} \times (H - 0.294) + (L - 0.2 - 0.3H) \\
 &\quad \times (H - 0.294)
 \end{aligned}$$

(2) TERRAPLENES ADYACENTES (POR m.)



$$(300 + D/2) \times 2 + D + 2000 = 600 + D + D + 2000 = 2,600 + 2D$$

1) Volumen de excavación

$$\begin{aligned}
 V9 &= \left\{ (1.30 + 1.5D) + (D + 1.00) \right\} \times (0.30 + D/2) \times \sqrt{2} \\
 &= (2.30 + 2.5D) \times (0.15 + D/4)
 \end{aligned}$$

2) Material base compactado (Clasificación A-4 ó Mayor)

$$\begin{aligned}
 V10 &= \left\{ (D + 1.30) + (D + 1.00) \right\} \times 0.30 \times \sqrt{2} \\
 &= (2D + 2.30) \times 0.15
 \end{aligned}$$

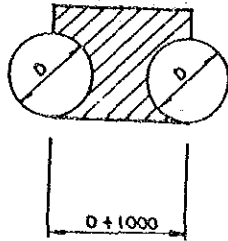
3) Material de Relleno

$$\begin{aligned}
 V11 &= \left\{ (1.30 + 1.5D) + (D + 1.30) \right\} \times D/2 \times \sqrt{2} \\
 &\quad + \left\{ (2D + 2.60) + (D + 2.00) \right\} \times (D/2 + 0.30) \times \sqrt{2} \\
 &\quad - \pi/4 D^2 \\
 &= (2.60 + 2.5D) \times D/4 + (3D + 4.60) \times (D/4 + 0.15) \\
 &\quad - \pi/4 D^2
 \end{aligned}$$

(3) INCREMENTO EN CANTIDAD EN CASO DE BATERIA. DE 2 TUBOS

(D+1.0m) de ancho por metro

1) Cabezal



$$V12 = V1 \times (D+1.00) / B - V2$$

2) Recubrimiento inferior

$$V13 = V5 \times (D+1.00) / B$$

$$V14 = (D+1.00) \times (L-0.2882) \times 0.12$$

$$V15 = V7 \times (D+1.00) / A$$

$$V16 = V13 + V14 + V15$$

3) Incremento en cantidad de revestimiento de Mortero

$$V5'' = 0.2882 \times (D+1.00) \times 0.03$$

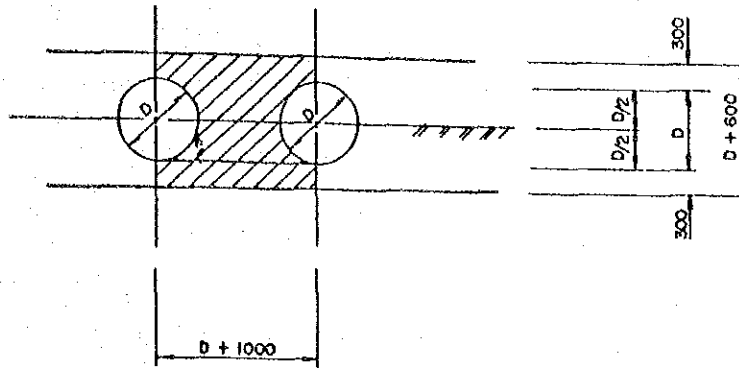
$$V6'' = (D+1.00) \times (L-0.2882) \times 0.03$$

$$V8'' = V5'' + V6''$$

4) Incremento de encofrado para alero

$$A6 = \sqrt{H^2 + (0.3H)^2} \times (D+1.00) \times 2 - A4$$

(4) INCREMENTO EN TERRAPLEN ADYACENTE (POR METRO)



1) Incremento en volumen de excavación

$$V17 = (D + 1.00) \times (D/2 + 0.30)$$

2) Incremento en Material de base (Clasificación A-4 ó Mayor)

$$V18 = (D + 1.00) \times 0.30$$

3) Incremento en Material de relleno

$$V19 = (D + 1.00) \times (D + 0.30) - \pi/4 D^2$$

(5) FORMULA DE CALCULOS PARA VOLUMEN UNITARIO

1) Volumen de muro cabezal (por unidad)

$$V1 = (0.40 + 0.3H) \times H \times B \times 1/2$$

$$V2 = \pi/4D^2(0.29 + 0.15D)$$

$$V3 = V1 - V2$$

2) Volumen de alero (2 aleros por unidad)

$$V4 = (0.3142 + 0.2H) (H - 0.294) (L - 0.2 - 0.3H) \times 1/3 \times 2$$

3) Volumen de recubrimiento inferior (por unidad)

$$V5 = 0.2882 \times B \times 0.12$$

$$V6 = (B + A) (L - 0.2882) \times 0.06$$

$$V7 = A \times C \times (P - 0.12)$$

$$V8 = V5 + V6 + V7$$

4) Revestimiento de mortero (por unidad)

$$V5' = 0.2882 \times B \times 0.03$$

$$V6' = (B + A) \times (L - 0.2882) \times 1/2 \times 0.03$$

$$V8' = V5' + V6'$$

5) Terraplenes adyacentes

a. Volumen de excavación

$$V9 = (2.30 + 2.5D) (0.15 + D/4)$$

b. Material base compactado (clasificación A-4 ó mayor)

$$V10 = (2D + 2.30) \times 0.15$$

c. Material de relleno (B)

$$V11 = (2.60 + 2.5D) \times D/4 + (3D + 4.60) \times (D/4 + 0.15) - \pi/4D^2$$

6) Cálculo para encofrado de muro cabezal

$$A1 = (0.20 + 0.20 + 0.3H) \times H \times 1/2 \times 2$$

$$A2 = \sqrt{H^2 + (0.3H)^2} \times B \times 2$$

$$A3 = \pi D \times (0.29 + 0.15D)$$

$$A4 = \pi/4 D^2 \times 2 \times \sqrt{H^2 + (0.3H)^2} / H$$

$$A5 = A1 + A2 + A3 + A4$$

$$= (0.40 + 0.3H) \times H + 2B \sqrt{H^2 + (0.3H)^2} + \pi D (0.29 + 0.15D) \times \pi/2 D^2 \times \sqrt{H^2 + (0.3H)^2} / H$$

7) Cálculo para encofrado de alero (2 aleros por cabezal)

$$A7 = (L - 0.2 - 0.3H) \times 2 / \sqrt{3} \times (H - 0.294) + (L - 0.2 - 0.3H) \times (H - 0.294)$$

8) Volúmen adicional en caso de baterías de 2 o más tubos

a. Volúmen de muro cabezal

$$V12 = V1(D + 1.00) / B - V2$$

b. Volúmen de recubrimiento inferior

$$V13 = V5 (D + 1.00) / B$$

$$V14 = (D + 1.00) (L - 0.2882) \times 0.12$$

$$V15 = V7(D + 1.00) / A$$

$$V16 = V13 + V14 + V15$$

c. Superficie de muro cabezal

$$A6 = \sqrt{H^2 + (0.3H)^2} \times (D + 1.00) \times 2 - A4$$

CANTIDAD UNITARIA DE CABEZALES

	VOLUMEN DE MURO CABEZAL (POR UNIDAD)	VOLUMEN DE ALEROS (2 ALEROS POR UNIDAD)	VOLUMEN DE RECUBRIMIENTO DE MORTERO INFERIOR (POR UNIDAD)	REVESTIMIENTO DE MORTERO (POR UNIDAD)	TERRAPLENES ADYACENTES			ENCOFRADO DE MURO CABEZAL (POR UNIDAD)
					EXCAVACION	BASE COMPACTADO (A-4 ó MAYOR)	RELLENO (B)	
	V3	V4	V8	V8'	V9	V10	V11	A5
Ø 900	0.541	0.936	1.257	0.169	1.706	0.615	3.193	7.902
Ø1,200	0.871	1.830	2.163	0.279	2.385	0.705	4.239	12.299
Ø1,500	1.306	3.112	3.312	0.417	3.176	0.795	5.392	17.656
Ø1,800	1.863	4.873	4.706	0.582	4.080	0.885	6.650	23.973
Ø2,100	2.555	7.149	6.219	0.774	5.096	0.975	8.015	31.251
Ø2,400	3.397	10.013	9.074	0.995	6.225	1.065	9.486	39.489
Ø2,700	4.406	13.528	11.426	1.243	7.466	1.155	11.063	48.686
Ø3,000	5.595	17.758	14.049	1.518	8.820	1.245	12.746	58.845

	ENCOFRADO PARA ALERO (2 ALEROS POR UNIDAD)	VOLUMEN ADICIONAL DE MURO CABEZAL (POR UNIDAD)	VOLUMEN ADICIONAL DE RECUBRIMIENTO INFERIOR (POR UNIDAD)	VOLUMEN ADICIONAL DE ENCOFRADO PARA MURO CABEZAL (POR UNIDAD)	VOLUMEN ADICIONAL DE REVESTIMIENTO DE MORTERO (POR UNIDAD)			
	A7	V12	V16	A6	V8			
Ø 900	3.006	0.596	0.764	3.432	0.120			
Ø1,200	5.327	0.871	1.175	4.529	0.178			
Ø1,500	8.307	1.205	1.665	5.706	0.248			
Ø1,800	11.947	1.603	2.234	6.964	0.328			
Ø2,100	16.245	2.071	2.837	8.303	0.419			
Ø2,400	21.203	2.613	3.917	9.722	0.520			
Ø2,700	26.821	3.236	4.795	11.222	0.633			
Ø3,000	33.098	3.943	5.760	12.803	0.756			

4. PAVIMENTO

SUMARIO DE VOLUMEN DE PAVIMENTO

(1)

SECTOR	I	II	III	IV	V	VI	VII	VII
Progresiva	0+0.000 10+368.937	10+368.937 29+100.000	29+100.000 50+000.000	50+0.000 85+400.000	85+400.000 156+100.000	156+100.000 184+100.000	184+100.000 204+100.000	204+100.000 221+934.639
Longitud de camino	10,111.557	18,533.743	20,900.000	35,400.000	70,397.040	27,970.740	19,979.340	17,555.009
Capa superficial (m ²)	70,781							
Capa base (m ³)	7,179							
Capa sub-base (m ³)	14,763	37,067	42,009	71,154	141,498	56,221	40,158	35,487
Berma (m ²)	20,223							

(2) Cálculo de Pavimento

1) Nº 0+0.000 -- Nº 10+368.937 (I)

a. Capa superficial (t=6 cm) = 7.00 m²/m

b. Capa base (t=10 cm)
(7.0+0.05x2)x0.10 = 0.71 m³/m

c. Capa subbase (t=20cm)
(7.0+0.15x2)x0.20 = 1.46 m³/m

d. Berma(sello) = 2.00 m²/m

2) Nº 10+368.937 -- Nº 29+100.000 (II)

Capa subbase (t=20 cm)
(9.00+0.50x2) x0.20 = 2.00 m³/m

3) Nº 29+100.000 -- Nº 50+0.000 (III)

Capa subbase (t=20cm)
(9.00+0.52x2) x0.20 = 2.01 m³/m

4) Nº 50+0.000 -- Nº 85+400.000 (IV)

Capa subbase (t=20 cm)
(9.00+0.52x2)x0.20 = 2.01 m³/m

5) Nº 85+400.000 -- Nº 156+100.000 (V) (t=20cm)

Nº 184+100.000 -- Nº 264+100.000 (VII)

Capa subbase
(9.00+0.53x2)x0.20 = 2.01 m³/m

6) Nº 156+100.000 -- Nº 184+100.000 (VI)

Nº 204+100.000 -- Nº 221+934.669 (VIII)

Capa subbase
(9.00+0.52x2)x0.20 = 2.01 m³/m

(3) Marcas en el Paviment

Rayas limitadoras de la calzada

$$10,368.9 \times 2 = 20,737.8 \text{ m}$$

Rayas centrales discontinuas

$$10,368.9 - 12 \times 4.5 = 3,888.3 \text{ m}$$

Rayas centrales continuas

$$4 \text{ puentes} \times 150 \times 2 + (25.7 \times 3 + 180.4) \times 2 = 1,715.0 \text{ m}$$

$$\text{Total} \quad 26,341.1 \text{ m}$$

5. INSTALACIONES DE TRANSBORDADOR

SUMARIO DE CANTIDADES
FACILIDADES PARA TRANSBORDADOR:

TIPO DE OBRA		NORMA	UNIDAD	CANTIDAD	OBSERVACION
PTO. VARADERO	Rampa de hormigón armado	Tipo A	Parte	8.992	Por 10m.
	Capa base		Parte	8.842	Por 10m.
	Juntas	Juntas Transversales	m	81.0	
		Juntas Longitudinales	Parte	9	
	Armação de hormigón y mampostería de ladrillos		m ²	1189.71	
	Cordón de bloque de hormigón		m	167.000	
	Atracadero		global	1	
PTO. GANADERO	Rampa de hormigón armado	Tipo A	Parte	8.992	Por 10m.
	Capa base		Parte	8.842	Por 10m.
	Juntas	Juntas Transversales	m	81.0	
		Juntas Longitudinales	Parte	9	
	Armação de hormigón y mampostería de ladrillos		m ²	469.60	
	Cordón de bloque de hormigón	Hormigón con cascote de ladrillos	m	111.610	
	Atracadero		Global	1	
PUERTOS Y CANALES	Movimiento de tierra	Excavación	m ³	722,249	Fuera de agua 433,350
					Dentro de agua 288,899
		Terrapienado	m ³	851.000	

Nota:

Excavación fuera del agua es del 60% del total.
Excavación dentro del agua es del 40% del total.

LADO PUERTO VARADOR

1. Rampa de hormigón armado

$$1 = 2.000 + 86.670 + 1.500 - 0.250 \\ = 89.92m$$

2. Capa Base

$$1 = 2.000 + 86.67 - 0.25 \\ = 88.42m$$

3. Juntas

$$(2 + 86.67) \% 10 = 8.8 \rightarrow 9 \text{ partes}$$

4. Armazón de hormigón y mampostería de ladrillos

$$7.903 \times 1.5 = 11.855$$

$$\sqrt{(7.903)^2 + (11.855)^2} = 14.248m$$

$$A = (60.000 + 23.500) \times 14.248 \times 1/2 \times 2 \\ = 1189.71m$$

5. Cordón de bloque de hormigón

$$1 = (60.000 + 23.500) \times 2 \\ = 167.000m$$

6. Antideslizador

$$1.726 \times 1189.71 = 2,053 \text{ kg}$$

7. Mortero

$$0.007 \times 1189.71 = 8.328 \text{ m}^3$$

LADO PUERTO GANADERO

1. Rampa de hormigón armado, capa base y juntas son las mismas que en el lado Puerto Varador.

2. Armazón de hormigón y mampostería de ladrillos

$$4.668 \times 1.5 = 7.002 \text{ m}$$

$$\sqrt{(7.002)^2 + (4.668)^2} = 8.415m$$

$$A = (12.054 + 43.751) \times 8.415 \times 1/2 \times 2 \\ = 469.599m$$

3. Cordón de bloque de hormigón

$$l = (12.054 + 43.751) \times 2 \\ = 111.610\text{m}$$

4. Antideslizador

$$1.726 \times 469.599 = 810.528\text{kg}$$

5. Mortero

$$0.007 \times 469.599 = 3.287\text{m}^3$$

CUADRO DE CANTIDADES: FACILIDADES PARA TRANSBORDADOR

TIPO DE OBRA	NORMA	UNIDAD	CANTIDAD	OBSERVACION
RAMPA DE HORMIGON ARMADO	Hormigón	m3	22.500	Cada 10m
	Acero de refuerzo	Kg	337.680	Cada 10m
	Encofrado	m2	7.25	Cada 10m
CAPA BASE		m3	22.500	Cada 10m
	Barra pasador	Kg/parte	51.334	9.0m por parte
JUNTAS	Acero para caballete	Kg/parte	21.719	9.0m por parte
	Barra transversal	Kg/ parte	59.978	9.0m por parte
	Relleno para junta	m2/parte	1.890	9.0m por parte
	Sello de juntas	m3/parte	0.009	9.0m por parte
	Hormigón	m3	0.048	Por m2
	Fierro de refuerzo	Kg	9.594	Por m2
MAMPOSTERIA DE LADRILLOS	Encofrado	m2	0.772	Por m2
	Ladrillos	Pzas/m2	0.684	Por m2
	Antideslizador	Kg	1.726	Por m2
	Mortero	m3	0.007	Por m2
	Hormigón con cascote de ladrillo	m3/m	0.173	
	Encofrado	m2/m	1.23	
	Amarradero	Ø200 l=1.50m	Pzas	2
CORDON DE BLOQUE DE HORMIGON	Hormigón	m3	1.806	
	Tubo de PVC	Ø250 l=0.75m	Pzas	14
	Fierro de refuerzo	Ø 10	Kg	105.924

(1) TERMINAL DE TRANSBORDADOR

Lado Pto. Varador (Común con el lado Pto. Ganadero)

1) Rampa de Hormigón (por 10ml)

- a. Hormigón
 $10.000 \times 9.000 \times 0.250 = 22.500 \text{ m}^3$
- b. Fierro de refuerzo
 $\varnothing 10 \quad l=9.800 \text{ m} \quad 31 \text{ pzas}$
 $\varnothing 10 \quad l=8.800 \text{ m} \quad 34 \text{ pzas}$
 $(9.800 \times 31 + 8.800 \times 34) \times 0.560 \text{ kg/m} = 337.680 \text{ kg}$
- c. Encofrado
 $0.25 \times 10 \text{ m} \times 2 + 9.0 \times 0.25 = 7.25 \text{ m}^2$

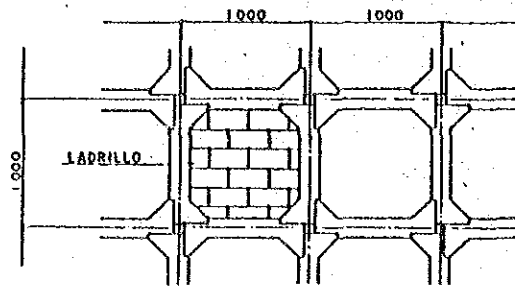
2) Capa Base (por 10ml)

$10.000 \times 9.000 \times 0.250 = 22.500 \text{ m}^3$

3) Juntas (9m/parte)

- a. Barra pasador
 $\varnothing 20 \quad l=0.675 \text{ m} \quad 25 \text{ pzas}$
 $0.675 \times 25 \times 2.466 \text{ kg/m} = 41.614 \text{ kg}$
- b. Fierro para caballete ($\varnothing 13$)
 $(0.200 + 0.1185 \times 2) \times 25 \times 0.994 \text{ kg/mx}^2 = 21.719 \text{ kg}$
- c. Barra transversal
 $l= 8.800 \text{ m} \quad \varnothing 13 \times 8$
 $8.80 \times 8 \times 0.994 \text{ kg} = 69.978 \text{ kg}$
- d. Cápsula
para $\varnothing 22 \quad 25 \text{ pzas}$
- e. Pintura bituminosa
para $\varnothing 22 \quad 25 \text{ pzas}$
- f. Relleno para junta
 $t= 25$
 $0.210 \times 9.000 = 1.890 \text{ m}^2$
- g. Sello de juntas
 $0.025 \times 0.040 \times 9.000 = 0.009 \text{ m}^3$

4) Mampostería de ladrillo con armazón de hormigón (por m²)



a. Armazón de hormigón

i) Hormigón

$$0.024 \times 2 = 0.048 \text{ m}^3$$

ii) Fierro de refuerzo

$$4.797 \times 2 = 9.594 \text{ kg}$$

iii) Encofrado

$$0.386 \times 2 = 0.772 \text{ m}^2$$

Marco de hormigón

$$\{ 0.925 \times 0.300 - 0.1875 \times 0.0375 \times 2 - (0.550 + 0.850) \times 0.15 \times 1/2 \} \times 0.150 = 0.024 \text{ m}^3$$

Encofrado

$$(0.925 + 0.0375 \times 2 + 0.2625 \times 2 + 0.0375 \times 2 + 0.15 \times \sqrt{2} \times 2 + 0.55) \times 0.15 = 0.386 \text{ m}^2$$

FIERRO DE REFUERZO

Nº	Ø	Longitud	Peso Unitario	Peso	Número de Piezas	Peso Total
1	10mm	0.490 m	0.560kg/m	0.274 kg	2	0.548 kg
2	10mm	0.865 m	0.560kg/m	0.484 kg	2	0.968 kg
3	10mm	0.430 m	0.560kg/m	0.241 kg	3	0.723 kg
4	10mm	0.400 m	0.560kg/m	0.224 kg	2	0.448 kg
5	10mm	0.655 m	0.560kg/m	0.367 kg	2	0.734 kg
6	10mm	0.330 m	0.560kg/m	0.185 kg	4	0.740 kg
7	10mm	0.240 m	0.560kg/m	0.134 kg	4	0.536 kg
8	10mm	0.090 m	0.560kg/m	0.050 kg	2	0.100 kg
TOTAL						4.797 kg

b. Mampostería de ladrillo

$$1.000 \times 1.000 - 0.158 \times 2 = 0.684 \text{ m}^2$$

5) Cordón de bloque de hormigón (por metro)

$$0.300 \times 0.600 - 0.100 \times 0.150 \times 1/2 = 0.173 \text{ m}^3/\text{m}$$

6) Mortero (para juntas)

$$0.075^2 \times 0.15 \times 1 \text{ parte}/\text{m}^2 = 0.00084 \text{ m}^3/\text{m}^2$$

$$(0.25 \times 0.13 - 0.24 \times 0.12) \times 0.05 = 0.000185$$

$$1.0 \times 1.0 / (0.25 \times 0.13) \times 0.000185 = 0.00569 \text{ m}^3/\text{m}^2$$

$$0.00084 + 0.00569 = 0.00653 \text{ m}^3/\text{m}^2$$

7) Antideslizador

Fierro \varnothing 20 l=0.70 m

$$0.02^2 \times \pi / 4 \times 0.70 \times 7.85 \text{ t}/\text{m}^3 = 0.001726 \text{ t}$$

$$= 1.726 \text{ kg}/\text{m}^2$$

8) Atracadero

a. Amarradero

\varnothing 200 l=1.500 m 2 pzas

b. Hormigón

$$(0.70 \times 0.70 - 0.20 \times 0.20 \times 4) \times (0.700 - 0.250)$$

$$- (\pi / 4 \times 0.314^2) \times 0.25 \times 14 \text{ partes} = 1.806 \text{ m}^3$$

c. Tubo de PVC

\varnothing 250 l=0.50m 14 pzas

FIERRO DE REFUERZO

	Día metro	Longitud	Cantidad	Longitud Total	Peso Unitario	Peso Total
1	\varnothing 10	0.520	8	4.160	0.560	2.330 kg
2	\varnothing 10	1.870	5	9.350	0.560	5.236 kg
TOTAL						7.566 kg

$$7.566 \text{ kg} \times 14 \text{ partes} = 105.924 \text{ kg}$$

TERMINAL DE TRANSBORDADOR (EARTHWORK)	
CUBICACION	722,249M3
TERRAPLENES	851M3

CUBICACION
=====

ESTACION	AREA	AREA PROMEDIO	LONGITUD	
No.0+ 0.000 (+ 11.640)	0.00		11.64	
+ 50.000	121.01	60.51	38.36	2,321
+ 200.000	517.47	319.24	150.00	47,886
+ 400.000	427.64	472.56	200.00	94,512
+ 600.000	442.47	435.06	200.00	87,012
+ 800.000	450.92	446.70	200.00	89,340
No.1+ 0.000	476.19	463.56	200.00	92,712
+ 200.000	261.96	369.08	200.00	73,816
				487,599 m3
=====				
No.3+ 800.000	93.95	135.35	200.00	27,070
No.4+ 0.000	176.75	232.14	200.00	46,428
+ 200.000	287.52	276.53	200.00	55,306
+ 400.000	265.54	211.13	200.00	42,226
(+ 700.000)	0.00	78.36	100.00	7,836
				178,866 m3
=====				
No.5+ 783.000	0.00	35.19	17.00	598
+ 800.000	70.38	192.33	200.00	38,466
No.6+ 0.000	314.27	157.14	85.00	13,357
+ 400.000	265.54			52,421 m3
=====				
No.6+ 796.000	153.34	165.42	4.00	662
+ 800.000	177.50	131.63	5.40	711
+ 805.400	85.76	42.88	46.41	1,990
(+ 851.805)	0.00		30.87	3,363 m3
				722,249 m3
			TOTAL	

TERRAPLENES

=====

ESTACION	AREA	AREA PROMEDIO	LONGITUD	
No.0 + 0.000 (+ 11.640)	23.30	11.65	11.64	136
			38.36	
+ 50.000			150.00	
+ 200.000			200.00	
+ 400.000			200.00	
+ 600.000			200.00	
+ 800.000			200.00	
No.1 + 0.000			200.00	
+ 200.000				
No.3 + 800.000			200.00	
No.4 + 0.000			200.00	
+ 200.000			200.00	
+ 400.000			200.00	
+ 600.000			200.00	
(+ 700.000)			100.00	
No.5 + 783.000			17.00	
+ 800.000			200.00	
No.6 + 0.000			85.00	
No.6 + 796.000			4.00	
+ 800.000			5.40	
+ 805.400			46.41	
(+ 851.805)	0.00			
+ 882.670	46.32	23.16	30.87	715
				TOTAL
				851

SUMARIO DE DEFENSAS

PROGRESIVA (Derecha)	LONGITUD (m.)	PROGRESIVA (Izquierda)	LONGITUD (m.)
7+150.00 - 7+490.00	340.00	7+509.80 - 8+081.80	572.00
8+262.20 - 8+302.20	40.00	8+330.00 - 8+582.00	252.00
8+620.00 - 9+088.00	468.00	9+175.00 - 9+531.00	356.00
9+747.00 - 10+115.00	368.00	20+186.00 - 20+706.00	520.00
10+519.00 - 10+603.00	84.00	22+323.00 - 22+363.00	40.00
21+824.00 - 22+344.00	540.00	84+029.00 - 84+357.00	328.00
22+499.00 - 22+539.00	40.00	85+490.00 - 85+610.00	120.00
83+609.00 - 83+945.00	336.00	104+161.00 - 104+201.00	40.00
84+855.00 - 85+111.00	256.00	110+281.50 - 110+321.50	40.00
104+293.00 - 104+645.00	352.00	119+783.00 - 119+823.00	40.00
109+673.60 - 110+321.60	648.00	119+976.00 - 120+348.00	372.00
110+404.00 - 110+444.00	40.00	163+045.00 - 163+085.00	40.00
113+839.00 - 114+419.00	580.00	203+392.50 - 203+432.50	40.00
119+361.00 - 119+793.00	432.00	208+772.00 - 208+812.00	40.00
119+853.00 - 119+893.00	40.00	219+611.00 - 219+651.00	40.00
163+115.00 - 163+155.00	40.00	219+884.00 - 220+596.00	712.00
203+453.50 - 203+493.50	40.00	SUB TOTAL	3,552.00
208+838.00 - 208+878.00	40.00	Sector I 2396.00	Sector V 2704.00
218+880.00 - 219+496.00	616.00	Sector II 1224.00	Sector VI 80.00
219+805.00 - 219+845.00	40.00	Sector IV 920.00	Sector VII 80.00
SUB TOTAL	5,340.00		Sector VIII 1488.00
		TOTAL	8,892.00

ZANJA TRAPEZOIDAL DE ENCAUCE

113+500.00 - 114+200.00	700.00	102+700.00 - 103+280.00	600.00
TOTAL			1300.00

DESVIO CANAL

Pto. VANADOR	No.1		80.00
	No.2		190.00
TOTAL			270.00

Cantidad de sitio para la colocación de señalizaciones

D: Derecha

I: Izquierda

Sector Tipo de Señal	I	II	III	IV	V	VI	VII	VIII	TOTAL
P - 10A				D 82+0.0					1
P - 10B					I 86+0.0				1
P - 35		D 11+400.0	I 35+800.0		D91+800.0	I161+500.0	I202+400.0		5
					I102+700.0	D178+0.0			2
					D131+0.0				1
P - 13A					I148+0.0				1
					D152+200.0				1
					D 85+500.0				1
P - 13B								1	
P - 22				I 82+400.0					1
	8	6			12	2	2	4	34
	8	7	1	2	19	4	3	4	48
Sub - Total	10	19	21	35	70	28	20	18	221
S - 11	D 9+800.0	I 10+870.0							2
Identificación	10	19	21	35	70	28	20	18	221
	D 0+400.0		D 45+400.0		I85+800.0	D 172+0.0		I220+600.0	
Destino			I 47+400.0	D82+200.0	D129+600.0	I172+400.0			
					I130+300.0				
Sub - total	1		2	1	3	2		1	10
Señalización de Kilometraje (B.M.)	2	4	4	7	14	6	4	4	45

1) Cálculo de Volumen: Señal de Kilometraje

Excavación

$$V = 0.50 \text{ m}^2 \times 0.90 \text{ m} = 0.45 \text{ m}^3$$

Hormigón

$$V = (0.25^2 + 0.45^2) \times 1/2 \times 1.00 + 0.65^2 \times 0.15 = 0.20 \text{ m}^3$$

Encofrado

$$A = (0.25 + 0.45) \times 1/2 \times 1.00 \times 4 + 0.65 \times 0.15 \times 4 = 1.80 \text{ m}^2$$

2) Longitud total: Marca de Pavimento

$$1) 10,368.94 \text{ m} \div 12.0 \text{ m} \times 4.50 \text{ m} = 3888.35 \text{ m}$$

$$2) 25.66 \text{ m} \times 3 + 180.40 + 300 \text{ m} \times 4 = 1457.38 \text{ m}$$

$$\text{Total} = 5345.73 \text{ m}$$

3) Oficina Administrativa de Transbordo Río Mamoré

Oficina	=	30 m ²
Depósito	=	30 m ²
Dormitorio	=	20 m ²
Baño	=	6 m ²
Cocina	=	6 m ²
Cenereria	=	15 m ²
	=	107 m ² /Oficina

4) Oficina Administrativa de ejecución de la Obra

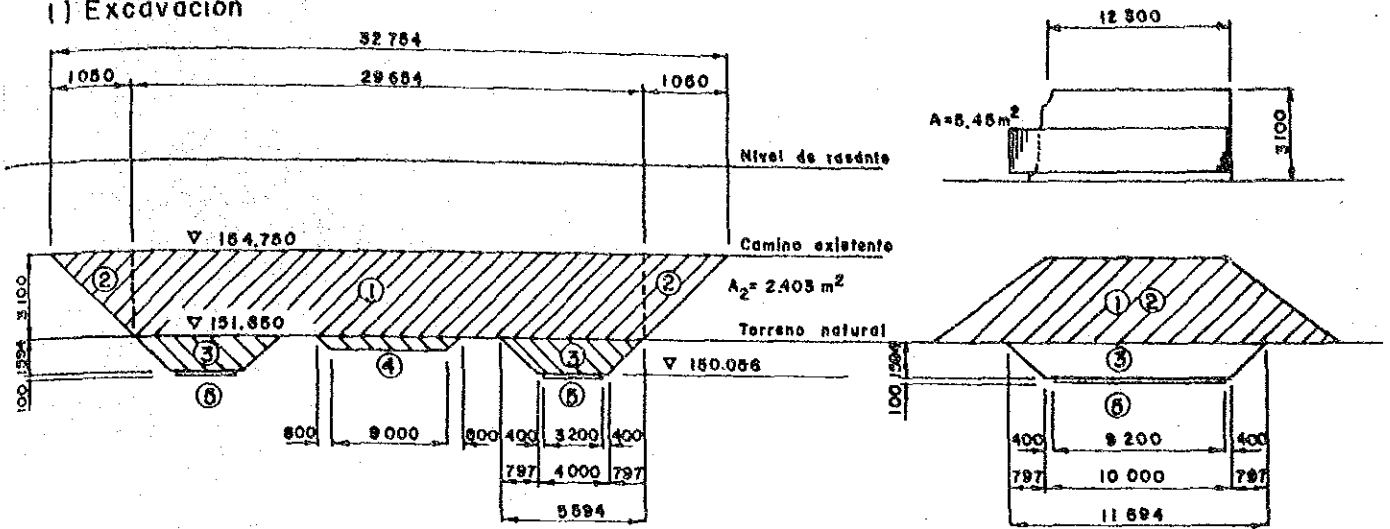
Ing 15 Prs , Dormitorio 20 m ² x 10	=	200 m ²
Oficina 10 m ² x 15	=	150 m ²
Laboratorio 10m ² x 20	=	200 m ²
Otros 100m ² x 2	=	200 m ²
Dormitorio p/trabajador 20 Prs	=	300 m ²
Comedor	=	300 m ²
Cocina	=	70 m ²
Baño	=	40 m ²
	=	1460 m ² /Oficina

CUADRO DE MATERIALES PARA INFRAESTRUCTURA

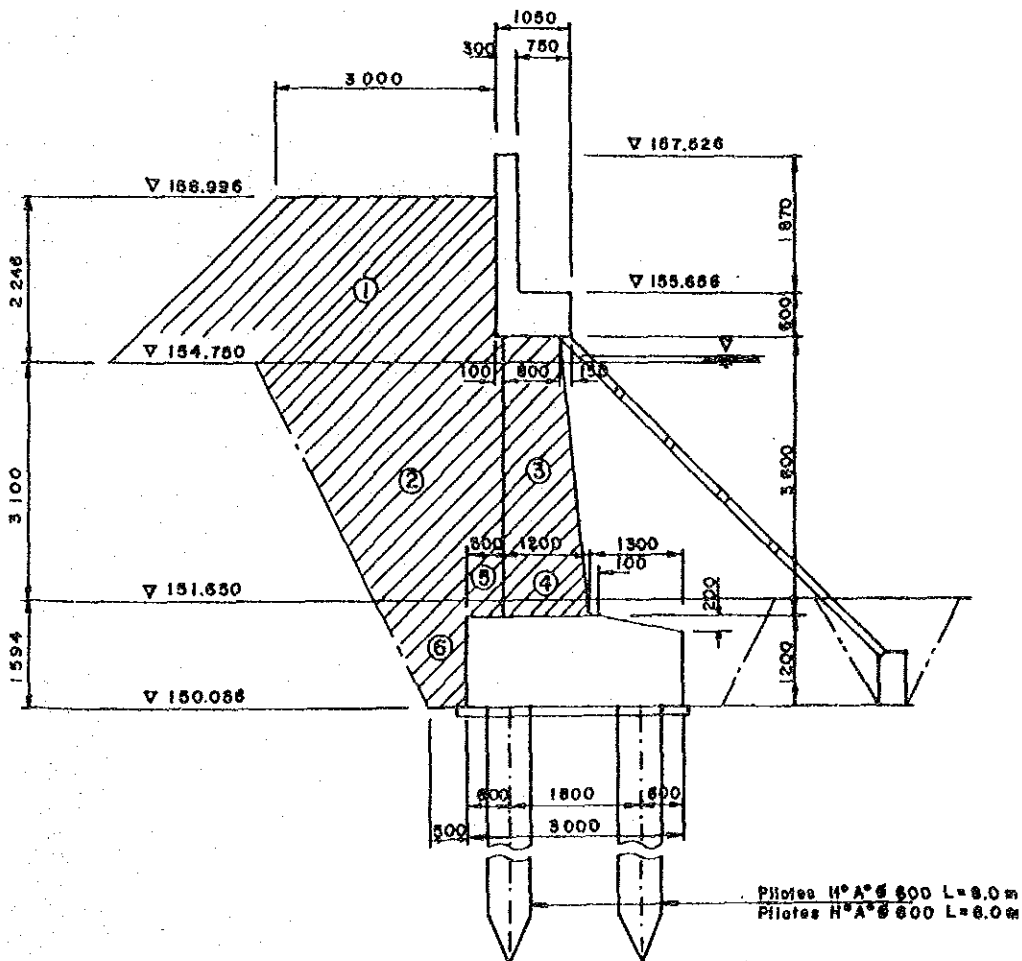
TAMANO Y TIPO	UNIDAD	SAN JUAN	SAN GUEORGIO	PUEBLO ALMACEN	AMISTAD	SICRI	TAJIBO	MURURITA	CURIRABITA	DIRRABA	TOTAL
Excavacion	m ³	1241.8	1241.8	947.1	2270.3	2082.7	832.3	1259.8	522.3	1047.3	11445.4
Excavacion de mano	m ³	31.2	31.2	31.2	31.2	31.2	29.6	31.2	29.6	29.6	276.0
Relleno	m ³	538.3	538.3	502.9	808.8	871.7	198.7	577.0	338.5	248.1	4622.4
Relleno de Acompañamiento	m ³	436.8	436.8	457.8	623.3	647.6	309.2	467.2	343.0	317.2	4038.8
Hornigón	m ³	101.484	101.484	100.584	106.312	106.312	82.334	103.356	82.838	84.786	869.490
Encofrado	m ²	275.252	275.252	269.858	304.272	304.272	235.650	288.910	236.788	240.876	2431.130
Hornigón de Niviracion (Encofrado)	m ³ (m ²)	5.888 (4.960)	5.888 (4.960)	5.888 (4.960)	5.888 (4.960)	5.888 (4.960)	5.520 (4.880)	5.888 (4.960)	5.520 (4.880)	5.520 (4.880)	51.888 (44.400)
φ 10	Kg	17.624	17.624	17.624	24.488	24.488	10.760	17.624	13.848	14.192	158.272
φ 13	Kg	2127.844	2127.844	1841.966	2061.890	2061.890	1962.560	2229.670	1902.468	1981.926	18298.068
φ 16	Kg	1101.912	1101.912	1091.298	731.676	731.676	822.004	960.372	1131.650	995.732	8668.232
φ 19	Kg	1170.686	1170.686	1170.686	1455.518	1455.518	1219.650	1361.114	1029.422	1029.422	11062.902
φ 22	Kg	1659.210	1659.210	1648.260	1384.170	1384.170	1330.508	1409.154	1272.162	1251.104	12997.948
φ 25	Kg	686.520	686.520	650.790	1479.156	1479.156	338.496	1025.016	615.030	531.600	7492.284
Sub total	Kg	6763.796	6763.796	6420.644	7136.898	7136.898	5684.178	7002.950	5964.570	5603.976	58677.706
Longitud total de Pilotes	m	192.000	144.000	144.000	360.000	360.000	160.000	288.000	280.000	300.000	2228.0
Excavacion	m ³	195.200	216.800	114.600	229.400	190.600	126.800	246.600	164.400	195.600	1681.0
Cordon	m	123.946	123.946	119.800	136.142	136.142	94.720	126.144	110.604	102.660	1074.104
Area	m ²	522.224	522.224	476.152	655.136	655.136	230.882	537.898	389.322	307.322	4296.296
Prapeto de Acceso	个所	4	4	4	4	4	4	4	4	4	36

