

Description	Calculation Details	Unit	Quantity	Remarks
109 Concrete, class H, for levelling concrete of drain ditch and catch basin	$V = 0.8 \times 0.03 \times \{(105.0 + 60.0) \times 0.8\}$ $+ 0.8 \times 0.05 \times \{(105.0 + 60.0) \times 0.2\}$ $+ 1.2 \times 1.2 \times 0.03 \times 2$ $= 4.57 \text{ m}^3$	m ³	5	
110 Formwork, F1 finish, for concrete of Items 103, 04, 105 and 107	<p>Inlet tunnel</p> $A = 4.6 \times \pi \times (14.98 + 1.0) + (6.2^2 \times \pi \times 1/4)$ $- 4.6^2 \times \pi \times 1/4 = 244.50 \text{ m}^2$			
	<p>Inlet shaft</p> $A_1 = (16.0 \times 2 \times \pi \times 16.2602 / 360^\circ \times 2 + 7.667$ $\times 2 \times \pi \times 147.4796 / 360^\circ) \times (70.231 - 66.031)$ $- 3.7 \times 3.7 = 107.34 \text{ m}^2$			
	$A_2 = (16.0 \times 2 \times \pi \times 16.2602 / 360^\circ \times 2 + 7.667$ $\times 2 \times \pi \times 147.4796 / 360^\circ) \times (70.231$ $- 64.9) - 1.0 \times (70.231 - 64.9) \times 2$ $- 4.6^2 \times \pi \times 1/4 = 126.34 \text{ m}^2$			
	$A_3 = 2.3 \times (70.231 - 64.9) \times 2$ $+ 2.3 \times (70.231 - 66.031) \times 2 = 43.84 \text{ m}^2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$A_4 = 5.9 \times 5.9 - 3.7 \times 3.7 = 21.12 \text{ m}^2$			
	<i>Tunnel lining (contraction joint)</i>			
	$A = 5.5^2 \times \pi \times 1/8 + 5.5 \times 2.75 - 3.3173$			
	$\times 1.85^2 + 4.9^2 \times \pi \times 1/8 + 4.9 \times 2.45$			
	$- 3.3173 \times 1.85^2 = 25.73 \text{ m}^2$			
	<i>Concrete facing wall</i>			
	$A = 10.621 \times 0.3 + 6.149 \times 0.3 \times 2$			
	$+ 0.5 \times 10 \times 2 = 16.88 \text{ m}^2$			
	<i>Plug</i>			
	$A = (4.6^2 \times \pi \times 1/4 - 1.4^2 \times \pi \times 1/4) \times 2$			
	$- 0.8^2 \times \pi \times 1/4) \times 2 = 26.08 \text{ m}^2$			
	<i>Total area</i>			
	$A = 244.50 + 107.34 + 126.34 + 43.84$			
	$+ 21.12 + 25.73 + 16.88 + 26.08$			
	$= 611.83 \text{ m}^2$	m^2	612	
	<i>/// Formwork, F1 finish, for concrete of Item 06</i>			
	$A = 0.62 \times 2 \times (105.0 + 60.0)$			
	$+ 0.95 \times 4 \times 1.0 \times 2 = 212.2 \text{ m}^2$	m^2	213	
	<i>/// Formwork, F1 finish, for concrete of Item 08</i>			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Anchor block	$A = 5.0 \times 4 \times 4.0 = 80.0 \text{ m}^2$			
Foundation concrete	$A = 0.25 \times 4 \times 0.5 \times 6 = 3.0 \text{ m}^2$			
Total area	$A = 80.0 + 3.0 = 83.0 \text{ m}^2$	m^2	83	
/13 Formwork, F2 finish, for concrete of Items 102, 103, 105 and 109				
Floor slab and beam at EL. 90.2m				
Floor	$A_1 = 7.867^2 \times \pi \times 133.3168^\circ / 360^\circ \times 2$			
	$- 1.3 \times 2.977 - 1.0 \times 1.0 \times 2$			
	$+ (2.709 + 1.3) \times 0.3 + 1.0 \times 4 \times 0.2 \times 2$			
	$= 140.94 \text{ m}^2$			
Floor				
	$A_2 = (15.1 + 16.4) / 2 \times 4.1 \times 2 - 0.4 \times 4.1$			
	$\times 8 - 3.0 \times 3.0 \times 2 - 3.5 \times 3.5 \times 2$			
	$+ 0.3 \times 3.0 \times 4 \times 2 + 0.3 \times 3.5 \times 4 \times 2$			
	$+ 0.1 \times 3.3 \times 4 \times 2 + 0.1 \times 3.8 \times 4 \times 2$			
	$= 94.81 \text{ m}^2$			
Beam				
	$A_3 = (1.0 + 1.0 + 0.9) \times 16.4 + 1/2 \times 0.6 \times 0.3 \times 4$			
	$+ [(1.0 + 1.0 + 0.9) \times 14.802 + 1/2 \times 0.6 \times 0.3 \times 4]$			
	$\times 2 = 34.49 \text{ m}^2$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Beam				
	$A_4 = (0.4 + 0.35 + 0.35) \times 4.1 \times 8 = 36.08 \text{ m}^2$			
Subtotal				
	$A = 140.94 + 94.81 + 139.49 + 36.08$			
	$= 406.32 \text{ m}^2$			
Floor slab and beam at EL. 82.0m				
Floor				
	$A_1 = 7.667^2 \times \pi \times 132.0237 / 360^\circ \times 2$			
	$- 1.3 \times 2.713 + (2.461 + 1.3) \times 0.2$			
	$= 132.68 \text{ m}^2$			
Floor				
	$A_2 = (16.4 + 14.68) / 2 \times 4.1 \times 2 - 3.0 \times 3.0$			
	$\times 2 - 3.5 \times 3.5 \times 2 + 3.0 \times 0.2 \times 4 \times 2$			
	$+ 3.5 \times 0.2 \times 4 \times 2 = 95.33 \text{ m}^2$			
Beam				
	$A_3 = (0.9 + 1.0 + 1.0) \times 16.0 + 1/2 \times 0.6 \times 0.3 \times 4$			
	$+ \{ (0.9 + 1.0 + 1.0) \times 19.376 + 1/2 \times 0.6 \times 0.3$			
	$\times 4 \} \times 2 = 130.86 \text{ m}^2$			
Subtotal				
	$A = 132.68 + 95.33 + 130.86 = 358.87 \text{ m}^2$			
Floor slab and beam at EL. 74.0m				
Floor				
	$A_1 = 7.667^2 \times \pi \times 132.0237 / 360^\circ - 1.3 \times 2.713$			
	$+ (2.461 + 1.3) \times 0.2 = 64.95 \text{ m}^2$			

4-1-24

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Floor	$A_2 = 7.667^2 \times \pi \times 132.8404 / 360 - 1.5^2 \times \pi \times 1/3$ $- 0.3 \times 1.0 = 67.45 \text{ m}^2$			
Floor	$A_3 = (0.97 + 14.68) / 2 \times 3.55 - 3.0 \times 3.0$ $\times 2 + 3.0 \times 0.2 \times 4 \times 2 = 41.20 \text{ m}^2$			
Floor	$A_4 = \{ 0.85 \times 4.6 + 0.9 \times 3.5 + 0.3 \times 3.5$ $+ (2.75 + 2.07) / 2 \times 4.6 - 0.8 \times 0.85$ $+ 3.5 \times 0.2 \times 4 \} \times 2 = 42.63 \text{ m}^2$			
Beam	$A_5 = (0.9 + 1.0 + 1.0) \times 14.376 + 1/2 \times 0.6 \times 0.3 \times 4$ $+ (0.4 + 0.35 + 0.35) \times 4.6 \times 2$ $+ (0.8 + 0.8 + 0.8) \times 13.376 = 84.27 \text{ m}^2$			
Ditch	$A_6 = 0.2 \times (56.062 - 1.0 \times 2 - 3.3) = 10.15 \text{ m}^2$			
Subtotal	$A = 64.95 + 67.45 + 41.20 + 42.63$ $+ 84.27 + 10.15 = 310.65 \text{ m}^2$			
Stair	$A_1 = \{ 0.2 \times 1.2 + (0.15 + 0.35) / 2$ $\times 0.25 \} \times 40 + 1.2 \times 14.751$ $+ 3.8 \times 1.5 \times 2 + 3.8 \times 0.2 \times 2$ $= 42.72 \text{ m}^2$			
	$A_2 = \{ 0.2 \times 1.2 + (0.15 + 0.35) / 2 \times 0.25 \}$ $\times 39 + 1.2 \times 13.988 + 3.8 \times 1.5 \times 2$ $+ 3.8 \times 0.2 \times 2 = 41.50 \text{ m}^2$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$A_3 = \{0.2 \times 1.2 + (0.15 + 0.35) / 2 \times 0.25\} \times 10 + 1.2 \times 6.196 = 12.88 \text{ m}^2$			
	Subtotal			
	$A = 42.72 + 41.50 + 12.88 = 97.10 \text{ m}^2$			
	Inlet shaft			
	$A_1 = (16.2 \times 2 \times \pi \times 16.2602 / 360^\circ \times 4 + 7.867 \times 2 \times \pi \times 147.4796 / 360^\circ \times 2) \times 8.0 - 1.3 \times 0.9 \times 6 = 464.09 \text{ m}^2$			
	A2 = $(16.0 \times 2 \times \pi \times 16.2602 / 360^\circ \times 4 + 7.667 \times 2 \times \pi \times 147.4796 / 360^\circ \times 2) \times (EL. 82 - EL. 70.231 - 0.2 - 0.2) - 1.3 \times 0.9 \times 8 - 0.8 \times 0.8 \times 2 - 1.0 \times 3.589 \times 2 = 637.45 \text{ m}^2$			
	Subtotal			
	$A = 464.09 + 637.45 = 1,101.54 \text{ m}^2$			
	Concrete facing wall			
	$A = (9.871 + 4.371) / 2 \times 5.5 \times 1.118 + (20.871 + 14.871) / 2 \times 4.0 \times 1.118 = 123.71 \text{ m}^2$			
	Secondary concrete and partition wall in inlet shaft			
	$A = (1.4 + 11.4 + 4.3 + 4.3) \times (70.231 - 64.9)$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$- 1.4^2 \times \pi \times \frac{1}{4} \times 4 + 1.0 \times 1.5 \times 4 = 166.23 \text{ m}^2$			
	Total area of Form Fl (Item 103)			
	$A = 406.32 + 358.87 + 310.65 + 97.10$			
	$+ 1,101.54 + 123.71 + 166.23$			
	$= 2,564.42 \text{ m}^2$	m^2	2,564	
	114 Formwork, F3 finish, for concrete of Items 101, 103, 105 and 107			
	Corner buffer			
	$A = (2.828 \times 0.3 + 1.414 \times 2.828 \times \frac{1}{2}) \times 4 \times 7 = 22.78 \text{ m}^2$			
	Valve pit and partition wall			
	$A = 5.2 \times 4 \times 10.4 \times 2 + 5.2 \times 4.2 \times 2$			
	$+ 7.5 \times 3.569 \times 2 + 5.7 \times 7.419 \times 2$			
	$+ 1.0 \times \pi \times \frac{1}{2} \times 7.769 - 0.8 \times 0.8 \times 2$			
	$= 625.36 \text{ m}^2$			
	Secondary concrete in inlet shaft			
	$A = 11.5 \times 4.2 \times 2 = 96.6 \text{ m}^2$			
	Concrete facing wall			
	$A = (12.75 + 10.0) / 2 \times 5.5 \times 1.118 + (5.75 + 5.0) / 2 \times 5.5 \times 1.118 + (6.189 + 5.657) / 2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$5.0 = 132.51 \text{ m}^2$			
	Total area of form F3			
	$A = 22.78 + 625.36 + 96.6 + 132.51$			
	$= 877.25 \text{ m}^2$	m^2	877	
	115 Formwork, F3 finish, for concrete of Item 106			
	Drain ditch and catch basin			
	$A = 0.5 \times 2 \times (105.0 + 60.0)$			
	$+ 0.8 \times 4 \times 0.8 \times 2 + (0.1 \times 2 + 0.6)$			
	$\times (7.0 + 7.0) = 181.32 \text{ m}^2$	m^2	182	
	116 Formwork, F4 finish, for concrete of Item 104			
	Tunnel transition part			
	$A = (3.7 \times 3 + 8.95) / 2 \times 10.0$			
	$= 100.25 \text{ m}^2$			
	Tunnel			
	$A = 8.950 \times 8.275 \times 8.28 = 74.068.66 \text{ m}^2$			
	Tunnel outlet part			
	$A = (8.950 + 3.7 \times \pi \times 1/2 + 1.85 \times 2) / 2$			
	$\times 10 = 92.31 \text{ m}^2$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Total of form F9 (without form of invert)			
	$A = 100.25 + 74.068.66 + 92.31$			
	$= 74.261.22 \text{ m}^2$	m^2	74.261	
	Concrete Works of Item /01			
	Foundation concrete for valves			
	$w_1 = 5.04 \times 40 \text{ kg/m}^3 = 201.6 \text{ kg}$			
	Corner buffer			
	$w_2 = 10.14 \times 30 \text{ kg/m}^3 = 304.2 \text{ kg}$			
	Concrete Works of Item /02			
	Floor slab			
	$w_1 = (20.44 + 15.52 + 14.00 + 12.84$			
	$+ 13.55 + 16.99 + 12.84 + 13.49 + 7.28$			
	$+ 10.14) \times 80 \text{ kg/m}^3 = 10,967.2 \text{ kg}$			
	Beam			
	$w_2 = (17.89 + 32.33 + 7.22 + 17.46 + 31.41$			
	$+ 28.43) \times 120 \text{ kg/m}^3 = 16,168.8 \text{ kg}$			
	Stair			
	$w_3 = 10.73 \times 100 \text{ kg/m}^3 = 1,073 \text{ kg}$			
	Concrete Works of Item /03			
	Inlet tunnel			
	$w_1 = 148.68 \times 70 \text{ kg/m}^3 = 10,407.6 \text{ kg}$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Inlet shaft	$w_2 = 2.717 \times 60 \text{ kg/m}^3 = 163.020 \text{ kg}$			
Concrete Works of Item 104	Transition part			
Transition part	$w_1 = 166.07 \times 70 \text{ kg/m}^3 = 11.624.9 \text{ kg}$			
Tunnel	Tunnel			
Tunnel outlet part	$w_2 = 0 \text{ kg}$			
Facing concrete	$w_3 = 96.46 \times 70 \text{ kg/m}^3 = 6.752.2 \text{ kg}$			
Concrete Works of Item 105	Facing concrete			
Concrete Works of Item 106	$w_1 = 45.29 \times 30 \text{ kg/m}^3 = 2,858.7 \text{ kg}$			
Concrete Works of Item 107	$w = 31.98 \times 30 \text{ kg/m}^3 = 959.4 \text{ kg}$			
Concrete Works of Item 108	$w = 0 \text{ kg}$			
Total Weight	$W = 201.6 + 304.2 + 10,967.2 + 16,168.8$ $+ 1,073 + 10,407.6 + 163,020 + 11,624.9$ $+ 6,752.2 + 2,858.7 + 959.4 = 224,337.6$	ton	224	