1.1 Puentes San Juan y San Gregorio

1) Excavación



Relleño de acompañamiento



(1) Excavación

a) Excavación primaria

$$\begin{aligned} 1) -A & 3.100 \times 12.300 \times 29.654 + 5.45 \times 12.30 \times 5 & = 795.5 \text{ m}^3 \\ 2) -A & \frac{1}{3} \times 2.403 \times (2 \times 12.30 + 12.300) \times 2 & = 59.1 \text{ m}^3 \\ & & \hline V & = 854.6 \text{ m}^3 \end{aligned}$$

b) Excavación secundaria

$$\begin{aligned} 3) -A & \frac{1}{6} \times 1.294 \times \left\{ (2 \times 5.594 + 4.30) \times 11.594 + (2 \times 4.30 + 5.594) \right. \\ & \left. \times 10.03 \right\} \times 2 & = 140.5 \text{ m}^3 \\ -B & \frac{1}{6} \times 0.30 \times \left\{ (2 \times 4.30 + 4.0) \times 10.30 + (2 \times 4.0 + 4.3) \times \right. \\ & \left. 10.0 \right\} \times 2 & = 25.3 \text{ m}^3 \\ 4) -A & \frac{1}{2} (9.00 + 10.60) \times 0.80 \times 32.80 & = 246.7 \text{ m}^3 \\ 5) -B & 3.20 \times 9.20 \times 0.10 \times 2 & = 5.9 \text{ m}^3 \\ & & \hline V & = 418.4 \text{ m}^3 \end{aligned}$$

Volúmen total de excavación 1273.0 m³

Excavación con equipo (A) 1241.8 m³

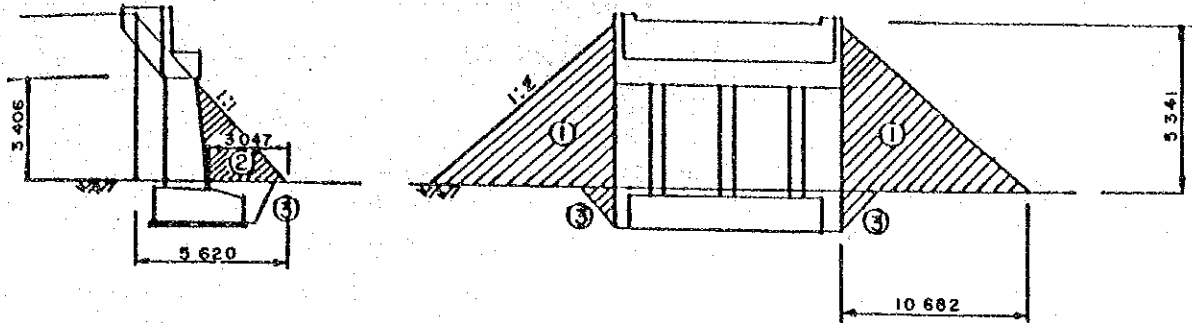
Excavación manual (B) 31.2 m³

(2) Material de relleno

$$\begin{aligned} 1) & \frac{1}{2} (3.0 + 5.246) \times 2.246 \times 10.1 & = 93.5 \text{ m}^3 \\ 2) & \frac{1}{2} (1.797 + 3.347) \times 3.10 \times 10.1 & = 80.5 \text{ m}^3 \\ 3) & \frac{1}{2} (0.80 + 1.159) \times 3.50 \times (10.1 - 3 \times 0.5) & = 29.5 \text{ m}^3 \\ 4) & \frac{1}{2} (1.159 + 1.20) \times 0.30 \times (10.1 - 3 \times 0.5) & = 3.0 \text{ m}^3 \\ 5) & 0.50 \times 0.30 \times 10.1 & = 1.5 \text{ m}^3 \\ 6) & \frac{1}{2} (0.50 + 0.798) \times 1.594 \times 10.1 & = 10.4 \text{ m}^3 \\ & & \hline V & = 218.4 \text{ m}^3 \end{aligned}$$

Volúmen total de relleno 218.4 x 2 = 436.8 m³

(3) Volumen utilizado de material excavado



$$\begin{aligned}
 1) & \quad \frac{3}{8} \times \pi \times 5.341^3 \times 2 & = 359.0 \text{ m}^3 \\
 2) & \quad \frac{1}{2} \times 3.406 \times 3.047 \times 10.10 \times 2 & = 104.8 \text{ m}^3 \\
 3) & \quad (140.5 + 34.1) - (1.80 \times 0.2 + \sqrt{2} \times 1.20 \times 0.20 + 3.0 \times 1.0) \\
 & \quad \times 10.10 \times 2 - (3.0 + 1.5 + 10.4) \times 2 & = 74.5 \text{ m}^3 \\
 \hline
 V & & = 538.3 \text{ m}^3
 \end{aligned}$$

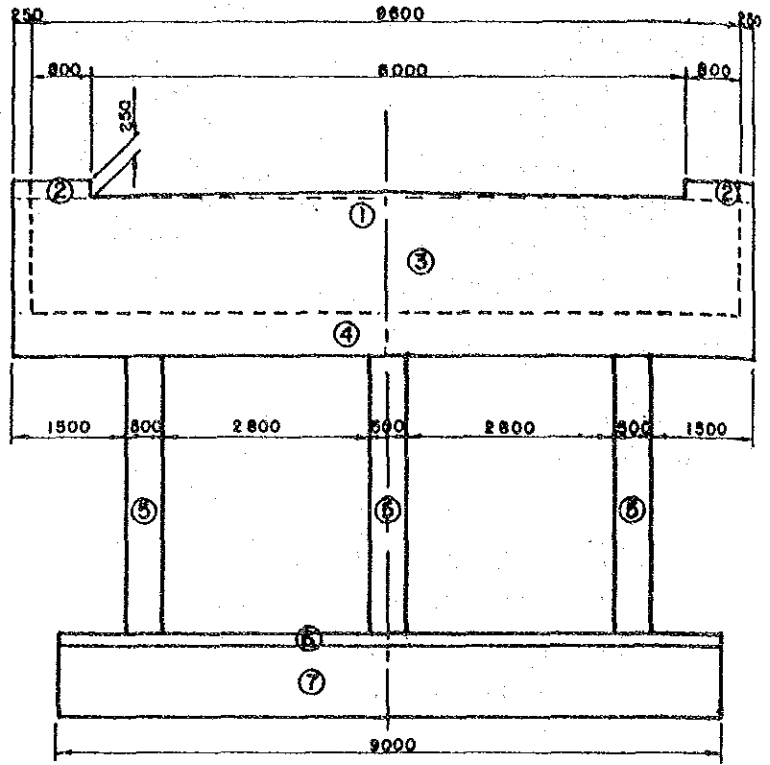
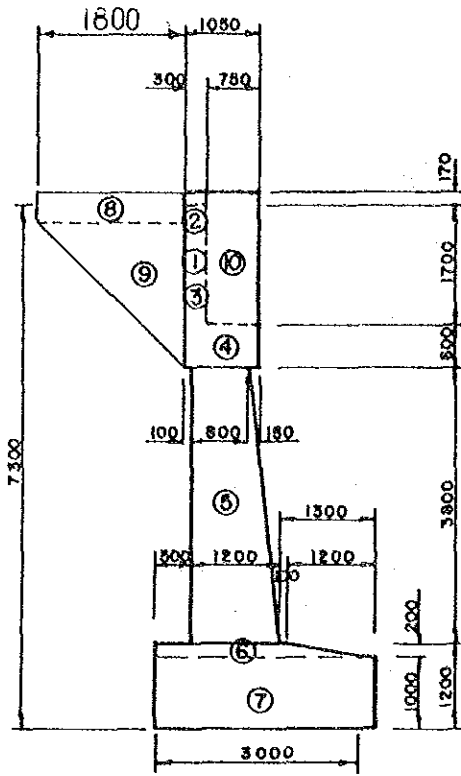
Volúmen utilizado 538.3 m³

(4) Volumen excedente de material excavado

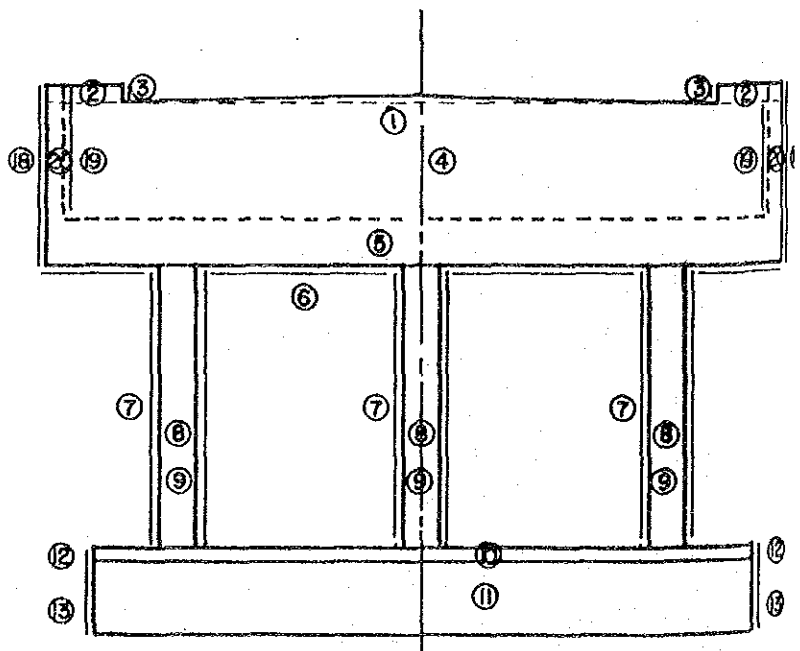
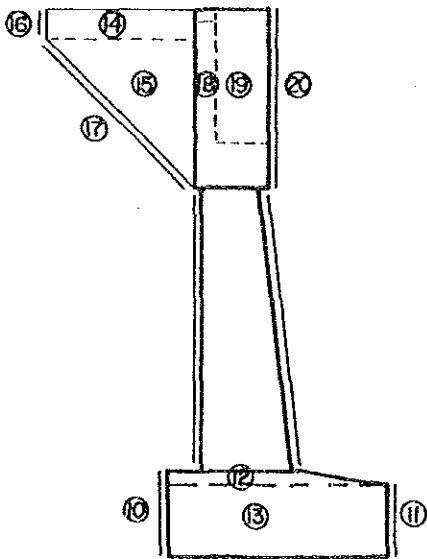
$$V = 1273.0 - 538.3 = 734.7 \text{ m}^3$$

Puentes San Juan y San Gregorio

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo - A)

1) $\frac{1}{2} \times 0.08 \times 4.00 \times 0.30 \times 2$	= 0.096
2) $0.25 \times 1.050 \times 0.30 \times 2$	= 0.158
3) $(1.700 - 0.08) \times 10.10 \times 0.30$	= 4.909
4) $0.60 \times 1.050 \times 10.10$	= 6.363
5) $\frac{1}{2} \times (0.80 + 1.20) \times 3.80 \times 0.50 \times 3$	= 5.700
6) $\frac{1}{2} \times (1.80 + 3.00) \times 9.00 \times 0.2$	= 4.320
7) $1.00 \times 3.00 \times 9.00$	= 27.000
8) $0.670 \times 1.80 \times 0.25 \times 2$	= 0.603
9) $\frac{1}{2} \times 1.8 \times 1.8 \times 0.25 \times 2$	= 0.810
10) $0.75 \times 0.25 \times 1.87 \times 2$	= 0.701

TOTAL = 50.660 m³/Estribo

(2) Encofrado

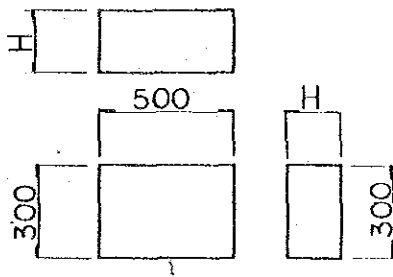
1) $\frac{1}{2} \times 0.08 \times 4.00 \times 2 \times 2$	= 0.640
2) $0.25 \times 0.80 \times 2 \times 2$	= 0.800
3) $0.25 \times 0.30 \times 2$	= 0.150
4) $(1.70 - 0.08) \times 9.60 \times 2$	= 31.104
5) $0.60 \times 9.60 \times 2$	= 11.520
6) $1.050 \times 10.10 - 0.50 \times 0.80 \times 3$	= 9.405
7) $\frac{1}{2} (0.80 + 1.20) \times 3.80 \times 2 \times 3$	= 22.800
8) $0.50 \times 3.80 \times 3$	= 5.700
9) $\sqrt{0.40^2 + 3.80^2} \times 0.50 \times 3$	= 5.731
10) 1.20×9.00	= 10.800
11) 1.00×9.00	= 9.000
12) $\frac{1}{2} (1.80 + 3.00) \times 0.20 \times 2$	= 0.960
13) $1.00 \times 3.00 \times 2$	= 6.000
14) $0.67 \times 1.80 \times 2 \times 2$	= 4.824
15) $\frac{1}{2} \times 1.80 \times 1.80 \times 2 \times 2$	= 6.480
16) $0.67 \times 0.25 \times 2$	= 0.335
17) $\sqrt{1.8^2 + 1.8^2} \times 0.25 \times 2$	= 1.273
18) $1.050 \times 2.47 \times 2$	= 5.187
19) $0.75 \times 1.87 \times 2$	= 2.805
20) $2.47 \times 0.25 \times 2$	= 1.235

TOTAL = 136.749 m²/Estribo

(3). Hormigón Pobre (Tipo-F)

(Hormigón) $3.20 \times 9.20 \times 0.10 = 2.944 \text{ m}^3 / \text{Estribo}$
 (Encofrado) $3.20 \times 0.10 \times 2 + 9.20 \times 0.10 \times 2 = 2.480 \text{ m}^2 / \text{Estribo}$

(4) Hormigón para asiento de apoyo
 Grupo I 25m



Hormigón
 $A = 0.500 \times 0.300 = 0.150 \text{ m}^2$
 $V = A \times H = 0.150 \times (0.115 + 0.159) \times 2 = 0.082 \text{ m}^3 / \text{Estribo}$

Encofrado
 $A = (0.50 + 0.30) \times 2 \times (0.115 + 0.159) \times 2 = 0.877 / \text{Estribo}$

Unidad: mm

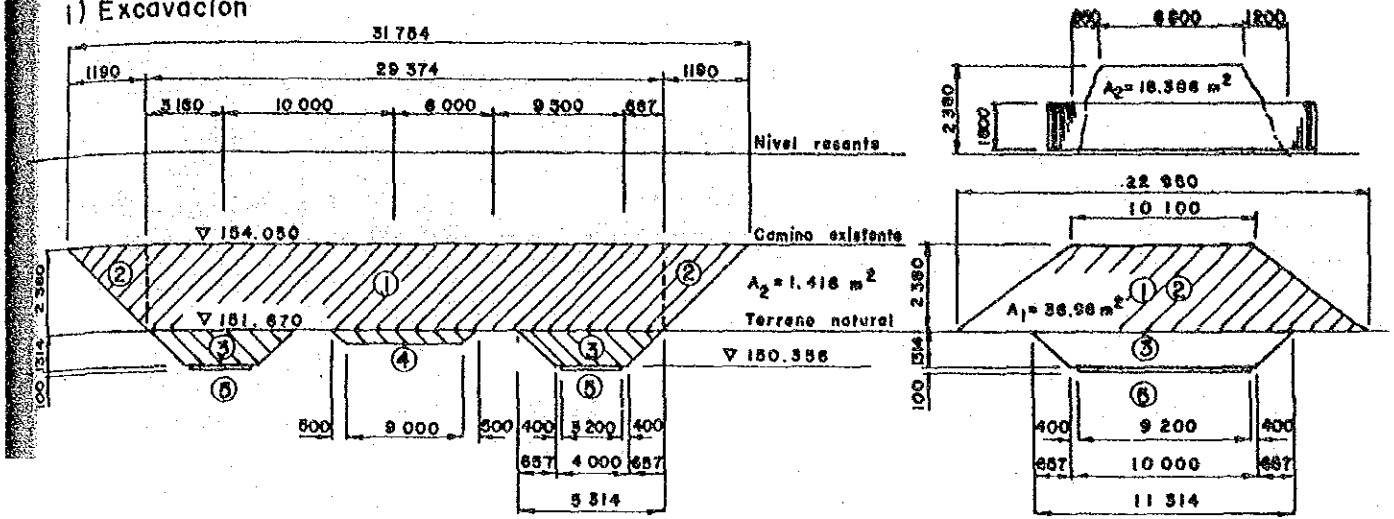
	VE	VI	VI	VE
H	115	159	159	115

VE:Viga Externa
 VI:Viga Interna

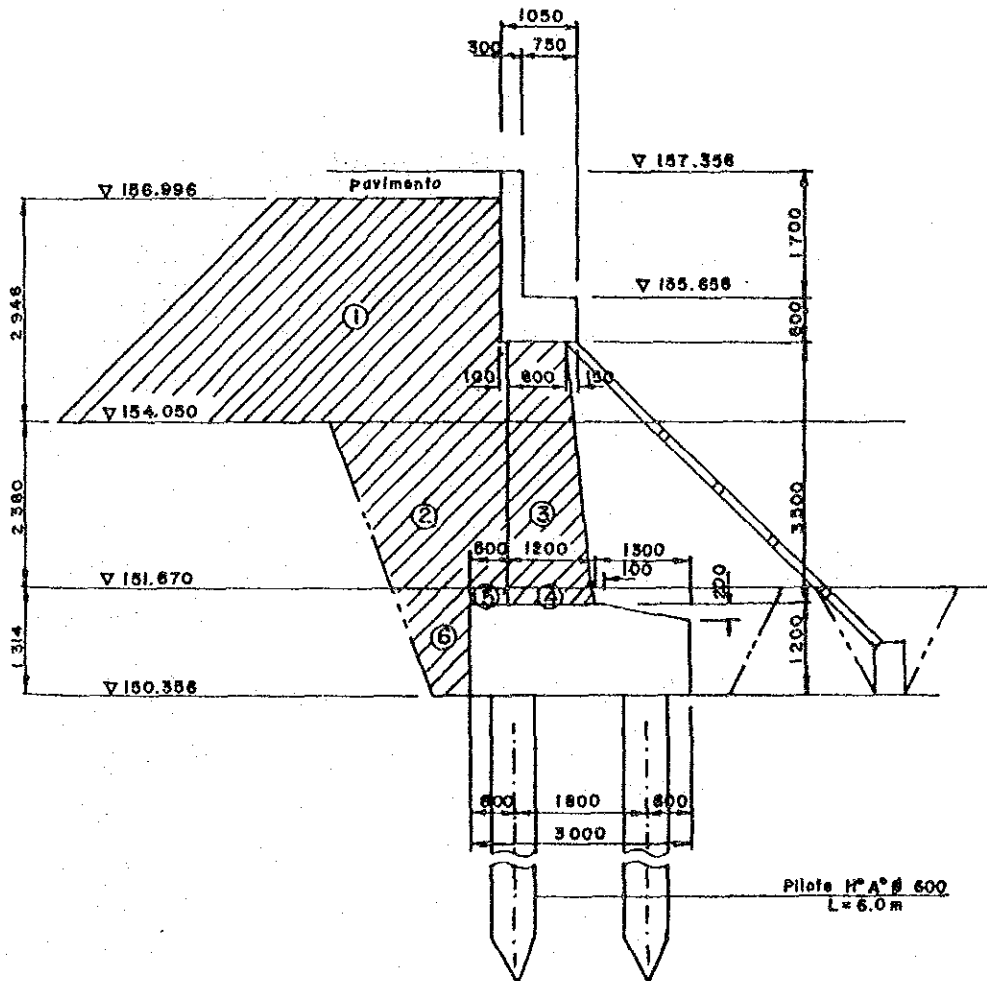
(5) Cantidad total de Hormigón y Encofrado

	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Hormigón		(50.66 × 2) 101.320	(0.082 × 2) 0.164	101.484	(2.944 × 2) 5.888
Encofrado		(136.749 × 2) 273.498	(0.877 × 2) 1.754	275.252	(2.480 × 2) 4.960

2 Puente Puerto Almacen
1) Excavación



Relleno de acompañamiento



(1) Excavación

a) Excavación primaria

$$1) -A \quad 18.386 \times 6.00 + \frac{1}{2}(18.386 + 36.98) \times (9.50 + 10.0) + 36.98 \times (3.187 + 0.687) - \sqrt{4} \times \pi \times 1.80^2 \times 8.65 \times 2 = 634.7 \text{ m}^3$$

$$2) -A \quad \frac{1}{3} \times 1.416 \times (2 \times 10.10 + 22.95) \times 2 = 40.7 \text{ m}^3$$

$$V = 675.4 \text{ m}^3$$

b) Excavación secundaria

$$3) -A \quad \frac{1}{6} \times 1.114 \times \{ (2 \times 5.314 + 4.30 \times 11.314 + (2 \times 4.30 + 5.314) \times 10.3) \} \times 2 = 115.9 \text{ m}^3$$

$$-B \quad \frac{1}{6} \times 0.30 \times \{ (2 \times 4.30 + 4.0) \times 10.30 + (2 \times 4.0 + 4.3) \times 10.0 \} \times 2 = 25.3 \text{ m}^3$$

$$4) -A \quad \frac{1}{2}(9.00 + 10.00) \times 0.50 \times 32.80 = 155.8 \text{ m}^3$$

$$5) -B \quad 3.20 \times 9.20 \times 0.10 \times 2 = 5.9 \text{ m}^3$$

Volúmen total de excavación 978.3 m³

Excavación con equipos (A) 947.1 m³

Excavación manual (B) 31.2 m³

(2) Material de relleno

$$1) \quad \frac{1}{2}(3.0 + 5.946) \times 2.946 \times 10.1 = 133.1 \text{ m}^3$$

$$2) \quad \frac{1}{2}(1.657 + 2.847) \times 2.38 \times 10.1 = 54.1 \text{ m}^3$$

$$3) \quad \frac{1}{2}(0.80 + 1.187) \times 3.386 \times (10.1 - 3 \times 0.5) = 28.9 \text{ m}^3$$

$$4) \quad \frac{1}{2}(1.187 + 1.20) \times 0.114 \times (10.1 - 3 \times 0.5) = 1.2 \text{ m}^3$$

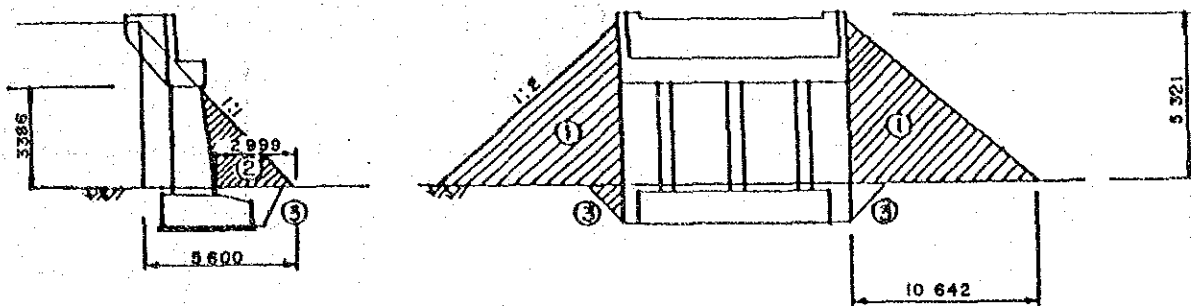
$$5) \quad 0.50 \times 0.114 \times 10.1 = 0.6 \text{ m}^3$$

$$6) \quad \frac{1}{2}(0.50 + 1.157) \times 1.314 \times 10.1 = 11.0 \text{ m}^3$$

$$V = 228.9 \text{ m}^3$$

Volúmen total de relleno 228.9 x 2 = 457.8

(3) Volumen utilizado de material excavado



$$1) \quad \frac{3}{8} \times \pi \times 5.321^3 \times 2 = 355.0 \text{ m}^3$$

$$2) \quad \frac{1}{2} \times 3.386 \times 2.999 \times 10.10 \times 2 = 102.6 \text{ m}^3$$

$$3) \quad (115.9 + 25.3) - (1.80 \times 0.2 + \frac{1}{2} \times 1.20 \times 0.20 + 3.0 \times 1.0) \\ \times 10.10 \times 2 - (1.2 + 0.6 + 11.0) \times 2 = 45.3 \text{ m}^3$$

$$V = 502.9 \text{ m}^3$$

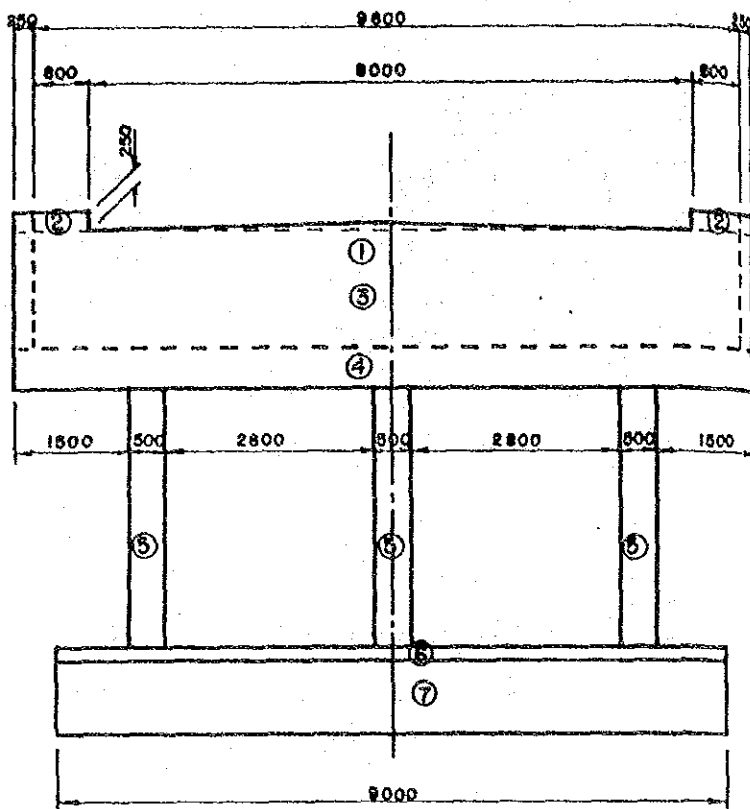
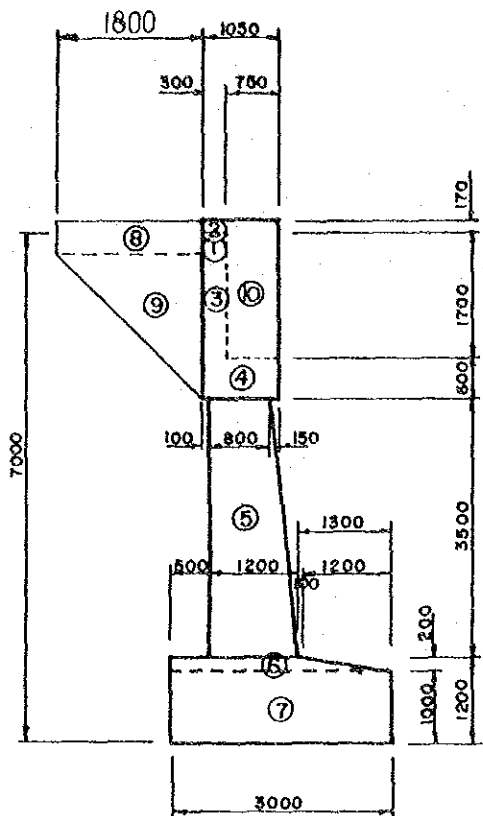
Volumen utilizado 502.9 m³

(4) Volumen excedente de material excavado

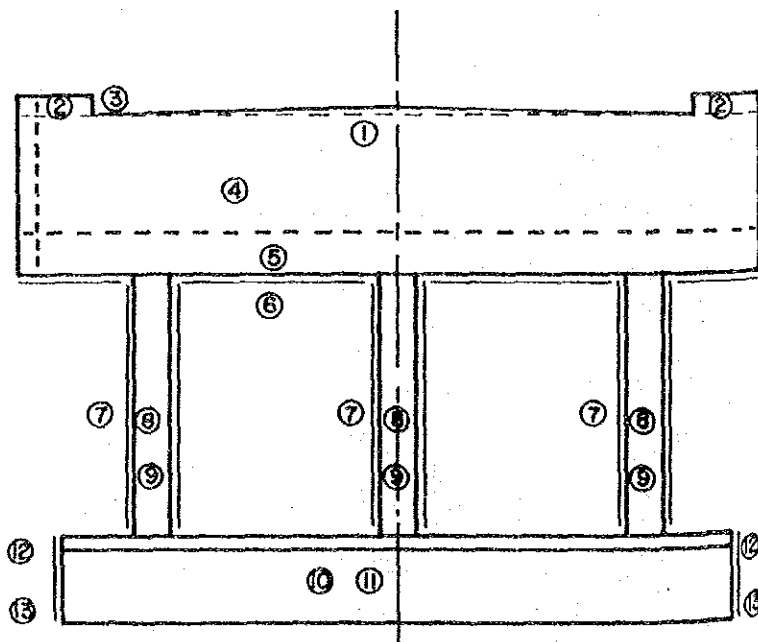
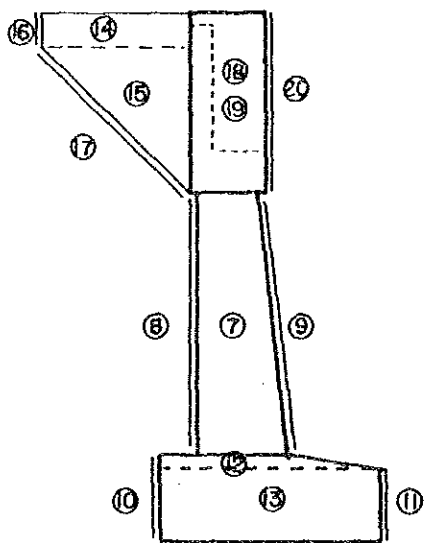
$$V = 978.3 - 502.9 = 475.4 \text{ m}^3$$

Puente Puerto Almacen

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo-A)

1) $\frac{1}{2} \times 4.00 \times 0.300 \times 0.08 \times 2$	= 0.096
2) $(0.800 + 0.25) \times 0.300 \times 0.25 \times 2$	= 0.158
3) $10.10 \times 0.300 \times (1.700 - 0.08)$	= 4.909
4) $10.10 \times 1.050 \times 0.600$	= 6.363
5) $\frac{1}{2} (0.80 + 1.20) \times 3.50 \times 0.50 \times 3$	= 5.250
6) $\frac{1}{2} (1.80 + 3.00) \times 0.20 \times 9.0$	= 4.320
7) $1.00 \times 3.00 \times 9.00$	= 27.000
8) $0.670 \times 1.80 \times 0.25 \times 2$	= 0.603
9) $\frac{1}{2} \times 1.8 \times 1.8 \times 0.25 \times 2$	= 0.810
10) $0.75 \times 1.87 \times 0.25 \times 2$	= 0.701

TOTAL = 50.210 m³ / Estribo

(2) Encofrado

1) $\frac{1}{2} \times 4.00 \times 0.08 \times 2 \times 2$	= 0.640
2) $0.250 \times 0.80 \times 2 \times 2$	= 0.800
3) $0.25 \times 0.30 \times 2$	= 0.150
4) $9.60 \times (1.70 - 0.08) \times 2$	= 31.104
5) $9.60 \times 0.60 \times 2$	= 11.520
6) $1.05 \times 10.10 - 0.80 \times 0.50 \times 3$	= 9.405
7) $\frac{1}{2} (0.80 + 1.20) \times 3.50 \times 2 \times 3$	= 21.000
8) $0.50 \times 3.50 \times 3$	= 5.250
9) $\sqrt{0.40^2 + 3.50^2} \times 0.50 \times 3$	= 5.284
10) 1.20×9.0	= 10.800
11) 1.00×9.0	= 9.000
12) $\frac{1}{2} (1.80 + 3.00) \times 0.20 \times 2$	= 0.960
13) $1.00 \times 3.00 \times 2$	= 6.000
14) $0.67 \times 1.80 \times 2 \times 2$	= 4.824
15) $\frac{1}{2} \times 1.80 \times 1.80 \times 2 \times 2$	= 6.480
16) $0.67 \times 0.25 \times 2$	= 0.335
17) $\sqrt{1.80^2 + 1.80^2} \times 0.25 \times 2$	= 1.273
18) $1.05 \times 2.47 \times 2$	= 5.187

19) $0.75 \times 1.87 \times 2$

= 2.805

20) $2.47 \times 0.25 \times 2$

= 1.235

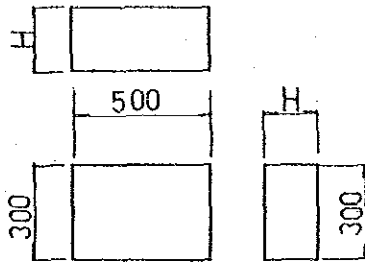
TOTAL = $134.052 \text{ m}^2 / \text{Estribo}$

(3) Hormigón Pobre (Tipo-F)

(Hormigón) $3.20 \times 9.20 \times 0.10$ = 2.944m³ / Estribo

(Encofrado) $3.20 \times 0.10 \times 2 + 9.20 \times 0.10 \times 2$ = 2.480m² / Estribo

(4) Homigón para asiento de apoyo
Grupo I 25m



Homigón

$A = 0.500 \times 0.300 = 0.150 \text{ m}^2$

$V = A \times H = 0.150 \times (0.115 + 0.159) \times 2$
= 0.082m³/Estribo

Encofrado

$A = (0.50 + 0.30) \times 2 \times (0.115 + 0.159) \times 2$
= 0.877/Estribo

Unidad: mm

	VE	VI	VI	VE
H	115	159	159	115

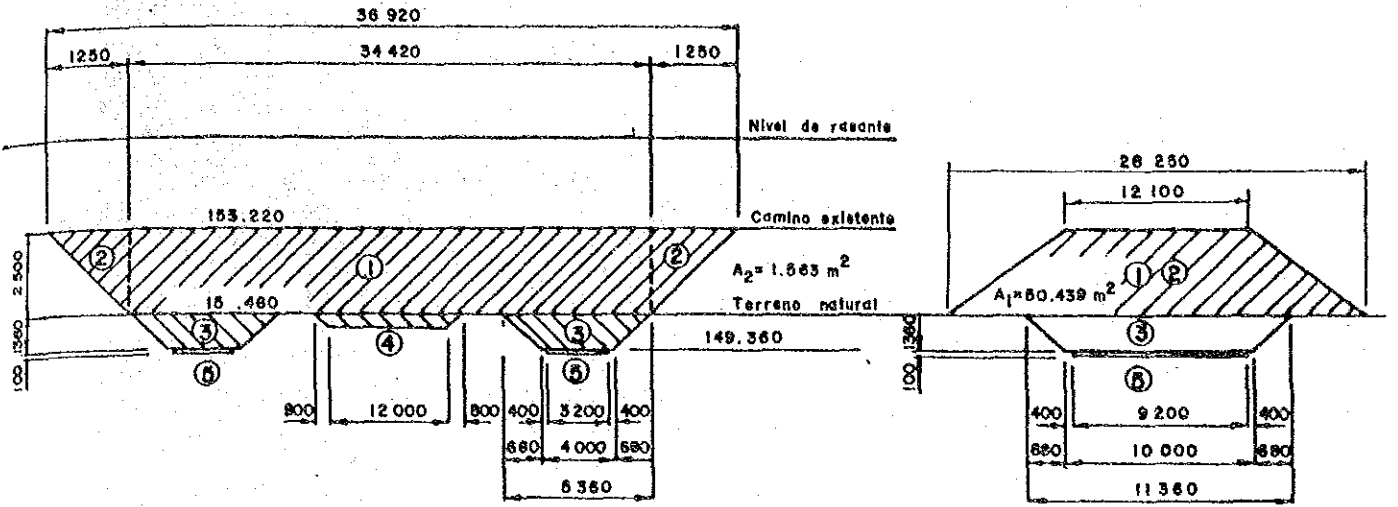
VE: Viga Externa

VI: Viga Interna

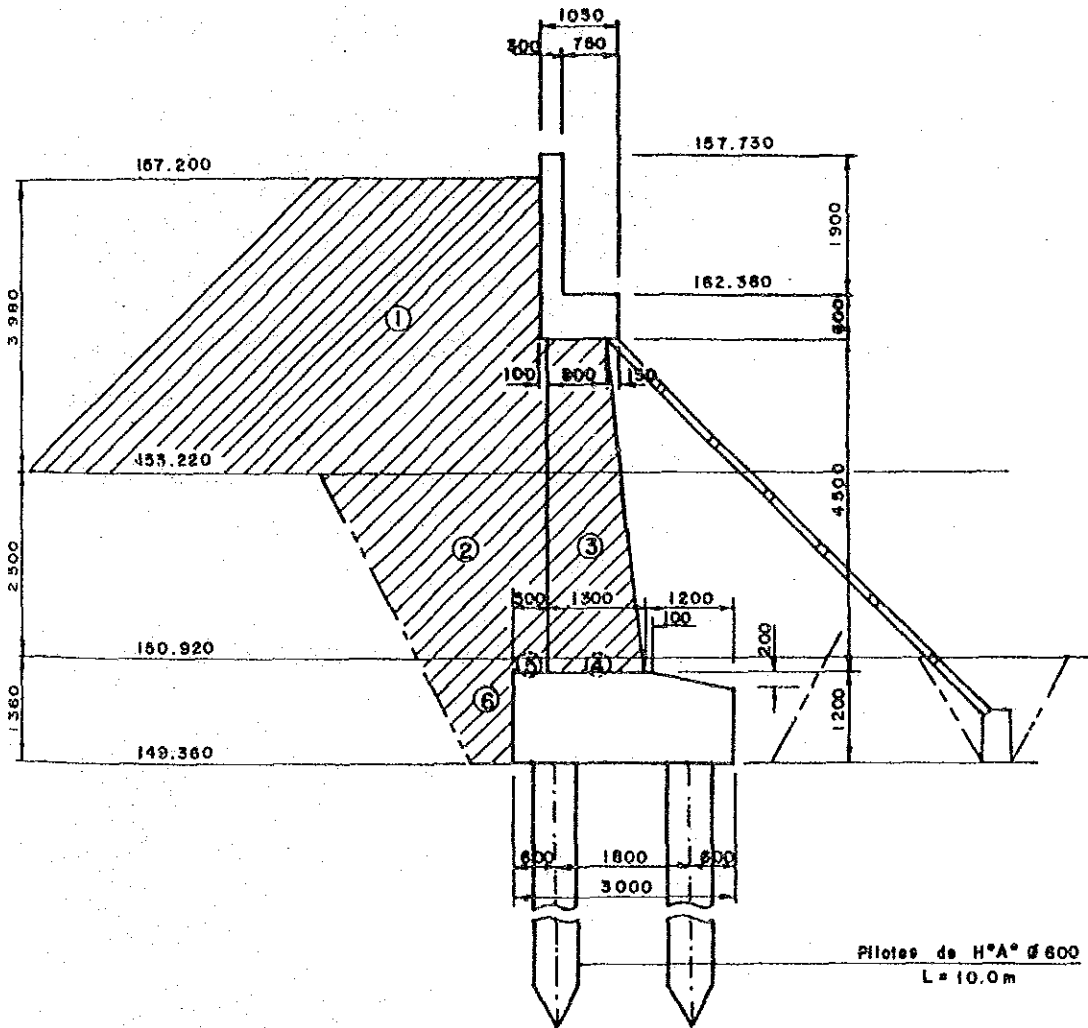
(5) Cantidad total de Homigón y Encofrado

	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Homigón		(50.210×2)	(0.082×2)	100.584	(2.944×2)
		100.420	0.164		5.888
Encofrado		(134.052×2)	(0.877×2)	269.858	(2.480×2)
		268.104	1.754		4.960

1.3 Puente Amistad
1) Excavación



Relleño de acompañamiento



(1) Excavación

a) Excavación primaria

$$1) -A \quad 50.437 \times 34.420 \quad = 1736.0 \text{ m}^3$$

$$2) -A \quad 1/3 \times 1.563 \times (2 \times 12.10 + 28.25) \times 2 \quad = 54.6 \text{ m}^3$$

$$V = 1790.6 \text{ m}^3$$

b) Excavación secundaria

$$3) -A \quad 1/6 \times 1.060 \times \left\{ (2 \times 5.360 + 4.30) \times 11.360 + (2 \times 4.30 + 5.360) \times 10.3 \right\} \times 2 \quad = 111.1 \text{ m}^3$$

$$-B \quad 1/6 \times 0.30 \times \left\{ (2 \times 4.30 + 4.0) \times 10.30 + (2 \times 4.0 + 4.3) \times 10.0 \right\} \times 2 \quad = 25.3 \text{ m}^3$$

$$4) -A \quad 1/2 (12.00 + 13.600) \times 0.80 \times 36.00 \quad = 368.6 \text{ m}^3$$

$$5) -B \quad 3.20 \times 9.20 \times 0.10 \times 2 \quad = 5.9 \text{ m}^3$$

Volúmen total de excavación 2301.5 m³

Excavación con equipos (A) 2270.3 m³

Excavación manual (B) 31.2 m³

(2) Material de relleno

$$1) \quad 1/2 (3.0 + 6.980) \times 3.980 \times 10.1 \quad = 200.6 \text{ m}^3$$

$$2) \quad 1/2 (1.680 + 2.930) \times 2.50 \times 10.1 \quad = 58.2 \text{ m}^3$$

$$3) \quad 1/2 (0.80 + 1.282) \times 4.364 \times (10.1 - 3 \times 0.5) \quad = 39.1 \text{ m}^3$$

$$4) \quad 1/2 (1.282 + 1.30) \times 0.136 \times (10.1 - 3 \times 0.5) \quad = 1.5 \text{ m}^3$$

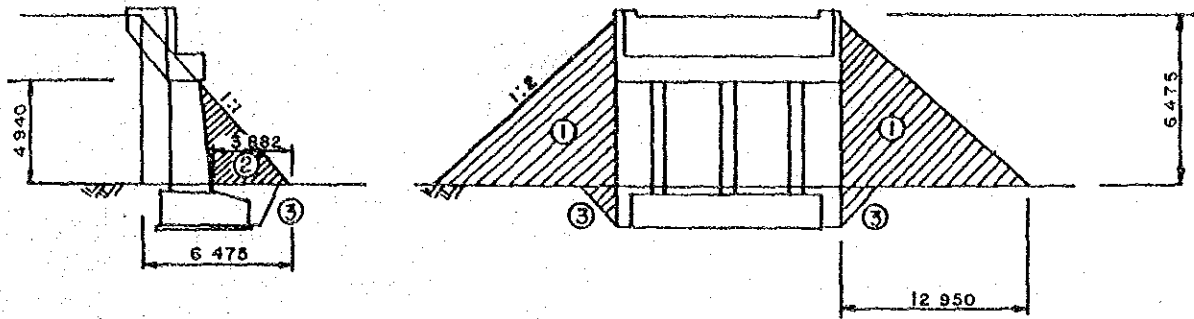
$$5) \quad 0.50 \times 0.136 \times 10.1 \quad = 0.7 \text{ m}^3$$

$$6) \quad 1/2 (0.50 + 1.180) \times 1.360 \times 10.1 \quad = 11.5 \text{ m}^3$$

$$V = 311.6 \text{ m}^3$$

Volúmen total de relleno 311.6 x 2 = 623.2 m³

(3) Volumen utilizado de material excavado



$$1) \quad \frac{3}{8} \times \pi \times 6.475^3 \times 2 = 639.6 \text{ m}^3$$

$$2) \quad \frac{1}{2} \times 4.490 \times 2.882 \times 10.10 \times 2 = 130.7 \text{ m}^3$$

$$3) \quad (111.1 + 25.3) - (1.90 \times 0.2 + \frac{1}{2} \times 1.10 \times 0.20 + 3.0 \times 1.0) \\ \times 10.10 \times 2 - (1.5 + 0.7 + 11.5) \times 2 = 38.5 \text{ m}^3$$

$$V = 808.8 \text{ m}^3$$

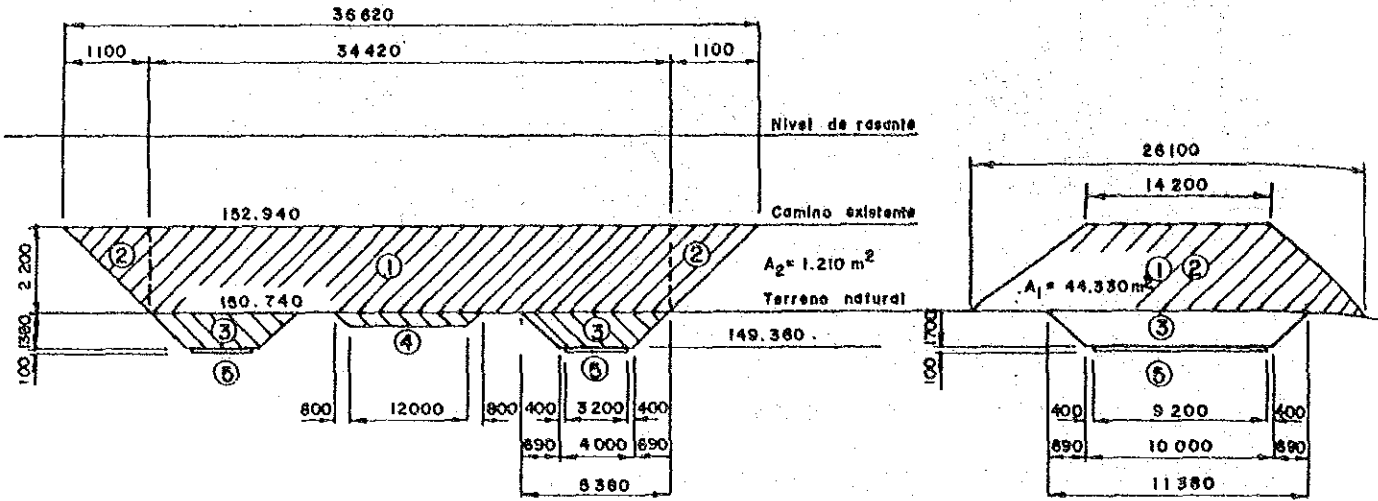
Volumen utilizado 808.8 m³

(4) Volumen excedente de material excavado

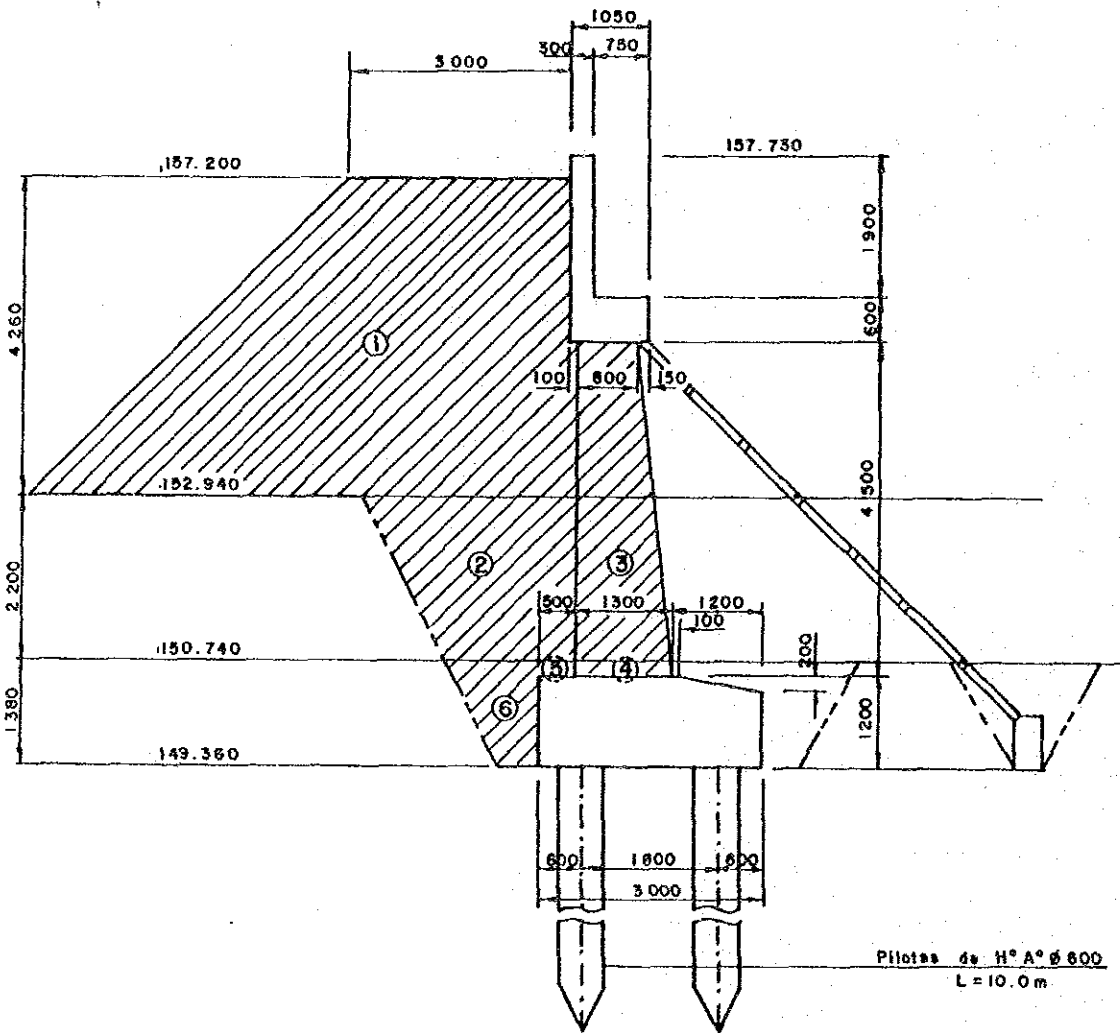
$$V = 2301.5 - 808.8 = 1892.7 \text{ m}^3$$

1.4 Puente Scuri

1) Excavación



Relleno de acompañamiento



(1) Excavación

a) Excavación primaria

$$\begin{aligned} 1) -A & 44.33 \times 34.420 & = 1525.8 \text{ m}^3 \\ 2) -A & \frac{1}{3} \times 1.210 \times (2 \times 14.20 + 26.10) \times 2 & = 44.0 \text{ m}^3 \\ & & \hline V & = 1569.8 \text{ m}^3 \end{aligned}$$

b) Excavación secundaria

$$\begin{aligned} 3) -A & \frac{1}{6} \times 1.380 \times \left\{ (2 \times 5.380 + 4.30) \times 11.380 + (2 \times 4.30 + 5.380) \right. \\ & \left. \times 10.3 \right\} \times 2 & = 145.1 \text{ m}^3 \\ -B & \frac{1}{6} \times 0.30 \times \left\{ (2 \times 4.30 + 4.0) \times 10.30 + (2 \times 4.0 + 4.3) \times 10.0 \right\} \times 2 & = 25.3 \text{ m}^3 \\ 4) -A & \frac{1}{2} (12.00 + 13.60) \times 0.80 \times 35.92 & = 367.8 \text{ m}^3 \\ 5) -B & 3.20 \times 9.20 \times 0.10 \times 2 & = 5.9 \text{ m}^3 \end{aligned}$$

Volumen total de excavación 2113.9 m³

Excavación con equipos (A) 2082.7 m³

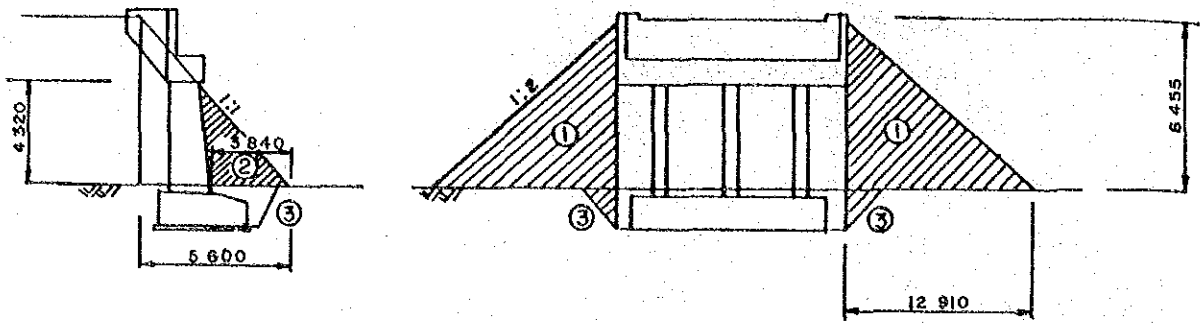
Excavación manual (B) 31.2 m³

(2) Material de relleno

$$\begin{aligned} 1) & \frac{1}{2} (3.0 + 7.260) \times 4.260 \times 10.1 & = 220.7 \text{ m}^3 \\ 2) & \frac{1}{2} (1.690 + 2.790) \times 2.20 \times 10.1 & = 49.8 \text{ m}^3 \\ 3) & \frac{1}{2} (0.80 + 1.280) \times 4.320 \times (10.1 - 3 \times 0.5) & = 38.6 \text{ m}^3 \\ 4) & \frac{1}{2} (1.280 + 1.30) \times 0.180 \times (10.1 - 3 \times 0.5) & = 2.0 \text{ m}^3 \\ 5) & 0.50 \times 0.180 \times 10.1 & = 0.9 \text{ m}^3 \\ 6) & \frac{1}{2} (0.50 + 1.190) \times 1.380 \times 10.1 & = 11.8 \text{ m}^3 \\ & & \hline V & = 323.8 \text{ m}^3 \end{aligned}$$

Volumen total de relleno 323.8x2 = 647.6 m³

(3) Volumen utilizado de material excavado



$$\begin{aligned}
 1) & \quad \frac{3}{8} \times \pi \times 6.455^3 \times 2 & = 633.7 \text{ m}^3 \\
 2) & \quad \frac{1}{2} \times 4.320 \times 3.840 \times 10.10 \times 2 & = 167.5 \text{ m}^3 \\
 3) & \quad (145.1 + 25.3) - (1.90 \times 0.2 + \frac{1}{2} \times 1.10 \times 0.20 + 3.0 \times 1.0) \\
 & \quad \times 10.10 \times 2 - (2.0 + 0.9 + 11.8) \times 2 & = 70.5 \text{ m}^3 \\
 & & \underline{V = 871.7 \text{ m}^3}
 \end{aligned}$$

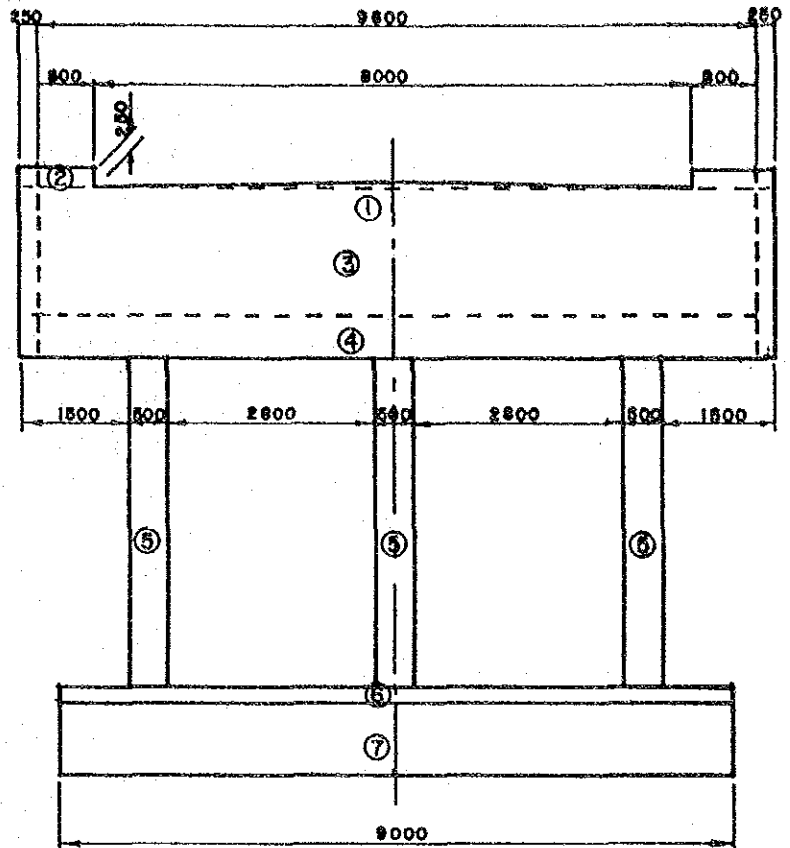
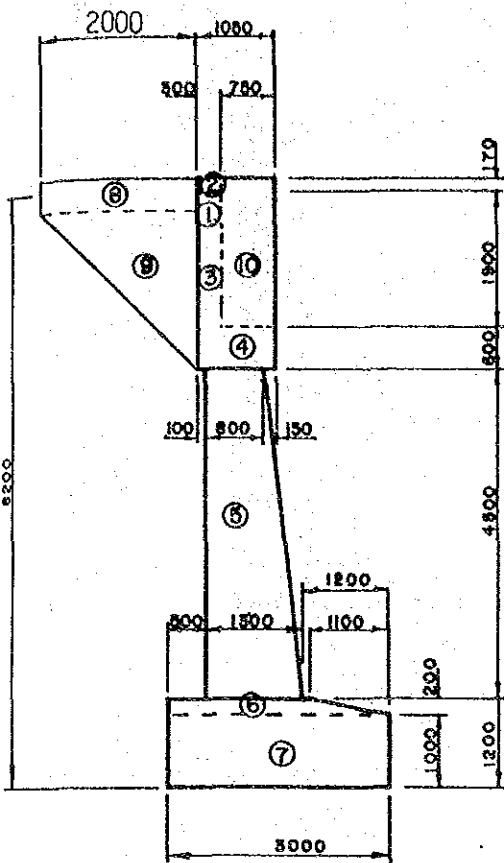
Volumen utilizado 871.7 m³

(4) Volumen excedente de material excavado

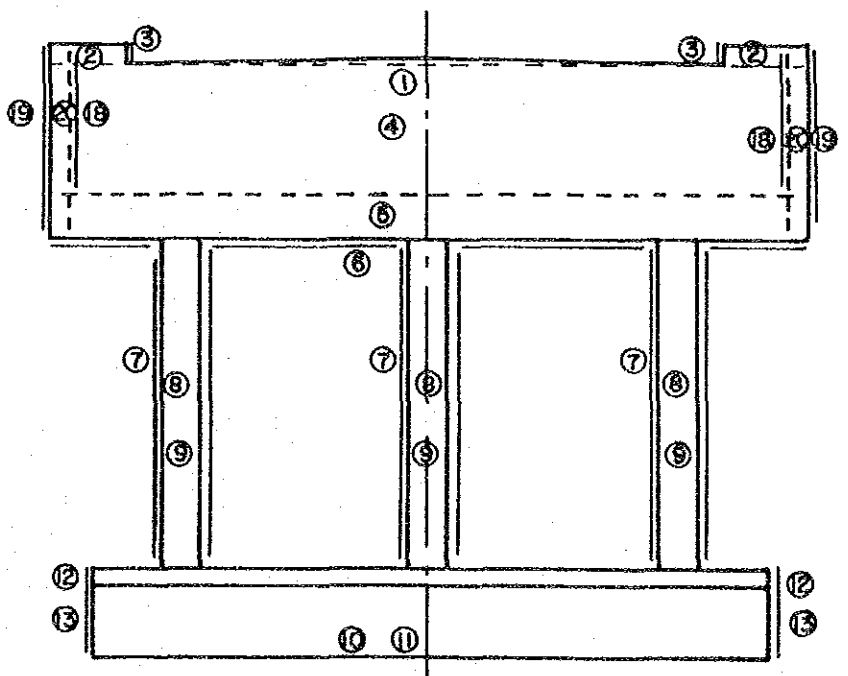
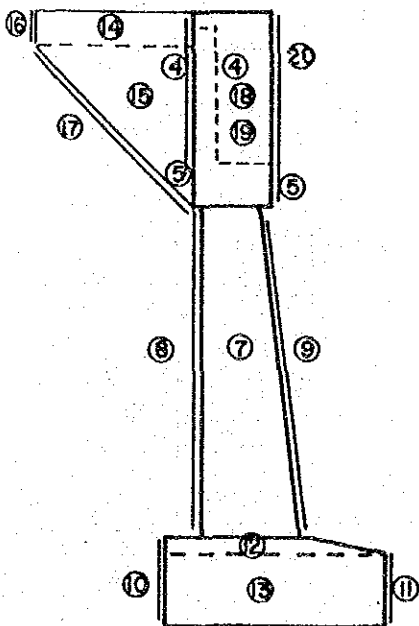
$$V = 2113,9 - 871.7 = 1242.2$$

Puente Sicurí

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo - A)

1) $\frac{1}{2} \times 4.00 \times 0.300 \times 0.08 \times 2$	=	0.096
2) $(0.800 + 0.250) \times 0.300 \times 0.25 \times 2$	=	0.158
3) $10.10 \times 0.300 \times (1.900 - 0.08)$	=	5.515
4) $10.10 \times 1.050 \times 0.600$	=	6.363
5) $\frac{1}{2} (0.800 + 1.300) \times 4.50 \times 0.500 \times 3$	=	7.088
6) $\frac{1}{2} (3.0 + 1.90) \times 0.20 \times 9.00$	=	4.410
7) $3.00 \times 1.00 \times 9.00$	=	27.000
8) $0.670 \times 2.00 \times 0.25 \times 2$	=	0.670
9) $\frac{1}{2} \times 2.00 \times 2.00 \times 0.25 \times 2$	=	1.000
10) $0.75 \times 2.07 \times 0.25 \times 2$	=	0.776

TOTAL = 53.076 m³/Estribo

(2) Encofrado

1) $\frac{1}{2} \times 4.00 \times 0.08 \times 2 \times 2$	=	0.640
2) $0.25 \times 0.80 \times 2 \times 2$	=	0.800
3) $0.25 \times 0.30 \times 2$	=	0.150
4) $(1.90 - 0.08) \times 9.60 \times 2$	=	34.944
5) $0.60 \times 9.60 \times 2$	=	11.520
6) $1.050 \times 10.10 - 0.80 \times 0.50 \times 3$	=	9.405
7) $\frac{1}{2} (0.8 + 1.30) \times 4.50 \times 2 \times 3$	=	28.350
8) $0.50 \times 4.50 \times 3$	=	6.750
9) $\sqrt{(1.30 - 0.80)^2 + 4.50^2} \times 0.50 \times 3$	=	6.792
10) 1.20×9.00	=	10.800
11) 1.00×9.00	=	9.000
12) $\frac{1}{2} (3.00 + 1.90) \times 0.20 \times 2$	=	0.980
13) $1.00 \times 3.00 \times 2$	=	6.000
14) $0.67 \times 2.00 \times 2 \times 2$	=	5.360
15) $\frac{1}{2} \times 2.00 \times 2.00 \times 2 \times 2$	=	8.000
16) $0.25 \times 0.67 \times 2$	=	0.335
17) $\sqrt{2.00^2 + 2.00^2} \times 0.25 \times 2$	=	1.414

$$\begin{aligned}
 18) & 1.05 \times 2.67 \times 2 & = & 5.607 \\
 19) & 0.75 \times 2.07 \times 2 & = & 3.405 \\
 20) & 0.25 \times 2.67 \times 2 & = & 1.335
 \end{aligned}$$

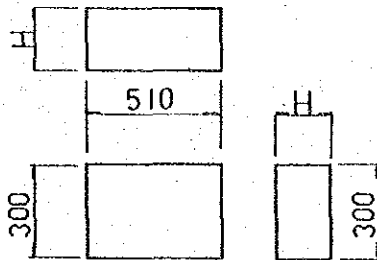
$$\text{TOTAL} = 151.287 \text{ m}^2 / \text{Estribo}$$

(3) Hormigón Pobre (Tipo - F)

$$\text{(Hormigón)} \quad 9.2 \times 3.2 \times 0.10 = 2.944 \text{ m}^3 / \text{Estribo}$$

$$\text{(Encofrado)} \quad 9.2 \times 0.10 \times 2 + 3.2 \times 0.10 \times 2 = 2.480 \text{ m}^2 / \text{Estribo}$$

(4) Homigón para asiento de apoyo
Grupos 11, 111 30m



Homigón
 $A = 0.510 \times 0.300 = 0.153 \text{ m}^2$
 $V = A \times H = 0.153 \times (0.109 + 0.153) \times 2$
 $= 0.080 \text{ m}^3 / \text{Estribo}$

Encofrado
 $A = (0.510 \times 2 + 0.30 \times 2) \times (0.109 + 0.153) \times 2$
 $= 0.849 \text{ m}^2 / \text{Estribo}$

Unidad: mm

	VE	VI	VI	VE
II	109	153	153	109

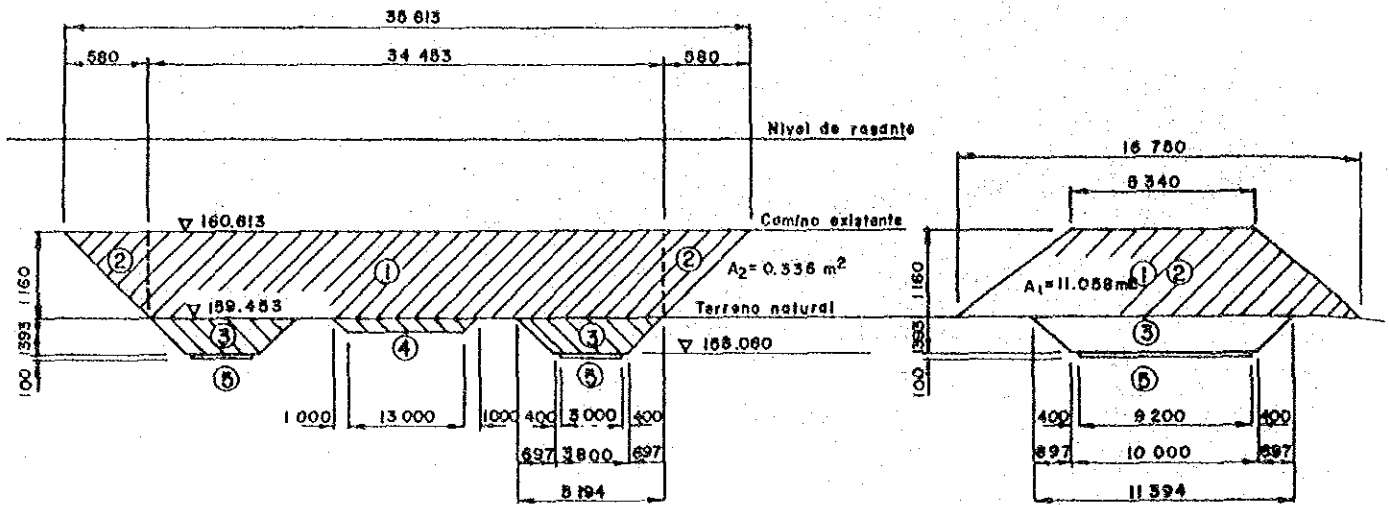
VE: Viga Externa
VI: Viga Interna

(5) Cantidad total de Homigón y Encofrado

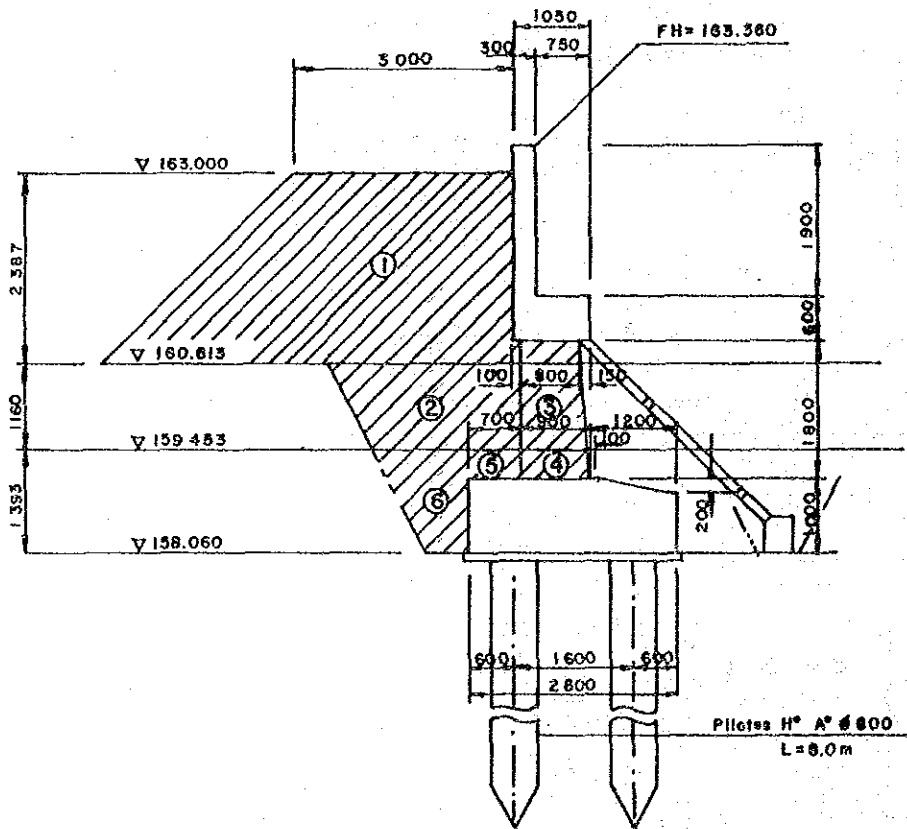
	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Homigón		(53.076×2) 106.152	(0.080×2) 0.160	106.312	(2.944×2) 5.888
Encofrado		(151.287×2) 302.574	(0.849×2) 1.698	304.272	(2.480×2) 4.960

1.5 Puente Tajiho

1) Excavación



Relleno de acompañamiento



(1) Excavación

a) Excavación primaria

1) -A	11.058×34.453	= 381.0	m ³
2) -A	$\sqrt[3]{3 \times 0.336 \times (2 \times 5.34 + 16.750)} \times 2$	= 6.1	m ³
		<hr/>	
V		= 387.1	m ³

b) Excavación secundaria

3) -A	$\sqrt[6]{6 \times 1.393 \times \{(2 \times 5.194 + 4.10 \times 11.394 + (2 \times 4.10 + 5.194) \times 10.3\}} \times 2$	= 140.7	m ³
-R	$\sqrt[6]{6 \times 0.30 \times \{(2 \times 4.10 + 3.8) \times 10.30 + (2 \times 3.8 + 4.1) \times 10.0\}} \times 2$	= 24.1	m ³
4) -A	$\sqrt[2]{(13.00 + 15.00) \times 1.00 \times 21.75}$	= 304.5	m ³
5) -B	$3.00 \times 9.20 \times 0.10 \times 2$	= 5.5	m ³
		<hr/>	
V		= 474.8	m ³