5-1-20

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
1/18 Shotcrete in tunnel and inlet structure				
Inlet tunnel	$V = (6.1^2 \times \pi \times 1/4 - 5.9^2 \times \pi \times 1/4) \times 13.98$ $+ (6.3^2 \times \pi \times 1/4 - 6.1^2 \times \pi \times 1/4) \times 1.0 = 28.30 \text{ m}^3$			
Inlet shaft	$V_1 = \left\{ (17.25^2 \times \pi - 17.1^2 \times \pi) \times 16.2602 / 360^\circ \right.$ $\times 2 + (8.917^2 \times \pi - 8.767^2 \times \pi) \times 147.4796 / 360^\circ \left. \right\}$ $\times (EL. 89.9 - EL. 64.831) = 122.24 \text{ m}^3$			
	$V_2 = \left\{ (17.25^2 \times \pi - 17.1^2 \times \pi) \times 16.2602 / 360^\circ \times 2 \right.$ $+ (8.917^2 \times \pi - 8.767^2 \times \pi) \times 147.4796 / 360^\circ \left. \right\}$ $\times (EL. 89.9 - EL. 63.7) = 127.76$			
	$V_3 = 13.9 \times 10.5 \times 0.15 + 6.3 \times 10.5 \times 0.15 \times 2$ $+ 1.1 \times 9.369 \times 2 \times 0.15 + 13.9 \times 9.369$ $\times 0.15 = 64.36 \text{ m}^3$			
	$V_4 = -(6.3^2 \times \pi \times 1/4 + 5.9 \times 5.9) \times 0.15$ $= -9.90 \text{ m}^3$			
Subtotal	$V = 122.24 + 127.76 + 64.36 - 9.90$ $= 304.46 \text{ m}^3$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Tunnel transition part	$V = (6.2 \times 6.05 - 5.9 \times 5.9) \times 1.0$ $+ \left\{ (5.8 \times 5.65 - 5.5 \times 5.5) + (5.8^2 \times \pi \times \frac{1}{8} + 5.8 \times 2.25 - 5.5^2 \times \pi \times \frac{1}{8} - 5.5 \times 2.75) \right\} \times \frac{1}{2} \times 9.0 = 23.74 \text{ m}^3$			
Tunnel type II (shotcrete area)	$A = 1.178 \text{ m}^2$ $V = 1.178 \times 7.665 = 9.03035 \text{ m}^3$			
Tunnel type IV (shotcrete area)	$A = 1.181 \text{ m}^2$ $V = 1.181 \times 610.0 = 720.41 \text{ m}^3$			
Tunnel outlet part	$V = (5.1^2 \times \pi \times \frac{1}{8} + 5.1 \times 2.45 - 4.9^2 \times \pi \times \frac{1}{8} - 4.9 \times 2.45) \times 10.0$ $= 12.75 \text{ m}^3$			
Total volume	$V = 28.3 + 304.46 + 23.74 + 9.03035$ $+ 720.41 + 12.75 = 10,120.01 \text{ m}^3$	m ³	10,120	
1/9 Steel wire mesh for Item/18				
Inlet tunnel	$a = 5.95 \times \pi \times 13.98 + 6.15 \times \pi \times 1.0$ $= 280.64 \text{ m}^2$			

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Description	Calculation Details	Unit	Quantity	Remarks
Inlet shaft				
	$A_1 = (17.2 \times 2 \times \pi \times 16.2602^\circ / 360^\circ) \times 2$			
	$+ 8.867 \times 2 \times \pi \times 147.4796^\circ / 360^\circ$			
	$\times (EL. 89.9 - EL. 64.831) = 816.90 m^2$			
	$A_2 = (17.2 \times 2 \times \pi \times 16.2602^\circ / 360^\circ) \times 2$			
	$+ 8.867 \times 2 \times \pi \times 147.4796^\circ / 360^\circ$			
	$\times (EL. 89.9 - EL. 63.7) = 853.76 m^2$			
	$A_3 = 13.9 \times 10.5 + 6.3 \times 10.5 \times 2 + 1.1$			
	$\times 9.369 \times 2 + 13.9 \times 9.369$			
	$= 429.09 m^2$			
	$A_4 = - (6.3^2 \times \pi \times 1/4 + 5.9 \times 5.9)$			
	$= -65.98 m^2$			
Tunnel transition part				
	$A = (6.1 + 6.0 \times 2) \times 1.0$			
	$+ (5.9 + 5.6 \times 2) \times 9.0 = 170.20 m^2$			
Tunnel type II				
	$A = 11.78 \times 7.665.828 = 90,303.45 m^2$			
Tunnel type IV				
	$A = 11.81 \times 610 = 7,204.10 m^2$			
Tunnel outlet part				
	$A = (5.0 \times \pi \times 1/2 + 2.45 \times 2) \times 10 = 127.54 m^2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Total area			
	$A = 280.64 + 816.9 + 853.76 + 429.09$			
	$- 65.98 + 170.2 + 90,303.45$			
	$+ 7,204.1 + 127.54$			
	$= 100,119.7 \text{ m}^2$	m^2	100,120	
120	Shotcrete with wire mesh for cut slope protection $t = 100 \text{ m}$			
	$A = 1,640.7 + 716.9 = 2,357.6$	m^2	2,358	
121	Shotcrete with wire mesh for cut slope protection $t = 50 \text{ m}$			
	$A = (\text{EL. } 90.0 - \text{EL. } 80.0) \times 60.0$ $\times 1.5 = 900 \text{ m}^2$	m^2	900	
122	Anchor bars, D. 25 mm			
	Facing wall $N = (23.71 + 132.51) / 9.0 \text{ m} = 30 \text{ nos}$ $L = 30 \times 3.0 = 90.0$	m	90	

5-1-20

Description	Calculation Details	Unit	Quantity	Remarks
123	P.V.C. water stop, type B			
	Inlet tunnel			
	$l = 5.0 \times \pi \times 2 + 4.6 \times \pi = 45.87 \text{m}$			
	Circumference of steel pipe (in block out)			
	$l = 2.5 \times 4 \times 2 + 1.4 \times 4 = 25.6 \text{m}$			
	Total length	m	72	
	$L = 45.87 + 25.6 = 71.47$			
124	Bituminous coating for contraction joint			
	$A_1 = (5.8^2 \times \pi \times 1/4 - 4.6^2 \times \pi \times 1/4)$			
	$+ (6.2^2 \times \pi \times 1/4 - 4.6^2 \times \pi \times 1/4)$			
	$= 23.37 \text{m}^2$			
	$A_2 = (5.9 \times 5.9 - 3.7 \times 3.7)$			
	$+ (5.5^2 \times \pi \times 1/8 + 5.5 \times 2.75$			
	$- 3.3173 \times 1.85^2) + (4.9^2 \times \pi$			
	$\times 1/8 + 4.9 \times 2.45 - 3.3173 \times 1.85^2)$			
	$= 46.85 \text{m}^2$			
	Total area	m ²	71	
	$A = 23.37 + 46.85 = 70.22$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
125 P.V.C. pipe, D. 50 mm for weep hole				
	Facing wall			
	$N = (123.71 + 132.51) / 4.0 = 64$ nos			
	$L = 64 \times 0.4 = 25.6$ m			
	Shotcrete			
	$N = (2.358 \times 0.7) / 4.0 = 412$			
	$L = 412 \times 0.2 = 82.4$ m	m	108	
126 P.V.C. pipe, D. 75 mm				
	Inlet shaft			
	$L = (EL.84 - EL.74) \times 32$			
	+ $0.4 \times 32 \times 3 + 1.0 \times 32 = 390.4$	m	391	
127 P.V.C. pipe, D. 150 mm				
	Inlet shaft			
	$L = 4.0 \times 3 = 12.0$	m	12	

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
2.5	MISCELLANEOUS METAL WORKS			
/01	Embedded metal			
	D.16 anchor bars.			
	$N = (3.0 \times 4 \times 2 + 3.5 \times 4 \times 4 + 11.9 \times 2 + 4.3 \times 2) / 0.5 = 222 \text{ nos}$			
	$W_1 = 222 \times 0.4 \times 1.56 = 138.5 \text{ kg}$			
	Joint bar			
	$N = (2.5 \times 4 \times 2 + 1.4 \times 3) / 0.3 \times 2 = 160 \text{ nos}$			
	$W_2 = 160 \times 1.0 \times 1.56 = 256.0 \text{ kg}$			
	Embedded hook			
	$W_3 = 0.8 \times 2.984 \times 5 + (0.25 \times 0.15 \times 0.01$			
	$\times 7.850) \times 5 = 26.65 \text{ kg}$			
	Total weight			
	$W = 138.5 + 256.0 + 26.65 = 421.15 \text{ kg}$	kg	422	
/02	Steel pipe handrail			
	$W_1 = (2.8 + 1.3) \times 17 \text{ kg/m} = 69.7$			
	$W_2 = (3.4 \times 4 \times 4 + 3.9 \times 4 \times 2) \times 17 = 1455.7$			
	Stair			
	$W_3 = (13.9 + 13.6 + 5.9) \times 17 = 567.8 \text{ kg}$			
	Total weight			
	$W = 69.7 + 1455.2 + 567.8$			
	$= 2,092.7 \text{ kg}$	kg	2,093	
/03	Steel ladder			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$W = (EL. 74 - 70.231) \times 15 \text{ kg/m} \times 2 = 113.07$	kg	113	
104 Steel step	2.69 kg/m (φ 22 Round bar)			
	$N = (70.231 - 55.631) / 0.35 \approx 41 \text{ nos}$			
	$N = (70.231 - 66.031) / 0.35 \approx 12 \text{ nos}$			
	$N = (70.231 - 64.9) / 0.35 \approx 15 \text{ nos}$			
	$W = (41 \times 2 + 12 \times 2 + 15) \times 2.69$ $= 325.49$	kg	326	
105 Steel pipes for water level gauge				
	φ. 400 mm			
	$W1 = (EL. 74.5 - EL. 65.031) \times 77.6 \text{ kg/m}$ $= 734.79 \text{ kg}$			
	φ. 200 mm			
	$W2 = 0.35 \times 2 \times 30.1 \text{ kg/m} = 21.07 \text{ kg}$			
	Total weight			
	$W = 734.79 + 21.07 = 755.86$	kg	756	
106 Grating and hatch cover				
	Hatch cover (3.0 x 3.0 m)			
	R - 3/100 x 3.150 x 4.5 : W1 = 344.95 kg			
	H - 150 x 150 x 7 x 10 x 3.150 : W2 = 99.23 kg			
	L - 6 x 75 x 75 x 3.150 x 2 : W3 = 43.16 kg			
	L - 4 x 50 x 50 x 3.100 x 2 : W4 = 18.97 kg			

1-1-39

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	L- 4x50x50x2,950x4 : W5 = 36.11 kg			
	L- 4x50x50x2,800x5 : W6 = 42.84 kg			
	R- 200x75x9x2 nos : W7 = 2.12 kg			
	<u>587.38 kg</u>			
	Hatch cover (3.5 x 3.5 m)			
	R- 3,600 x 3,650 x 4.5 : W1 = 464.17 kg			
	H- 150 x 150 x 7 x 10 x 3,650 x 2 : W2 = 229.95 kg			
	L- 6 x 75 x 75 x 3,600 x 2 : W3 = 49.32 kg			
	L- 4 x 50 x 50 x 3,650 x 2 : W4 = 22.34 kg			
	L- 6 x 65 x 65 x 3,550 x 6 : W5 = 125.9 kg			
	L- 4 x 50 x 50 x 3,150 x 5 : W6 = 48.2 kg			
	R- 200 x 75 x 9 x 4 : W7 = 4.24 kg			
	<u>944.12 kg</u>			
	Total weight of hatch cover			
	W = (587.38 + 944.12) x 2 = 3,063 kg			
	Grating (W = 4.3 m)			
	H- 150 x 150 x 7 x 10 x 4,400 x 2 : W1 = 277.2			
	L- 4x50x50x4,400x2 : W2 = 26.93			
	L- 4x50x50x7,400x1 : W3 = 22.64			
	R- 100x9x7,400x7 : W4 = 104.56			
	FB- 50x5x4,400x248 : W5 = 2,141.48			
	FB- 20x3x7,400x43 : W6 = 149.87			
	<u>2,722.68 kg</u>			
	Grating (3.5 x 3.5 m)			
	L- 4 x 50 x 50 x 3,600 x 4 : W1 = 44.06			
	R- 50 x 9 x 3,600 x 2 : W2 = 25.43			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	R-50x9x1,600x2 : WS = 11.30			
	FB-50x5x3,600x50 : WS = 353.25			
	FB-20x3x1,600x35 : WS = 26.38			
	460.42kg			
	Total weight of grating			
	W = 2,722.68 + 460.42 x 2 = 3,643.52kg			
	Total weight			
	W = 3,063 + 3,643.5 = 6,706.5kg	kg	6,707	
107	Wire net fence			
	W = 7.0 x 13.0 kg/m = 91kg	kg	100	

5-1-81

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
2.6	CONVERGENCE MEASUREMENTS			
101	Measurement of horizontal convergence			
	Required number of measurement point $n = 8.296 / (106.54/3) \approx 234$ points			
	Required number of measurement $N = 234 \times 20 = 4,680$ nos	nos	4,680	
102	Measurement of diagonal convergence			
		nos	4,680	
103	Measurement of roof settlement			
		nos	4,680	
104	Measurement of invert upheaval			
		nos	4,680	
105	Stress measurement of rock bolts			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Required number of measurement point			
	$n = 8,296 / (106.54 \times 2) \approx 39$			
	Required number of measurement	nos	975	
	$N = 39 \times 25 = 975$			
106	Stress measurement of shotcrete	nos	975	
107	Stress measurement of steel support			
	Required number of measurement point			
	$n = 3$ points			
	Required number of measurement	nos	60	
	$N = 3 \times 20 = 60$			

5-1-20

Working Division:

11184

Description	Calculation Details	Unit	Quantity	Remarks
2.9	MISCELLANEOUS			
101	Trash boom			
	$L = 80 \times \pi / 2 = 125 \text{ m}$	m	125	
102	Dredging of the existing inlet channel of the Conguilla inlet	L.S.		
	$V = (5.5 \times 3.2 + 6.6 \times 3.2) / 2 \times 32.0$			
	$+ (5.5 \times 4.4 + 5.5 \times 3.2) / 2 \times 4.5$			
	$+ 11.0 \times 0.8 \times 38.0 + (8.6 + 24.6) / 2$			
	$\times 4.0 \times 30.0 = 3,039 \text{ m}^3$	m^3	3,000	
103	Staff gauge			
	Inclined length			
	$L = (EL. 88.0 - 70.0) \times 1.5 = 27.0 \text{ m}$	L.S.		

Working Division: 3. Conguill Work Adit

Description	Calculation Details	Unit	Quantity	Remarks
3.1	EARTH WORKS			
101	Clearing the site for adit portal (AP-1)	m ²	1958.55	
102	Open-cut excavation, in common, for adit portal (AP-1)	m ³	3073.900	
103	Open-cut excavation, in weathered rock, for adit portal (AP-1)	m ³	10751.700	
104	Open-cut excavation, in rock for adit portal (AP-1)	m ³	565.050	
105	Underground excavation, all classes, in adit (AP-2)	m ³	3560.202	
106	Trench excavation, all classes, for drain ditch and catch basin (AP-1)	m ³	36.236	
	33.406			
	2.830			
	36.236			

571-47

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
107	Permanent steel support H-125 x 125 mm (AP-2)	Ton	10 920	
108	D.25 mm rock bolts in adit tunnel (AP-2)	m	2632 000	
109	Backfilling for adit portal (AP-1)	m ³	133 849	
110	Backfilling (AP-1)	m ³	14 256	
	drain ditch : 13.228 m ³			
	catch basin : 1.028 m ³			
	Total : 14.256 m ³			
111	Gravel surfacing (AP-1)	m ³	94 120	
112	Gravel bedding for drain and catch basin (AP-1)	m ³	1	
	drain ditch : 0.960 m ³			
	catch basin : 0.128 m ³			
	Total : 1.088 m ³			
113	Wet rubble masonry (AP-1)	m ³	10 000	

T-1-46

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
101 Sod facing	(AP-1)	m ²	230.85	
3.1.2 CONCRETE WORKS				
101 Concrete, class D, for lining concrete of adit tunnel	(AP-2)	m ³	611.477	
102 Concrete, class E, for concrete facing walls and ported structure	(AP-1)	m ³	26.572	
103 Concrete class F, for drain ditch and catch basin	(AP-1)	m ³	10.192	
	drain ditch :		9.828 m ³	
	catch basin :		0.364 m ³	
	Total :		10.192 m ³	
104 Concrete, Class H, for levelling concrete of drain ditch and catch basin	(AP-1)	m ³	1.343	
	drain ditch :		1.305 m ³	
	catch basin :		0.038 m ³	
	Total :		1.343 m ³	

5-53

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
105	Formwork, F1 finish, for concrete of Item 102 (AP-1)	m ²	8.526	
106	Formwork, F1 finish, for concrete of Item 103 (AP-1) drain ditch : 74.340 m ² catch basin : 3.524 m ² Total : 77.864 m ²	m ²	77.864	
107	Formwork, F2 finish, for concrete of Item 102 (AP-1)	m ²	102.856	
108	Formwork, F3 finish, for concrete of Item 103 (CAP-1) drain ditch : 45.900 m ² catch basin : 1.300 m ² Total : 47.200 m ²	m ²	47.200	
109	Formwork, F4 finish, for concrete of Item 101 (AP-1)	m ²	511.477	

4-1-40

Working Division:

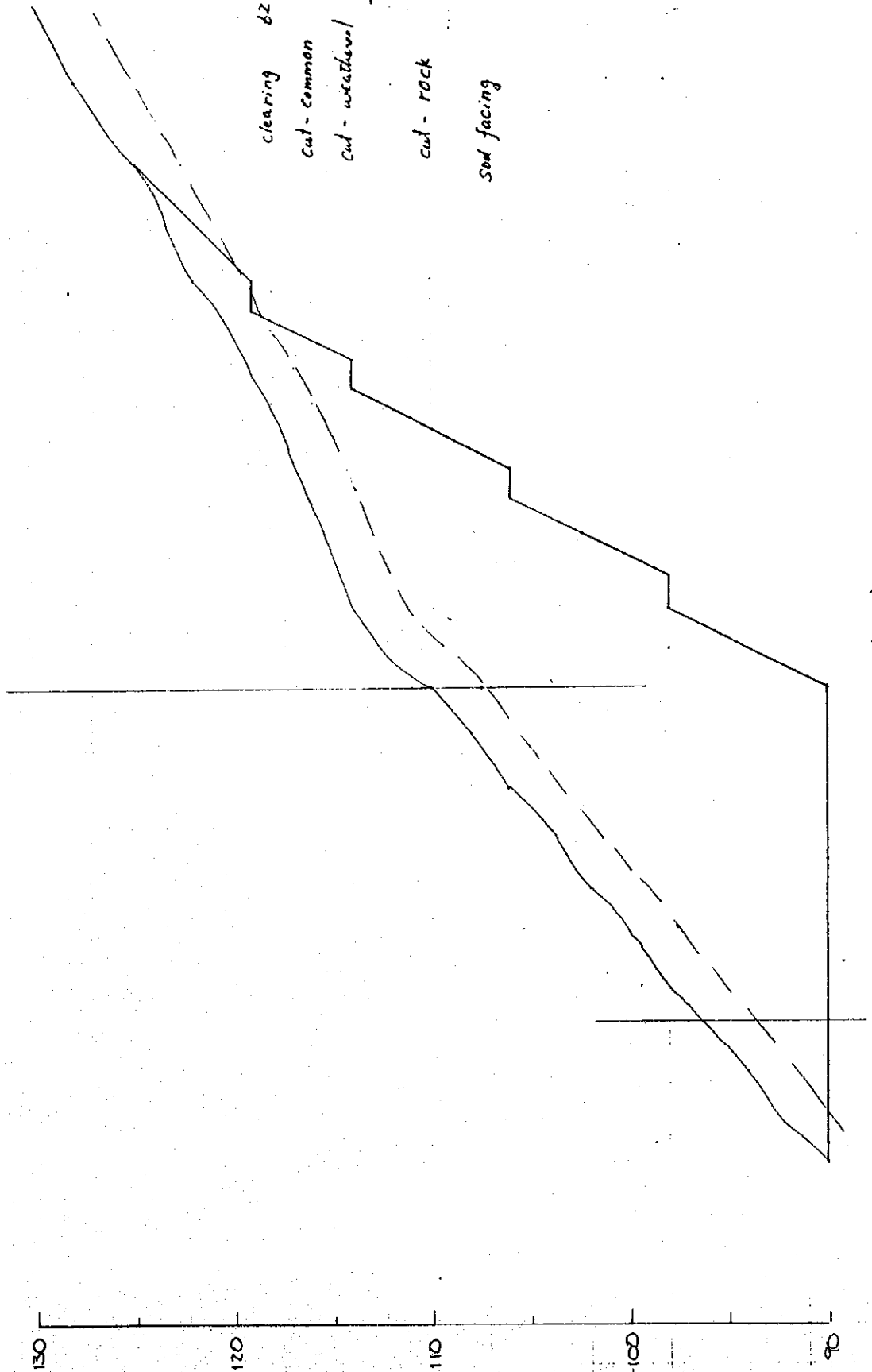
Description	Calculation Details	Unit	Quantity	Remarks
/10	Reinforcing bars for concrete works (AP-1)	Ton	0.797	
	Facing concrete 30 kg/m ³			
	∴ 26.572 × 30 = 797.160			
/11	Shotcrete in adit tunnel (AP-2)	m ³	224.736	
/12	Steel wire mesh for stem 111 (AP-2)	m ²	2115.406	
/13	Anchor bars, D.25 mm for concrete facing wall (AP-1)	m	33.000	
/14	P.V.C pipe D.50 mm for weephole (AP-1, 2)	m	26.200	
	Adit portal : 9.2 m			
	Adit tunnel : 17.0 m			
	Total : 26.2 m			

AP-1

Adit portal & ditch

05-11-11

Conguillo



clearing 62m

cut - common 120.0 m²

cut - weathered $\frac{(351.2) \text{ m}^2}{19.56}$
333.64 m²

cut - rock 17.56 m²

sod facing 7.5 m

A-A

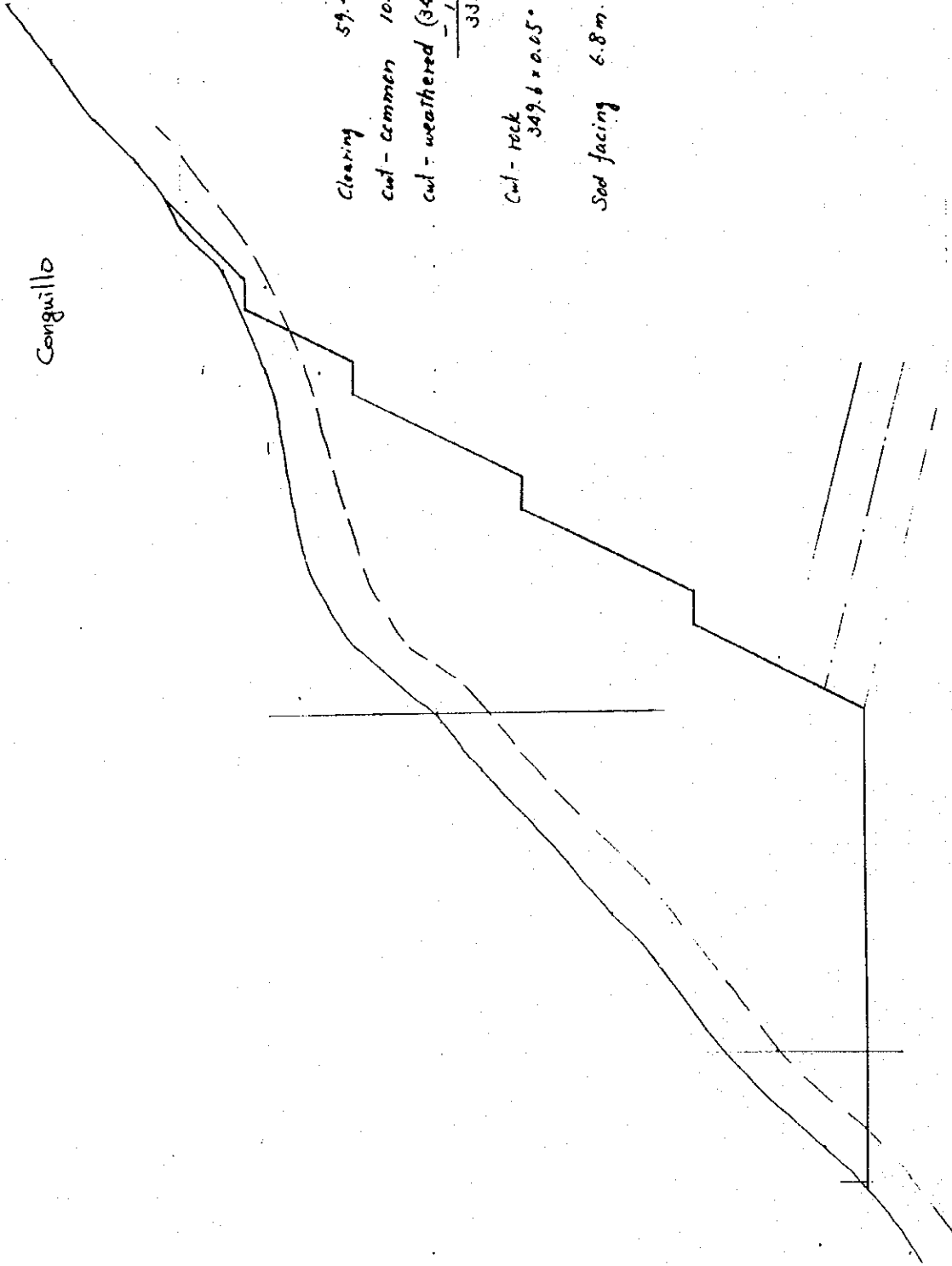
130
120
110
100
90

1-1-2

Conguillo

Clearing 59.4 m
cut - common 105.2 m²
cut - weathered (349.6) m²
- 17.48
332.12 m²
Cut - rock 349.6 x 0.05 = 17.48 m²
Seed facing 6.8 m

B-B





- Excavation, common.

$$\textcircled{A} \sim \textcircled{A} \quad 120 \text{ m}^2 \times \frac{1}{2} \times 23.0 \text{ m} = 1,380 \text{ m}^3$$

$$\textcircled{A} \sim \textcircled{B} \quad (120 + 105.2) \times \frac{1}{2} \times 10.0 \text{ m} = 563 \text{ m}^3$$

$$\textcircled{B} \sim \textcircled{B'} \quad 105.2 \times \frac{1}{2} \times 21.5 \text{ m} = \underline{1,130.9 \text{ m}^3}$$

$$\text{Total} \quad 3,073.9 \text{ m}^3$$

- Excavation, weathered.

$$\textcircled{A} \sim \textcircled{A} \quad 333.64 \text{ m}^2 \times \frac{1}{2} \times 23.0 \text{ m} = 3,836.86 \text{ m}^3$$

$$\textcircled{A} \sim \textcircled{B} \quad (333.64 + 332.12) \times \frac{1}{2} \times 10.0 = 3,333.8 \text{ m}^3$$

$$\textcircled{B} \sim \textcircled{B'} \quad 333.12 \times \frac{1}{2} \times 21.5 = \underline{3,581.04 \text{ m}^3}$$

$$10,751.7 \text{ m}^3$$

- Excavation, rock.