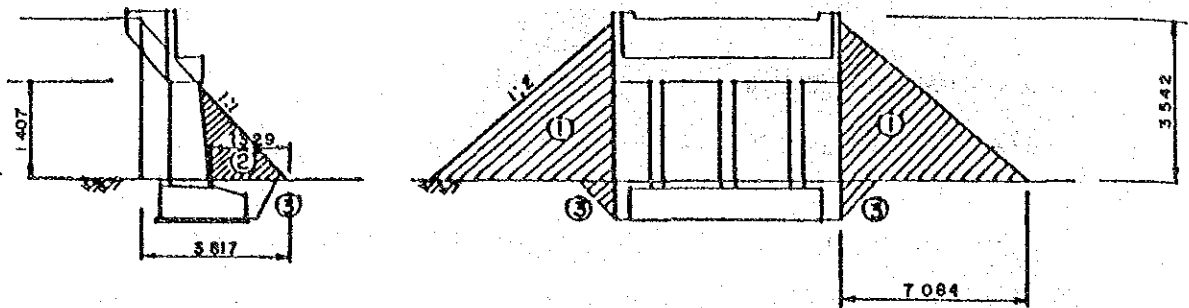
Volúmen total de excavación	861.9 m ³
Excavación con equipos (A)	832.3 m ³
Excavación manual (B)	29.6 m ³

(2) Material de relleno

1)	$\sqrt[2]{(3.0 + 5.387) \times 2.387 \times 10.1}$	= 101.1	m ³
2)	$\sqrt[2]{(1.897 + 2.477) \times 1.160 \times 10.1}$	= 25.6	m ³
3)	$\sqrt[2]{(0.80 + 0.878) \times 1.407 \times (10.1 - 3 \times 0.5)}$	= 10.2	m ³
4)	$\sqrt[2]{(0.878 + 0.900) \times 0.393 \times (10.1 - 3 \times 0.5)}$	= 3.0	m ³
5)	$0.70 \times 0.393 \times 10.1$	= 2.8	m ³
6)	$\sqrt[2]{(0.50 + 1.197) \times 1.393 \times 10.1}$	= 11.9	m ³
		<hr/>	
V		= 154.6	m ³

Volúmen total de relleno	$154.6 \times 2 = 309.2$ m ³
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(3) Volúmen utilizado de material excavado



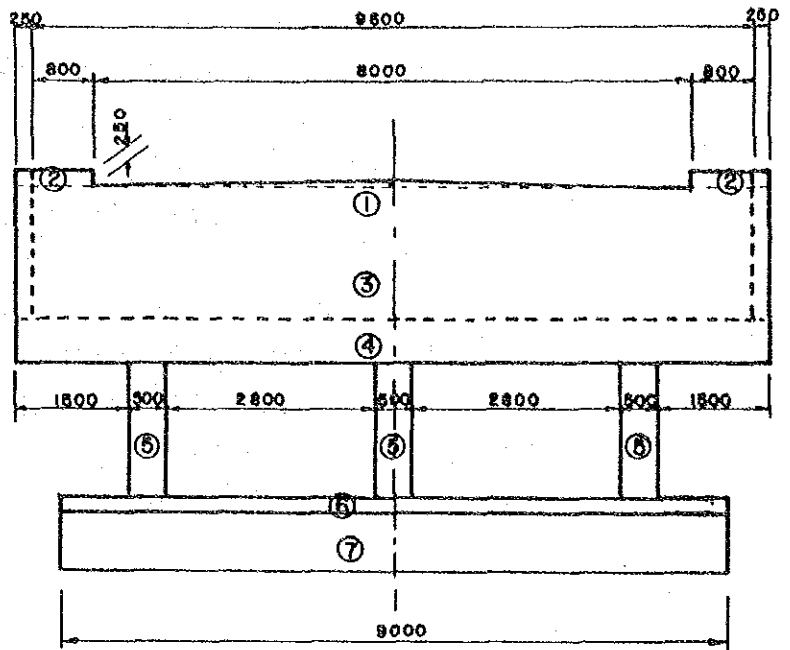
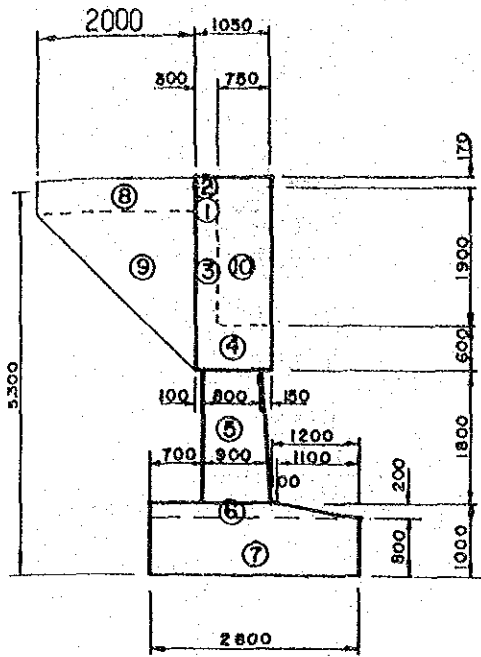
$$\begin{aligned}
 1) & \quad \frac{3}{8} \times \pi \times 3.542^3 \times 2 & = 104.7 \text{ m}^3 \\
 2) & \quad \frac{1}{2} \times 1.407 \times 1.329 \times 10.10 \times 2 & = 18.9 \text{ m}^3 \\
 3) & \quad (104.7 + 24.1) - (1.70 \times 0.2 + \frac{1}{2} \times 1.10 \times 0.20 + 2.8 \times 0.8) \times 10.10 \times 2 \\
 & \quad - (3.0 + 2.8 + 11.9) \times 2 & = 75.1 \text{ m}^3 \\
 \hline
 V & = 198.7 \text{ m}^3
 \end{aligned}$$

Volúmen utilizado 198.7 m³

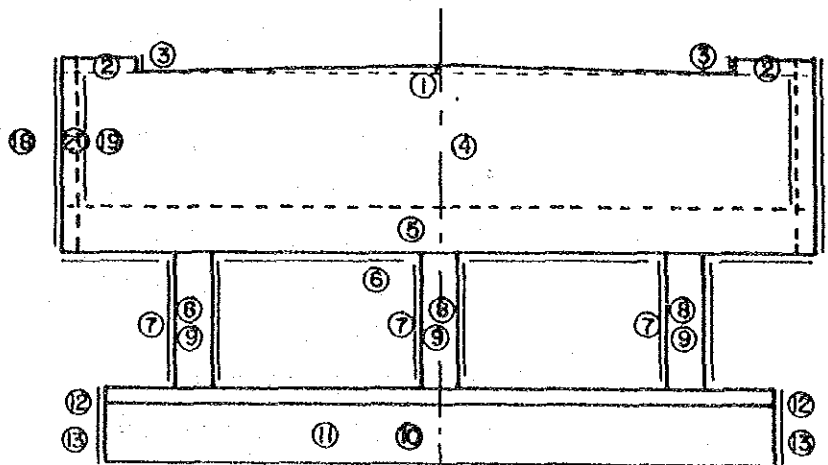
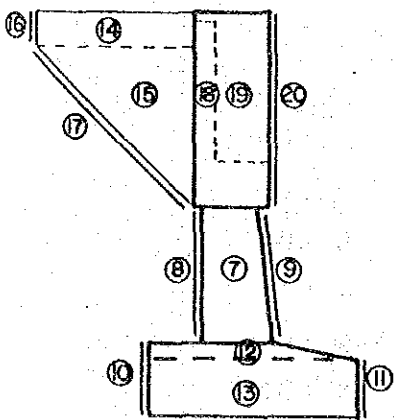
(4) Volúmen excedente de material excavado

$$V = 861.9 - 198.7 = 663.2 \text{ m}^3$$

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo-A)

1) $\frac{1}{2} \times 0.08 \times 4.00 \times 0.30 \times 2$	=	0.096
2) $(0.80 + 0.25) \times 0.30 \times 0.25 \times 2$	=	0.158
3) $(1.90 - 0.08) \times 10.10 \times 0.30$	=	5.515
4) $0.60 \times 10.10 \times 1.050$	=	6.363
5) $\frac{1}{2} (0.80 + 0.90) \times 1.80 \times 0.50 \times 3$	=	2.295
6) $\frac{1}{2} (1.70 + 2.80) \times 0.20 \times 9.00$	=	4.050
7) $2.80 \times 0.80 \times 9.00$	=	20.160
8) $0.67 \times 2.00 \times 0.25 \times 2$	=	0.670
9) $\frac{1}{2} \times 2.00 \times 2.00 \times 0.25 \times 2$	=	1.000
10) $0.75 \times 0.25 \times 2.07 \times 2$	=	0.776
TOTAL	=	41.087 m ³ / Estribo

(2) Encofrado

1) $\frac{1}{2} \times 4.00 \times 0.08 \times 2 \times 2$	=	0.640
2) $0.80 \times 0.25 \times 2 \times 2$	=	0.800
3) $0.25 \times 0.30 \times 2$	=	0.150
4) $(1.90 - 0.08) \times 9.60 \times 2$	=	34.944
5) $0.60 \times 9.60 \times 2$	=	11.520
6) $1.050 \times 10.10 - 0.50 \times 0.80 \times 3$	=	9.405
7) $\frac{1}{2} (0.80 + 0.90) \times 1.80 \times 2 \times 3$	=	9.180
8) $0.50 \times 1.80 \times 3$	=	2.700
9) $\sqrt{0.10^2 + 1.80^2} \times 0.50$	=	0.901
10) 1.00×9.0	=	9.000
11) 0.80×9.0	=	7.200
12) $\frac{1}{2} (1.70 + 2.80) \times 0.20 \times 2$	=	0.900
13) $0.80 \times 2.80 \times 2$	=	4.480
14) $0.67 \times 2.00 \times 2 \times 2$	=	5.360
15) $\frac{1}{2} \times 2.00 \times 2.00 \times 2 \times 2$	=	8.000
16) $0.67 \times 0.25 \times 2$	=	0.335
17) $\sqrt{2.00^2 + 2.00^2} \times 0.25 \times 2$	=	1.414

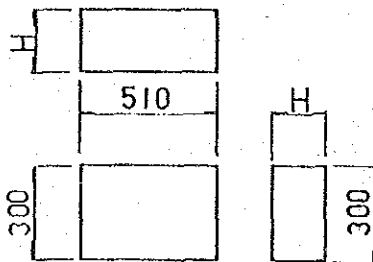
$$\begin{aligned}
 18) & 1.05 \times 2.67 \times 2 & = & 5.607 \\
 19) & 0.75 \times 2.07 \times 2 & = & 3.105 \\
 20) & 0.25 \times 2.67 \times 2 & = & 1.335
 \end{aligned}$$

TOTAL = 116.976 m²/Estribo

(3) Hormigón Pobre (Tipo-F)

$$\begin{aligned}
 (\text{Hormigón}) & 3.0 \times 9.2 \times 0.10 & = & 2.760 \text{ m}^3 / \text{Estribo} \\
 (\text{Encofrado}) & 3.0 \times 0.10 \times 2 + 9.2 \times 0.10 \times 2 & = & 2.440 \text{ m}^2 / \text{Estribo}
 \end{aligned}$$

(4) Hormigón para asiento de apoyo
Grupos 11, 111 30m



Hormigón

$$\begin{aligned}
 A &= 0.510 \times 0.300 = 0.153 \text{ m}^2 \\
 V &= A \times H = 0.153 \times (0.109 + 0.153) \times 2 \\
 &= 0.080 \text{ m}^3 / \text{Estribo}
 \end{aligned}$$

Encofrado

$$\begin{aligned}
 A &= (0.510 \times 2 + 0.30 \times 2) \times (0.109 + 0.153) \times 2 \\
 &= 0.849 \text{ m}^2 / \text{Estribo}
 \end{aligned}$$

Unidad: mm

	VE	VI	VI	VE
H	109	153	153	109

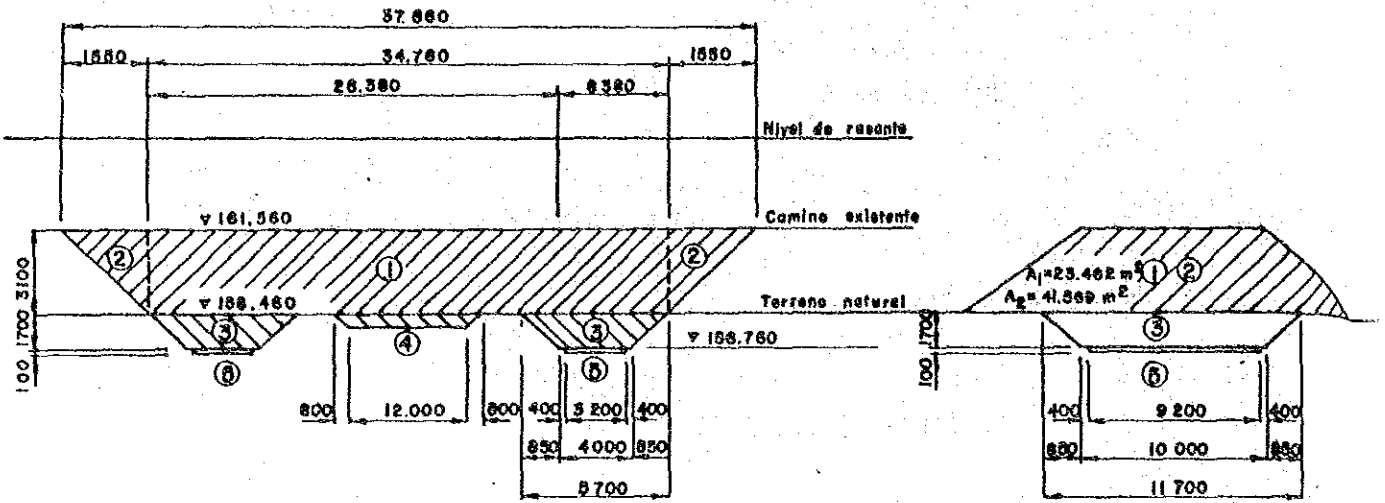
VE:Viga Externa
VI:Viga Interna

(5) Cantidad total de Hormigón y Encofrado

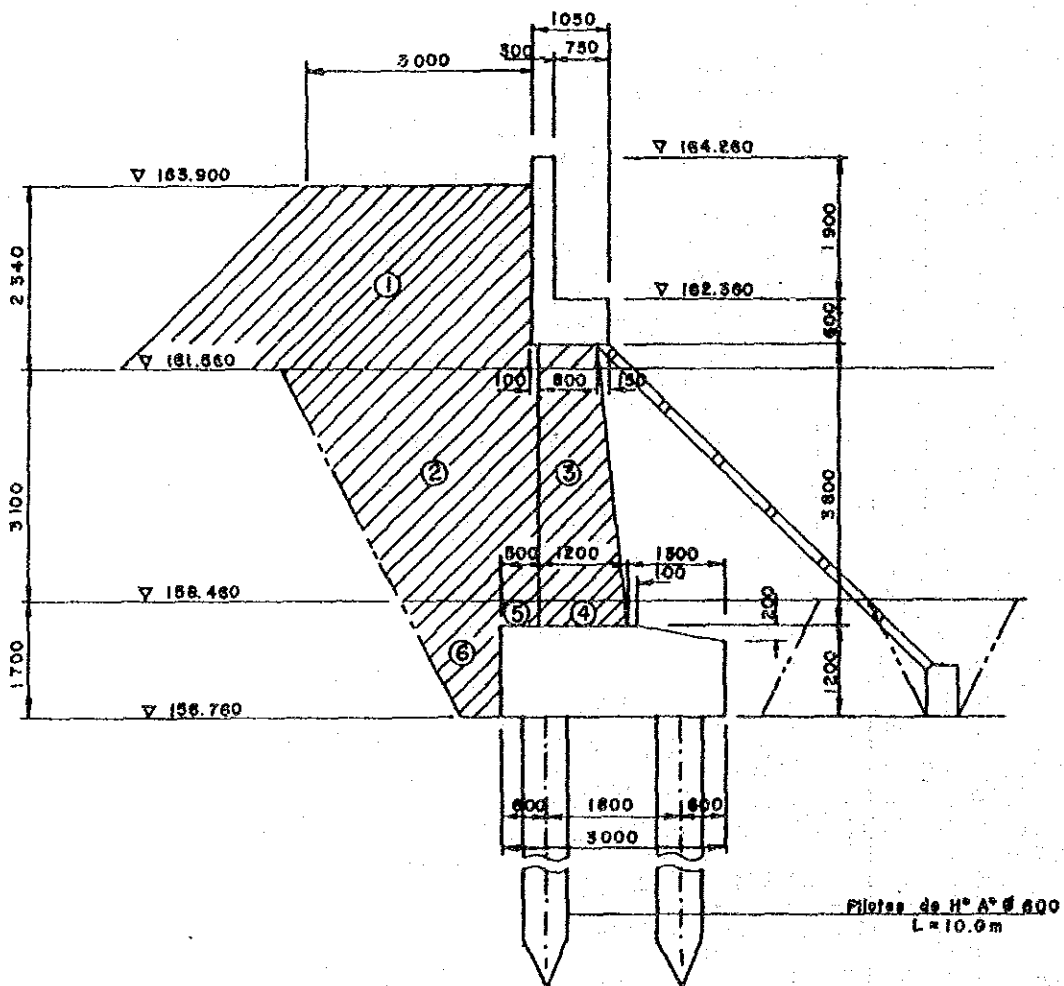
	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Hormigón		(41.087 × 2) 82.174	(0.080 × 2) 0.160	82.334	(2.760 × 2) 5.520
Encofrado		(116.976 × 2) 233.952	(0.849 × 2) 1.698	235.650	(2.440 × 2) 4.880

1.6 Puente Mururita

1) Excavación



Relleno de acompañamiento



(1) Excavación

a) Excavación primaria

$$\begin{aligned} 1)-A & 23.462 \times 26.380 + 41.569 \times 8.380 - \frac{1}{4} \pi \times 1.80^2 \times 9.30 \times 3 & = 896.3 \text{ m}^3 \\ 2)-A & \frac{1}{3} \times 2.403 \times (2 \times 7.700 + 10.200) + \frac{1}{3} \times 2.403 \times (2 \times 11.10 + 16.50) & = 51.5 \text{ m}^3 \\ & & \underline{V = 947.8 \text{ m}^3} \end{aligned}$$

b) Excavación secundaria

$$\begin{aligned} 3)-A & \frac{1}{6} \times 1.70 \times \{ (2 \times 5.70 + 4.30) \times 11.70 + (2 \times 4.30 + 5.70) \times 10.3 \} \times 2 & = 187.6 \text{ m}^3 \\ & -B & \frac{1}{6} \times 0.30 \times \{ (2 \times 4.30 + 4.0) \times 10.30 + (2 \times 4.0 + 4.3) \times 10.0 \} \times 2 & = 25.3 \text{ m}^3 \\ 4)-A & \frac{1}{2} (12.00 + 13.60) \times 0.80 \times 12.150 & = 124.4 \text{ m}^3 \\ 5)-B & 3.20 \times 9.20 \times 0.10 \times 2 & = 5.9 \text{ m}^3 \\ & & \underline{V = 343.2 \text{ m}^3} \end{aligned}$$

Volúmen total de excavación 1291.0 m³

Excavación con equipos (A) 1259.8 m³

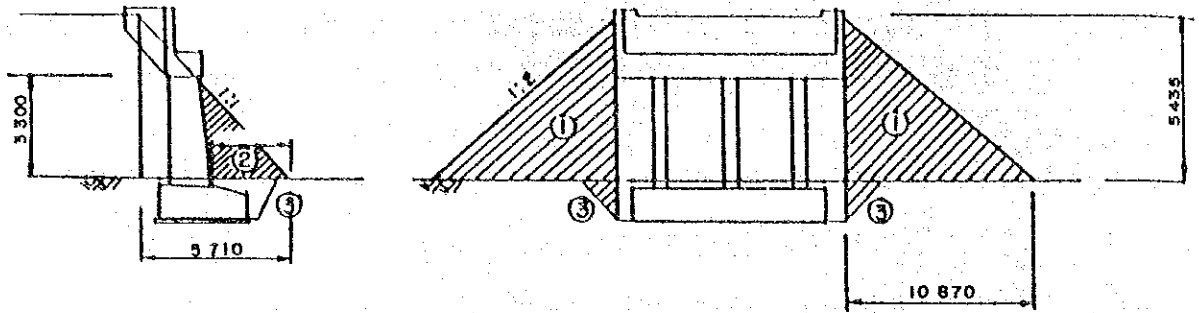
Excavación manual (B) 31.2 m³

(2) Material de Relleno

$$\begin{aligned} 1) & \frac{1}{2} (3.0 + 5.340) \times 2.340 \times 10.1 & = 98.6 \text{ m}^3 \\ 2) & \frac{1}{2} (1.85 + 3.400) \times 3.19 \times 10.1 & = 84.6 \text{ m}^3 \\ 3) & \frac{1}{2} (0.80 + 1.87) \times 3.50 \times (10.1 - 3 \times 0.5) & = 29.9 \text{ m}^3 \\ 4) & \frac{1}{2} (1.187 + 1.20) \times 0.30 \times (10.1 - 3 \times 0.5) & = 3.1 \text{ m}^3 \\ 5) & 0.50 \times 0.30 \times 10.1 & = 1.5 \text{ m}^3 \\ 6) & \frac{1}{2} (0.50 + 1.35) \times 1.70 \times 10.1 & = 15.9 \text{ m}^3 \\ & & \underline{V = 233.6 \text{ m}^3} \end{aligned}$$

Volúmen total de relleno $233.6 \times 2 = 467.2 \text{ m}^3$

(3). Volúmen utilizado de material excavado



$$\begin{aligned}
 1) \quad & 3/8 \times \pi \times 5.435^3 \times 2 & = 378.3 \text{ m}^3 \\
 2) \quad & 1/2 \times 3.30 \times 2.913 \times 10.10 \times 2 & = 97.1 \text{ m}^3 \\
 3) \quad & (187.6 + 25.3) - (1.80 \times 0.2 + 1/2 \times 1.20 \times 0.20 + 3.0 \times 1.0) \times 10.10 \times 2 \\
 & - (3.1 + 1.5 + 15.9) \times 2 & = 101.6 \text{ m}^3 \\
 \hline
 & & V = 577.0 \text{ m}^3
 \end{aligned}$$

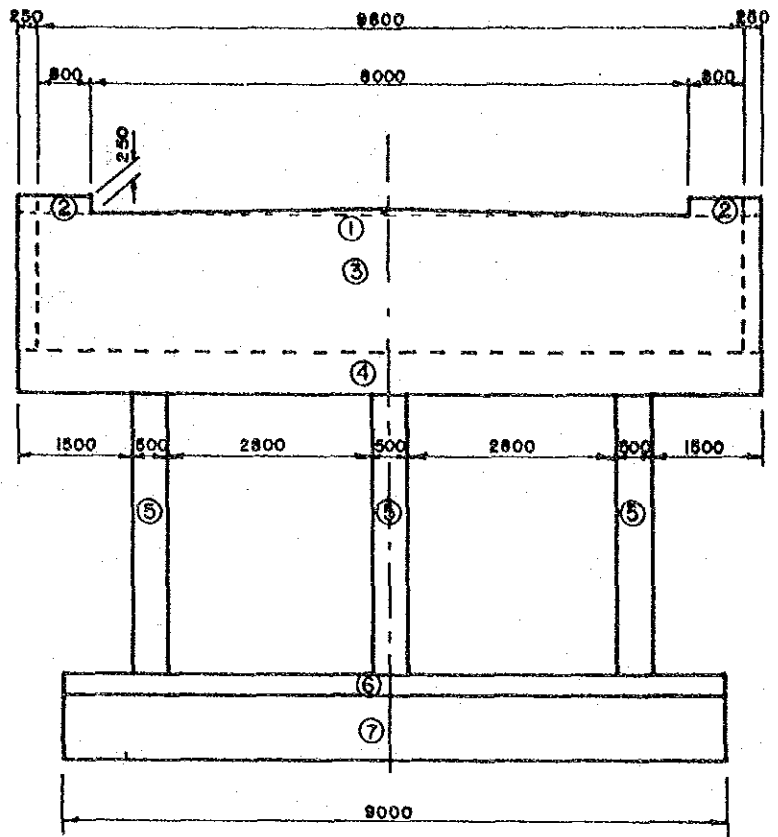
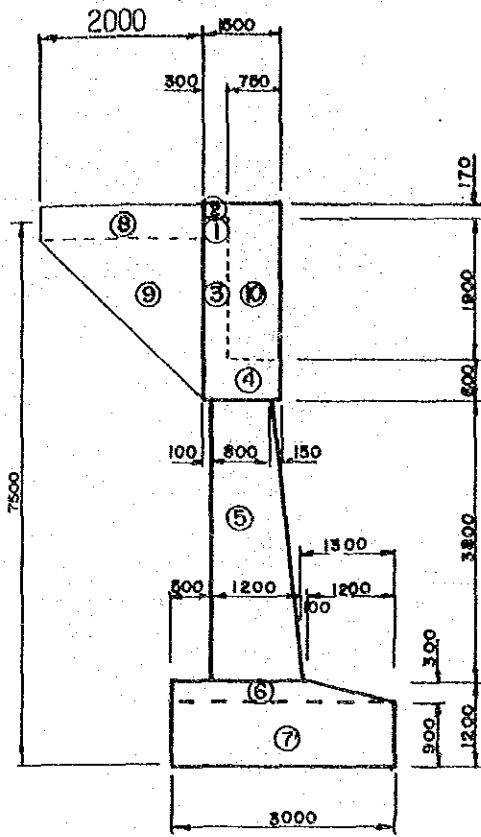
Volúmen utilizado 577.0 m³

(4) Volúmen excedente de material excavado

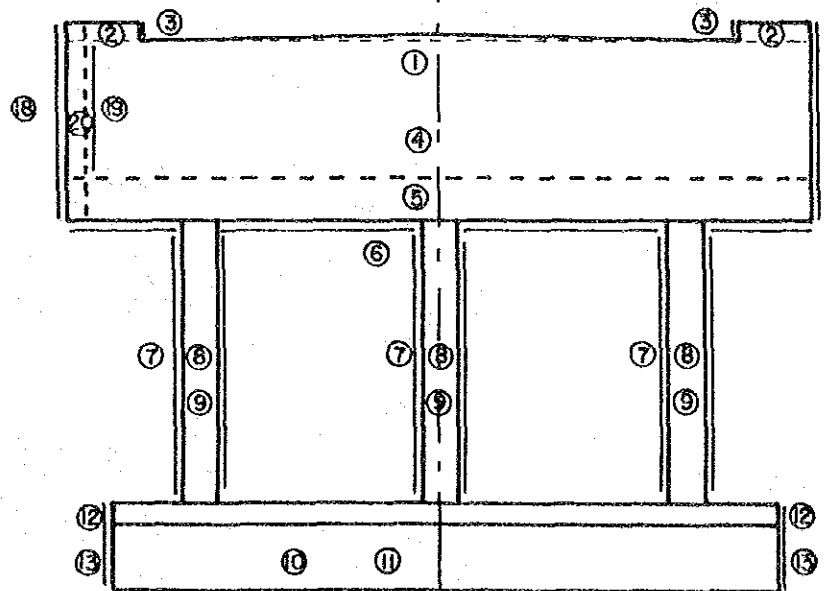
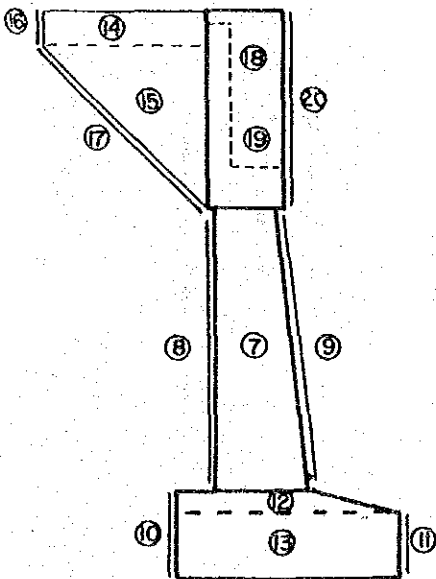
$$V = 1,291.0 - 577.0 = 714.0 \text{ m}^3$$

Puente Mururita

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo-A)

1) $\frac{1}{2} \times 0.08 \times 4.00 \times 0.30 \times 2$	=	0.096
2) $1.05 \times 0.25 \times 0.30 \times 2$	=	0.158
3) $(1.90 - 0.08) \times 10.10 \times 0.30$	=	5.515
4) $0.60 \times 1.050 \times 10.10$	=	6.363
5) $\frac{1}{2} (0.80 + 1.20) \times 3.80 \times 0.50 \times 3$	=	5.700
6) $\frac{1}{2} (1.8 + 3.0) \times 0.20 \times 9.0$	=	4.320
7) $1.00 \times 3.00 \times 9.00$	=	27.000
8) $0.67 \times 2.00 \times 0.25 \times 2$	=	0.670
9) $2.00 \times 2.00 \times 0.25 \times 2 \times \frac{1}{2}$	=	1.000
10) $0.75 \times 2.070 \times 2 \times 0.25$	=	0.776
		<hr/>
TOTAL	=	51.598 m ³ / Estribo

(2) Encofrado

1) $\frac{1}{2} \times 0.08 \times 4.00 \times 2 \times 2$	=	0.640
2) $0.25 \times 0.80 \times 2 \times 2$	=	0.800
3) $0.25 \times 0.30 \times 2$	=	0.150
4) $(1.90 - 0.08) \times 9.60 \times 2$	=	34.944
5) $0.60 \times 9.60 \times 2$	=	11.520
6) $1.05 \times 10.10 - 0.50 \times 0.80 \times 3$	=	9.405
7) $\frac{1}{2} (0.80 + 1.20) \times 3.80 \times 2 \times 3$	=	22.800
8) $0.50 \times 3.80 \times 3$	=	5.700
9) $\sqrt{0.40^2 + 3.80^2} \times 0.50 \times 3$	=	5.731
10) 1.20×9.00	=	10.800
11) 1.00×9.00	=	9.000
12) $\frac{1}{2} (1.8 + 3.0) \times 0.20 \times 2$	=	0.960
13) $1.0 \times 3.0 \times 2$	=	6.000
14) $0.67 \times 2.00 \times 2 \times 2$	=	5.360
15) $\frac{1}{2} \times 2.00 \times 2.00 \times 2 \times 2$	=	8.000
16) $0.67 \times 0.25 \times 2$	=	0.335
17) $\sqrt{2.0^2 + 2.0^2} \times 0.25 \times 2$	=	1.414

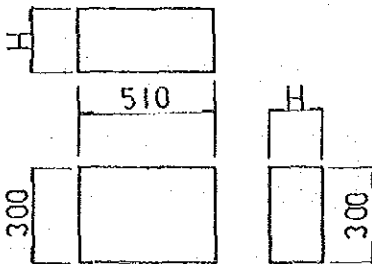
$$\begin{aligned}
 18) & 1.05 \times 2.67 \times 2 & = & 5.607 \\
 19) & 0.75 \times 2.07 \times 2 & = & 3.105 \\
 20) & 2.67 \times 0.25 \times 2 & = & 1.335
 \end{aligned}$$

$$\text{TOTAL} = 143.606 \text{ m}^2 / \text{Estribo}$$

(3) Hormigón Pobre (Tipo - F)

$$\begin{aligned}
 (\text{Hormigón}) & 3.20 \times 0.10 \times 9.20 & = & 2.944 \text{ m}^3 / \text{Estribo} \\
 (\text{Encofrado}) & 3.20 \times 0.10 \times 2 + 9.20 \times 0.10 \times 2 & = & 2.480 \text{ m}^2 / \text{Estribo}
 \end{aligned}$$

(4) Hormigón para asiento de apoyo
Grupos 11, 111 30m



$$\begin{aligned}
 \text{Hormigón} \\
 A &= 0.510 \times 0.300 = 0.153 \text{ m}^2 \\
 V &= A \times H = 0.153 \times (0.109 + 0.153) \times 2 \\
 &= 0.080 \text{ m}^3 / \text{Estribo}
 \end{aligned}$$

$$\begin{aligned}
 \text{Encofrado} \\
 A &= (0.510 \times 2 + 0.30 \times 2) \times (0.109 + 0.153) \times 2 \\
 &= 0.849 \text{ m}^2 / \text{Estribo}
 \end{aligned}$$

Unidad: mm

	VE	VI	VI	VE
H	109	153	153	109

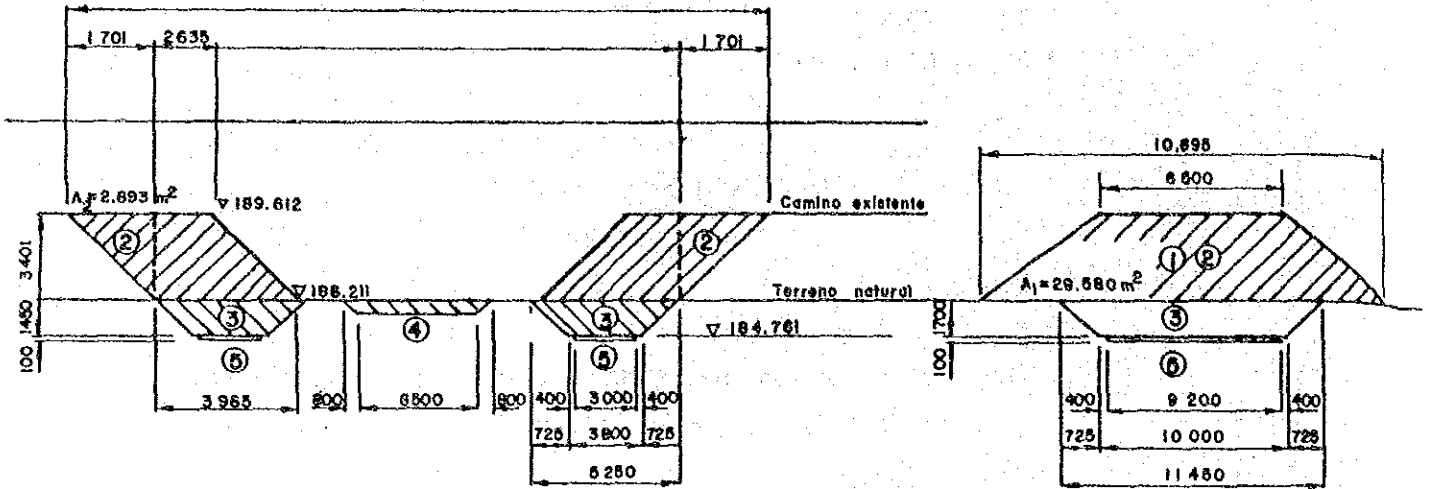
VE: Viga Externa
VI: Viga Interna

(5) Cantidad total de Hormigón y Encofrado

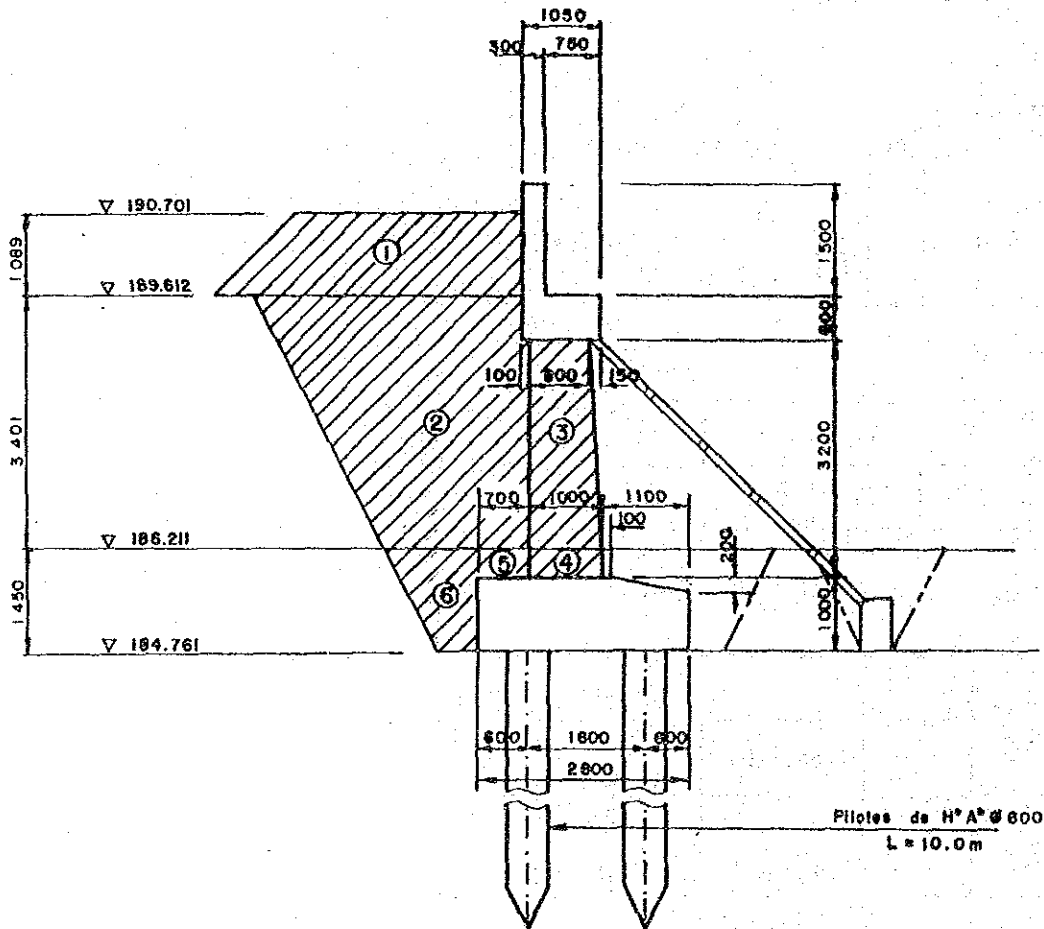
	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Hormigón		(51.598 × 2)	(0.080 × 2)	103.356	(2.944 × 2)
		103.196	0.160		5.888
Encofrado		(143.606 × 2)	(0.849 × 2)	288.910	(2.480 × 2)
		287.212	1.698		4.960