$$\textcircled{A} \sim \textcircled{A} \quad 17.56 \times \frac{1}{2} \times 23.0 = 201.94 \text{ m}^3$$

$$\textcircled{A} \sim \textcircled{B} \quad (17.56 + 17.48) \times \frac{1}{2} \times 10.0 = 175.2 \text{ m}^3$$

$$\textcircled{B} \sim \textcircled{B'} \quad 17.48 \times \frac{1}{2} \times 21.5 = \underline{187.91 \text{ m}^3}$$

$$565.05 \text{ m}^3$$

- Clearing.

$$\textcircled{A} \sim \textcircled{A} \quad 62 \text{ m} \times \frac{1}{2} \times 23.0 = 713 \text{ m}^2$$

$$\textcircled{A} \sim \textcircled{B} \quad (62 + 59.4) \times \frac{1}{2} \times 10.0 = 607 \text{ m}^2$$

$$\textcircled{B} \sim \textcircled{B'} \quad 59.4 \times \frac{1}{2} \times 21.5 = \underline{638.55 \text{ m}^2}$$

$$1,958.55 \text{ m}^2$$

- Sod facing

$(A) \sim (A) \quad 7.5 \times \frac{1}{2} \times 23.0 \text{ m} = 86.25 \text{ m}^2$
 $(A) \sim (B) \quad (7.5 + 6.8) \times \frac{1}{2} \times 10.0 = 71.50 \text{ m}^2$
 $(B) \sim (B) \quad 6.8 \times \frac{1}{2} \times 21.5 = \frac{73.10 \text{ m}^2}{230.85 \text{ m}^2}$

- Gravel ^{surfacing} bedding

$441.2 \text{ m}^2 \times 0.1 \text{ m} = 44.12 \text{ m}^3$

- Facing concrete (t = 300 mm)

$(10.0 \text{ m} + 13.0 \text{ m}) \times 8.944 \times \frac{1}{2} \times 0.3 \text{ m} = 30.857 \text{ m}^3$
 $30.857 \text{ m}^3 - (2.0 \times 4.0 + 2.0^2 \times \pi \times \frac{1}{2}) \times 0.3 = 26.572 \text{ m}^3$

- Form work for facing concrete.

front : $(10.0 + 13.0) \times 8.944 \times \frac{1}{2} = 107.856 \text{ m}^2 \dots \text{ FZ}$
 edge : $L = \sqrt{(8.944^2 + 1.5^2)} = 9.069 \text{ m}$
 $9.069 \text{ m} \times 0.3 \text{ m} \times 2 \text{ set} = 5.441$

tunnel : $0.3 \text{ m} \times 2.0 \text{ m} \times 2 = 1.2 \text{ m}$
 $0.3 \times 4.0 \text{ m} \times \pi \times \frac{1}{2} = 1.885 \text{ m}$

F1: Total 8.526 m^2

- Anchor bars for facing concrete

$(10.0 + 13.0) \times 8.0 \times \frac{1}{2} = 92 \text{ m}^2$
 $92 \text{ m}^2 \times \frac{1}{9} \text{ m}^2 = 10.222 \text{ nos}$
 $3 \text{ m/nos.} \times 11 \text{ nos.} = 33 \text{ m}$

5-1-55

- Weephole for facing concrete

$$92 \text{ m}^2 \times \frac{1}{4} \text{ m}^2 = 23 \text{ nos.}$$

$$0.4 \text{ m} \times 23 \text{ nos} = 9.2 \text{ m}$$

- Wet rubble mesonty

$$V = 5.0 \times 5.0 \times 0.4 = 10 \text{ m}^3$$

- Backfilling.

$$133.849 \text{ m}^3 \text{ — cf La Seca Work adit}$$

- Drain ditch

Type 0.3 x 0.3

w/o gravel : 56.5 m.

Type 0.5 x 0.5 with cover

w/ gravel : 12.0 m

→ Attache

- Catch basin (with cover) (cf. La Seca Wert Adit)

$$1. \text{ Excavation} : 1.415 \text{ m}^3 \times 2 = 2.83 \text{ m}^3$$

$$2. \text{ concrete} : 0.182 \text{ m}^3 \times 2 = 0.364 \text{ m}^3$$

$$3. \text{ Formwork} : \begin{array}{l} \text{F1 } 1.762 \text{ m}^2 \times 2 = 3.524 \text{ m}^2 \\ \text{F3 } 0.65 \text{ m}^2 \times 2 = 1.300 \text{ m}^2 \end{array}$$

$$4. \text{ leveling concrete} : 0.019 \times 2 = 0.038 \text{ m}^3$$

$$5. \text{ gravel} : 0.064 \text{ m}^3 \times 2 = 0.128 \text{ m}^3$$

$$6. \text{ Backfill} : 0.514 \text{ m}^3 \times 2 = 1.028 \text{ m}^3$$

Type (0.3x0.3) without gravel
L= 56.5 m

Item	Unit	Qty
Excavation	0.371 m3	20.962 m3
Concrete	0.12 m3	6.780 m3
F1 formwork	0.84 m2	47.460 m2
F3 formwork	0.6 m2	33.900 m2
Leveling conc.	0.018 m3	1.017 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.143 m3	8.080 m3

Type (0.3x0.3) with gravel
L= 0 m

Item	Unit	Qty
Excavation	0.481 m3	0.000 m3
Concrete	0.12 m3	0.000 m3
F1 formwork	0.84 m2	0.000 m2
F3 formwork	0.6 m2	0.000 m2
Leveling conc.	0.018 m3	0.000 m3
Gravel bedding	0.06 m3	0.000 m3
Backfilling	0.193 m3	0.000 m3

Type (0.5x0.5) without gravel, with cover
L= 0 m

Item	Unit	Qty
Excavation	0.878 m3	0.000 m3
Concrete	0.254 m3	0.000 m3
F1 formwork	2.24 m2	0.000 m2
F3 formwork	1 m2	0.000 m2
Leveling conc.	0.024 m3	0.000 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.35 m3	0.000 m3

Type (0.3x0.3) with gravel, with cover
L= 12 m

Item	Unit	Qty
Excavation	1.037 m3	12.444 m3
Concrete	0.254 m3	3.048 m3
F1 formwork	2.24 m2	26.880 m2
F3 formwork	1 m2	12.000 m2
Leveling conc.	0.024 m3	0.288 m3
Gravel bedding	0.08 m3	0.960 m3
Backfilling	0.429 m3	5.148 m3

Total

Item	Qty
Excavation	33.406 m3
Concrete	9.828 m3
F1 formwork	74.340 m2
F3 formwork	45.900 m2
Leveling conc.	1.305 m3
Gravel bedding	0.960 m3
Backfilling	13.228 m3

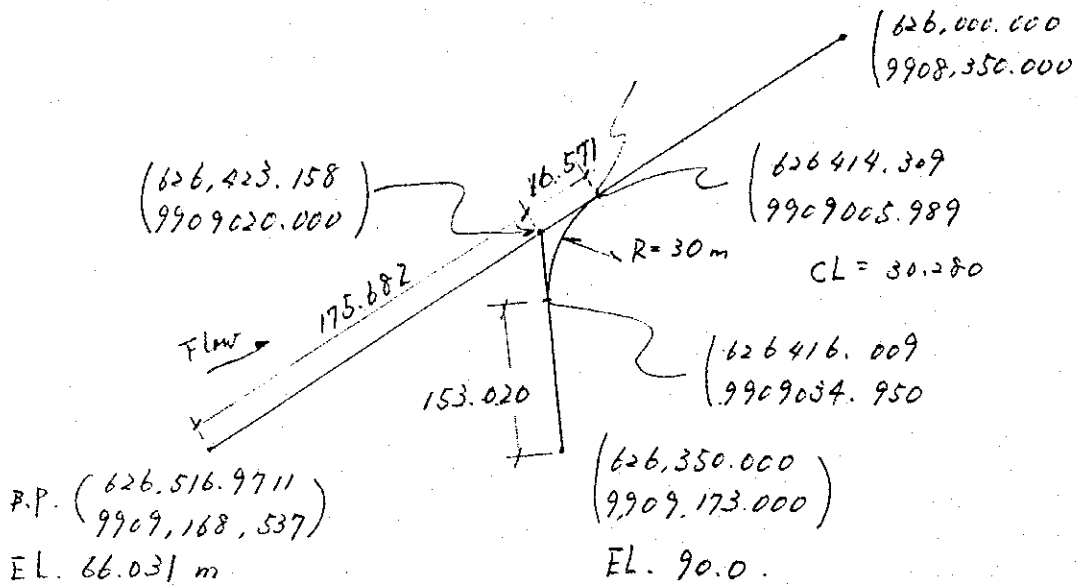
5-1-50

conquillo work Adil

AP-2

Adil Tunnel

5-1-89

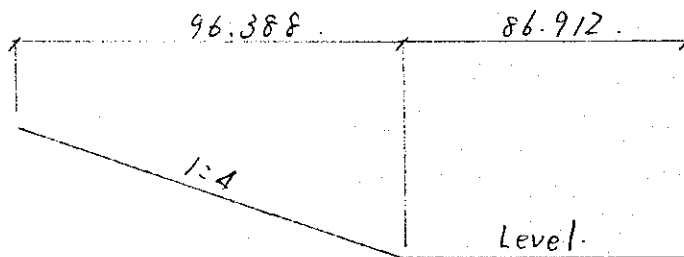


EL. of junction point

$$66.031 - (175.682 + 16.571) / 1.500 = 65.903 \text{ m}$$

$$90.0 - 65.903 = 24.097$$

$$24.097 \times 4 = 96.388$$



Type I : 48.194 m

Type II : 48.194 m

Type I with concrete : 86.912 m

(cf. La Seca Work Adit)

Type II Item	L=	Unit	Qty
Excavation	48.194 m	17.685 m ³	852.311 m ³
Concrete		- m ³	0.000 m ³
Shotcrete		1.369 m ³	65.978 m ³
Wire mesh		10.952 m ²	527.821
Rockbolt		34 m/2.4m	696.000 m
Steel support		0.273 ton/1.2m	10.920 ton
Weephole		- m/2.5m	0.000 m

Type I Item	L=	Unit	Qty
Excavation	48.194 m	16.843 m ³	811.732 m ³
Concrete		- m ³	0.000 m ³
Shotcrete		1.076 m ³	51.857 m ³
Wire mesh		10.76 m ²	518.567
Rockbolt		34 m/2.4m	696.000 m
Steel support		- ton/1.2m	0.000 ton
Weephole		- m/2.5m	0.000 m

Type II with concrete Item	L=	Unit	Qty
Excavation	0 m	22.54 m ³	0.000 m ³
Concrete		5.885 m ³	0.000 m ³
Form		10.283 m ²	0.000 m ²
Shotcrete		1.55 m ³	0.000 m ³
Wire mesh		10.333 m ²	0.000 m ²
Rockbolt		34 m/2.4m	0.000 m
Steel support		- ton/1.2m	0.000 ton
Weephole		0.5 m/2.5m	0.000 m

Type I with concrete Item	L=	Unit	Qty
Excavation	86.912 m	21.817 m ³	1,896.159 m ³
Concrete		5.885 m ³	511.477 m ³
Form		10.283 m ²	893.716
Shotcrete		1.23 m ³	106.902 m ³
Wire mesh		12.3 m ²	1,069.018
Rockbolt		34 m/2.4m	1,240.000 m
Steel support		- ton/1.2m	0.000 ton
Weephole		0.5 m/2.5m	17.000 m

Total Item	Qty
Excavation	3,560.202 m ³
Concrete	511.477 m ³
Form	893.716 m ²
Shotcrete	224.736 m ³
Wire mesh	2,115.406 m ²
Rockbolt	2,632.000 m
Steel support	10.920 ton
Weephole	17.000 m

18-1-5

Working Division: EL GUASMO WORK ADIT

Description	Calculation Details	Unit	Quantity	Remarks
4.1	EARTHWORK			
101	Clearing the site for adit portal	m ²	1,664	
102	Open-cut excavation, in common for adit portal	m ³	3,726	
103	Open-cut excavation, in weathered rock, for adit portal			
	$7,680 \times 95\% = 7,296$	m ³	7,296	
104	Open-cut excavation, in rock			
	$7,680 \times 5\% = 384$	m ³	384	
105	Underground excavation, all classes, in adit			
	Horizontal tunnel length $L = 349.624 \text{ m}$			
	Tunnel length of the inclined part (horizontal length) $L' = (EL. 130.0 - EL. 63.738) \times 4.0 = 265.048 \text{ m}$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	(Length along tunnel invert)			
	$L = 265.048 / \cos 14.0362^\circ$			
	$= 273.205 \text{ m}$			
	Tunnel length of the horizontal part			
	$L = 349.624 - 265.048 = 84.576 \text{ m}$			
		m^3	6.562	
106	Trench excavation, all classes, for drain ditch and catch basin			
	Length of drain ditch			
	$L = 2.5 + 29.0 + 7.5 + 28.0 + 27.0$			
	$+ 9.5 = 103.5 \text{ m}$			
	Required number of catch basin			
	$N = 0$			
		m^3	41	

5-1-63

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
107	Permanent steel support H-12.5 x 12.5 mm	Ton	31	
108	12.5 mm rock bolts in adit tunnel	m	5,046	
109	Backfilling for adit portal	m ³	134	
110	Backfilling	m ³	16	
	drain ditch : 15.8 m ³			
	catch basin : 0 m ³			
	Total : 15.8 m ³			
111	Gravel surfacing 804 m ² x 0.1 = 80.4	m ³	80	
112	Gravel bedding for drain and catch basin	m ³	2	
	drain ditch : 1.2 m ³			
	catch basin : 0 m ³			
	Total : 1.2 m ³			
113	Wet rubble masonry	m ³	10	

411-64

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
1/4	Sad facing $6.0 \times 32.0 + 4.0 \times 5.0 + 3.5 \times 30.0$ $= 497 \text{ m}^2$	m^2	497	
2	CONCRETE WORKS			
1/01	Concrete class D, for lining concrete of adit tunnel	m^3	598	
1/02	Concrete class E, for concrete facing walls and portal structure $(20.4 + 15.0) / 2 \times 8.944 \times 0.3 - (4.0^2 \times \pi \times 1/8) + 4.0 \times 2) \times 0.335 = 42.7$	m^3	43	
1/03	Concrete class F, for drain ditch and catch basin drain ditch : 12.4 m^3 catch basin : 0 m^3 Total : 12.4 m^3	m^3	13	
1/04	Concrete class H, for levelling concrete of drain ditch and catch basin drain ditch : 1.9 m^3 catch basin : 0 m^3 Total : 1.9 m^3	m^3	2	

5-1-65

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
105	Formwork, F1 finish, for concrete of Item 102	m ²	3	
	$(20.4 + 15.0) \times 2 \times 8.944 - (4.0^2 \times \pi \times 1/8 + 4 \times 2.0) \times 1.118 + (4.0 \times \pi \times 1/2 + 2.0 \times 2) \times 0.335 = 145.8 \text{ m}^2$			
106	Formwork, F1 finish, for concrete of Item 103	m ²	87	
	drain ditch : 86.9 m ²			
	catch basin : 0 m ²			
	Total : 86.9 m ²			
107	Formwork, F2 finish, for concrete of Item 102	m ²	146	
	$8.944 \times 0.3 = 2.68 \text{ m}^2$			
108	Formwork, F3 finish, for concrete of Item 103	m ²	62	
	drain ditch : 62.1 m ²			
	catch basin : 0 m ²			
	Total : 62.1 m ²			
109	Formwork, F4 finish, for concrete of Item 101	m ²	870	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
/10	Reinforcing bars for concrete works	Ton	1.3	
	Facing concrete 30 kg/m ³			
	∴ 43 x 30 = 1.290 kg			
/11	Shotcrete in add'l tunnel	m ³	438	
/12	Steel wire mesh for Atom 111	m ²	4,006	
/13	Anchor bars. D. 25 mm for concrete facing wall	m	48	
	145.8 / 9.0 m ² = 16			
	16 x 3.0m = 48			
/14	P.V.C pipe 750 mm for weephole	m	31	
	146 / 4.0 = 36 nos. 36 x 0.4 = 14.4			
	Add'l portal : 14.4 m			
	Add'l tunnel : 16.5 m			
	Total : 30.9 m			

Working Division: EL GUASMO WORK ADIT

Section No.	Distance m	4.1/01 Clearing		Area Volume		4.1/02 Common			Remarks
		Sectional Area m ²	Mean m	Volume m ³	Sectional Area m ²	Mean m	Volume m ³		
0		17							
1	21	45	31.0	651	34	66.0	1,386.0		
2	15	50	47.5	712.5	98	102.5	1,537.5		
3	15	0	20.0	300	107	53.5	807.5		
					0				
				Total		1,663.5 m ²		3,726.0 m ³	

5-1-68

Working Division: EL GUASMO WORK ADIT

Section No.	Distance m	4.1/03 Weathered rock			Sectional Area m ²	Mean m ²	Volume m ³	Remarks
		Sectional Area m ²	Mean m ²	Volume m ³				
0	21	26	105.0	2,205.0				
1	15	184	228.5	3,427.5				
2	15	273	136.5	2,047.5				
3		0						
		Total		7,680.0m ³				

5-1-69

Type (0.3x0.3) without gravel 82.8 m

Item	Unit	Qty
Excavation	0.371 m3	30.719 m3
Concrete	0.12 m3	9.936 m3
F1 formwork	0.84 m2	69.552 m2
F3 formwork	0.6 m2	49.680 m2
Leveling conc.	0.018 m3	1.490 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.143 m3	11.840 m3

Type (0.3x0.3) with gravel 20.7 m

Item	Unit	Qty
Excavation	0.481 m3	9.957 m3
Concrete	0.12 m3	2.484 m3
F1 formwork	0.84 m2	17.388 m2
F3 formwork	0.6 m2	12.420 m2
Leveling conc.	0.018 m3	0.373 m3
Gravel bedding	0.06 m3	1.242 m3
Backfilling	0.193 m3	3.995 m3

Type (0.5x0.5) without gravel, with cover 0 m

Item	Unit	Qty
Excavation	0.878 m3	0.000 m3
Concrete	0.254 m3	0.000 m3
F1 formwork	2.24 m2	0.000 m2
F3 formwork	1 m2	0.000 m2
Leveling conc.	0.024 m3	0.000 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.35 m3	0.000 m3

Type (0.3x0.3) with gravel, with cover 0 m

Item	Unit	Qty
Excavation	1.037 m3	0.000 m3
Concrete	0.254 m3	0.000 m3
F1 formwork	2.24 m2	0.000 m2
F3 formwork	1 m2	0.000 m2
Leveling conc.	0.024 m3	0.000 m3
Gravel bedding	0.08 m3	0.000 m3
Backfilling	0.429 m3	0.000 m3

Total

Item	Qty
Excavation	40.676 m3
Concrete	12.420 m3
F1 formwork	86.940 m2
F3 formwork	62.100 m2
Leveling conc.	1.863 m3
Gravel bedding	1.242 m3
Backfilling	15.836 m3

7-1-70

1994/9/19 9:32 PM qty. adit

Type II Item	Unit	L= 136.603 m	Qty
Excavation	m ³	17.685	2,415.824
Concrete	- m ³		0.000
Shotcrete	m ³	1.369	187.010
Wire mesh	m ²	10.952	1,496.076
Rockbolt	34 m/2.4m		1,920.000
Steel support	0.273 ton/1.2m		30.849
Weephole	- m/2.5m		0.000

Type II with concrete Item	Unit	L= 0 m	Qty
Excavation	m ³	22.54	0.000
Concrete	m ³	5.885	0.000
Form	m ²	10.283	0.000
Shotcrete	m ³	1.55	0.000
Wire mesh	m ²	10.333	0.000
Rockbolt	34 m/2.4m		0.000
Steel support	- ton/1.2m		0.000
Weephole	0.5 m/2.5m		0.000

Type I Item	Unit	L= 136.603 m	Qty
Excavation	m ³	16.843	2,300.804
Concrete	- m ³		0.000
Shotcrete	m ³	1.076	146.995
Wire mesh	m ²	10.76	1,469.848
Rockbolt	34 m/2.4m		1,920.000
Steel support	- ton/1.2m		0.000
Weephole	- m/2.5m		0.000

Type I with concrete Item	Unit	L= 84.576 m	Qty
Excavation	m ³	21.817	1,845.195
Concrete	m ³	5.885	497.730
Form	m ²	10.283	869.695
Shotcrete	m ³	1.23	104.028
Wire mesh	m ²	12.3	1,040.285
Rockbolt	34 m/2.4m		1,206.000
Steel support	- ton/1.2m		0.000
Weephole	0.5 m/2.5m		16.500

Total Item	Qty
Excavation	6,561.823 m ³
Concrete	497.730 m ³
Form	869.695 m ²
Shotcrete	438.023 m ³
Wire mesh	4,006.209 m ²
Rockbolt	5,046.000 m
Steel support	30.849 ton
Weephole	16.500 m

7-1-71

Working Division: 5. Membrillo Work Adit

Description	Calculation Details	Unit	Quantity	Remarks
5.1	EARTH WORKS			
101	clearing the site for adit portal (Mm-1)	m ³	1713.500	
102	Open-cut excavation, in common for adit portal (Mm-1)	m ³	2557.620	
103	Open-cut excavation, in weathered rock, for adit portal (Mm-1)	m ³	4035.035	
104	Open-cut excavation, in rock for adit portal (Mm-1)	m ³	212.265	
105	Underground excavation, all classes, in adit (Mm-6)	m ³	2546.252	
106	Trench excavation, all classes, for drain ditch and catch basin (Mm-3.4)	m ³	37.126	
	ditch 34.296			
	catch basin 2.83			
	37.126			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
107	Permanent steel support 4.075×2 4.075×2 (Mm-6)	Ton	8.19	
108	D.25 mm rock bolts in adit tunnel (Mm-6)	m	1748.000	
109	Backfilling for adit portal (Mm-3)	m ³	133.849	
110	Backfilling (Mm-3)	m ³	14.599	
	drain ditch : 13.571 m ³			
	catch basin : 1.028 m ³			
	Total : 14.599 m ³			
111	Gravel surfacing (Mm-2)	m ³	77.880	
112	Gravel bedding for drain and catch basin (Mm-3.4)	m ³	1.088	
	drain ditch : 0.960 m ³			
	catch basin : 0.128 m ³			
	Total : 1.088 m ³			
113	Wet rubble masonry (Mm-3)	m ³	10.0	

V-1-73

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
1.19 Sod facing	(Mm-2)	m ²	436.620	
5.2 CONCRETE WORKS				
1.01 Concrete class D, for lining concrete of adit tunnel	(Mm-8)	m ³	611.477	
1.02 Concrete, class E, for concrete facing walls and portal structure (Mm-2)		m ³	25.125	
1.03 Concrete class F, for drain ditch and catch basin	(Mm-3)	m ³	10.480	
	drain ditch : 10.116 m ³			
	catch basin : 0.364 m ³			
	Total : 10.480 m ³			
1.04 Concrete, class H, for levelling concrete of drain ditch and catch basin		m ³	1.386	
	drain ditch : 1.348 m ³			
	catch basin : 0.038 m ³			
	Total : 1.386 m ³			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
105	Formwork, F1 finish, for concrete of Item 102 (Mm-2)	m ²	5.450	
106	Formwork, F1 finish, for concrete of Item 103 (Mm-3,4) drain ditch : 76.356 m ² catch basin : 3.524 m ² Total : 79.880 m ²	m ²	79.880	
107	Formwork, F2 finish, for concrete of Item 102 (Mm-2)	m ²	98.035	
108	Formwork, F3 finish, for concrete of Item 103 (Mm-3,4) drain ditch : 47.340 m ² catch basin : 1.300 m ² Total : 48.640 m ²	m ²	48.640	
109	Formwork, F4 finish, for concrete of Item 101 (Mm-6)	m ²	893.716	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
/10	Reinforcing bars for concrete works	Ton	0.753	
	Facing concrete 30 kg/m ³			
	∴ 25.125 × 30 = 753.75			
/11	Shotcrete in adit tunnel (Mm-6)	m ³	152.936	
/12	Steel wire mesh for Shotcrete / 11 (Mm-6)	m ²	1477.811	
/13	Anchor bars, P.25mm for concrete facing wall (Mm-2)	m	30.0	
/14	P.V.C pipe P.50mm for weephole	m	25.8	
	Adit portal : 8.8 m			
	Adit tunnel : 17.0 m			
	Total : 25.8 m			

- Clearing

$$\textcircled{A} \sim \textcircled{B} \quad (43.2 + 44.2) \times \frac{1}{2} \times 22.1 \text{ m} = 965.77 \text{ m}^2$$

$$\textcircled{B} \sim \textcircled{C} \quad (44.2 + 30.5) \times \frac{1}{2} \times 14.8 \text{ m} = 552.78 \text{ m}^2$$

$$\textcircled{C} \sim \textcircled{C} \quad 30.5 \times \frac{1}{2} \times 12.8 \text{ m} = \frac{195.2 \text{ m}^2}{1713.5 \text{ m}^2}$$

- Excavation, common.

$$\textcircled{A} \sim \textcircled{B} \quad (46.8 + 72.0) \times \frac{1}{2} \times 22.1 = 1312.74 \text{ m}^3$$

$$\textcircled{B} \sim \textcircled{C} \quad (72.0 + 51.6) \times \frac{1}{2} \times 14.8 = 914.64 \text{ m}^3$$

$$\textcircled{C} \sim \textcircled{C} \quad 51.6 \times \frac{1}{2} \times 12.8 = \frac{330.24 \text{ m}^3}{2557.62 \text{ m}^3}$$

- Excavation, weathered

$$\textcircled{A} \sim \textcircled{B} \quad (9.12 + 159.98) \times \frac{1}{2} \times 22.1 = 1868.555 \text{ m}^3$$

$$\textcircled{B} \sim \textcircled{C} \quad (159.98 + 71.06) \times \frac{1}{2} \times 14.8 = 1709.696 \text{ m}^3$$

$$\textcircled{C} \sim \textcircled{C} \quad 71.06 \times \frac{1}{2} \times 12.8 = \frac{454.784 \text{ m}^3}{4035.035 \text{ m}^3}$$

- Excavation, rock

$$\textcircled{A} \sim \textcircled{B} \quad (0.48 + 8.42) \times \frac{1}{2} \times 22.1 = 98.345$$

$$\textcircled{B} \sim \textcircled{C} \quad (8.42 + 3.74) \times \frac{1}{2} \times 14.8 = 89.984$$

$$\textcircled{C} \sim \textcircled{C} \quad 3.74 \times \frac{1}{2} \times 12.8 = \frac{23.936}{212.265 \text{ m}^3}$$

Sod facing

$$A \sim B \quad (5.5 + 5.7) \times \frac{1}{2} \times 22.1 \text{ m} = 344.76$$

$$B \sim C \quad (5.7 + 3.6) \times \frac{1}{2} \times 14.8 \text{ m} = 68.82$$

$$C \sim D \quad 3.6 \times \frac{1}{2} \times 12.8 \text{ m} = 23.04$$

$$436.62$$

- Gravel surfacing

$$778.8 \text{ m}^2 \times 0.1 \text{ m} = 77.88 \text{ m}^3$$

- Facing concrete (t = 300 mm)

$$(10.0 + 11.8) \times 8.994 \times \frac{1}{2} \times 0.3 = 29.410 \text{ m}^3$$

$$29.410 - (2.0 \times 4.0 + 2.0^2 \times \pi \times \frac{1}{2}) \times 0.3 = 25.125 \text{ m}^3$$