1.7 Puente Curirabita

1) Excavacion



relleno de acompañamiento



(1) Excavación

a) Excavación primaria

$$1) -A \quad 29.580 \times \frac{1}{2} (2.635 + 3.965) \times 2 = 195.2 \text{ m}^3$$

$$2) -A \quad \frac{1}{3} \times 2.893 \times (2 \times 6.5 + 10.895) \times 2 = \frac{46.1 \text{ m}^3}{V = 241.3 \text{ m}^3}$$

b) Excavación Secundaria

$$3) -A \quad \frac{1}{6} \times 1.150 \times \left\{ (2 \times 5.25 + 4.100) \times 11.450 + (2 \times 4.10 + 5.250) \times 10.3 \right\} \times 2 = 117.2 \text{ m}^3$$

$$-B \quad \frac{1}{6} \times 0.30 \times \left\{ (2 \times 4.10 + 3.8) \times 10.30 + (2 \times 3.80 + 4.10) \times 10.0 \right\} \times 2 = 24.1 \text{ m}^3$$

$$4) -A \quad \frac{1}{2} (6.50 + 8.10) \times 0.80 \times 28.04 = 163.8 \text{ m}^3$$

$$5) -B \quad 3.0 \times 9.2 \times 0.10 \times 2 = 5.5 \text{ m}^3$$

Volúmen total de excavación 551.9 m³

Excavación con equipos (A) 522.3 m³

Excavación manual (B) 29.6 m³

(2) Material de relleno

$$1) \quad \frac{1}{2} \times (3.0 + 4.089) \times 1.089 \times 10.1 = 39.0 \text{ m}^3$$

$$2) \quad \frac{1}{2} (1.925 + 3.626) \times 3.401 \times 10.1 = 95.3 \text{ m}^3$$

$$3) \quad \frac{1}{2} (0.80 + 0.972) \times 2.750 \times (10.1 - 3 \times 0.5) = 21.0 \text{ m}^3$$

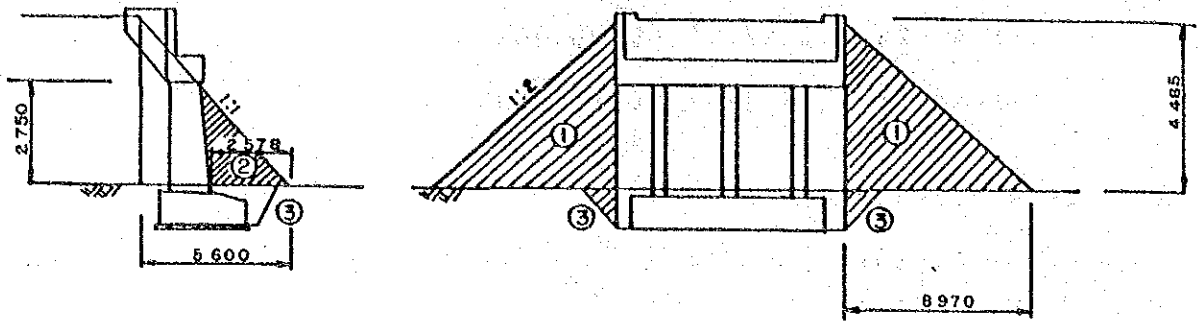
$$4) \quad \frac{1}{2} (0.972 + 1.00) \times 0.450 \times (10.1 - 3 \times 0.50) = 0.4 \text{ m}^3$$

$$5) \quad 0.70 \times 0.450 \times 10.1 = 3.2 \text{ m}^3$$

$$6) \quad \frac{1}{2} (0.50 + 1.225) \times 1.450 \times 10.1 = \frac{12.6 \text{ m}^3}{V = 171.5 \text{ m}^3}$$

Volúmen total de relleno $171.5 \times 2 = 343.0 \text{ m}^3$

3. Volumen utilizado de material excavado



$$\begin{aligned}
 1) & \frac{3}{8} \times \pi \times 4.485^3 \times 2 & = 212.6 \text{ m}^3 \\
 2) & \frac{1}{2} \times 2.750 \times 2.578 \times 10.10 \times 2 & = 71.6 \text{ m}^3 \\
 3) & (117.2 + 24.3) - (1.80 \times 0.2 + \frac{1}{2} \times 1.10 \times 0.20 + 2.8 \times 0.8) \\
 & \times 10.10 \times 2 - (0.4 + 3.2 + 12.6) \times 2 & = 54.4 \text{ m}^3 \\
 & & \underline{V = 338.6 \text{ m}^3}
 \end{aligned}$$

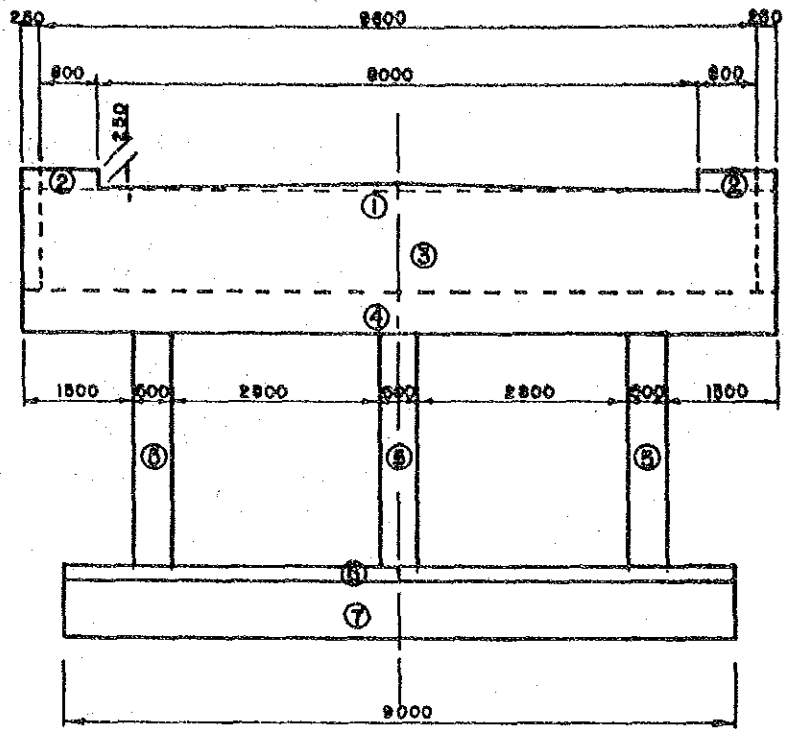
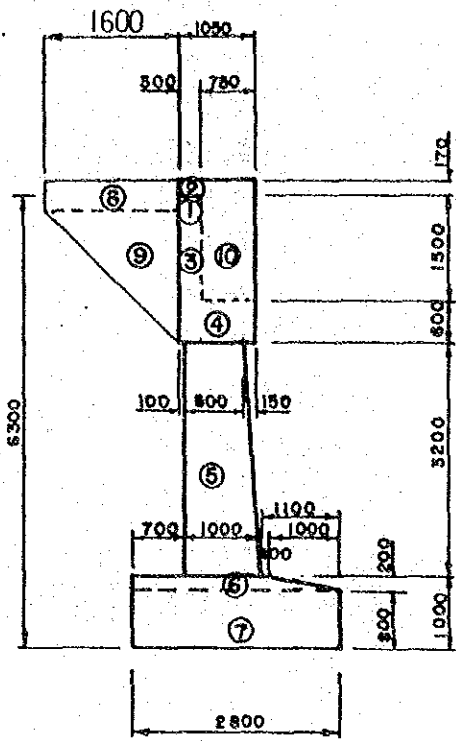
Volumen utilizado 338.6 m³

4. Volumen excedente de material excavado

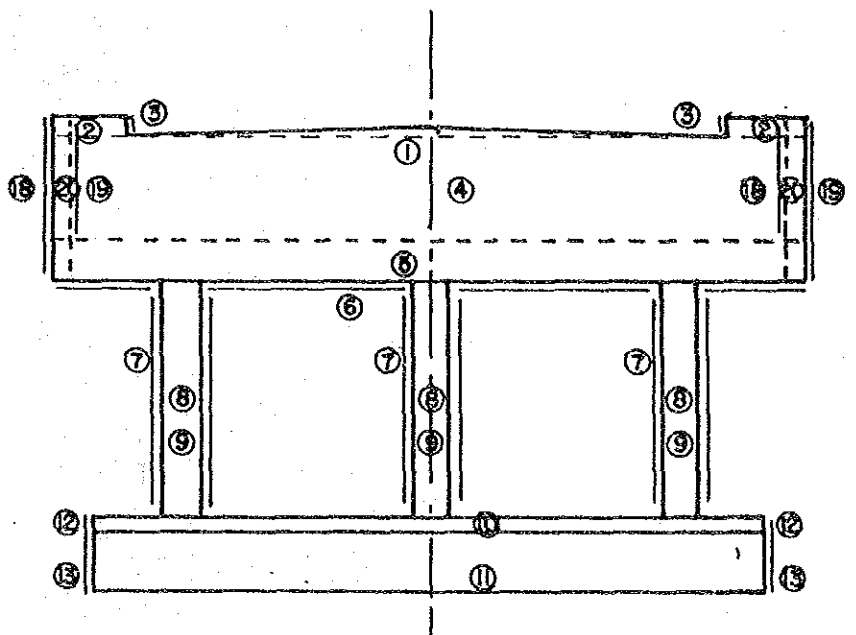
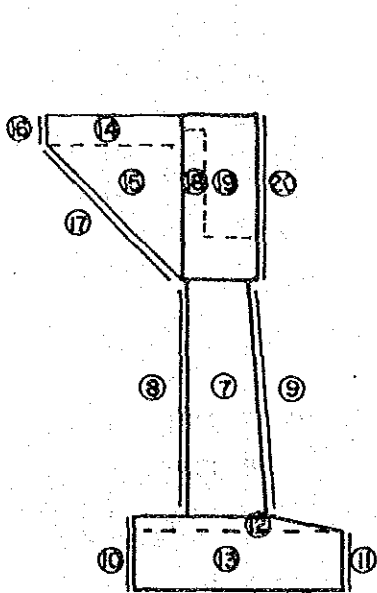
$$V = 551.9 - 338.6 = 213.3 \text{ m}^3$$

Puente Curirabita

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo-A)

1) $\frac{1}{2} \times 4.00 \times 0.08 \times 0.30 \times 2$	= 0.096
2) $(0.25 + 0.80) \times 0.25 \times 0.30 \times 2$	= 0.158
3) $(1.50 - 0.08) \times 10.10 \times 0.30$	= 4.303
4) $0.60 \times 10.10 \times 1.050$	= 6.363
5) $\frac{1}{2} (0.80 + 1.00) \times 3.20 \times 0.50 \times 3$	= 4.320
6) $\frac{1}{2} (1.80 + 2.80) \times 0.200 \times 9.00$	= 4.140
7) $2.80 \times 0.80 \times 9.00$	= 20.160
8) $0.670 \times 1.60 \times 0.25 \times 2$	= 0.536
9) $\frac{1}{2} \times 1.60 \times 1.60 \times 0.25 \times 2$	= 0.640
10) $0.75 \times 1.670 \times 0.25 \times 2$	= 0.626

TOTAL = 41.342 m³ / Estribo

(2) Encofrado

1) $\frac{1}{2} \times 0.08 \times 4.00 \times 2 \times 2$	= 0.640
2) $0.250 \times 0.80 \times 2 \times 2$	= 0.800
3) $0.250 \times 0.30 \times 2$	= 0.150
4) $(1.50 - 0.08) \times 9.60 \times 2$	= 27.264
5) $0.60 \times 9.60 \times 2$	= 11.520
6) $1.050 \times 10.10 - 0.50 \times 0.80 \times 3$	= 9.405
7) $\frac{1}{2} (0.80 + 1.00) \times 3.2 \times 2 \times 3$	= 17.280
8) $0.50 \times 3.20 \times 3$	= 4.800
9) $\sqrt{0.20^2 + 3.20^2} \times 0.50 \times 3$	= 4.809
10) 1.00×9.00	= 9.000
11) 0.80×9.0	= 7.200
12) $\frac{1}{2} (1.8 + 2.80) \times 0.20 \times 2$	= 0.920
13) $0.80 \times 2.80 \times 2$	= 4.480
14) $0.67 \times 1.60 \times 2 \times 2$	= 4.288
15) $\frac{1}{2} \times 1.60 \times 1.60 \times 2 \times 2$	= 5.120
16) $0.67 \times 0.25 \times 2$	= 0.335
17) $\sqrt{1.60^2 + 1.60^2} \times 0.25 \times 2$	= 1.131

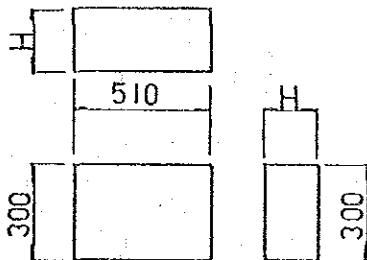
$$\begin{aligned}
 18) & 1.050 \times 2.27 \times 2 & = & 4.767 \\
 19) & 0.75 \times 1.67 \times 2 & = & 2.505 \\
 20) & 0.25 \times 2.27 \times 2 & = & 1.135
 \end{aligned}$$

$$\text{TOTAL} = 117.549 \text{ m}^2 / \text{Estribo}$$

(3) Hormigón Pobre (Tipo-F)

$$\begin{aligned}
 (\text{Hormigón}) & 3.0 \times 9.20 \times 0.10 & = & 2.760 \text{ m}^3 / \text{Estribo} \\
 (\text{Encofrado}) & 3.0 \times 0.1 \times 2 + 9.20 \times 0.10 \times 2 & = & 2.440 \text{ m}^2 / \text{Estribo}
 \end{aligned}$$

(4) Hormigón para asiento de apoyo
Grupos 11, 111 30m



Hormigón
 $A = 0.460 \times 0.300 = 0.138 \text{ m}^2$
 $V = A \times H = 0.138 \times (0.117 + 0.161) \times 2$
 $= 0.077 \text{ m}^3 / \text{Estribo}$

Encofrado
 $A = (0.460 \times 2 + 0.30 \times 2) \times (0.117 + 0.161) \times 2$
 $= 0.845 \text{ m}^2 / \text{Estribo}$

Unidad:mm

	VE	VI	VI	VE
H	117	161	161	117

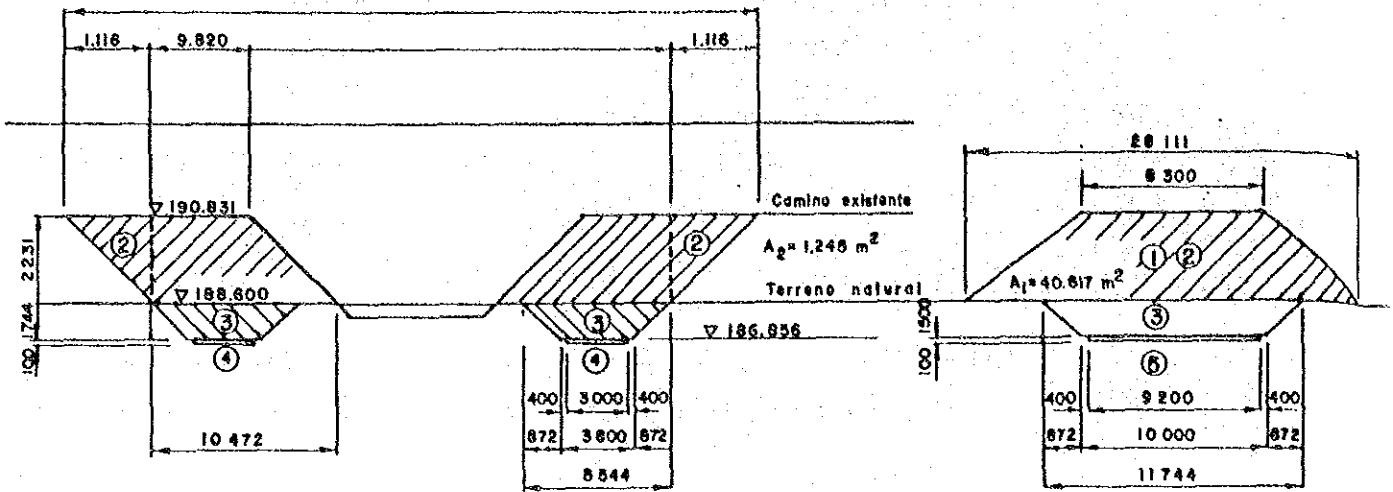
VE:Viga Externa
VI:Viga Interna

(5) Cantidad total de Hormigón y Encofrado

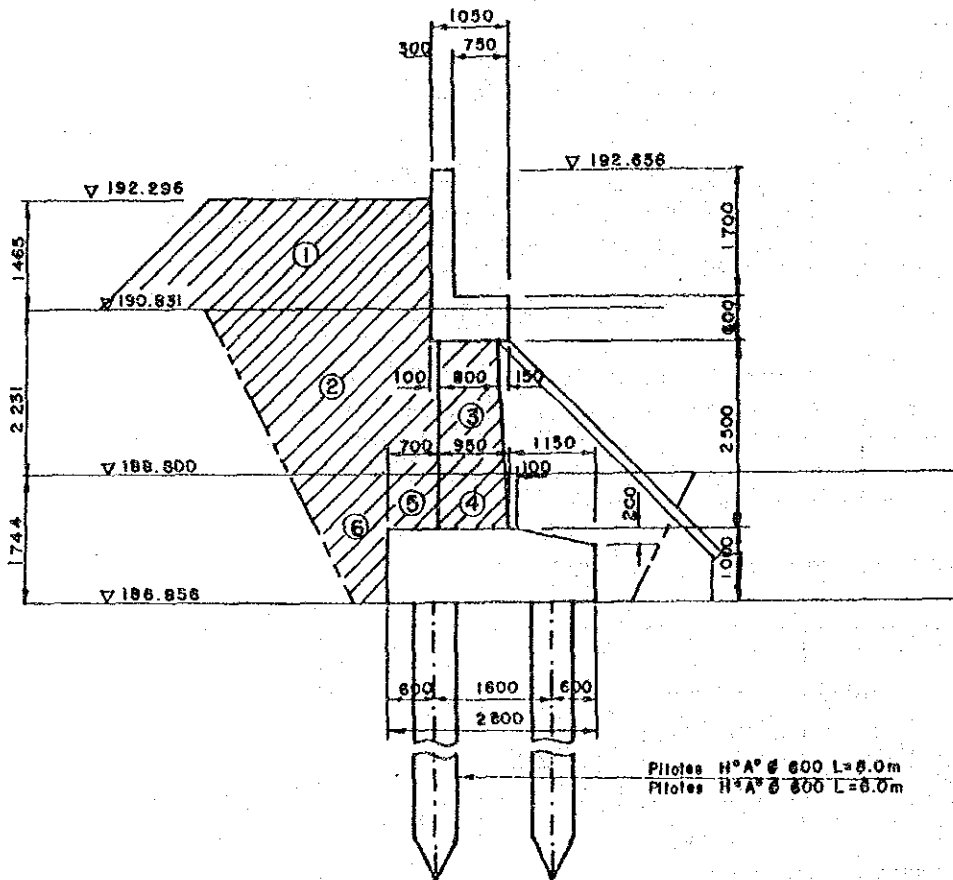
	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Hormigón		(41.342×2) 82.684	(0.077×2) 0.154	82.838	(2.760×2) 5.520
Encofrado		(117.549×2) 235.098	(0.845×2) 1.690	236.788	(2.440×2) 4.880

1.8 Puente Curiraba

1) Excavación



Relleno de acompañamiento



(1) Excavación

a) Excavación primaria

1) -A $1/2 \times (9.820 + 10.472) \times 40.617 \times 2 = 824.2 \text{ m}^3$

2) -A $1/3 \times 1.245 \times (2 \times 8.300 + 28.111) \times 2 = 37.1 \text{ m}^3$

V = 861.3 m³

b) Excavación secundaria

3) -A $1/6 \times 1.744 \times \{ (2 \times 5.544 + 4.10) \times 11.744 + (2 \times 4.10 + 5.544) \times 10.3 \} \times 2 = 186.0 \text{ m}^3$

-B $1/6 \times 0.30 \times \{ (2 \times 4.10 + 3.80) \times 10.30 + (2 \times 3.80 + 4.10) \times 10.0 \} \times 2 = 24.1 \text{ m}^3$

4) - B $3.00 \times 9.20 \times 0.10 \times 2 = 5.5 \text{ m}^3$

V = 1076.9 m³

Volumen total de excavación 1076.9 m³

Excavación con equipos (A) 1047.3 m³

Excavación manual (B) 29.6 m³

(2) Material de relleno

1) $1/2 \times (3.0 + 4.465) \times 1.465 \times 10.1 = 55.2 \text{ m}^3$

2) $1/2 \times (2.072 + 3.188) \times 2.231 \times 10.1 = 59.3 \text{ m}^3$

3) $1/2 \times (0.80 + 0.905) \times 2.231 \times (10.1 - 3 \times 0.5) = 16.4 \text{ m}^3$

4) $1/2 \times (0.905 + 0.95) \times 0.744 \times (10.1 - 3 \times 0.5) = 5.9 \text{ m}^3$

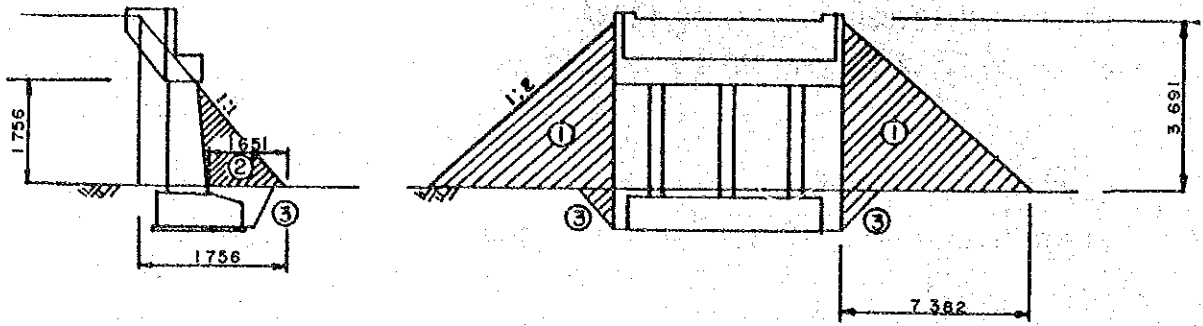
5) $0.70 \times 0.744 \times 10.1 = 5.3 \text{ m}^3$

6) $1/2 \times (0.50 + 1.372) \times 1.744 \times 10.1 = 16.5 \text{ m}^3$

V = 158.6 m³

Volumen total de relleno $158.6 \times 2 = 317.2 \text{ m}^3$

(3) Volúmen utilizado de material excavado



$$\begin{aligned} 1) & \frac{3}{8} \times \pi \times 3.691^3 \times 2 & = & 118.5 \text{ m}^3 \\ 2) & \frac{1}{2} \times 1.756 \times 1.651 \times 10.10 \times 2 & = & 29.3 \text{ m}^3 \\ 3) & (186.0 + 24.1) - (1.75 \times 0.2 + \frac{1}{2} \times 1.05 \times 0.20 + 2.8 \\ & \times 0.8) \times 10.10 \times 2 - (5.9 + 5.3 + 16.5) \times 2 & = & 100.3 \text{ m}^3 \\ & & \underline{\hspace{10em}} & \\ & & V = & 248.1 \text{ m}^3 \end{aligned}$$

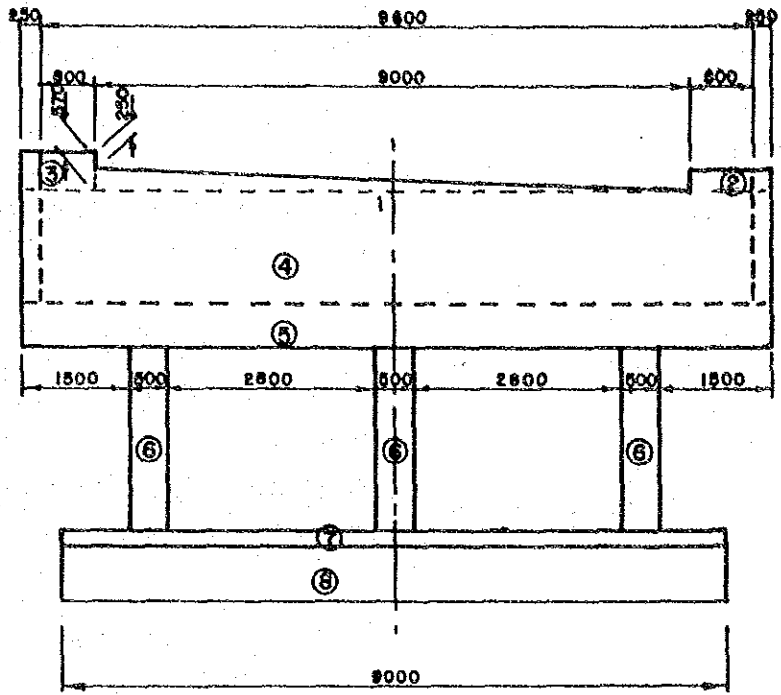
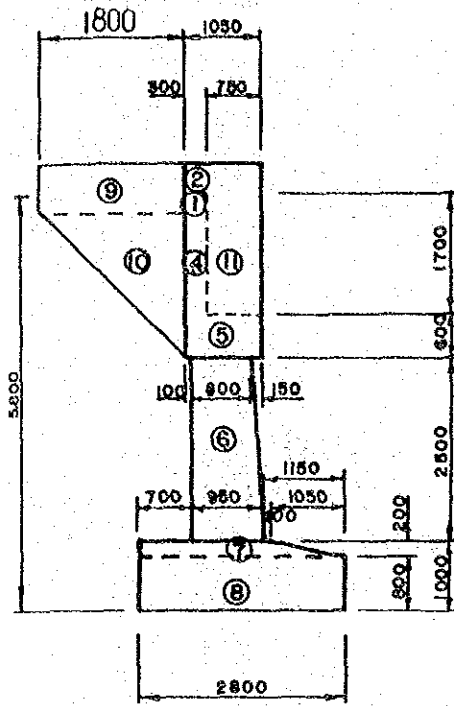
Volúmen utilizado 248.1 m³

(4) Volúmen excedente de material excavado

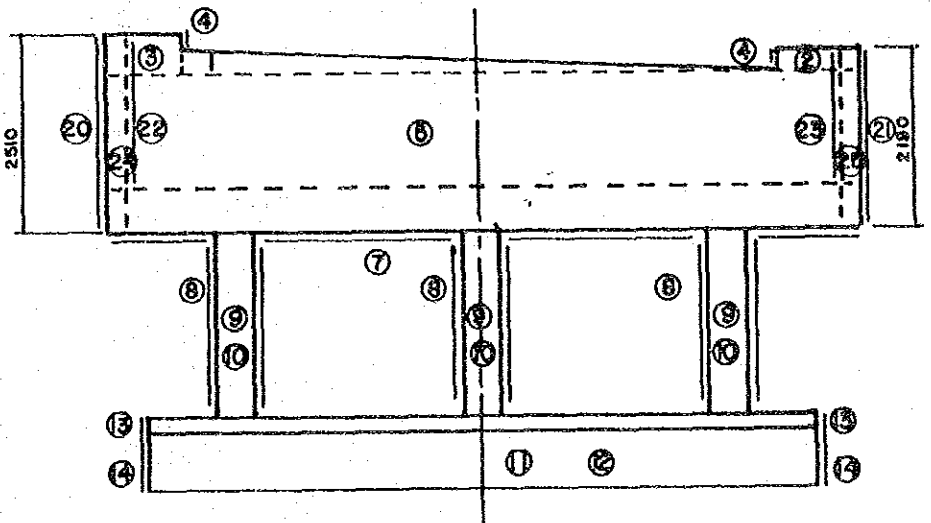
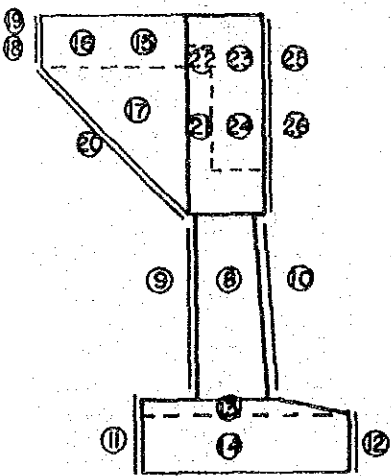
$$V = 1,076.9 - 248.1 = 828.8 \text{ m}^3$$

Puente Curiraba

Numeraciones para hormigón



Numeraciones para encofrado



(1) Hormigón (Tipo-A)

1) $\frac{1}{2} \times 0.32 \times 8.0$	=	1.280
2) $0.25 \times (0.80 + 0.25) \times 0.30$	=	0.079
3) $0.57 \times (0.80 + 0.25) \times 0.30$	=	0.180
4) $(1.70 - 0.16) \times 10.10 \times 0.30$	=	4.666
5) $0.60 \times 1.050 \times 10.10$	=	6.363
6) $\frac{1}{2} (0.80 + 0.95) \times 2.50 \times 0.50 \times 3$	=	3.281
7) $\frac{1}{2} (1.75 + 2.80) \times 0.20 \times 9.00$	=	4.095
8) $2.80 \times 0.80 \times 9.00$	=	20.160
9) $0.670 \times 0.25 \times 1.80 + 0.670 \times 0.25 \times 1.80$	=	0.603
10) $\frac{1}{2} \times 1.80 \times 2.04 \times 0.25 + \frac{1}{2} \times 1.80 \times 1.72$ $\times 0.25$	=	0.846
11) $0.75 \times (2.11 + 1.79) \times 0.25$	=	0.731
TOTAL		= 42.284 m ³ / Estribo

(2) Encofrado

1) $\frac{1}{2} \times 0.32 \times 8.0 \times 2$	=	2.560
2) $0.25 \times 0.80 \times 2$	=	0.400
3) $(0.32 + 0.25) \times 0.80 \times 2$	=	0.912
4) $0.25 \times 0.30 \times 2$	=	0.150
5) $(1.70 - 0.16) \times 9.60 \times 2$	=	29.568
6) $0.60 \times 9.60 \times 2$	=	11.520
7) $1.050 \times 10.10 - 0.80 \times 0.50 \times 3$	=	9.405
8) $\frac{1}{2} (0.80 + 0.95) \times 2.50 \times 2 \times 3$	=	13.125
9) $0.50 \times 2.50 \times 3$	=	3.750
10) $\sqrt{0.15^2 + 2.50^2} \times 0.50 \times 3$	=	3.757
11) 1.00×9.0	=	9.000
12) 0.80×9.0	=	7.200
13) $\frac{1}{2} \times (1.75 + 2.80) \times 0.20 \times 2$	=	0.910
14) $0.80 \times 2.80 \times 2$	=	4.480
15) $0.670 \times 1.80 \times 2$	=	2.412
16) $0.670 \times 1.80 \times 2$	=	2.412
17) $\frac{1}{2} \times 1.8 \times 2.04 + \frac{1}{2} \times 1.8 \times 1.72$	=	5.220

- 18) $0.67 \times 0.25 = 0.168$
- 19) $0.67 \times 0.25 = 0.168$
- 20) $1.8^2 + 2.04^2 \times 0.25 \times 2 + 1.8^2 + 1.72^2 \times 0.25 \times 2 = 2.605$
- 21) $1.050 \times 2.710 = 2.846$
- 22) $1.050 \times 2.390 = 2.510$
- 23) $0.75 \times 2.11 = 1.583$
- 24) $0.75 \times 1.79 = 1.343$
- 25) $0.25 \times 2.71 = 0.678$
- 26) $0.25 \times 2.390 = 0.598$

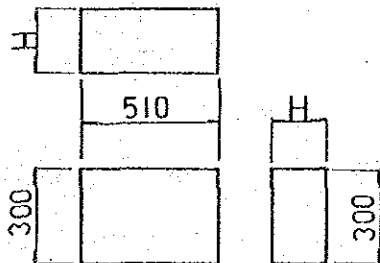
TOTAL = 119.280m²/Estribo

(3) Hormigón Pobre (Tipo-F)

(Hormigón) $3.00 \times 9.20 \times 0.10 = 2.760\text{m}^3/\text{Estribo}$

(Encofrado) $3.00 \times 0.10 \times 2 + 9.20 \times 0.10 \times 2 = 2.440\text{m}^2/\text{Estribo}$

(4) Hormigón para asiento de apoyo
Grupos IV (curiraba) 25m



Hormigón
 $A = 0.500 \times 0.300 = 0.150\text{m}^2$
 $V = A \times H = 0.150 \times (0.313 + 0.225 + 0.137 + 0.049) \times 2 = 0.109\text{m}^3/\text{Estribo}$

Encofrado
 $A = (0.50 \times 2 + 0.30 \times 2) \times (0.313 + 0.225 + 0.137 + 0.049) = 1.158\text{m}^2/\text{Estribo}$

Unidad: mm

	VE	VI	VI	VE
H	313	225	137	49

VE: Viga Externa
 VI: Viga Interna

(5) Cantidad total de Hormigón y Encofrado

	Unidad	Tipo-A			Tipo-F
		Estribo	Asiento de apoyo	Total	
Hormigón		(42.284×2)	(0.109×2)	84.786	(2.760×2)
		84.568	0.218		5.520
Encofrado		(119.280×2)	(1.158×2)	240.876	(2.440×2)
		238.560	2.316		4.880

1.9 Cantidad de Pilotes por puente

		por 2 estribos							
		San Juan	San Gregorio Pto. Almacen	Amistad Sicuri	Tajibo	Mururita	Curirabita	Curiraba	
Cantidad de Pilote	Pza	24	24	24	20	24	20	20	
Longitud de Pilote	m	8.00	6.00	15.00	8.00	12.00	14.00	15.00	
Longitud total	m	192.00	144.00	360.00	160.00	288.00	280.00	300.00	
Materiales por un pilote	Hormigón	m ³	2.149	1.584	4.128	2.149	3.280	3.845	4.128
	Encofrado	m ²	14.231	10.461	27.426	14.231	21.771	25.541	27.426
	Acero de refuerzo	Kg	287.029	231.595	624.497	287.029	533.309	590.078	624.497
	Plancha de acero	Kg	51.937	51.937	78.568	51.937	78.568	78.568	78.568

Puente San Juan y Tajibo

Volumen de Hormigón:

$$A = 1/4 \times \pi \times R^2 = 1/4 \times \pi \times 0.60^2 = 0.2827 \text{ m}^2$$

$$V1 = 0.2827 \times (8.00 - 0.60) = 2.092 \text{ m}^3$$

$$V2 = 1/3 \times \pi \times 0.30^2 \times 0.60 = 0.057 \text{ m}^3$$

$$= 2.149 \text{ m}^3/\text{pilote}$$

Volumen total de:

Puente San Juan $V0 = 2.149 \times 12 = 25.788 \text{ m}^3$

Puente Tajibo $V0 = 2.149 \times 10 = 21.490 \text{ m}^3$

Area de Encofrado:

$$A = \pi \times R \times (L - 0.60) + A$$

$$= \pi \times 0.6 \times (8.00 - 0.60) + 0.2827 = 14.231 \text{ m}^2/\text{pilote}$$

Area total de:

Puente San Juan $A0 = 14.231 \times 12 = 170.772 \text{ m}^2$

Puente Tajibo $A0 = 14.231 \times 10 = 142.310 \text{ m}^2$

Puentes San Gregorio y Puerto Almacén

Volumen de Hormigón:

$$V1 = 0.2827 \times (6.00 - 0.60) = 1.527 \text{ m}^3$$

$$V2 = 1/3 \times \pi \times 0.30^2 \times 0.60 = 0.057 \text{ m}^3$$

$$= 1.584 \text{ m}^3/\text{pilote}$$

Volumen total de:

Puente San Gregorio $V0 = 1.584 \times 12 = 19.008 \text{ m}^3$

Puente Pto. Almacen $V0 = 1.584 \times 12 = 19.008 \text{ m}^3$

Area de Encofrado:

$$A = \pi \times 0.6 \times (6.00 - 0.60) + 0.2827 = 10.461 \text{ m}^2/\text{pilote}$$

Area total de:

Puente San Gregorio $A_0 = 10.461 \times 12 = 125.532 \text{ m}^2$

Puente Pto Almacén $A_0 = 10.461 \times 12 = 125.532 \text{ m}^2$

Puentes Amistad , Sicurí y Curiraba

Volumen de Hormigón

$$V_1 = 0.2827 \times (15.00 - 0.60) = 4.071 \text{ m}^3$$

$$V_2 = \frac{1}{3} \times \pi \times 0.30^2 \times 0.6 = 0.057 \text{ m}^3$$

$$= 4.128 \text{ m}^3/\text{pilote}$$

Volumen total de:

Puentes Amistad y Sicurí $V_0 = 4.128 \times 12 = 49.536 \text{ m}^3$

Puente Curiraba $V_0 = 4.128 \times 10 = 41.280 \text{ m}^3$

Area de Encofrado:

$$A = \pi \times 0.6 \times (15.00 - 0.60) + 0.2827 = 27.426 \text{ m}^2/\text{pilote}$$

Area total de:

Puentes Amistad y Sicurí $A_0 = 27.426 \times 12 = 329.112 \text{ m}^2$

Puente Curiraba $A_0 = 27.426 \times 10 = 274.260 \text{ m}^2$

Puente Mururita

Volumen de Hormigón:

$$V_1 = 0.2827 \times (12.00 - 0.60) = 3.223 \text{ m}^3$$

$$V_2 = \frac{1}{3} \times \pi \times 0.30^2 \times 0.6 = 0.057 \text{ m}^3$$

$$= 3.280 \text{ m}^3/\text{pilote}$$

Volumen total:

$$V_0 = 3.280 \times 12 = 39.36 \text{ m}^3$$

Area de Encofrado:

$$A = \pi \times 0.6 \times (12.00 - 0.60) + 0.2827 \times 12 = 21.771 \text{ m}^2/\text{pilote}$$

Area total:

$$A_0 = 21.771 \times 12 = 261.252 \text{ m}^2$$

Area de Encofrado:

$$A = \pi \times 0.6 \times (14.00 - 0.60) + 0.2827 = 25.541 \text{ m}^2/\text{pilote}$$

Area total:

$$A_0 = 25.541 \times 10 = 255.410 \text{ m}^2$$

Puente Curirabita

Volumen de Hormigón:

$$V_1 = 0.2827 \times (14.00 - 0.60) = 3.788 \text{ m}^3$$

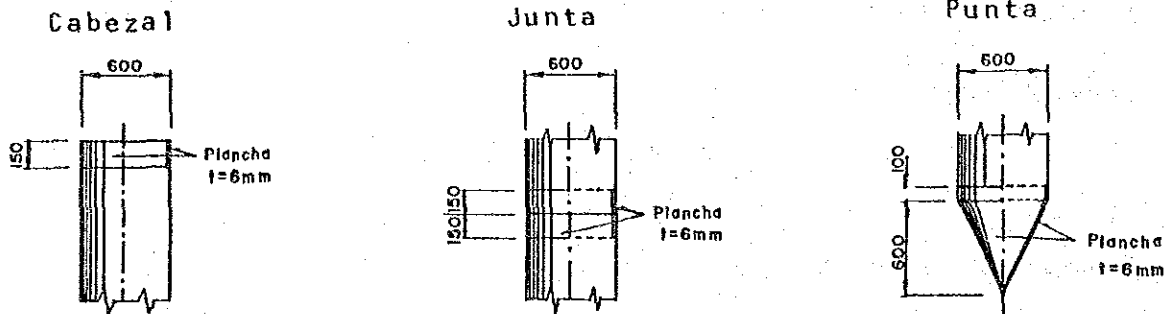
$$V_2 = \frac{1}{3} \times \pi \times 0.30^2 \times 0.6 = 0.057 \text{ m}^3$$

$$= 3.845 \text{ m}^3/\text{pilote}$$

Volumen total:

$$V_0 = 3.845 \times 10 = 38.45 \text{ m}^3$$

Volúmen de planchas (Planchas de acero para refuerzo)



$$\begin{aligned} A_1 &= \pi \times R \times l \times N \\ &= 0.6 \times \pi \times 0.15 \times N \\ &= 0.2827 \times N \end{aligned}$$

$$S = \sqrt{0.6^2 + 0.3^2} = 0.671 \text{ m}^2$$

$$\begin{aligned} A_2 &= \pi \times r \times s + \pi \times R \times l \\ &= \pi \times 0.30 \times 0.671 \\ &\quad + \pi \times 0.6 \times 0.1 \end{aligned}$$

$$V = (A_1 + A_2) \times t \times 7,850 \text{ kg/m}^3$$

$$= 0.820 \text{ m}^2$$

Puentes: San Juan, San Gregorio, Pto. Almacen y Tajibo

$$A_1 = 0.2827 \times 1 = 0.2827 \text{ m}^2 \quad A_2 = 0.632 \text{ m}^2$$

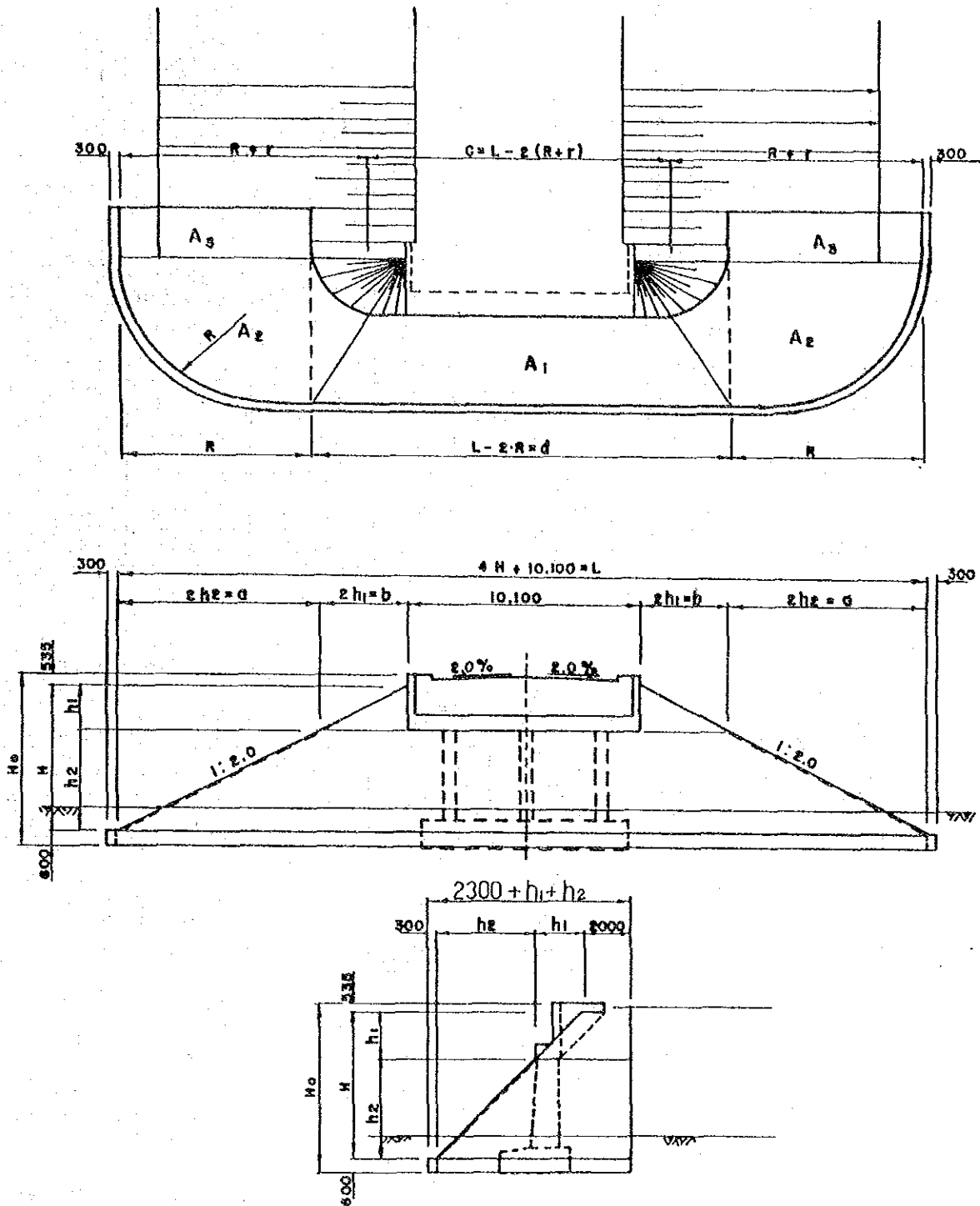
$$V = (0.2827 + 0.820) \times 0.006 \times 7850 = 51.937 \text{ kg}$$

Puentes: Amistad, Sicuri, Mururita, Curirabita y Curiraba

$$A_1 = 0.2827 \times 3 = 0.8481 \text{ m}^2 \quad A_2 = 0.632 \text{ m}^2$$

$$V = (0.8481 + 0.820) \times 0.006 \times 7850 = 78.568 \text{ kg}$$

1.10 Escollero



Dimensiones de Estructura (Escollero)

Puentes	H ₀	H	h ₁	h ₂	a	b	L	R	r	C	d
San Juan San Gregorio	7 470	6 335	1 935	4 400	8 800	3 870	35 440	6 335	1 935	18 900	22 700
Pfo. Almdeen	7 170	6 035	1 935	4 100	8 200	3 870	34 240	6 035	1 935	18 300	22 170
Amstgd Sicuri	8 370	7 235	2 135	5 100	10 200	4 270	39 040	7 235	2 135	20 300	24 570
Tajlbo	5 470	4 335	2 135	2 200	4 400	4 270	27 440	4 335	2 135	14 500	18 770
Murullta	7 670	6 535	2 135	4 400	8 800	4 270	36 240	6 535	2 135	18 900	23 170
Currabita	6 470	5 335	1 735	3 600	7 200	3 470	31 440	5 335	1 735	17 300	20 770
Curraaba	5 970	4 835	1 935	2 900	5 800	3 870	29 440	4 835	1 935	15 900	19 770

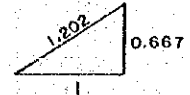
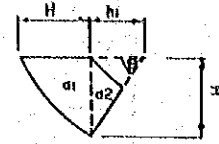
$$A_1 = 1/2 (c+d) \times \sqrt{2} \cdot h_2$$

$$A_2 = (a_1 + a_2) \times 1.202 \times 2$$

$$a_1 = H^2 \cdot \pi / 4, \quad a_2 = h_1 \cdot H - \left(\frac{3h_1}{2} \right)^2 \cdot \pi \cdot \frac{\sigma}{360}$$

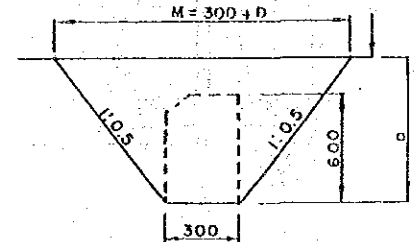
$$A = \sqrt{h_2^2 + d^2} \times 2.00 \times 2$$

$$L_c = \pi \cdot R + d + 4.0$$

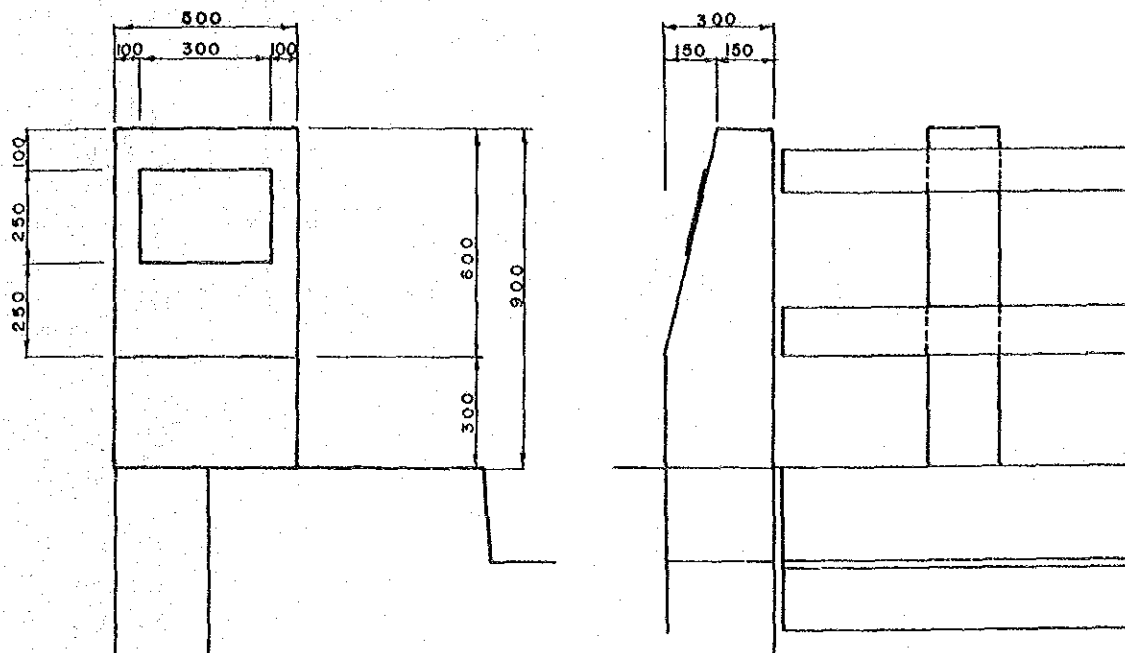


Puentes	A ₁ (m ²)	A ₂ (m ²)	A ₃ (m ²)	Total (m ²)	Longitud cordon (m)	Excavacion (m ³)
San Juan San Gregorio	129.429	92.338	39.355	261.112	61.973	97.6 108.4
Pto. Almacen	117.328	84.076	36.672	238.076	59.900	57.3
Amistad Stouri	161.812	120.140	45.616	327.568	68.071	114.7 95.3
Tajlbo	51.756	44.008	19.677	115.441	47.360	63.4
Mururita	130.891	98.703	39.355	268.949	63.072	123.3
Curirablla	96.910	65.463	32.199	194.872	55.302	82.2
Curiraba	73.145	54.578	25.938	153.661	51.330	98.3

Puentes	D (m)	M (m)	Excavacion (m ²)
San Juan San Gregorio	1.500 1.594	1.800 1.894	1.575 1.749
Pto. Almacen	1.349	1.614	1.257
Amistad Stouri	1.560 1.400	1.860 1.700	1.685 1.400
Tajlbo	1.393	1.693	1.338
Mururita	1.700	2.000	1.955
Curirablla	1.450	1.750	1.486
Curiraba	1.680	1.980	1.915



1.1) Parapeto de acceso al puente



(Hormigón)

$$V_1 = 1/2 (0.15 + 0.30) \times 0.600 \times 0.500$$

$$V_2 = 0.300 \times 0.300 \times 0.500$$

$$= 0.068 \text{ m}^3$$

$$= 0.045 \text{ m}^3$$

$$\text{Total } \bar{V} = 0.113 \text{ m}^3/\text{poste}$$

(Encofrado)

$$A_1 = 0.50 \times 0.90$$

$$A_2 = \sqrt{0.15^2 + 0.60^2} \times 0.50$$

$$A_3 = 0.30 \times 0.50$$

$$A_4 = 1/2 (0.15 + 0.30) \times 0.60 \times 2$$

$$A_5 = 0.30 \times 0.30 \times 2$$

$$= 0.450 \text{ m}^2$$

$$= 0.309 \text{ m}^2$$

$$= 0.150 \text{ m}^2$$

$$= 0.270 \text{ m}^2$$

$$= 0.180 \text{ m}^2$$

$$\text{Total } A = 1.359 \text{ m}^2/\text{poste}$$

Para un puente

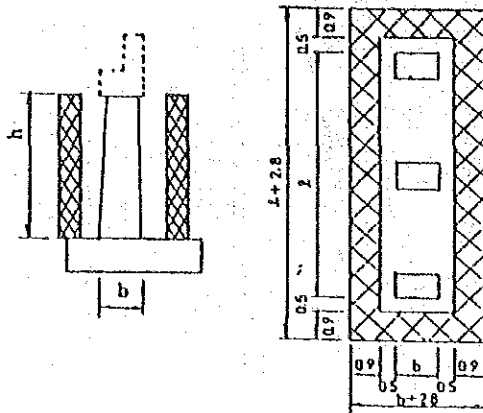
(Hormigón) $V = 0.113 \times 4 = 0.452 \text{ m}^3$

(Encofrado) $A = 1.359 \times 4 = 5.436 \text{ m}^2$

(Plaqueta) $N = 2$ plaquetas

1.12 Andamios

A·m2 = Área de Andamios



$$W = (2(b+L) + 7.6) h$$

Puentes: San Juan, San Gregorio, Murúrita

$$\begin{aligned} W &= 2(1.2+7.1)+7.6 \times 3.8 \\ &= 91.96 \text{ A·m}^2 \end{aligned}$$

Puente: Puerto Almacén

$$\begin{aligned} W &= 2(1.2+7.1) + 7.6 \times 3.5 \\ &= 84.7 \text{ A·m}^2 \end{aligned}$$

Puente Tajibo

$$\begin{aligned} W &= 2(0.9+7.1) + 7.6 \times 1.8 \\ &= 42.48 \text{ A·m}^2 \end{aligned}$$

Puente Curirabita

$$\begin{aligned} W &= 2x(1.0+7.1) + 7.6 \times 3.2 \\ &= 76.16 \text{ A·m}^2 \end{aligned}$$

Puente Curiraba

$$\begin{aligned} W &= 2x(0.95+7.1) + 7.6 \times 2.5 \\ &= 59.25 \text{ A·m}^2 \end{aligned}$$

CUADRO DE MATERIALES PARA SUPERESTRUCTURA

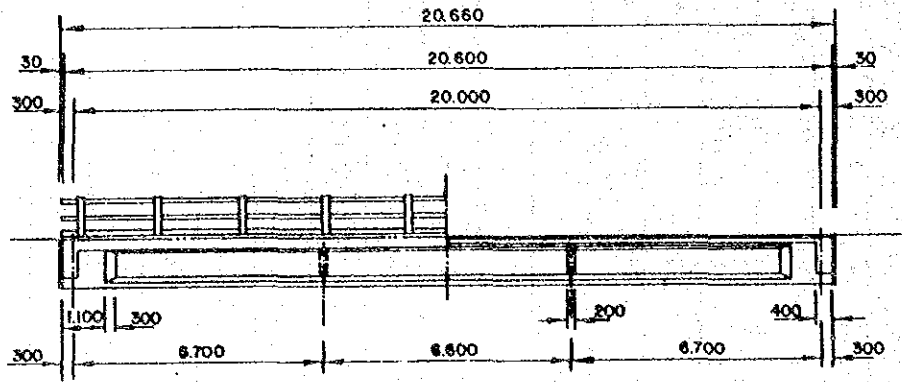
	CLASSE	UNIDAD	PUENTE SAN JUAN Tramo 25m	PUENTE SAN GREGORIO Tramo 25m	PUENTE PTO. ALMACEN Tramo 25m	PUENTE AMISTAD Tramo 30m	PUENTE SICURI Tramo 30m	PUENTE TAIJIBO Tramo 30m	PUENTE MURURITA Tramo 30m	PUENTE CURIRABITA Tramo 20m	PUENTE CURIRABA Tramo 25m	TOTAL
Homigón (Encofrado)	Diafragmas Tipo-P	m ²	7.834 (65.779)	7.834	7.834	9.402 (77.349)	9.402	9.402	9.402	5.845 (47.303)	7.834	74.789 (190.451)
	Losa Tipo-A	m ²	36.992 (171.098)	36.992	36.992	44.217 (198.454)	44.217	44.217	44.217	29.757 (140.838)	36.992	354.603 (510.390)
	Bordillo Tipo-A	m ²	5.400 (46.622)	6.400	6.400	7.550 (55.624)	7.550	7.550	7.550	5.150 (37.609)	6.400	51.350 (139.865)
	Panimento Tipo-A	m ²	4.096	4.096	4.096	4.896	4.896	4.896	4.896	3.296	4.096	39.264
Vigas	Sub-Total	m ²	47.488 (217.720)	47.488	47.488	56.763 (254.088)	56.763	56.763	56.763	38.213 (178.447)	47.488	455.217 (650.255)
	20m Homigón	m	102.40	102.40	102.40	122.40	122.40	122.40	122.40	82.40	102.40	409.60
	30m Tipo-P	m	102.40	102.40	102.40	122.40	122.40	122.40	122.40	82.40	102.40	409.60
Barra	φ 10 (No.3)	Kg	16.800	16.800	16.800	20.160	20.160	20.160	20.160	13.440	16.800	161.280
	φ 13 (No.4)	Kg	3726.796	3726.796	3726.796	4403.856	4403.856	4403.856	4403.856	2919.192	3726.796	35441.800
	φ 16 (No.5)	Kg	5145.424	5145.424	5145.424	6169.574	6169.574	6169.574	6169.574	4148.124	5145.424	49408.116
	φ 19 (No.6)	Kg	23.544	23.544	23.544	24.136	24.136	24.136	24.136	20.024	23.544	210.744
Barandado	φ 22 (No.7)	Kg	721.208	721.208	721.208	720.488	720.488	720.488	720.488	597.464	721.208	6364.248
	φ 25 (No.8)	Kg	9633.772	9633.772	9633.772	11338.214	11338.214	11338.214	11338.214	7698.244	9633.772	91586.188
	Sub-Total	Kg	51.20	51.20	51.20	61.20	61.20	61.20	61.20	41.20	51.20	499.89
Expansión	Goma Tipo-A	m	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	144.90
	Goma	m	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	144.90
Apoyo	Goma	Dm ³	14.40	14.40	14.40	20.16	20.16	20.16	20.16	11.20	14.40	149.44

2.1 Tramo de 20m

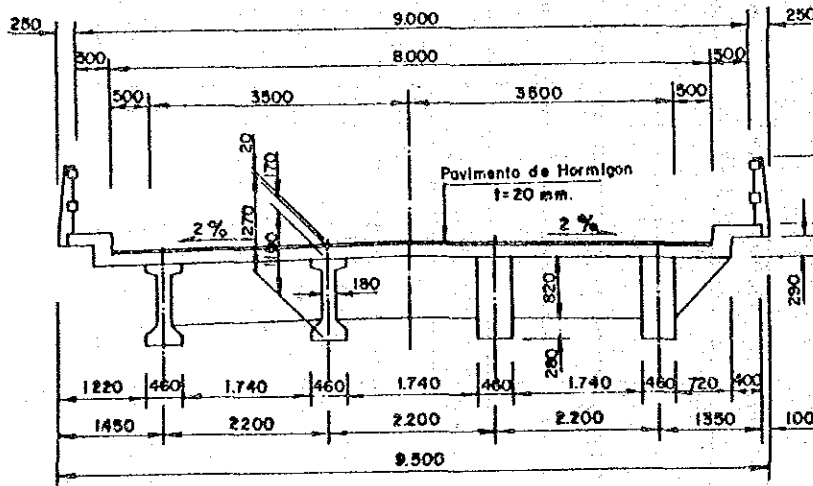
Unidad: mm.

Vista general

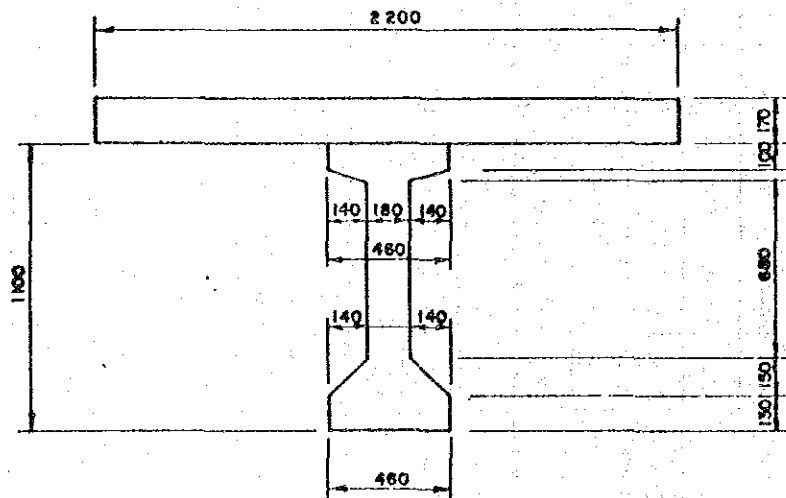
ELEVACION LATERAL



SECCION TRANSVERSAL TIPICA



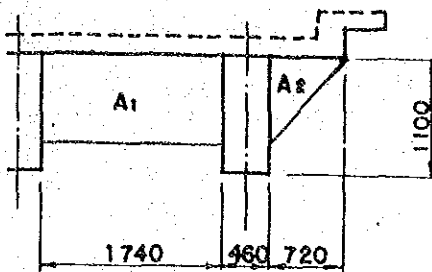
DETALLE Y SECCION DE VIGA



Tramo de 20m

(1) Hormigon

a) Diafragmas (Tipo-P)



(los extremos de las vigas)

$$A1 = 1.740 \times 0.820 = 1.427 \text{ m}^2$$

$$A2 = \frac{1}{2} \times 0.720 \times 0.820 = 0.295 \text{ m}^2$$

$$V = (A1 \times 3 + A2 \times 2) \times 0.400 \times 2 = (1.427 \times 3 + 0.295 \times 2) \times 0.400 \times 2 = 3.887 \text{ m}^3$$

(los intermedios)

$$1) 1.740 \times 0.100 = 0.174 \text{ m}^2$$

$$2) \frac{1}{2} (1.740 + 2.020) \times 0.040 = 0.075$$

$$3) 2.02 \times 0.680 = 1.374$$

$$A = 1.623 \text{ m}^2$$

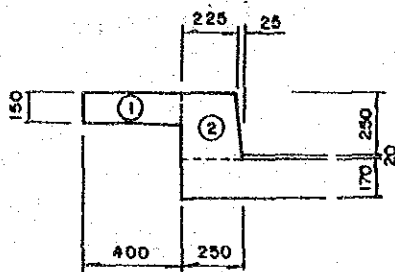
$$V = (A \times 3) \times 0.200 \times 2 = (1.623 \times 3 \times 0.200) \times 2 = 1.948 \text{ m}^3$$

Diafragmas $v = 5.845 \text{ m}^3$

b) Losa (Tipo-A)

$$V = 8.500 \times 0.17 \times 20.60 = 29.767 \text{ m}^3$$

c) Bordillo (Tipo-A)



$$1) 0.40 \times 0.15 = 0.060 \text{ m}^2$$

$$2) \frac{1}{2} (0.225 + 0.250) \times 0.275 = 0.065$$

$$A = 0.125 \text{ m}^2$$

$$V = A \times l \times 2 = 0.125 \times 20.6 \times 2 = 5.150 \text{ m}^3$$

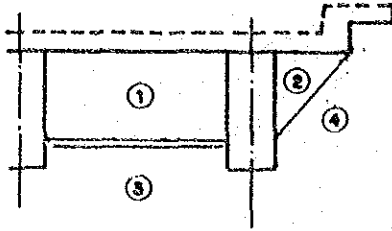
d) Pavimento de Hormigon (t=20mm ; Tipo-A)

$$V = 8.0 \times 0.020 \times 20.600 = 3.296 \text{ m}^3$$

TIPO A = 38.213 m³

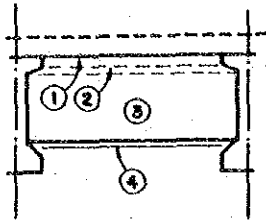
(2) Encofrado

a) Para diafragmas



(los extremos de las vigas)

1) $1.740 \times 0.820 \times 2 \times 3 \times 2$	= 17.122 m ²
2) $1/2 \times 0.820 \times 0.720 \times 2 \times 2 \times 2$	= 2.362 m ²
3) $1.740 \times 0.400 \times 3 \times 2$	= 4.176 m ²
4) $\sqrt{0.720^2 + 0.820^2} \times 0.400 \times 2 \times 2$	= 1.746 m ²
A1	= 25.406 m²



(los intermedios)

1) $1.740 \times 0.100 \times 2 \times 3 \times 2$	= 2.088 m ²
2) $1/2 (1.740 + 2.020) \times 0.040 \times 2 \times 3 \times 2$	= 0.902
3) $2.020 \times 0.680 \times 2 \times 3 \times 2$	= 16.483
4) $2.020 \times 0.200 \times 3 \times 2$	= 2.424
A2	= 21.897 m²

Encofrado para diafragmas A= 47.303 m²

b) Para losa (com pavimento de hormigon)

1) $1.740 \times (20.6 - 0.40 \times 2 - 0.20 \times 2) \times 3$	= 101.268 m ²
2) $0.720 \times (20.6 - 0.40 \times 2) \times 2$	= 28.512
3) $8.50 \times (0.17 + 0.02) \times 2$	= 3.230
4) $0.19 \times 20.6 \times 2$	= 7.828
	= 140.838 m²

Encofrado para losa A=140.838 m²

c) Para bordillo

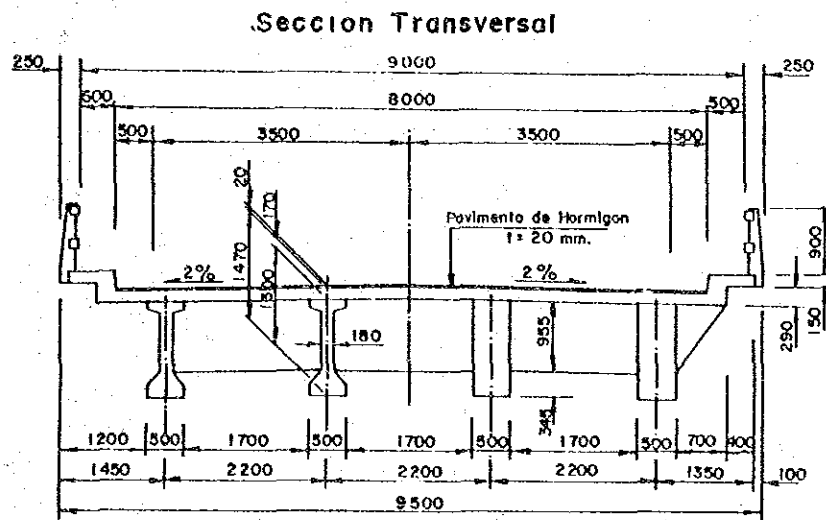
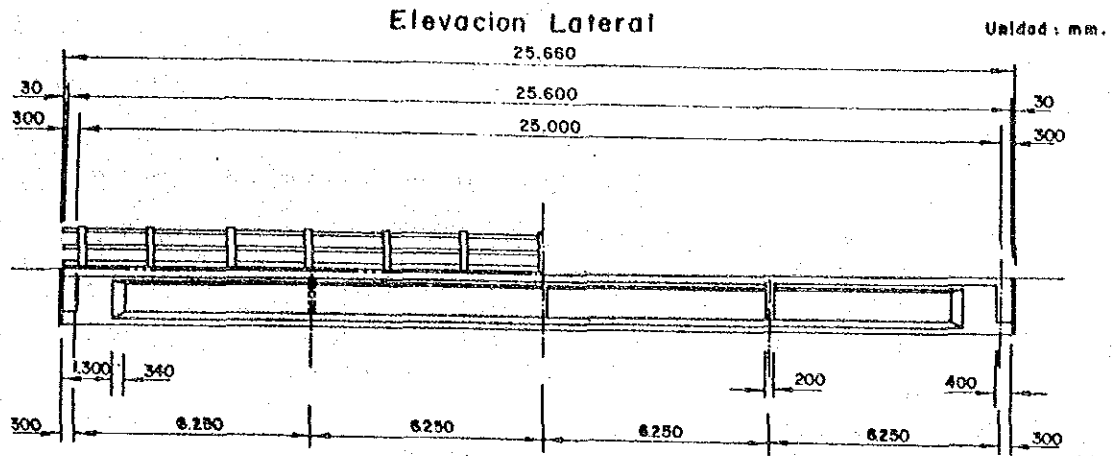
1) $\sqrt{0.250^2 + 0.025^2} \times 20.6 \times 2$	= 10.351 m ²
2) $0.100 \times 20.6 \times 2$	= 4.120
3) $0.400 \times 20.6 \times 2$	= 16.480
4) $0.150 \times 20.6 \times 2$	= 6.180
5) $0.150 \times 0.40 \times 2 \times 2$	= 0.240
6) $1/2 (0.225 + 0.25) \times 0.25 \times 2 \times 2$	= 0.238
	= 37.609 m²

Encofrado para bordillo A=37.609 m²

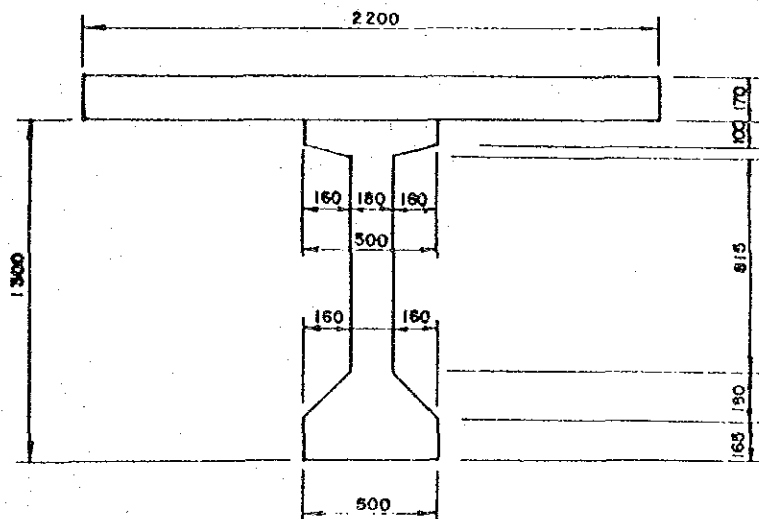
(3) Barandado (Ver planos)

L= 20.6×2	= 41.2 m
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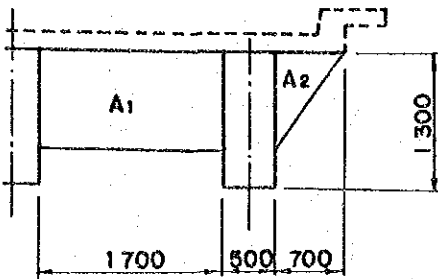
2.2 Tramo de 25 m
Vista General



Detalle y Seccion de Vigo



Tramo de 25m
 (1) Hormigon
 a) Diafragma



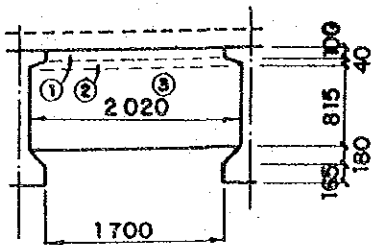
(los extremos de las vigas)

$$A1 = 1.700 \times 0.955 = 1.624$$

$$A2 = 1/2 \times 0.700 \times 0.955 = 0.334$$

$$V = (A1 \times 3 + A2 \times 2) \times 0.400 \times 2$$

$$= (1.624 \times 0.334 \times 2) \times 0.400 \times 2 = 4.432$$



(los intermedios)

$$1) 1.700 \times 0.100 = 0.170$$

$$2) 1/2(1.700 + 2.020) \times 0.040 = 0.074$$

$$3) 2.02 \times 0.815 = 1.646$$

$$A = 1.890$$

$$V = A \times 0.200 \times 3 \times 3$$

$$= 1.890 \times 0.200 \times 3 \times 3 = 3.402$$

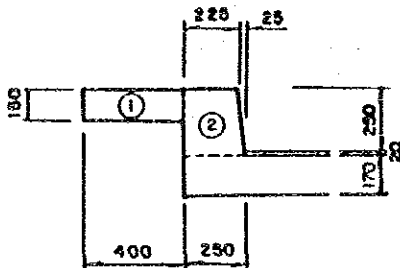
DIAFRAGMA

$$V = 7.834 \text{ m}^3$$

b) Losa

$$V = 8.500 \times 0.17 \times 25.60 = 36.992 \text{ m}^3$$

d) Bordillo



$$1) 0.40 \times 0.15 = 0.060 \text{ m}^2$$

$$2) 1/2(0.225 + 0.250) \times 0.275 = 0.065$$

$$A = 0.125 \text{ m}^2$$

$$V = A \times 1 \times 2$$

$$= 0.125 \times 25.6 \times 2 = 6.400 \text{ m}^3$$

c) Pavimento de Hormigon (t=20mm)