- Formwork for facing concrete

$$\text{front} : (10.0 + 11.8) \times 8.994 \times \frac{1}{2} = 98.035 \text{ m}^2 \text{ --- FZ}$$

$$\text{edge} : L = \sqrt{(8.994^2 + 1.8^2)} = 9.172 \text{ m}$$

$$9.172 \times 0.3 = 2.752 \text{ m}^2$$

$$8.994 \times 0.3 = 2.698 \text{ m}^2$$

$$\text{Tunnel} : 1.885 \text{ m}^2$$

$$\text{FI} : 5.45 \text{ m}^2$$

- Anchor bars for facing concrete

$$(10.0 + 11.8) \times 8.0 \times \frac{1}{2} = 87.2 \text{ m}^2$$

$$87.2 \text{ m}^2 \times \frac{1}{9} \text{ m} = 9.689$$

$$3 \text{ m / no.} \times 10 \text{ nos} = 30 \text{ m}$$

- Weephole for facing concrete

$$87.2 \times \frac{1}{4} m^2 = 21.8$$

$$0.4 \text{ m/no.} \times 22 \text{ nos} = 8.8 \text{ m}$$

- Wet rubble masonry = 10.0 m^3

- Backfilling = 133.849 m^3

- Drain ditch

Type 0.3×0.3
w/o gravel : $31.4 \text{ m} + 27.5 = 58.9 \text{ m}$

Type 0.5×0.5 with cover
w/ gravel : 12.0 m

- Catch basin (with cover)

1. Excavation : $1.415 \text{ m}^3 \times 2 = 2.83 \text{ m}^3$

2. concrete : $0.182 \text{ m}^3 \times 2 = 0.364 \text{ m}^3$

3. Formwork : F1 $1.762 \times 2 = 3.524 \text{ m}^2$
F3 $0.65 \times 2 = 1.300 \text{ m}^2$

4. Leveling $0.019 \times 2 = 0.038 \text{ m}^3$

5. gravel $0.064 \times 2 = 0.128 \text{ m}^3$

6. Backfill $0.514 \times 2 = 1.028 \text{ m}^3$

Type (0.3x0.3) without gravel
L= 58.9 m

Item	Unit	Qty
Excavation	0.371 m3	21.852 m3
Concrete	0.12 m3	7.068 m3
F1 formwork	0.84 m2	49.476 m2
F3 formwork	0.6 m2	35.340 m2
Leveling conc.	0.018 m3	1.060 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.143 m3	8.423 m3

Type (0.3x0.3) with gravel
L= 0 m

Item	Unit	Qty
Excavation	0.481 m3	0.000 m3
Concrete	0.12 m3	0.000 m3
F1 formwork	0.84 m2	0.000 m2
F3 formwork	0.6 m2	0.000 m2
Leveling conc.	0.018 m3	0.000 m3
Gravel bedding	0.06 m3	0.000 m3
Backfilling	0.193 m3	0.000 m3

Type (0.5x0.5) without gravel, with cover
L= 0 m

Item	Unit	Qty
Excavation	0.878 m3	0.000 m3
Concrete	0.254 m3	0.000 m3
F1 formwork	2.24 m2	0.000 m2
F3 formwork	1 m2	0.000 m2
Leveling conc.	0.024 m3	0.000 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.35 m3	0.000 m3

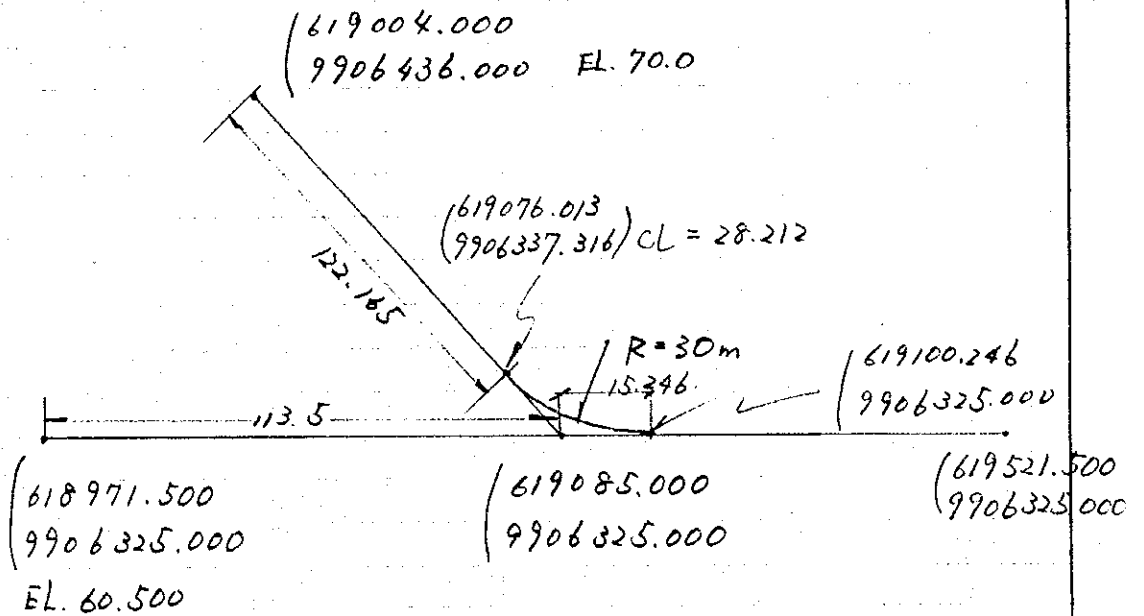
Type (0.3x0.3) with gravel, with cover
L= 12 m

Item	Unit	Qty
Excavation	1.037 m3	12.444 m3
Concrete	0.254 m3	3.048 m3
F1 formwork	2.24 m2	26.880 m2
F3 formwork	1 m2	12.000 m2
Leveling conc.	0.024 m3	0.288 m3
Gravel bedding	0.08 m3	0.960 m3
Backfilling	0.429 m3	5.148 m3

Total

Item	Qty
Excavation	34.296 m3
Concrete	10.116 m3
F1 formwork	76.356 m2
F3 formwork	47.340 m2
Leveling conc.	1.348 m3
Gravel bedding	0.960 m3
Backfilling	13.571 m3

5-1-80

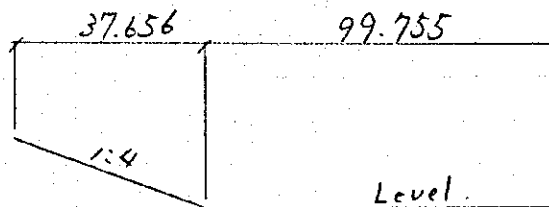


EL of junction point

$$60.500 + (113.5 + 15.246) / 1.500 = 60.586 \text{ m.}$$

$$70 - 60.586 = 9.414 \text{ m.}$$

$$9.414 \times 4 = 37.656 \text{ m.}$$



Type I : 18.828 m

Type II : 18.828 m

Type I with concrete : 86.912 m

Type II Item	L=	Unit	Qty
Excavation	18.828 m	17.685 m ³	332.973 m ³
Concrete		- m ³	0.000 m ³
Shotcrete		1.369 m ³	25.776 m ³
Wire mesh		10.952 m ²	206.204
Rockbolt		34 m/2.4m	254.000 m
Steel support		0.273 ton/1.2m	4.095 ton
Weephole		- m/2.5m	0.000 m

Type II with concrete Item	L=	Unit	Qty
Excavation	0 m	22.54 m ³	0.000 m ³
Concrete		5.885 m ³	0.000 m ³
Form		10.283 m ²	0.000 m ²
Shotcrete		1.55 m ³	0.000 m ³
Wire mesh		10.333 m ²	0.000 m ²
Rockbolt		34 m/2.4m	0.000 m
Steel support		- ton/1.2m	0.000 ton
Weephole		0.5 m/2.5m	0.000 m

Type I Item	L=	Unit	Qty
Excavation	18.828 m	16.843 m ³	317.120 m ³
Concrete		- m ³	0.000 m ³
Shotcrete		1.076 m ³	20.259 m ³
Wire mesh		10.76 m ²	202.589
Rockbolt		34 m/2.4m	254.000 m
Steel support		- ton/1.2m	0.000 ton
Weephole		- m/2.5m	0.000 m

Type I with concrete Item	L=	Unit	Qty
Excavation	86.912 m	21.817 m ³	1,896.159 m ³
Concrete		5.885 m ³	511.477 m ³
Form		10.283 m ²	893.716
Shotcrete		1.23 m ³	106.902 m ³
Wire mesh		12.3 m ²	1,069.018
Rockbolt		34 m/2.4m	1,240.000 m
Steel support		- ton/1.2m	0.000 ton
Weephole		0.5 m/2.5m	17.000 m

Total Item	Qty
Excavation	2,546.252 m ³
Concrete	511.477 m ³
Form	893.716 m ²
Shotcrete	152.936 m ³
Wire mesh	1,477.811 m ²
Rockbolt	1,748.000 m
Steel support	4.095 ton
Weephole	17.000 m

✓ 1002

Working Division: LA ESPERANZA - POZA HONDA DIVERSION TUNNEL

Description	Calculation Details	Unit	Quantity	Remarks
7.2	EARTHWORK			
101	Clearing			
	$A = 2.957.9 + 1.910.5 = 4,868.4$	m ²	4,868	
102	Open-cut excavation, in common			
	$V = 8.198.8 + 3,634 = 11,832.8$	m ³	11,833	
103	Open-cut excavation, in weathered rock			
	$V = (8.460.3 + 4.730.6) \times 0.95 = 12,531.4$	m ³	12,531	
104	Open-cut excavation, in rock			
	$V = (8.460.3 + 4.730.6) \times 0.05 = 659.5$	m ³	660	
105	Underground excavation			
	Tunnel inlet part			
	$V_1 = (4.9^2 \times \pi \times 1/8 + 4.9 \times 2.35) \times 100$			
	$= 209.4 \text{ m}^3$			
	Tunnel type II (L = 4.627.051m)			
	$V_2 = 17.049 \times 4.627.051 = 78,886.6 \text{ m}^3$			

41-20

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Tunnel type III (L = 6,300m)				
V3 =	$17.624 \times 6,300 = 111,031.2 \text{ m}^3$			
Tunnel type IV (L = 470m)				
V4 =	$17,080 \times 470 = 8,027.6 \text{ m}^3$			
Tunnel outlet part				
V5 =	$(4.9^2 \times \pi \times 1/8 + 4.9 \times 2.35) \times 10.0$ $= 209.4 \text{ m}^3$			
Total volume				
V =	$209.4 + 78,886.6 + 111,031.2$ $+ 8,027.6 + 209.4 = 198,364.2$	m^3	198,364	
106 Trench excavation				
Cana Dulce inlet, drain ditch				
V1 =	$(1.0 + 0.5) / 2 \times 0.5 \times 130 = 48.8 \text{ m}^3$			
Cana Dulce inlet, catch basin				
V2 =	$1.3 \times 1.3 \times 1.20 = 2.0 \text{ m}^3$			
Los Cuyuyes outlet, drain ditch				
V3 =	$(1.29 + 0.9) / 2 \times 0.65 \times 60.0$ $= 42.7 \text{ m}^3$			
Los Cuyuyes outlet, catch basin				
V4 =	$1.3 \times 1.3 \times 1.2 = 2.0 \text{ m}^3$			

57-1-88

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Total volume			
	$V = 48.8 + 2.0 + 42.7 + 2.0 = 95.5 \text{ m}^3$	m^3	96	
107	Permanent steel supports $H - 125 \times 125$			
	Required number of steel support			
	$N = (490 + 10.0 + 10.0) / 1.2 = 410$			
	$W = \{(4.3 \times \pi \times 1/2 + 2.15 \times 2) \times 23.8 \text{ kg/m} + 3.203 \times 2 + 3.768 \times 2 + 3.12 \times 2\}$			
	$\times 410 = 116,143.7 \text{ kg}$	ton	117	
108	D. 25 mm rock belts			
	Required number of rock bolts			
	$N = 11,417 / 1.2 = 9,514 \text{ nos}$			
	$L = 2.0 \text{ m} \times 9 \times 4,257 + 2.0 \text{ m} \times 8$			
	$\times 4,257 = 161,738 \text{ m}$	m	161,738	
109	Backfilling			
	Cana Duluce inlet, inlet culvert			
	$V = 6,277 \text{ m}^3$			

T-1-25

Section No.	Distance m	7.2/09 Backfilling (Cana Dulce Inlet)				Remarks
		Sectional Area m ²	Mean m	Volume m ³	Sectional Area m ²	
1	20	18.0	64.8	1,296		
2	20	111.5	81.7	1,634		
3	20	51.9	55.3	1,106		
4	18	58.7	58.7	1,057		
5	3.84	58.7	29.4	113		
6		0				
			Subtotal	5,206		
			$(23.0 + 40.0) / 2 \times 17.0 \times 2.0 =$	1,071		
			Total	6,277		

5-1-86

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Drain ditch	$V = \{(1.29 + 0.9) / 2 \times 0.65 - 0.7 \times 0.65\}$ $\times (10 + 60) = 18.0 \text{ m}^3$			
Total volume	$V = 6,277 + 18.0 = 6,295$	m^3	6,295	
/10 Gabion mattress				
	$V = 11.0 \times 0.5 \times 24.0 + 14.0 \times 0.5 \times 35$ $+ 4.5 \times 0.5 \times 20 = 422$	m^3	422	
/11 Sod facing				
	$A = 154.5 + 284.6 = 439.1$	m^2	439	

5-1-89

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
7.3 DRILLING AND GROUTING WORKS				
101	D. 45 mm drain holes Required number $N = 11,417 / 5.0 \times 2 = 4,567 \text{ nos}$ $L = 4,567 \times (1.5 + 0.3 + 0.1)$ $= 8,677.3 \text{ m}$	m	8,677	
102	Backfill grouting $V = 4.3 \times \pi \times 120^\circ / 360^\circ \times 0.03$ $\times 11,417 = 1,542 \text{ m}^3$	m ³	1,542	
103	D. 50 mm steel pipes for backfill grouting Required number $N = 11,417 / 5.0 = 2,283 \text{ nos}$ $W = 2,283 \times 0.4 \times 5.31 \text{ kg/m}$ $= 4,849$	kg	4,849	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
7/4	CONCRETE WORKS			
101	Concrete, class B, for inlet culvert			
	Culvert			
	$V_1 = (4.5 \times 4.55 - 3.5 \times 3.5 + 0.3 \times 0.3) \times 78.0 = 655.6 \text{ m}^3$			
	Wing wall			
	$V_2 = (1.9 + 1.0) / 2 \times 3.85 \times 0.5 \times 2 + 1.5 \times 10.0 \times 0.5 = 13.1 \text{ m}^3$			
	Total volume			
	$V = 655.6 + 13.1 = 668.7 \text{ m}^3$	m^3	669	
102	Concrete, class D, for tunnel			
	Tunnel inlet part			
	$V_1 = (4.7^2 \times \pi \times 1/8 + 4.7 \times 2.35 - 3.3173 \times 1.75^2) \times 10.0 = 95.6 \text{ m}^3$			
	Tunnel type II			
	$V_2 = 5.763 \text{ m}^2 \times 4.627.051 = 26,665.7 \text{ m}^3$			
	Tunnel type III			
	$V_3 = 5.763 \text{ m}^2 \times 6,302 \text{ m} = 36,306.9 \text{ m}^3$			

57-1289

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Tunnel type IV	$V_4 = 5.792 \text{ m}^2 \times 470 \text{ m} = 2,722.2 \text{ m}^3$			
Tunnel outlet part	$V_5 = (4.7^2 \times \pi \times 1/8 + 4.7 \times 2.35) \times 10$ $- (3.3173 \times 1.75^2 + 3.5^2 \times \pi \times 1/8$ $+ 1.75 \times 3.5) / 2 \times 10 = 91.7 \text{ m}^3$			
Total volume	$V = 95.6 + 26,665.7 + 36,306.9$ $+ 2,722.2 + 91.7 = 65,882.1$	m^3	65,882	
103 Concrete, class E, for concrete facing walls				
Los Cuyuzos outlet	$V_1 = (10.971 + 4.171) / 2 \times 6.8 \times 0.335$ $+ (20.971 + 15.971) / 2 \times 9.5 \times 0.335$ $= 44.7 \text{ m}^3$			
	$V_2 = (9.4 + 6.0) / 2 \times 6.8 \times 0.335 \times 2$ $+ (7.603 + 9.617) / 2 \times 6.0 \times 0.3 \times 2$ $= 66.1 \text{ m}^3$			
	$V_3 = 4.171 \times 0.5 \times 12.0 = 25.0 \text{ m}^3$			
Total volume	$V = 44.7 + 66.1 + 25.0 = 135.8 \text{ m}^3$	m^3	136	
104 Concrete, class F, for drain ditch and catch basin				

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Cone. Ditch inlet, ditch and catch basin	$V1 = \left\{ (0.62 \times 0.7 - 0.5 \times 0.5) + 0.6 \times 0.1 \right\} \times 10.0$ $+ (0.95 \times 0.95 \times 1.0 - 0.8 \times 0.8 \times 0.8) \times 1$ $= 2.83 \text{ m}^3$			
Los Cuyayes outlet	$V1 = (0.62 \times 0.7 - 0.5 \times 0.5) \times 60.0$ $+ (0.95 \times 0.95 \times 1.0 - 0.8 \times 0.8 \times 0.8) \times 1$ $= 11.43 \text{ m}^3$			
Total volume	$V = 2.83 + 11.43 = 14.26 \text{ m}^3$	m ³	15	
los Concrete, class H, for levelling concrete				
Inlet culvert	$V1 = 4.7 \times 0.1 \times 78.0 = 36.66 \text{ m}^3$			
Drain ditch and catch basin	$V2 = 0.8 \times 0.03 \times (10 + 60)$ $+ 1.2 \times 1.2 \times 0.03 \times 2 = 1.77 \text{ m}^3$			
Total volume	$V = 36.66 + 1.77 = 38.43 \text{ m}^3$	m ³	39	
los Formwork, F1 finish, for concrete				
concrete of Items 101 and 103				

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Inlet culvert				
	$a1 = 4.55 \times 2 \times 77.5 + (1.9 + 1.0) / 2 \times 3.85$			
	$\times 2 + 1.5 \times 10.0 + \{ (4.5 \times 4.55 -$			
	$3.5 \times 3.5) + 0.3 \times 0.3 \times 2 \} \times 8 = 798.7 m^2$			
Concrete facing wall				
	$a2 = 4.5 \times 1.18 \times 0.3 + 6.8 \times 1.18 \times 0.3$			
	$\times 2 + 4.171 \times 0.5 \times 2 = 10.2 m^2$			
Total area		m^2	809	
	$A = 798.7 + 10.2 = 808.9$			
107 Formwork, F1 finish, for concrete of Item 104				
	$A = (4.7^2 \times \pi \times 1/8 + 4.7 \times 2.35$			
	$- 3.3173 \times 1.75^2) \times 3 = 28.7 m^2$	m^2	29	
108 Formwork, F3 finish				
Facing wall				
	$a1 = (10.971 + 4.171) / 2 \times 6.8 \times 1.18$			
	$+ (20.471 + 15.971) / 2 \times 4.5 \times 1.18$			
	$= 149.2 m^2$			
	$a2 = (9.4 + 6.0) / 2 \times 6.8 \times 1.18 \times 2$			
	$+ (7.603 + 9.617) / 2 \times 6.0 \times 2 = 220.4 m^2$			
Total		m^2	370	
	$A = 149.2 + 220.4 = 369.6 m^2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
109 Formwork, F3 finish, for concrete of Item/01	Inlet culvert $A = (2.9 \times 3 + 0.424 \times 4) \times 78.0$ $+ (2.4 + 1.5) / 2 \times 3.85 \times 2 + 1.5 \times 10.0$ $= 840.7 \text{ m}^2$	m ²	841	
110 Formwork, F3 finish, for concrete of Item/04	$A = 0.5 \times 2 \times (10 + 60) + 0.8 \times 4 \times 0.8$ $\times 2 = 72.6 \text{ m}^2$	m ²	73	
111 Formwork, F4 finish, for concrete of Item/02	Tunnel (P = 8.466 m) $A = 8.466 \times 11.407.051$ $+ (8.466 + 3.5 \times \pi \times (2 + 1.75 \times 2)) / 2$ $\times 10.0 + (4.5 \times \pi \times 1/8 + 4.5 \times 2.25$ $- 3.5^2 \times \pi \times 1/8 - 3.5 \times 1.75)$ $= 96.666.6 \text{ m}^2$	m ²	96,667	
112 Reinforcing bars for concrete works				

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Inlet culvert	$w1 = 66.9 \times 60 \text{ kg/m}^3 = 40,140 \text{ kg}$			
Tunnel inlet and outlet part	$w2 = (95.6 + 91.7) \times 70 \text{ kg/m}^3 = 13,111 \text{ kg}$			
Concrete facing wall	$w3 = 135.8 \times 30 \text{ kg/m}^3 = 4,074 \text{ kg}$			
Drain ditch and catch basin	$w4 = 14.26 \times 30 \text{ kg/m}^3 = 427.8 \text{ kg}$			
Total weight	$w = 40,140 + 13,111 + 4,074 + 428$ $= 57,753$	ton	58	
1/3 Shotcrete in tunnel				
Tunnel inlet and outlet part	$v1 = \{ (4.9^2 \times \pi \times 1/8 + 4.9 \times 2.35) - (4.7^2 \times \pi \times 1/8 + 4.7 \times 2.35) \} \times 10.0$ $\times 2 = 24.5 \text{ m}^3$			
Tunnel type II ($a = 1.126 \text{ m}^2$)	$v2 = 1.126 \times 4,627.051 = 5,210.1 \text{ m}^3$			
Tunnel type III	$v3 = 1.701 \times 6,300 = 10,716.3 \text{ m}^3$			

5-1-84

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Tunnel type IV			
	$V_4 = 1.129 \times 470 = 530.6 \text{ m}^3$			
	Total volume			
	$V = 24.5 + 5,210.1 + 10,716.3 + 530.6$			
	$= 16,481.5 \text{ m}^3$	m^3	16,482	
114	Steel wire mesh for Item 113			
	Tunnel inlet and outlet part			
	$a_1 = (4.8 \times \pi \times \frac{1}{2} + 2.35 \times 2) \times 10.0 \times 2$			
	$= 244.8 \text{ m}^2$			
	Tunnel type II ($l = 11.264 \text{ m}$)			
	$a_2 = 11.264 \times 4,627.051 = 52,119.1 \text{ m}^2$			
	Tunnel type III ($l = 11.421 \text{ m}$)			
	$a_3 = 11.421 \times 6,300 = 71,952.3 \text{ m}^2$			
	Tunnel type IV ($l = 11.290 \text{ m}$)			
	$a_4 = 11.290 \times 470 = 5,306.3 \text{ m}^2$			
	Total area			
	$A = 244.8 + 52,119.1 + 71,952.3$			
	$+ 5,306.3 \text{ m}^2 = 129,622.5 \text{ m}^2$	m^2	129,623	
115	Shotcrete with wire mesh			
	$t = 100 \text{ mm}$			

5-1-25

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Los Cayuques Outlet				
A = 700.1 m ²		m ²	700	
116 Shotcrete with wire mesh				
t = 50 mm				
Canal Dulce inlet				
A = 252.6 + (13.739 + 5.5) / 2 × 8.24				
× 1.118 = 341.2 m ²		m ²	341	
117 P.V.C. waterstop, type B				
Inlet culvert				
l = 3.9 × 4 × 9 = 140.4		m	141	
118 Anchor bars, Ø.25 mm for concrete facing wall				
Required number				
N = (369.6 + 5.0 × 12.0) / 9.0 = 50 nos				
L = 50 × 3.0 m / no = 150 m		m	150	
119 Dowel bars, Ø.22 mm				
Inlet culvert				
Required number (Ø 500 mm)				
N = 32 nos × 9 nos. = 288 nos				
W = 288 × 1.0 m × 2.984 kg/m = 859.4		ton	859.4	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
120 Bituminous coating for contraction joint				
Inlet culvert				
	$A_1 = (4.5 \times 4.55 - 3.5 \times 3.5 + 0.3 \times 0.3) \times 2 = 75.6 \text{ m}^2$			
Tunnel				
	$A_2 = (4.7^2 \times \pi \times 1/8 + 4.7 \times 2.35 - 3.3173 \times 1.75^2) \times 2 = 19.1 \text{ m}^2$			
Total area		m^2	95	
A = 75.6 + 19.1 = 94.7 m^2				
121 P.V.C. pipe Φ 50 mm for weephole				
Fencing wall				
	$N = 369.6 / 4.0 = 92 \text{ nos}$			
	$L_1 = 92 \times 0.4 = 36.8 \text{ m}$			
Shotcrete				
	$N = (700.1 + 341.2) / 4.0 = 260 \text{ nos}$			
	$L_2 = 260 \times 0.2 = 52.0 \text{ m}$			
Total length		m	89	
L = 36.8 + 52.0 = 88.8 m				

5-1-89

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
7.5	CONVERGENCE MEASUREMENTS			
101	Measurement of horizontal convergence			
	Required number of measurement point			
	$n = 11.417 / (106.94/3) \approx 320$ points			
	Required number of measurement	nos	6,400	
102	Measurement of diagonal convergence	nos	6,400	
103	Measurement of roof settlement	nos	6,400	
104	Measurement of invert upheaval	nos	6,400	
105	Stress measurement of rock bolts			
	Required number of measurement point			
	$n = 11.417 / (106.94 \times 2) \approx 54$ points			

5-1-80

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$N = 54 \times 25 = 1,350$	nos	1,350	
106	Stress measurement of shotcrete			
		nos	1,350	
107	Stress measurement of steel support			
	Required number of measurement point $n = 2$ points			
	Required number of measurement $N = 2 \times 20 = 40$	nos	40	

5-1-89

La Esperanza-Poza Honda Diversion Tunnel(Cana Duluce Inlet)

Sec No	Dis.(m)	7.2/01 Clearing			7.2/02 Common		
		Length(m)	Mean(m)	Area(m ²)	Sec.area(m ²)	Mean(m ²)	Volume(m ³)
1	20	40.4	35.0	699.0	93.4	81.4	1,628.0
2	20	29.5	21.5	430.0	69.4	57.5	1,150.0
3	20	13.5	32.8	655.0	45.6	104.4	2,088.0
4	18	52.0	45.6	820.8	163.2	131.4	2,365.2
5	3.84	39.2	36.1	138.6	99.6	95.9	368.3
6	13	33.0	16.5	214.5	92.2	46.1	599.3
7		0.0			0.0		
		Total		2,957.9	Total		8,198.8

Sec No	Dis.(m)	7.2/03 Weathered rock			7.2/13 Sod facing		
		Sec.area(m ²)	Mean(m ²)	Volume(m ³)	Length(m)	Mean(m)	Area(m ²)
1	20	251.4	175.0	3,500.0	0.0	0.0	0.0
2	20	98.6	64.0	1,280.0	0.0	0.0	0.0
3	20	29.4	43.0	860.0	0.0	0.0	0.0
4	18	56.6	104.5	1,881.0	0.0	4.0	71.1
5	3.84	152.4	114.6	440.1	7.9	8.0	30.7
6	13	76.8	38.4	499.2	8.1	4.1	52.7
7		0.0			0.0		
		Total		8,460.3	Total		154.5

Sec No	Dis.(m)	7.4/15 Shotcrete		
		Length(m)	Mean(m)	Area(m ²)
1	20	0.0	0.0	0.0
2	20	0.0	0.0	0.0
3	20	0.0	0.0	0.0
4	18	0.0	0.0	0.0
5	3.84	0.0	15.0	57.6
6	13	30.0	15.0	195.0
7		0.0		
		Total		252.6

La Esperanza-Poza Honda Diversion Tunnel(Los Cuyuyes Inlet)

Sec No	Dis.(m)	7.2/01 Clearing			7.2/02 Common		
		Length(m)	Mean(m)	Area(m ²)	Sec.area(m ²)	Mean(m ²)	Volume(m ³)
0		0.0			0.0		
	12.5		24.0	300.0		47.4	592.5
1		48.0			94.8		
	10		47.9	479.0		94.2	942.0
2		47.8			93.6		
	6		39.4	236.4		78.6	471.6
3		31.0			63.6		
	5.65		29.5	166.7		61.4	346.9
4		28.0			59.2		
	6		24.0	144.0		49.1	294.6
5		20.0			39.0		
	6		21.4	128.4		38.4	230.4
6		22.8			37.8		
	40		11.4	456.0		18.9	756.0
7		0.0			0.0		
			Total	1,910.5		Total	3,634.0