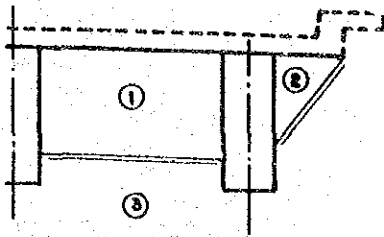
$$V = 8.0 \times 0.020 \times 25.600 = 4.096$$

TIPO A

$$= 47.488 \text{ m}^3$$

(2) Encofrado

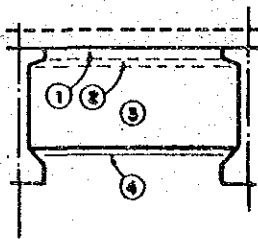
a) Para Diafragmas



(los extremos de las vigas)

- 1) $1.700 \times 0.955 \times 2 \times 3 \times 2 = 19.482 \text{ m}^2$
- 2) $\frac{1}{2} \times 0.700 \times 0.955 \times 2 \times 2 \times 2 = 2.674$
- 3) $1.700 \times 0.400 \times 3 \times 2 = 4.080$
- 4) $\sqrt{0.700^2 + 0.955^2} \times 0.400 \times 2 \times 2 = 1.895$

$$A1 = 28.131 \text{ m}^2$$



(los intermedios)

- 1) $1.700 \times 0.100 \times 2 \times 3 \times 3 = 3.060 \text{ m}^2$
- 2) $\frac{1}{2} (1.700 + 2.020) \times 0.040 \times 2 \times 3 \times 3 = 1.339$
- 3) $2.020 \times 0.815 \times 2 \times 3 \times 3 = 29.633$
- 4) $2.020 \times 0.200 \times 3 \times 3 = 3.636$

$$A2 = 37.668 \text{ m}^2$$

Encofrado para diafragma $A = 65.799 \text{ m}^2$

b) Para losa (con pavimento de hormigon)

- 1) $1.700 \times (25.6 - 0.40 \times 2 - 0.20 \times 3) \times 3 = 123.420 \text{ m}^2$
- 2) $0.700 \times (25.6 - 0.40 \times 2) \times 2 = 34.720$
- 3) $8.50 \times (0.17 + 0.02) \times 2 = 3.230$
- 4) $0.19 \times 25.6 \times 2 = 9.728$

$$= 171.098 \text{ m}^2$$

Encofrado para losa $A = 171.098 \text{ m}^2$

c) Para Bordillo

- 1) $\sqrt{0.250^2 + 0.025^2} \times 25.6 \times 2 = 12.864 \text{ m}^2$
- 2) $0.100 \times 25.6 \times 2 = 5.120$
- 3) $0.400 \times 25.6 \times 2 = 20.480$
- 4) $0.150 \times 25.6 \times 2 = 7.680$
- 5) $0.150 \times 0.40 \times 2 \times 2 = 0.240$
- 6) $\frac{1}{2} (0.225 + 0.25) \times 0.25 \times 2 \times 2 = 0.238$

$$= 46.622 \text{ m}^2$$

Encofrado para bordillo $A = 46.622$

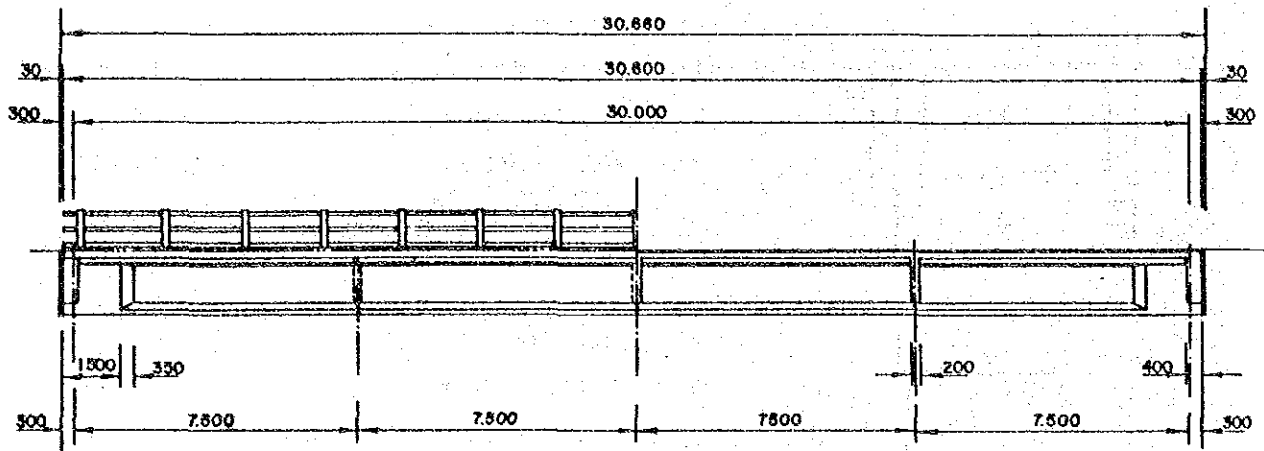
(3) Barandado (Ver planos)

$$L = 25.6 \times 2$$

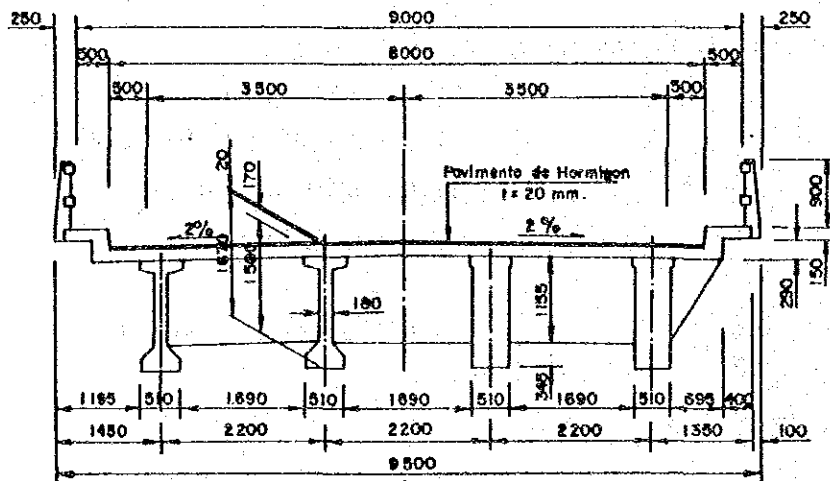
$$= 51.2 \text{ m}$$

Vista General

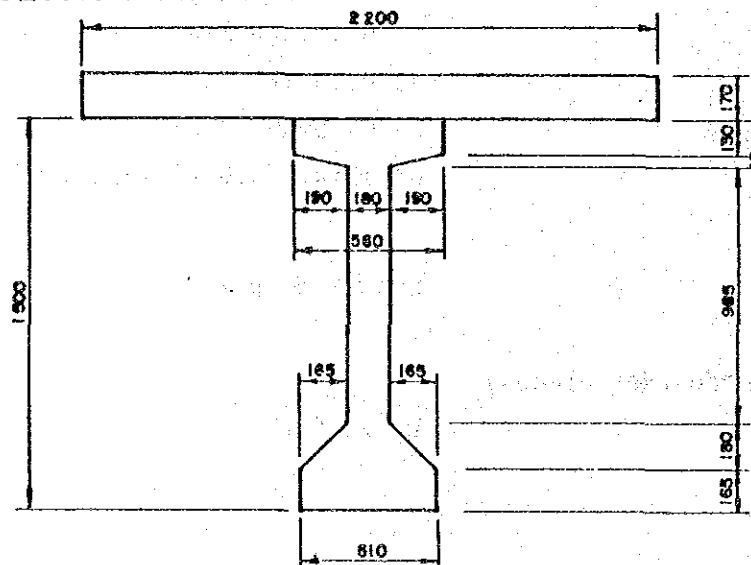
ELEVACION LATERAL



SECCION TRANSVERSAL TIPICA



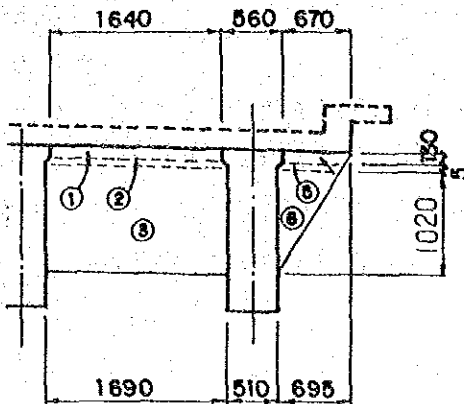
DETALLE Y SECCION DE VIGA



Tramo de 30m

(1) Hormigon

a) Diafragmas



(los extremos de las vigas)

$$1) 1.640 \times 0.130 = 0.213 \text{ m}^2$$

$$2) \frac{1}{2}(1.640 + 1.690) \times 0.005 = 0.008$$

$$3) 1.690 \times 1.020 = 1.724$$

$$A1 = 1.945 \text{ m}^2$$

$$4) \frac{1}{2}(0.670 + 0.592) \times 0.13 = 0.082 \text{ m}^2$$

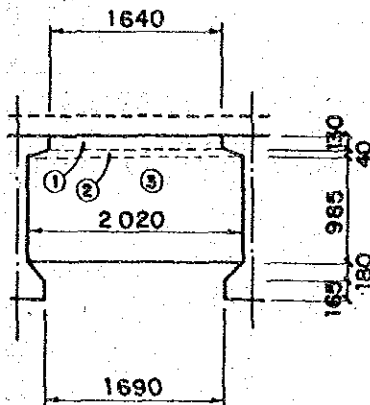
$$5) \frac{1}{2}(0.592 + 0.614) \times 0.005 = 0.003 \text{ m}^2$$

$$6) \frac{1}{2} \times 0.614 \times 1.020 = 0.313 \text{ m}^2$$

$$A2 = 0.398 \text{ m}^2$$

$$V = (A1 \times 3 + A2 \times 2) \times 0.400 \times 2$$

$$= (1.945 \times 3 + 0.398 \times 2) \times 0.400 \times 2 = 5.305 \text{ m}^3$$



(los intermedios)

$$1) 1.640 \times 0.130 = 0.213 \text{ m}^2$$

$$2) \frac{1}{2}(1.640 + 2.020) \times 0.040 = 0.073$$

$$3) 2.02 \times 0.985 = 1.990$$

$$A = 2.276 \text{ m}^2$$

$$V = A \times 0.200 \times 3 \times 3$$

$$= 2.276 \times 0.200 \times 3 \times 3 = 4.097 \text{ m}^3$$

Diafragma

$$V = 9.402 \text{ m}^3$$

b) Losa

$$V = 8.500 \times 0.17 \times 30.60$$

$$= 44.217 \text{ m}^3$$

c) Bordillo

$$1) 0.40 \times 0.15 = 0.060 \text{ m}^2$$

$$2) \frac{1}{2}(0.225 + 0.250) \times 0.275 = 0.065$$

$$A = 0.125 \text{ m}^2$$

$$V = A \times 1 \times 2$$

$$= 0.125 \times 30.6 \times 2 = 7.650 \text{ m}^3$$

d) Pavimento de Hormigon (t=20mm)

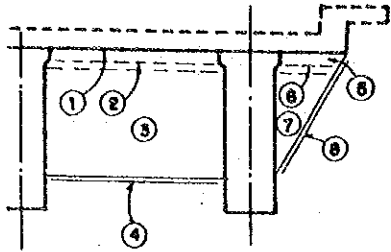
$$V = 8.0 \times 0.020 \times 30.600$$

$$= 4.896 \text{ m}^3$$

$$\text{TIPO A} = 56.763 \text{ m}^3$$

(2) Encofrado

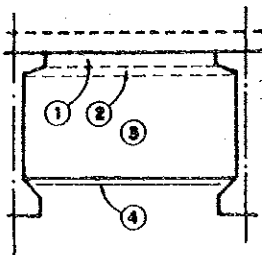
a) Para diafragmas



(los extremos de las vigas)

- 1) $1.640 \times 0.130 \times 2 \times 3 \times 2 = 2.558 \text{m}^2$
- 2) $\sqrt{2}(1.640 + 1.690) \times 0.005 \times 2 \times 3 \times 2 = 0.100$
- 3) $1.690 \times 1.020 \times 2 \times 3 \times 2 = 20.686$
- 4) $1.690 \times 0.40 \times 3 \times 2 = 4.056$
- 5) $\sqrt{2}(0.670 + 0.592) \times 0.13 \times 2 \times 2 \times 2 = 0.656$
- 6) $\sqrt{2}(0.592 + 0.614) \times 0.005 \times 2 \times 2 \times 2 = 0.024$
- 7) $\sqrt{2} \times 0.614 \times 1.020 \times 2 \times 2 \times 2 = 2.505$
- 8) $\sqrt{1.155^2 + 0.695^2} \times 0.40 \times 2 \times 2 = 2.157$

$A1 = 32.742 \text{m}^2$



(los intermedios)

- 1) $1.640 \times 0.130 \times 2 \times 3 \times 3 = 3.838 \text{m}^2$
- 2) $\sqrt{2}(1.640 + 2.020) \times 0.040 \times 2 \times 3 \times 3 = 1.318$
- 3) $2.020 \times 0.985 \times 2 \times 3 \times 3 = 35.815$
- 4) $2.020 \times 0.200 \times 3 \times 3 = 3.636$

$A2 = 44.607 \text{m}^2$

Encofrado para diafragmas $A = 77.349 \text{m}^2$

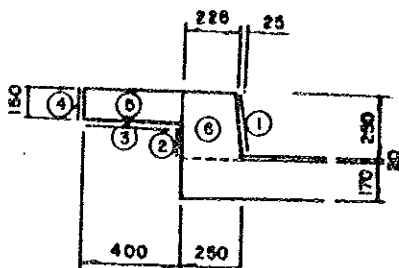
b) Para losa (con pavimento de hormigon)

- 1) $1.640 \times (30.6 - 0.40 \times 2 - 0.20 \times 3) \times 3 = 143.664 \text{m}^2$
- 2) $0.670 \times (30.6 - 0.40 \times 2) \times 2 = 39.932$
- 3) $8.50 \times (0.17 + 0.02) \times 2 = 3.230$
- 4) $0.19 \times 30.6 \times 2 = 11.628$

$= 198.454 \text{m}^2$

Encofrado para losa $A = 198.454 \text{m}^2$

c) Para bordillo



- 1) $\sqrt{0.250^2 + 0.025^2} \times 30.6 \times 2 = 15.376 \text{m}^2$
- 2) $0.100 \times 30.6 \times 2 = 6.120$
- 3) $0.400 \times 30.6 \times 2 = 24.480$
- 4) $0.150 \times 30.6 \times 2 = 9.180$
- 5) $0.150 \times 0.40 \times 2 \times 2 = 0.240$
- 6) $\sqrt{2}(0.225 + 0.25) \times 0.25 \times 2 \times 2 = 0.238$

$= 55.634 \text{m}^2$

Encofrado para bordillo $A = 55.634 \text{m}^2$

(3) Barandado (Ver planos)

$L = 30.6 \times 2$

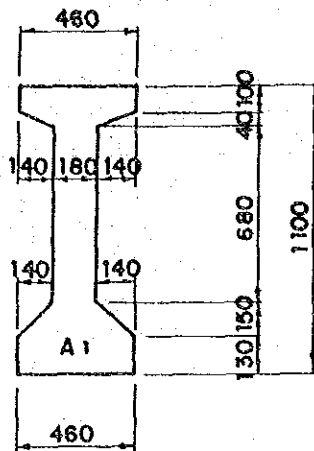
$= 61.2 \text{m}$

2.4 Materiales de viga

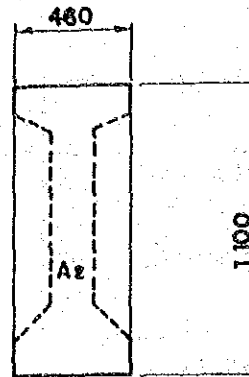
CUADRO DE MATERIAL PARA UNA VIGA

			TRAMO DE 20 ^m	TRAMO DE 25 ^m	TRAMO DE 30 ^m	OBSERVACIONES
HORMIGON (TIPO P)		m ³	6.50	9.93	13.79	LONGITUD DE UNA VIGA 20m-----20.6m 25m-----25.6m 30m-----30.6m
ENCOFRADO		m ²	61.45	88.85	120.92	
PC CABLE	12v1/2	m	—	—	94.644	
	6v1/2	m	83.757	132.660	—	
ANCLAJE	Para 12v1/2	Jgos	—	—	6	
	Para 6v1/2	Jgos	8	10	—	
BARRA	Ø 10 (Nº 3)	Kg	14.350	15.970	16.660	grado 60
	Ø 13 (Nº 4)	Kg	793.128	1055.378	1506.497	"
	Ø 16 (Nº 5)	Kg	—	—	—	"
	Ø 19 (Nº 6)	Kg	—	—	—	"
	Sub Total	Kg	807.478	1071.348	1523.157	"

Tramo de 20m



(los Intermedios)



(los extremos de las vigas)

a) Hormigon

$$0.140 \times 0.100 \times 2 = 0.0280$$

$$\frac{1}{2} \times 0.140 \times 0.040 \times 2 = 0.0056$$

$$1.100 \times 0.180 = 0.1980$$

$$\frac{1}{2} \times 0.140 \times 0.150 \times 2 = 0.0210$$

$$0.140 \times 0.130 \times 2 = 0.0364$$

$$\underline{A1 = 0.289 \text{ m}^2}$$

$$\frac{0.460 \times 1.100}{\quad} = 0.506$$

$$A2 = 0.506 \text{ m}^2$$

$$V1 = A1 \times (20.6 - 2 \times 1.100 - 2 \times 0.300) = 0.289 \times 17.8 = 5.144 \text{ m}^3$$

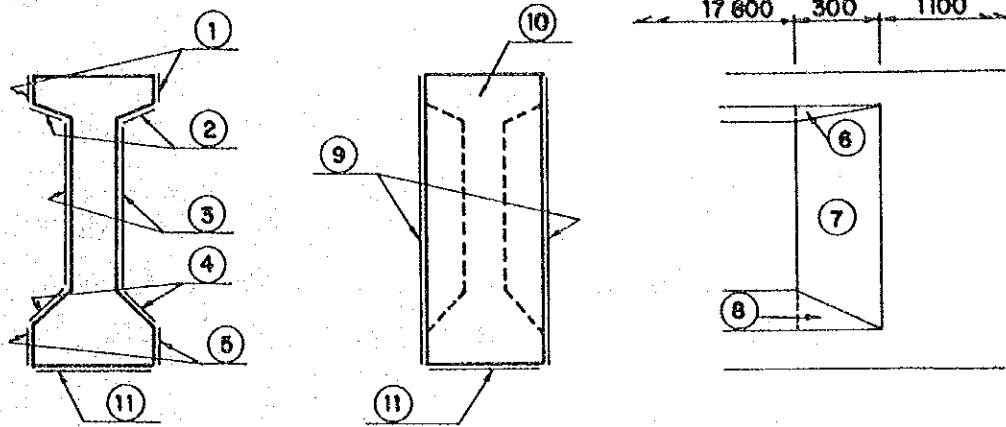
$$V2 = \frac{1}{2} (A1 + A2) \times 0.300 \times 2 = \frac{1}{2} (0.289 + 0.506) \times 0.300 \times 2 = 0.239$$

$$V3 = A2 \times 1.100 \times 2 = 0.506 \times 1.100 \times 2 = 1.113$$

$$\underline{V = 6.496 \text{ m}^3/\text{un viga}}$$

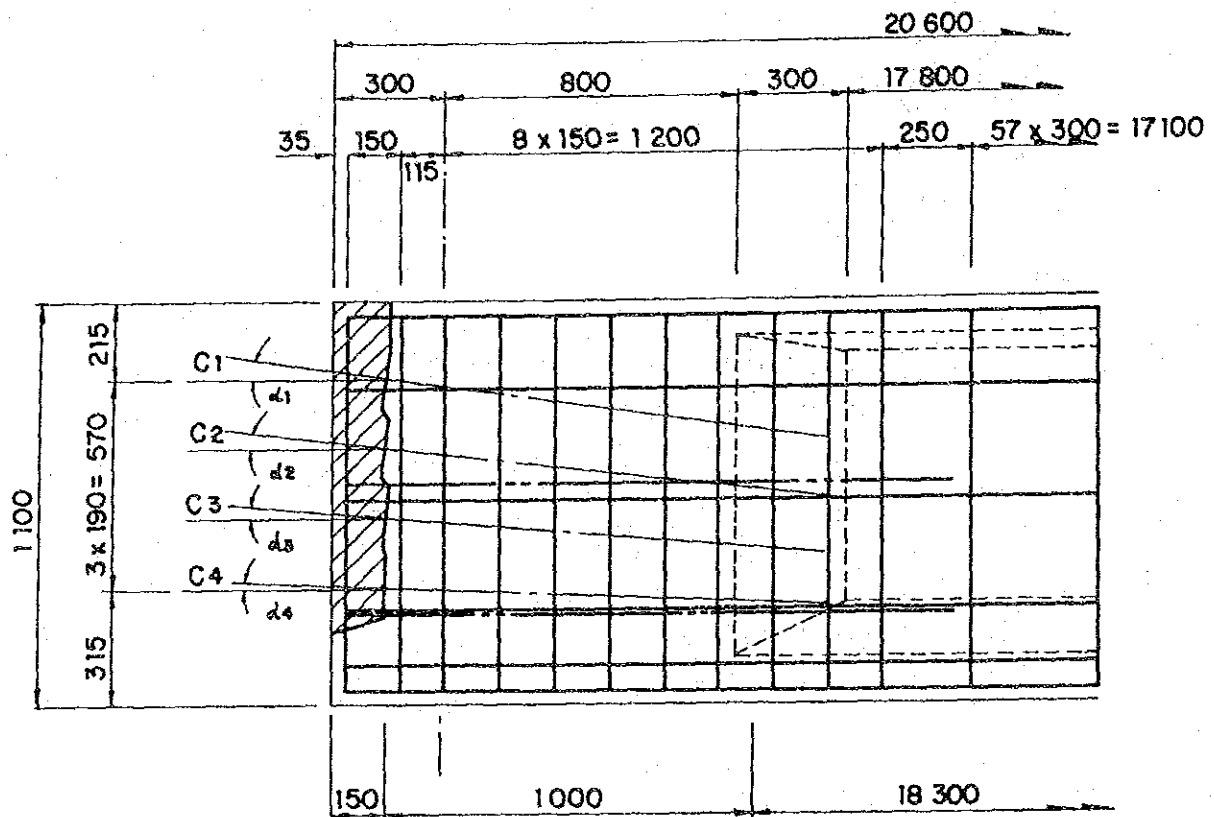
$$\text{Volúmen total de Hormigon para vigas} \quad V = 25.984 \text{ m}^3$$

b) Encofrado



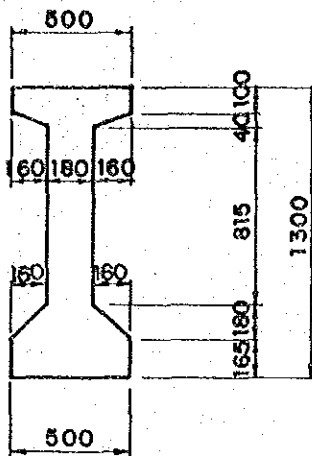
1) $0.100 \times 17.800 \times 2$	= 3.560m ²
2) $\sqrt{0.140^2 + 0.040^2} \times 17.800 \times 2$	= 5.183
3) $0.680 \times 17.800 \times 2$	= 24.208
4) $\sqrt{0.140^2 + 0.150^2} \times 17.800 \times 2$	= 7.305
5) $0.130 \times 17.800 \times 2$	= 4.628
6) $(\sqrt{0.140^2 + 0.040^2} \times 0.300) \times \sqrt{2} \times 4$	= 0.087
7) $\sqrt{2} \times (0.680 + 0.87) \times \sqrt{0.300^2 + 0.140^2} \times 4$	= 1.026
8) $(\sqrt{0.140^2 + 0.150^2} \times 0.300) \times \sqrt{2} \times 4$	= 0.123
9) $1.100 \times 1.100 \times 4$	= 4.840
10) $0.460 \times 1.100 \times 2$	= 1.012
11) 0.460×20.600	= 9.476
	<hr/>
	= 61.448m ²

Area total de Encofrado para una viga A=61.448m²



	Angulo (°)	Longitud de cables (m)		
		Longitud Efectiva	Holgura	Total
C 1	$\alpha_1 = 8^\circ 01' 32.8''$	20.363	600	20.963
C 2	$\alpha_2 = 6^\circ 30' 13.11''$	20.361	600	20.961
C 3	$\alpha_3 = 4^\circ 33' 45.13''$	20.328	600	20.928
C 4	$\alpha_4 = 2^\circ 36' 59.75''$	20.305	600	20.905
Total				83.767

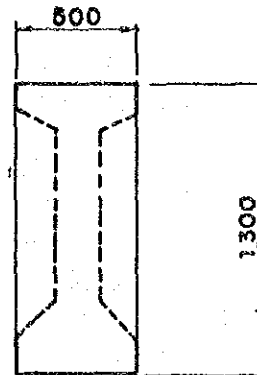
Tramo de 25m



(los Intermedios)

a) Hormigon

$$\begin{aligned}
 0.160 \times 0.100 \times 2 &= 0.0320 \\
 \frac{1}{2} \times 0.160 \times 0.040 \times 2 &= 0.0064 \\
 1.300 \times 0.180 &= 0.2340 \\
 \frac{1}{2} \times 0.160 \times 0.180 \times 2 &= 0.0288 \\
 0.165 \times 0.160 \times 2 &= 0.0528 \\
 \hline
 A1 &= 0.354 \text{ m}^2
 \end{aligned}$$



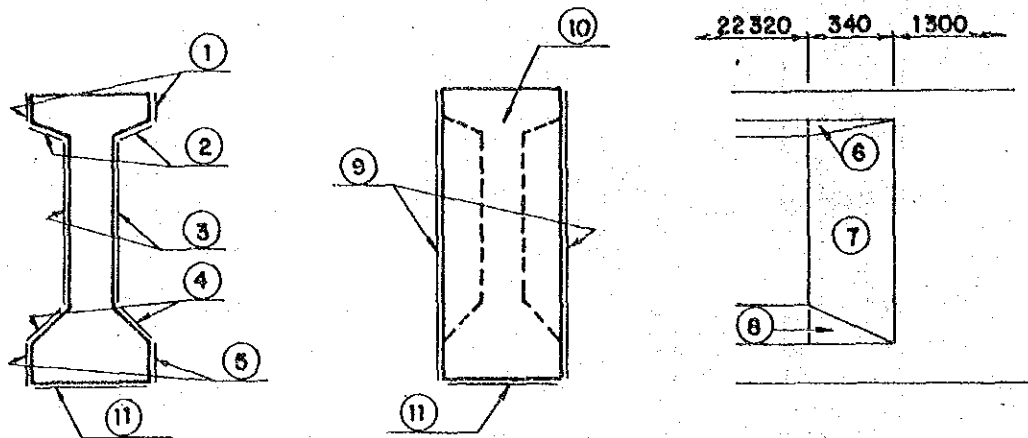
(los extremos de las viga)

$$\begin{aligned}
 \frac{0.500 \times 1.300}{A2} &= 0.650 \\
 A2 &= 0.650 \text{ m}^2
 \end{aligned}$$

$$\begin{aligned}
 V1 &= A1 \times (25.6 - 2 \times 1.300 - 2 \times 0.340) = 0.354 \times 22.32 = 7.901 \text{ m}^3 \\
 V2 &= \frac{1}{2} (A1 + A2) \times 0.340 \times 2 = \frac{1}{2} (0.354 + 0.650) \times 0.340 \times 2 = 0.341 \\
 V3 &= A2 \times 1.300 \times 2 = 0.650 \times 1.300 \times 2 = 1.690 \\
 \hline
 V &= 9.932 \text{ m}^3 / \text{viga}
 \end{aligned}$$

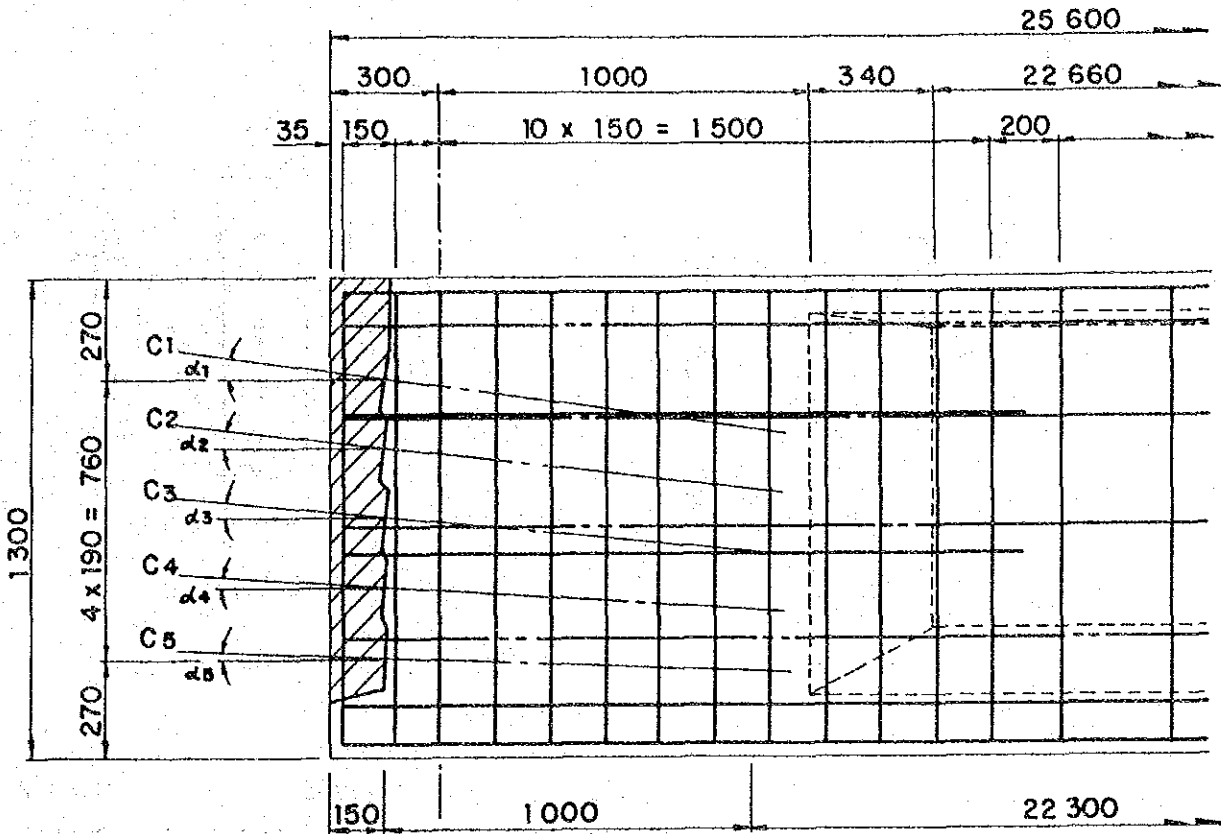
$$\text{Volúmen total de de Hormigon para vigas} \quad V = 39.728 \text{ m}^3$$

b) Encofrado



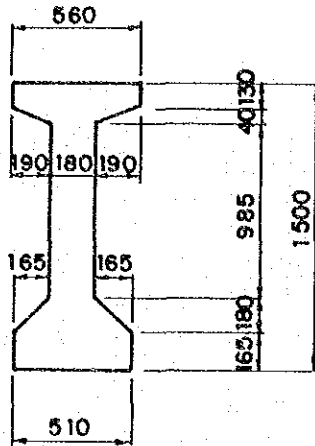
1) $0.100 \times 22.320 \times 2$	= 4.464m ²
2) $\sqrt{0.160^2 + 0.040^2} \times 22.320 \times 2$	= 7.362
3) $0.815 \times 22.320 \times 2$	= 36.382
4) $\sqrt{0.160^2 + 0.180^2} \times 22.320 \times 2$	= 10.751
5) $0.165 \times 22.320 \times 2$	= 7.366
6) $\frac{1}{2} \times \sqrt{0.160^2 + 0.040^2} \times 0.340 \times 4$	= 0.112
7) $\frac{1}{2} \times (0.815 + 1.035) \times \sqrt{0.160^2 + 0.340^2} \times 4$	= 1.390
8) $\frac{1}{2} \times \sqrt{0.160^2 + 0.180^2} \times 0.340 \times 4$	= 0.164
9) $1.300 \times 1.300 \times 4$	= 6.760
10) $0.500 \times 1.300 \times 2$	= 1.300
11) 0.500×25.60	= 12.800
	<hr/>
	= 88.851m ²

Area total de encofrado para una viga A= 88.851m²

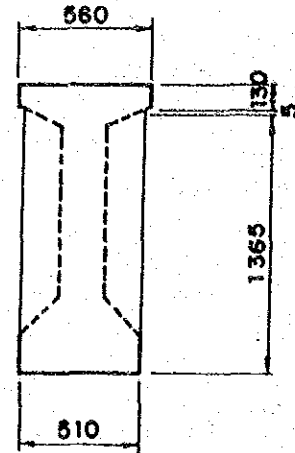


	Angulo (°)	Longitud de cables (m)		
		Longitud Efectiva	Holgura	Total
C 1	$1 = 7^{\circ} 31' 10.45''$	25.364	1.200	26.564
C 2	$2 = 6^{\circ} 16' 38.27''$	25.347	1.200	26.547
C 3	$3 = 5^{\circ} 01' 44.66''$	25.332	1.200	26.532
C 4	$4 = 3^{\circ} 26' 01.07''$	25.314	1.200	26.514
C 5	$5 = 1^{\circ} 49' 58.22''$	25.303	1.200	26.503
Total		132.860		

Tramo de 30m



(los Intermedios)



(los extremos de las viga)

a) Hormigon

$$\begin{aligned}
 0.190 \times 0.130 \times 2 &= 0.0494 \\
 \frac{1}{2} \times 0.190 \times 0.040 \times 2 &= 0.0076 \\
 1.500 \times 0.180 &= 0.2700 \\
 \frac{1}{2} \times 0.165 \times 0.180 \times 2 &= 0.0297 \\
 0.165 \times 0.165 \times 2 &= 0.0545
 \end{aligned}$$

$$A1 = 0.411 \text{ m}^2$$

$$\begin{aligned}
 0.510 \times 1.365 &= 0.6962 \\
 \frac{1}{2} (0.510 + 0.560) \times 0.005 &= 0.0027 \\
 0.560 \times 0.130 &= 0.0728
 \end{aligned}$$

$$A2 = 0.772 \text{ m}^2$$

$$V1 = A1 \times (30.6 - 2 \times 1.500 - 2 \times 0.350) = 0.411 \times 26.9 = 11.056 \text{ m}^3$$

$$V2 = \frac{1}{2} (A1 + A2) \times 0.350 \times 2 = \frac{1}{2} (0.411 + 0.772) \times 0.350 \times 2 = 0.414$$

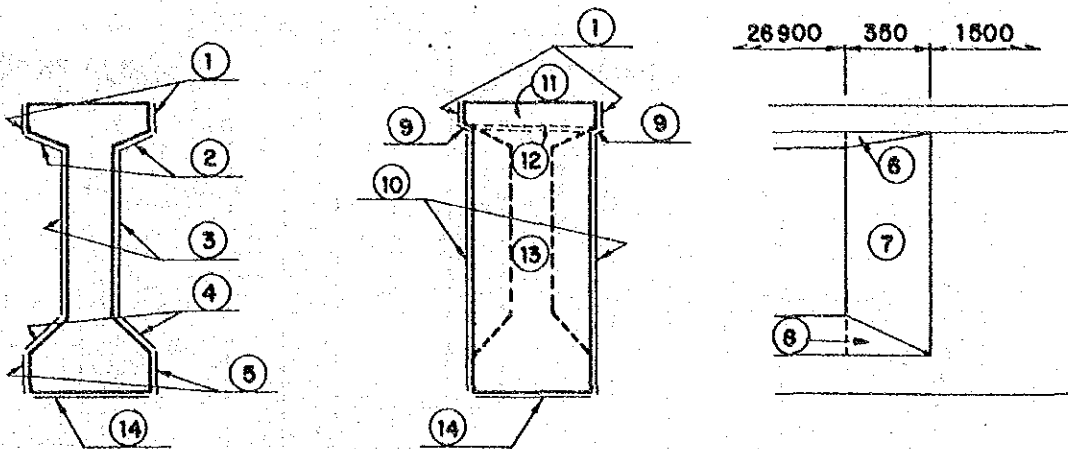
$$V3 = A2 \times 1.00 \times 2 = 0.772 \times 1.500 \times 2 = 2.316$$

$$\bar{V} = 13.786 \text{ m}^3 / \text{viga}$$

Volúmen total de Hormigon para vigas

$$\bar{V} = 55.144 \text{ m}^3$$

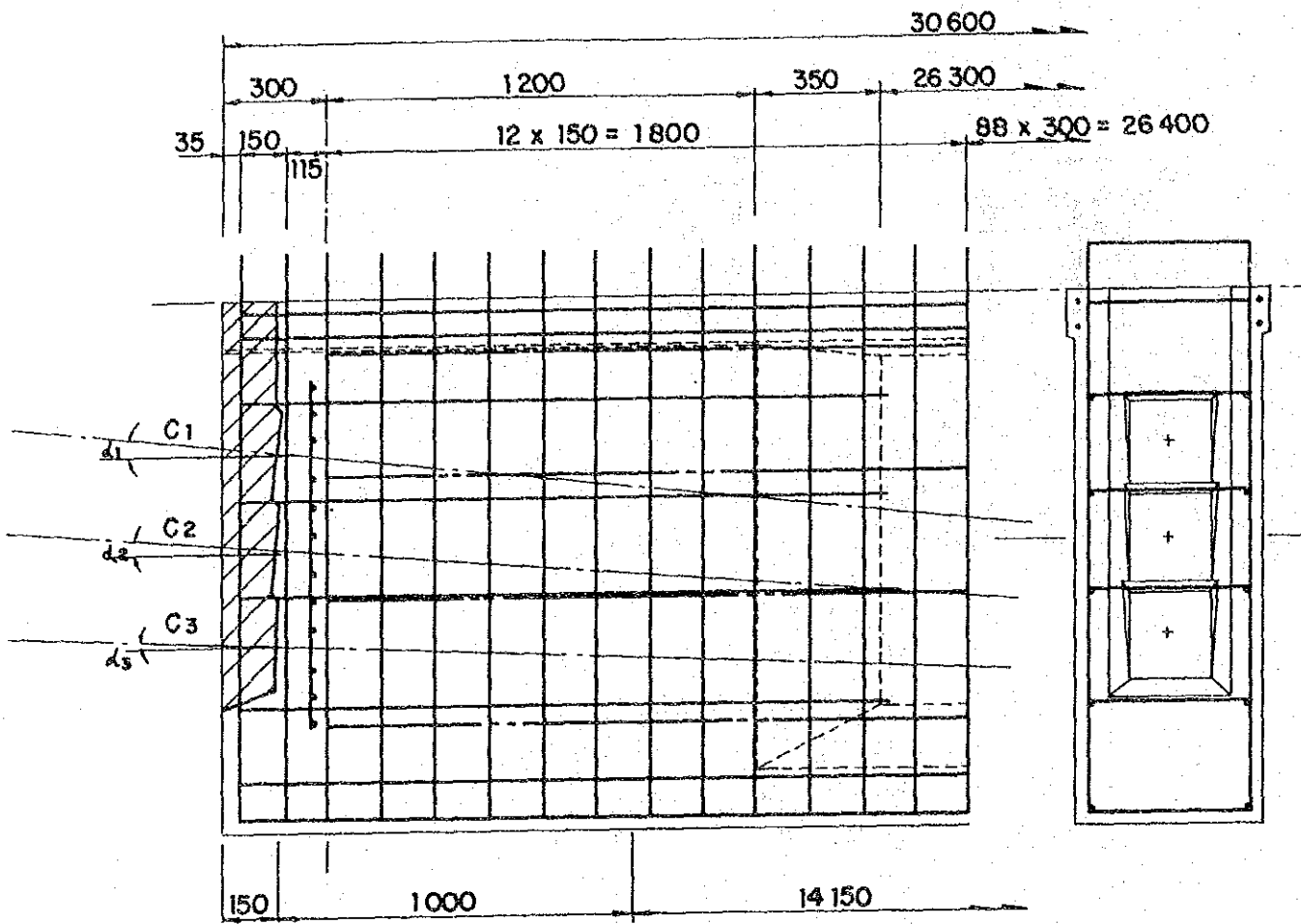
b) Encofrado



- 1) $0.13 \times 30.60 \times 2 = 7.956 \text{m}^2$
- 2) $\sqrt{0.190^2 + 0.040^2} \times 26.90 \times 2 = 10.446$
- 3) $0.985 \times 26.900 \times 2 = 52.993$
- 4) $\sqrt{0.165^2 + 0.180^2} \times 26.90 \times 2 = 13.137$
- 5) $0.165 \times 26.90 \times 2 = 8.877$
- 6) $1/2(\sqrt{0.190^2 + 0.040^2} + \sqrt{0.025^2 + 0.005^2}) \times 0.350 \times 4 = 0.154$
- 7) $1/2(0.985 + 1.205) \times \sqrt{0.350^2 + 0.165^2} \times 4 = 1.695$
- 8) $1/2 \times \sqrt{0.165^2 + 0.180^2} \times 0.350 \times 4 = 0.171$
- 9) $\sqrt{0.025^2 + 0.005^2} \times 1.500 \times 4 = 0.153$
- 10) $1.365 \times 1.500 \times 4 = 8.190$
- 11) $0.130 \times 0.560 \times 2 = 0.146$
- 12) $1/2(0.560 + 0.510) \times 0.005 \times 2 = 0.005$
- 13) $0.510 \times 1.365 \times 2 = 1.392$
- 14) $0.510 \times 30.60 = 15.606$

$$A = 120.921 \text{m}^2$$

Area total de encofrado para una viga A=120.921m²

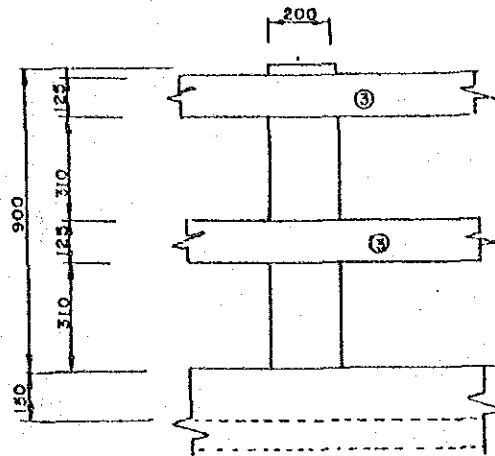
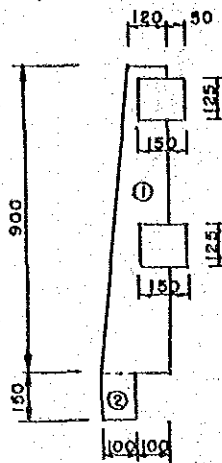


	Angulo (°)	Longitud de cables (m)		
		Longitud Efectiva	Holgura	Total
C 1	$\alpha_1 = 6^\circ 16' 38.27''$	30.386	1.200	31.586
C 2	$\alpha_2 = 4^\circ 24' 11.11''$	30.342	1.200	31.542
C 3	$\alpha_3 = 2^\circ 27' 43.95''$	30.316	1.200	31.516
Total				94.644 m

2.5 Barandado

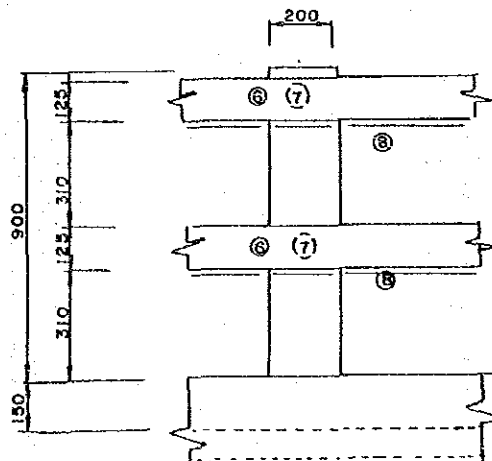
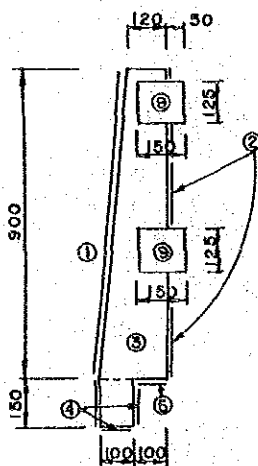
Barandado por tramo de 20 m

1) HORMIGON



1) $1/2(0.120+0.200) \times 0.200 \times 0.900 \times 22$	= 0.634 m ³
2) $0.100 \times 0.150 \times 0.200 \times 22$	= 0.066 m ³
3) $0.150 \times 0.125 \times 20.600 \times 4 - 0.100 \times 0.125 \times 0.200 \times 22 \times 2$	= 1.435 m ³
	= 2.135 m ³

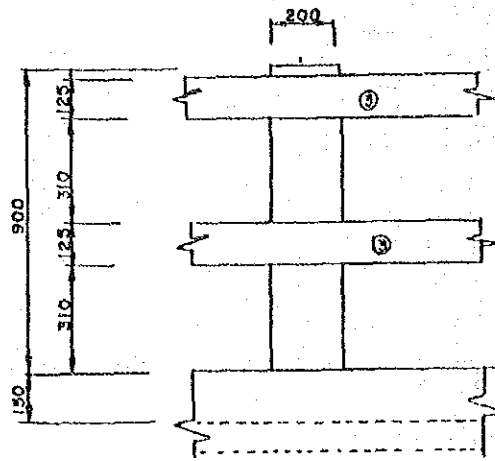
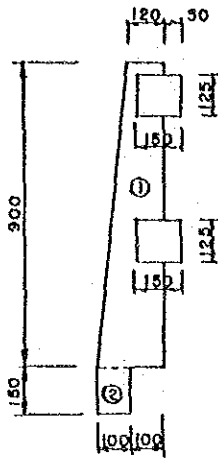
2) ENCOFRADO



1) $\sqrt{0.90^2 + 0.08^2} \times 0.200$	= 0.181 m ²
2) $(0.90 - 0.125 \times 2) \times 0.200$	= 0.130 m ²
3) $(1/2(0.120 + 0.200) \times 0.900 - 0.100 \times 0.125 \times 2) \times 2$	= 0.238 m ²
4) $0.150 \times 0.200 \times 2 + 0.100 \times 0.200$	= 0.080 m ²
5) 0.100×0.200	= 0.020 m ²
	= 0.649 m ² /poste
Sub - Total	= 0.649 m ² /poste
Total 0.649×22	= 14.278 m ²
6) $0.125 \times 20.60 \times 2 \times 2$	= 10.300 m ²
7) $(0.125 \times 20.60 - 0.200 \times 0.125 \times 11) \times 2 \times 2$	= 9.200 m ²
8) $(0.150 \times 20.60 - 0.100 \times 0.125 \times 11) \times 2 \times 2$	= 11.810 m ²
	= 31.310 m ²
Total	= 31.310 m ²

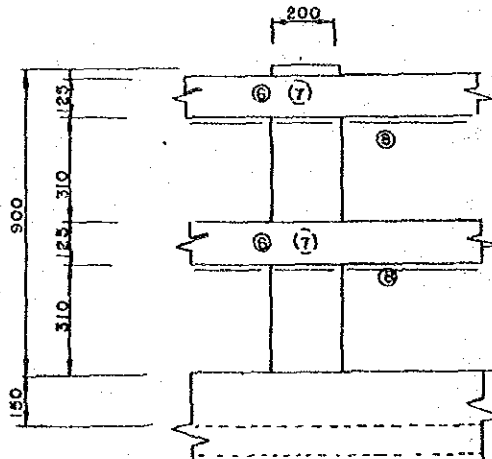
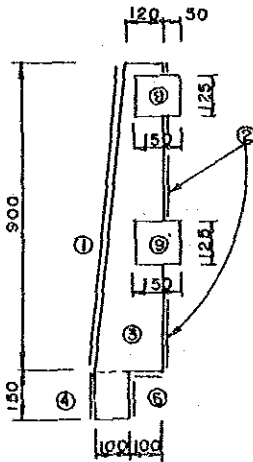
Barandado por tramo de 25 m

1) HORMIGON



1) $1/2(0.12+0.2) \times 0.200 \times 0.900 \times 26$	= 0.749 m ³
2) $0.100 \times 0.150 \times 0.200 \times 26$	= 0.078 m ³
3) $0.150 \times 0.125 \times 25.600 \times 4 - 0.100 \times 0.125 \times 0.200 \times 26 \times 2$	= 1.790 m ³
	= 2.617 m ³

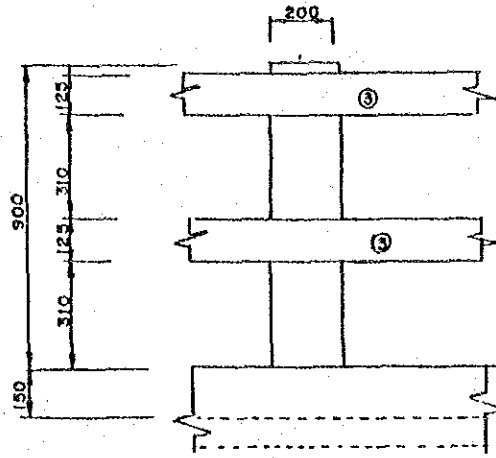
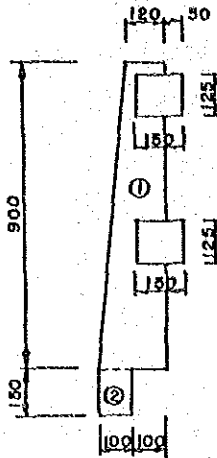
2) ENCOFRADO



1) $\sqrt{0.90^2 + 0.08^2} \times 0.200$	= 0.181 m ²
2) $(0.90 - 0.125 \times 2) \times 0.200$	= 0.130 m ²
3) $(1/2(0.120 + 0.200) \times 0.900 - 0.100 \times 0.125 \times 2) \times 2$	= 0.238 m ²
4) $0.150 \times 0.200 \times 2 + 0.100 \times 0.200$	= 0.080 m ²
5) 0.100×0.200	= 0.020 m ²
	Sub-total = 0.649 m ² /poste
	Total 0.649×26 = 16.874 m ²
6) $0.125 \times 25.60 \times 2 \times 2$	= 12.800 m ²
7) $(0.125 \times 25.60 - 0.200 \times 0.125 \times 13) \times 2 \times 2$	= 11.500 m ²
8) $(0.150 \times 25.60 - 0.100 \times 0.200 \times 13) \times 2 \times 2$	= 14.320 m ²
	Total = 38.620 m ²

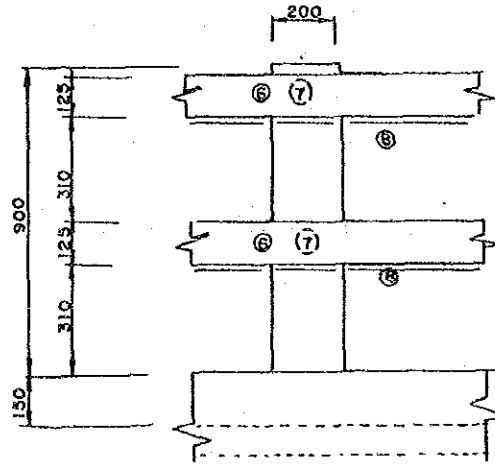
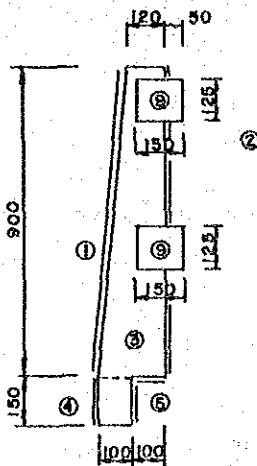
Barandado por tramo de 30 m

1) HORMIGON



- | | |
|---|------------------------|
| 1) $1/2(0.120+0.200) \times 0.200 \times 0.900 \times 30$ | = 0.864 m ³ |
| 2) $0.100 \times 0.150 \times 0.200 \times 30$ | = 0.090 m ³ |
| 3) $0.150 \times 0.125 \times 30.600 \times 4 - 0.100 \times 0.125 \times 0.200 \times 30 \times 2$ | = 2.145 m ³ |
| | <hr/> |
| | = 3.099 m ³ |

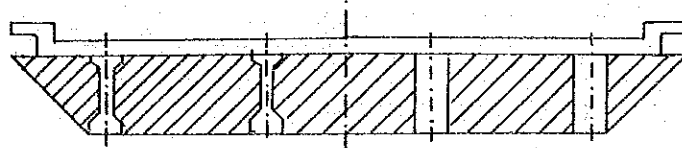
2) ENCOFRADO



- | | |
|---|-------------------------------|
| 1) $\sqrt{0.90^2 + 0.08^2} \times 0.200$ | = 0.181 m ² |
| 2) $(0.90 - 0.125 \times 2) \times 0.200$ | = 0.130 m ² |
| 3) $(1/2(0.120 + 0.200) \times 0.900 - 0.100 \times 0.125 \times 2) \times 2$ | = 0.238 m ² |
| 4) $0.150 \times 0.200 \times 2 + 0.100 \times 0.200$ | = 0.080 m ² |
| 5) 0.100×0.200 | = 0.020 m ² |
| | <hr/> |
| Sub-total | = 0.649 m ² /poste |
| Total 0.649×30 | = 19.470 m ² |
| 6) $0.125 \times 30.60 \times 2 \times 2$ | = 15.300 m ² |
| 7) $(0.125 \times 30.60 - 0.200 \times 0.125 \times 15) \times 2 \times 2$ | = 13.800 m ² |
| 8) $(0.150 \times 30.60 - 0.100 \times 0.200 \times 15) \times 2 \times 2$ | = 17.160 m ² |
| | <hr/> |
| Total | = 46.260 m ² |

2.6 Estructura de Apuntalamiento

V m3 = Metros Cubicos de Vacfo



Tramo 20 m

$$S = 2.02 \times 1.10 \times (20.66 - 0.75) \times 3 + 1/2 \times 1.12 \times 1.10 \times (20.66 - 0.75) \times 2$$
$$= 157.25 \text{ V m}^3$$

Tramo 25 m

$$S = 2.02 \times 1.30 \times (25.66 - 0.75) \times 3 + 1/2 \times 1.10 \times 1.30 \times (25.66 - 0.75) \times 2$$
$$= 231.86 \text{ V m}^3$$

Tramo 30 m

$$S = 2.02 \times 1.50 \times (30.66 - 0.75) \times 3 + 1/2 \times 1.095 \times 1.50 \times (30.66 - 0.75) \times 2$$
$$= 321.01 \text{ V m}^3$$

APENDICE 4

Cálculo de Cantidades y Costos de Mantenimiento y Administración Anual

- | | |
|------------------------|-----|
| 1. Oficina Trinidad | 4-1 |
| 2. Oficina San Ignacio | 4-3 |
| 3. Oficina Nueva | 4-5 |

APENDICE - 4

Cálculo de Cantidades y Costos de Mantenimiento y Administración Anual

1. Oficina Trinidad

a. Piedra triturada

Para asfalto

$$V = 68m^2 \times 5.1m^3/100m^2 = 3.47m^3$$

Para ripio

$$V = 31,830m \times 7m \times 0.05m + 5 \text{ años} = 2,228.10m^3$$

$$\text{Total} = 2,231.57m^3$$

b. Asfalto

$$V = 68m^2 \times 535 \text{ lt}/100m^2 = 363.80 \text{ lt}$$

c. Volquetas (para transporte de material pétreo)

Operación

$$Q = \frac{60 \times q \times E}{2.4 L + 15} = \frac{60 \times 5.5m^3 \times 0.9}{2.4 \times 203.2Km + 15} = 0.5905m^3/hr$$

Unidades

$$V = 3,773hr + 6.4hr/día + 24 \text{ días/mes} + 12 \text{ meses/año} = 2.0 \Rightarrow 2 \text{ unidades}$$

Horas de trabajo

$$H = 2228.10m^3 + 0.5905m^3/hr = 3,773hr$$

(Bacheo) Horas de trabajo

$$H = 68 \text{ lugares} + 3 \text{ lugares/día} \times 6.4hr/día = 145hr \text{ (1 unidad)}$$

$$\text{Total} = 3,918hr$$

d. Motoniveladora

Nivelación

$$A_1 = 31,830m \times 9m = 286,470m^2$$

Aumento de ripio

$$A_2 = 31,830m \times 7m + 5 \text{ años} = 44,562 m^2$$

Promedio de 20 años

$$TPD = 200 \text{ unidades/día}$$

Ciclos de nivelación

$$R = \frac{365 \times 200}{7000} = 11 \text{ ciclos}$$

Superficie de trabajo

$$A = 386,470\text{m}^2 \times 11 + 44,562\text{m}^2 = 4,295,732\text{m}^2$$

Operación

$$Q = \frac{2.9\text{m} \times 1800\text{m/hr} \times 0.55}{2} = 1436 \text{ m}^2/\text{hr}$$

Horas de trabajo

$$H = 4,295,732\text{m}^2 \div 1436\text{m}^2/\text{hr} = 2991 \text{ hr}$$

Unidades

$$V = 2991\text{hr} \div 6.4\text{hr/día} \div 24 \text{ días/mes} \div 12 \text{ meses/año} = 1.6 \Rightarrow 2 \text{ unidades}$$

e. Compactador de rodillo vibratorio

Superficie de trabajo

$$A = 44,562\text{m}^2$$

Operación

$$Q = 240\text{m}^2/\text{hr} \text{ (N= 3 veces, ver A-67)}$$

Horas de trabajo

$$H = 44,562\text{m}^2 \div 240\text{m}^2/\text{hr} = 186\text{hr}$$

Unidades

$$V = 186\text{hr} \div 6.4\text{hr/día} \div 24 \text{ días/mes} \div 12 \text{ meses/año} = 0.1 \Rightarrow 1 \text{ unidad}$$

f. Pala mecánica (3 días de trabajo por Km)

Horas de trabajo

$$H = 42.4\text{Km} \times 3 \text{ días/Km} \times 6.4\text{hr/día} = 815\text{hr}$$

Unidades

$$V = 815\text{hr} \div 6.4\text{hr/día} \div 24 \text{ días/mes} \div 12 \text{ meses/año} = 0.4 \Rightarrow 1 \text{ unidad}$$

g. Camión regador

Como promedio regará 1 vez por semana, a 20Km/hr promedio (incluye cargado de agua)

Horas de trabajo

$$H = 42.4\text{Km} \times 2 \div 20\text{Km/hr} \times (365 \text{ días} + 7 \text{ días/semana}) = 221\text{hr} \text{ (1 unidad)}$$

h. Camioneta

5 veces por semana, velocidad promedio de 30Km/hr

Horas de trabajo

$$H = 42.4\text{Km} \times 2 \div 30\text{Km/hr} \times (365 \times 5/7) = 767\text{hr} \text{ (1 unidad)}$$

i. Motorregadora (Se usará durante una hora por lugar)

Horas de trabajo

$$H = 68 \text{ lugares} \times 1.0\text{hr/lugar} = 68\text{hr} \text{ (1 unidad)}$$

j. Apisonadora

Se usará durante una hora por lugar

Horas de trabajo

$$H = 68 \text{ lugares} \times 1.0 \text{ hr/lugar} + 6.4 \text{ hr/día} = 11 \text{ días}$$

k. Cruce del río Mamoré

$$V = 2,228.10 \text{ m}^3$$

l. Generador

Se usará medio día

Tiempo de trabajo

$$H = 365 \text{ días} \times 0.5 = 183 \text{ días}$$

2. Oficina San Ignacio

a. Agregados (Caripo y río Dartagnán)

Para ripio

$$V = 87,797 \text{ m} \times 7 \text{ m} \times 0.05 \text{ m} + 5 \text{ años} = 6,145.79 \text{ m}^3$$

b. Volqueta

Operación

$$Q = \frac{60 \times 5.5 \times 0.9}{2.4 \times 191.6 \text{ Km} + 15} = 0.63 \text{ m}^3/\text{hr}$$

Horas de trabajo

$$H = 6,145.79 \text{ m}^3 + 0.63 \text{ m}^3/\text{hr} = 9,755 \text{ hr}$$

Unidades

$$V = 9,755 \text{ hr} + 6.4 \text{ hr/día} + 24 \text{ días/mes} + 12 \text{ meses/año} = 5.2 \Rightarrow 6 \text{ unidades}$$

c. Motoniveladora

Nivelación

$$A_1 = 87,797 \text{ m} \times 9 \text{ m} = 790,173 \text{ m}^2$$

Aumento de ripio

$$A_2 = 87,797 \text{ m} \times 7 \text{ m} + 5 \text{ años} = 122,915 \text{ m}^2$$

Promedio de 20 años

$$\text{TPD} = 80 \text{ unidades/día}$$

Ciclos de nivelación

$$R = \frac{365 \times 80}{7000} = 5 \text{ ciclos}$$

Superficie de trabajo

$$A = 790,173\text{m}^2 \times 5 \text{ ciclos} + 122,915\text{m}^2 = 4,073,788\text{m}^2$$

Operación

$$Q = 1,436\text{m}^2/\text{hr}$$

Horas de trabajo

$$H = 4,073,788\text{m}^2 \div 1436\text{m}^2/\text{hr} = 2,837\text{hr}$$

Unidades

$$V = 2,837\text{hr} \div 1843.2\text{hr/año} = 1.5 \Rightarrow 2 \text{ unidades}$$

d. Compactadora de rodillo vibratorio

Superficie de trabajo

$$A = 122,915\text{m}^2$$

Operación

$$Q = 240\text{m}^2/\text{hr} \text{ (N=3, ver A-67)}$$

Horas de trabajo

$$H = 122,915\text{m}^2 \div 240\text{m}^2/\text{hr} = 512\text{hr}$$

Unidades

$$V = 512\text{hr} \div 1,843.2\text{hr/año} = 0.3 \Rightarrow 1 \text{ unidad}$$

e. Pala mecánica (3 días de trabajo por Km)

Horas de trabajo

$$H = 88.1\text{Km} \times 3 \text{ días/Km} \times 6.4\text{hr/día} = 1,692\text{hr}$$

Unidades

$$V = 1692\text{hr} \div 1843.2\text{hr/año} = 0.92 \Rightarrow 1 \text{ unidad}$$

f. Camión regador

Como promedio regará 1 vez por semana, a 20Km/hr promedio (incluye cargado de agua)

Horas de trabajo

$$H = 88.1\text{Km} \times 2 \div 20\text{Km/hr} \times 365/7 = 459\text{hr} \text{ (1 unidad)}$$

g. Camioneta

5 veces por semana, velocidad promedio de 30Km/hr

Horas de trabajo

$$H = 88.1\text{Km} \times 2 \div 30\text{Km/hr} \text{ (365 x 5/7)} = 1531\text{hr} \text{ (1 unidad)}$$

h. Generador

Igual que en la oficina Trinidad

3. Oficina Nueva

a. Agregados (Caripo y río Dartagnán)

Para ripio

$$V = 91,271\text{m} \times 7\text{m} \times 0.05\text{m} + 5 \text{ años} = 6,388.97\text{m}^3$$

b. Volqueta

Operación

$$Q = \frac{60 \times 5.5 \times 0.9}{2.4 \times 101.8\text{Km} + 15} = 1.15\text{m}^3/\text{hr}$$

Horas de trabajo

$$H = 6,388.97\text{m}^3 \div 1.15\text{m}^3/\text{hr} = 5,556\text{hr}$$

Unidades

$$V = 5,556\text{hr} \div 1843.2\text{hr/año} = 3 \text{ unidades}$$

c. Motoniveladora

Nivelación

$$A_1 = 91,271\text{m} \times 9\text{m} = 821,439\text{m}^2$$

Aumento de ripio

$$A_2 = 91,271\text{m} \times 7\text{m} + 5 = 127,779\text{m}^2$$

Promedio de 20 años

$$\text{TPD} = 80 \text{ unidades/día}$$

Ciclos de nivelación

$$R = \frac{365 \times 80}{7000} = 5 \text{ ciclos}$$

Superficie de trabajo

$$A = 821,439\text{m}^2 \times 5 \text{ ciclos} + 127,779\text{m}^2 = 4,234,974\text{m}^2$$

Operación

$$Q = 1,436\text{m}^2/\text{hr}$$

Horas de trabajo

$$H = 4,234,974\text{m}^2 \div 1436\text{m}^2/\text{hr} = 2,949\text{hr}$$

Unidades

$$V = 2,949\text{hr} \div 1843.2\text{hr/año} = 1.6 \Rightarrow 2 \text{ unidades}$$

d. Compactadora de rodillo vibratorio

Superficie de trabajo

$$A = 127,779\text{m}^2$$

Horas de trabajo

$$H = 127,779\text{m}^2 \div 240\text{m}^2/\text{hr} = 532\text{hr} \quad (1 \text{ unidad})$$

e. Pala mecánica (3 días de trabajo por Km)

Horas de trabajo

$$H = 91.5\text{Km} \times 3 \text{ días/Km} \times 6.4\text{hr/día} = 1,757\text{hr}$$

Unidades

$$V = 1,757\text{hr} \div 1843.2\text{hr/año} = 0.95 \Rightarrow 1 \text{ unidad}$$

f. Camión regador

Horas de trabajo

$$H = 91.5\text{Km} \times 2 \div 20\text{Km/hr} \times 365/7 = 477\text{hr} (1 \text{ unidad})$$

g. Camioneta

Horas de trabajo

$$H = 91.5\text{Km} \times 2 \div 30\text{Km/hr} (365 \times 5/7) = 1590\text{hr} (1 \text{ unidad})$$

h. Generador

Igual que en la oficina Trinidad

Costo de Operación y Mantenimiento (Oficina Nueva)										Por año
Nombre del Trabajo	Tamaño y Tipo	Unidad	Volumen	Costo Unitario			Costos			Observaciones
				M.L.		M.E	M.L.		M.E.	
				Imp.	Otros		Imp.	Otros		
Grava (Caripo y Rio Dartogañan)		M3	6,388.97	0.59	0.595	2.585	3,769	3,801	16,515	
Volqueta	lit	Unid/hrs	3 5,556	3.53	2.92	15.03	19,612	16,224	83,506	
Motoniveladora	3.7 m	Unid/hrs	2 2,949	6.46	3.13	29.16	19,051	9,230	85,993	
Compac. Rodillo Lisos Vibrat.	11 t	Unid/hrs	1 532	8.10	4.65	36.13	4,309	2,474	19,221	
Pala Mecánica	2.1m3	Unid/hrs	1 1,757	13.74	3.64	63.38	24,141	6,395	111,359	
Camión Cisterna Regador		Unid/hrs	1 477	2.86	1.66	12.60	1,364	791	6,010	
Camioneta		Unid/hrs	1 1,590	1.10	1.45	4.59	1,749	2,306	7,298	
Generador		Unid/hrs	1 183	6.41	4.21	28.39	1,173	770	5,195	
Sobrestante		Prs/año	1	892.8	8,920.8	-	893	8,921	-	
Operador		Prs/año	3	614.9	6,148.8	-	1,845	18,446	-	
Chofer		Prs/año	5	470.5	4,705.2	-	2,353	23,526	-	
Peón		Prs/año	3	284.4	2,844.0	-	853	8,532	-	
Oficinista		Prs/año	3	892.1	8,920.8	-	2,676	26,762	-	
Cocinero		Prs/año	1	394.2	3,942.0	-	394	3,942	-	
Ayudante Cocinero		Prs/año	1	284.4	2,844.0	-	284	2,844	-	
Sereno		Prs/año	1	284.4	2,844.0	-	284	2,844	-	
Gastos de Componento		Mes	12	-	200	-	-	2,400	-	
Total							84,750	140,208	335,097	

Costo de Operación y Mantenimiento (Oficina TDD)										Por año
Nombre del Trabajo	Tamaño y Tipo	Unidad	Volumen	Costo Unitario			Costos			Observaciones
				M. L.		M. E.	M. L.		M. E.	
				Imp.	Otros		Imp.	Otros		
Trituración de piedra	San Jorge	M3	2,228.10	1.71	2.26	6.41	3,810	5,036	14,282	A - 66
Asfalto	Diluido	lt	363.80	0.23	0.20	0.57	84	73	207	C
Volqueta	11 t	Unid/hrs	4 3,918	3.53	2.92	15.02	13,831	11,441	58,848	C
Motoniveladora	3.7 m	Unid/hrs	2 2,991	6.46	3.13	29.16	19,322	9,362	87,218	C
Compac. Rodillo Lisos Vibrat.	11 t	Unid/hrs	1 186	8.10	4.65	36.13	1,507	865	6,720	C
Pala Mecánica	2.1 m3	Unid/hrs	1 815	13.74	3.64	63.38	11,198	2,967	51,655	C
Camión Cisterna Regador		Unid/hrs	1 221	2.86	1.66	12.60	632	667	2,785	C
Camioneta		Unid/hrs	1 767	1.10	1.45	4.59	844	1,112	3,521	C
Máquina Regadora	200 l	Unid/hrs	1 68	0.21	0.28	0.97	14	19	66	C
Apisonadora	60-100 kg	Unid/hrs	1 11	2.11	1.39	9.17	23	15	101	C
Generador	75 Kw	Unid/hrs	1 183	6.41	4.21	28.39	1,173	770	5,195	C
Sobrestante		Prs/año	1	892.8	8,920.8	-	893	8,920	-	
Operador		Prs/año	3	614.9	6,148.8	-	1,845	18,446	-	
Chofer		Prs/año	5.08	470.5	4,705.2	-	2,390	23,902	-	
Capatáz		Prs/año	0.08	421.2	4,212.0	-	34	337	-	
Peón		Prs/año	3.24	284.4	2,844.0	-	922	9,215	-	
Oficinista		Prs/año	3	892.1	8,920.8	-	2,676	26,762	-	
Cocinero		Prs/año	1	394.2	3,942.0	-	394	3,942	-	
Ayudante Cocinero		Prs/año	1	284.4	2,844.0	-	284	2,844	-	
Sereno		Prs/año	1	284.4	2,844.0	-	284	2,844	-	
Cruce Río Manare		M3	2,228.1	0.72	2.79	3.72	1,604	6,216	8,289	A - 83
Gastos de Compañen- to		Mes	12	-	200	-	-	2,400	-	
Total							63,764	138,155	238,887	Total 440,806

Costo de Operación y Mantenimiento (Oficina SIM)										Por año
Nombre del Trabajo	Tamaño y Tipo	Unidad	Volumen	Costo Unitario			Costos			Observaciones
				M. L.		M. E.	M. L.		M. E.	
				Imp.	Otros		Imp.	Otros		
Grava (Caripo y Rio Dartoghan)		M3	6,145.79	0.59	0.595	2,585	3,626	3,657	15,887	A - 81 A - 82
Volqueta	11 t	Unid/hrs	6 9,755	3.53	2.92	15.02	34,435	28,485	146,520	
Motoniveladora	3,7 m	Unid/hrs	2 2,837	6.46	3.13	29.16	18,327	8,880	82,727	
Compac. Rodillo Lisos Vibrat	11 t	Unid/hrs	1 512	8.10	4.65	36.13	4,147	2,381	18,499	
Pala Mecánica	2.1 m3	Unid/hrs	1 1,692	13.74	3.64	63.38	23,248	6,159	107,239	
Camión Cisterna Regador		Unid/hrs	1 459	2.86	1.66	12.60	1,313	762	5,783	
Camioneta		Unid/hrs	1,531	1.10	1.45	4.59	1,684	2,220	7,027	
Generador		Veh/día	183	6.41	4.21	28.39	1,173	770	5,195	
Jefe de Comp.		Prs/año	1	2,105.3	21,052.8	-	2,105	21,053	-	
Ing. Mecánico		Prs/año	1	2,105.3	21,052.8	-	2,105	21,053	-	
Mecánico		Prs/año	2	730.4	7,304.4	-	1,461	14,609	-	
Operador		Prs/año	3	614.9	6,148.8	-	1,845	18,446	-	
Chofer		Prs/año	8	470.5	4,705.2	-	3,764	37,642	-	
Peón		Prs/año	3	284.4	2,844.0	-	853	8,532	-	
Oficinista		Prs/año	3	892.1	8,920.8	-	2,676	26,762	-	
Cocinero		Prs/año	1	394.2	3,942.0	-	394	3,942	-	
Ayudante Cocinero		Prs/año	1	284.4	2,844.0	-	284	2,844	-	
Sereno		Prs/año	1	284.4	2,844.0	-	284	2,844	-	
Gastos de Compen- to		Mes	12	-	200	-	-	2,400	-	
Total							103,724	213,441	388,877	

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