Sec No	Dis.(m)	7.2/03 Weathered rock			7.2/13 Sod facing		
		Sec.area(m ²)	Mean(m ²)	Volume(m ³)	Length(m)	Mean(m)	Area(m ²)
0		0.0			0.0		
	12.5		48.2	602.5		1.1	13.8
1		96.4			2.2		
	10		126.5	1,265.0		3.5	34.5
2		156.6			4.7		
	6		119.1	714.6		3.6	21.6
3		81.6			2.5		
	5.65		90.1	509.1		5.3	29.7
4		98.6			8.0		
	6		73.1	438.6		7.7	45.9
5		47.6			7.3		
	6		46.8	280.8		6.2	37.2
6		46.0			5.1		
	40		23.0	920.0		2.6	102.0
7		0.0			0.0		
			Total	4,730.6		Total	284.6

5-1-10/

Sec No	Dis.(m)	7.4/15 Shotcrete		
		Length(m)	Mean(m)	Area(m ²)
0		0.0		
	12.5		20.4	255.0
1		40.8		
	10		29.0	289.5
2		17.1		
	6		11.3	67.8
3		5.5		
	5.65		9.0	50.6
4		12.4		
	6		6.2	37.2
5		0.0		
	6		0.0	0.0
6		0.0		
	40		0.0	0.0
7		0.0		
			Total	700.1

5-1-102

Working Division: 9 LA SECA WCRK ADIT

Description	Calculation Details	Unit	Quantity	Remarks
91	Earth Works			
101	Clearing the site for adit portal (cf. AP-1)	m ²	1381.605	
102	Open-cut excavation in common for adit portal (cf. AP-1)	m ³	2518.890	
103	Open-cut excavation, in weathered rock, for adit portal $2437.730 \times 95\% = 2315.843 \text{ m}^3$	m ³	2315.843	
104	Open-cut excavation, in rock, for adit portal (weathered rock) $\times 5\% = 2437.730 \times 0.05 = 121.887 \text{ m}^3$	m ³	121.887	
105	Underground excavation, all classes, in adit (cf. AP-2)	m ³	9591.115	
106	Trench excavation, all classes, for drain ditch and catch basin (cf. AP-3)	m ³	32.627	
	$31212 \text{ m}^3 (\text{ditch}) + 1415 \text{ m}^3 (\text{catch basin})$ $= 32627 \text{ m}^3$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
107	Permanent steel support H=125 x 125 mm (cf. AP-2)	ton	50.505	
108	D. 25mm rock bolts in adit tunnel (cf. AP-2)	m	7528.000	
109	Backfilling for adit portal (cf. AP-1)	m ³	133.849	
110	Backfilling (cf. AP-3)	m ³	12.811	
111	Gravel surfacing (cf. AP-1)	m ³	84.160	
112	Gravel bedding for drain ditch and catch basin drain ditch 1.2 m ³ catch basin 0.064 m ³ 1.264 m ³	m ³	1.264	
113	Wet rubble masonry (cf. AP-1)	m ³	10.000	
114	Sod facing (cf. AP-1)	m ²	339.622	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
9.2	CONCRETE WORKS			
101	Concrete, class P. for lining concrete of adit tunnel (cf. AP-2)	m ³	619.369	
102	Concrete, class E. for concrete facing walls and portal structure (cf. AP-1)	m ³	45.616	
103	Concrete, class E. for drain ditch and catch basin (cf. AP-3)	m ³	9.362	
	drain ditch		9.180 m ³	
	catch basin		0.182 m ³	
			9.362 m ³	
104	Concrete, class H. for levelling concrete of drain ditch and catch basin (cf. AP-3)	m ³	1.311	
	drain ditch		1.292 m ³	
	catch basin		0.019 m ³	
			1.311 m ³	
105	Formwork, F1 finish, for concrete of Item 102 (cf. AP-1)	m ²	8.681	

57-1105

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
106	Formwork, F1 finish, for concrete of Item 103 (cf. AP-3) drain ditch 67.032 m ² catch basin 1.762 m ² 68.794 m ²	m ²	68.794	
107	Formwork, F2 finish, for concrete of Item 102 (cf. AP-1)	m ²	152.053	
108	Formwork, F3 finish, for concrete of Item 103 (cf. AP-3) drain ditch 44.280 m ² catch basin 0.65 m ² 44.93 m ²	m ²	44.930	
109	Formwork, F4 finish, for concrete of Item 101 (cf. AP-2)	m ²	907.506	
110	Reinforcing bars for concrete works Facing concrete 30 kg/m ³ ∴ 45.616 m ³ × 30 kg/m ³ = 1368.48 kg	Ton	1.368	

of 11-106

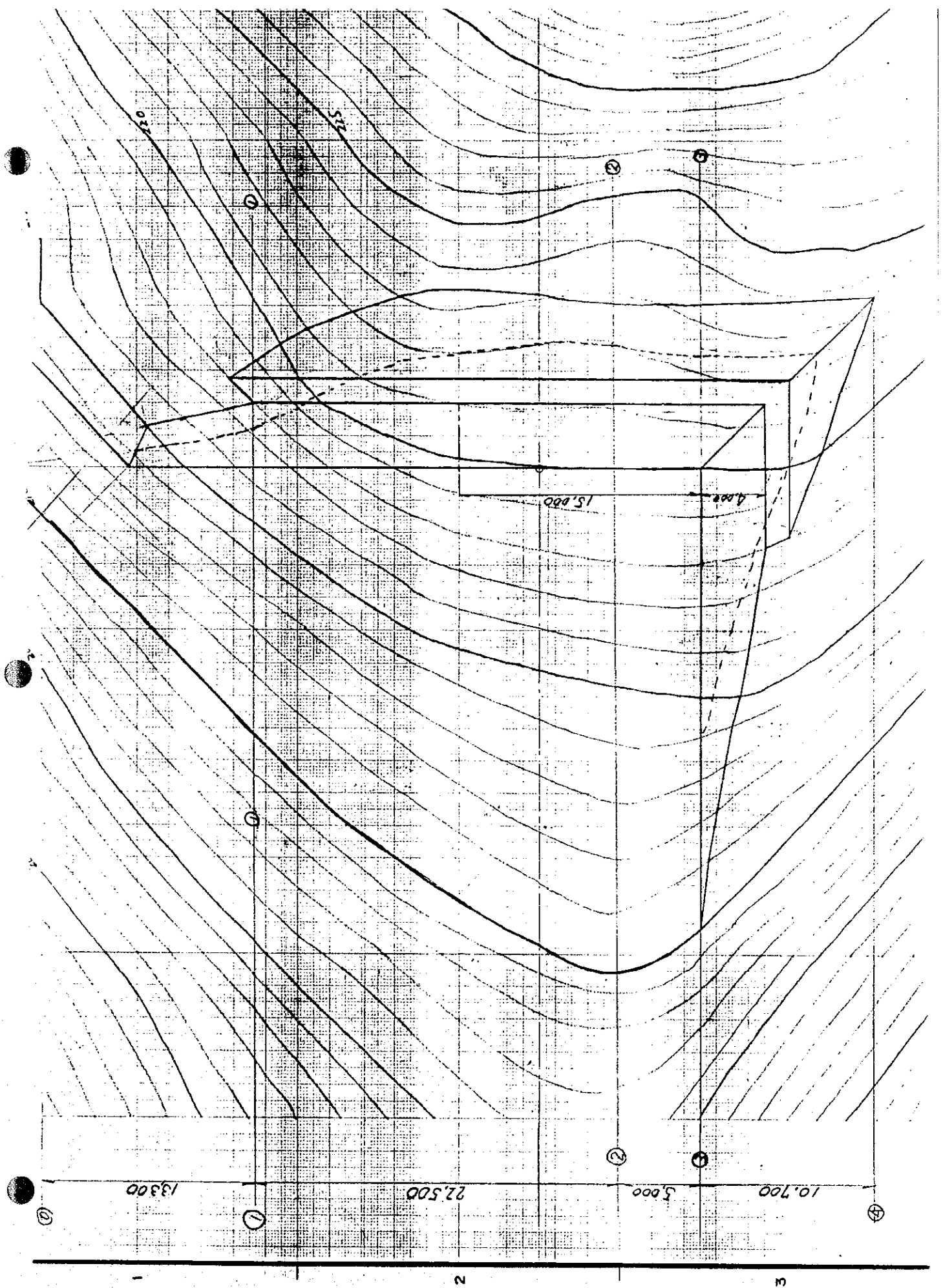
Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
111 Shotcrete in adit tunnel	(cf. AP-2)	m ³	651.375	
112 Steel wire mesh for Item 111	(cf. AP-2)	m ²	5905.880	
113 Anchor bars D.25 mm for concrete facing wall	(cf. AP-1)	m	45.000	
114 P.V.C pipe D.50 mm for weephole	(cf. AP-1, 2)	m	31.100	
Addit Portal	13.6 m			
Addit Tunnel	17.5 m			
	31.1 m			

AP-1

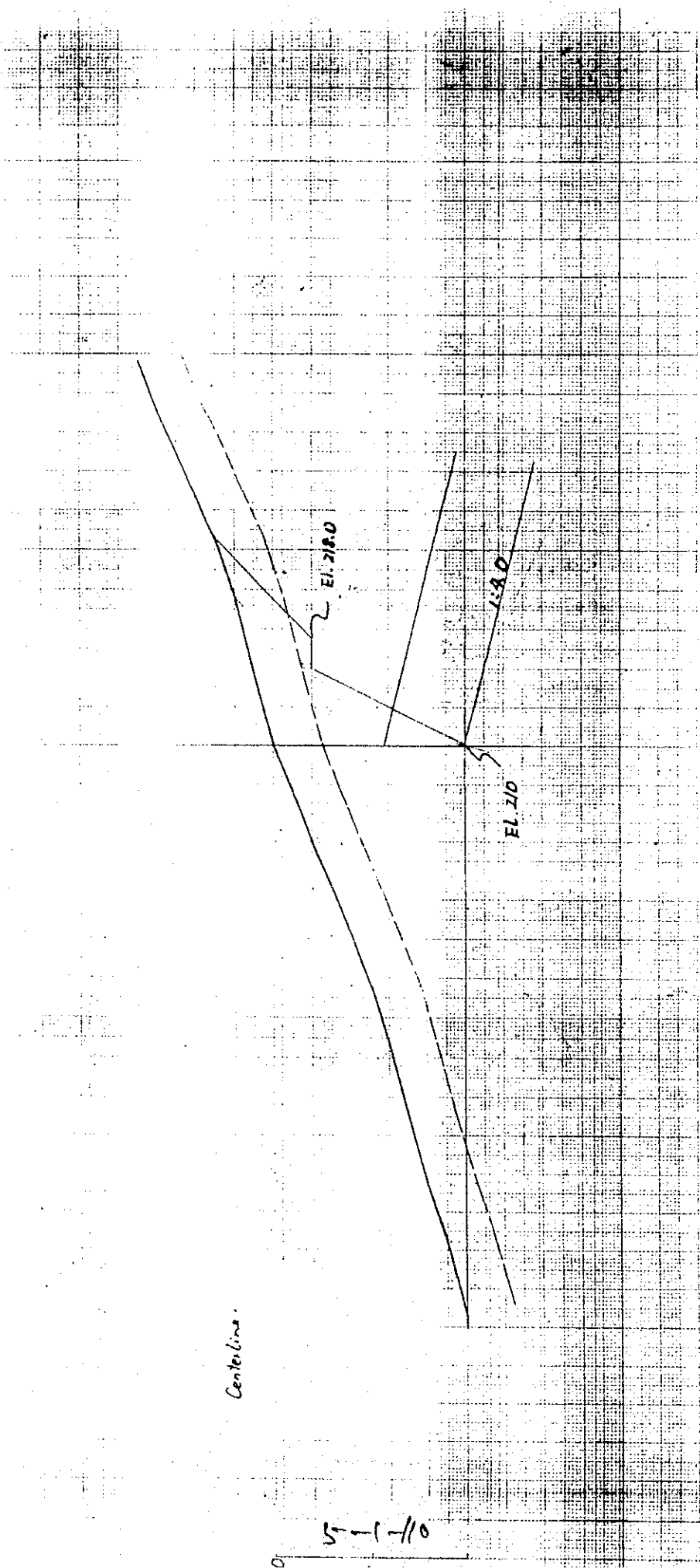
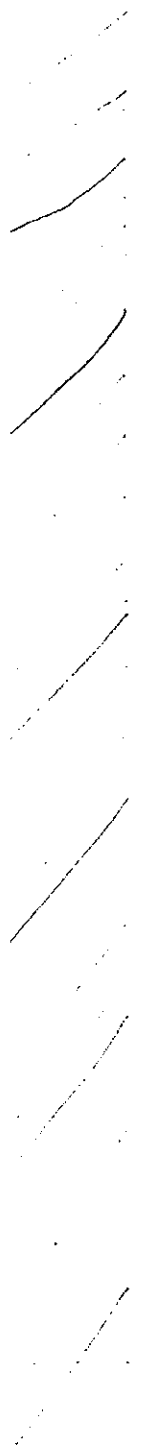
Audit Portal

101-1-15



5-1-10p

6.9



Centerline

5-1-110



U		
RE		
REV. Nº	REVISADO	APROBADO
		FECHA

① $C_c = 37.8 \text{ m}^2$
 $C_w = 21.0 \text{ m}^2$
 $S_f = 6.8 \text{ m}$

$Cl = 25.0$

② $C_c = 84.2$
 $C_w = 96.9$
 $S_f = 4.5$

$Cl = 43.5$

③ $C_c = 87.2$

$C_w = 93.8$

$S_f = 5.0$

$Cl = 42.8$

220

215

210

220

210

220

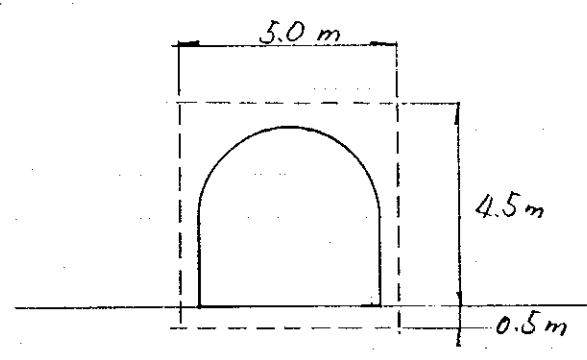
210

5-1-111

Excavation, Common	Clearing	face concrete (t=300mm)	Gravel bedding
1. ① ~ ① $37.8 / 2 \times 13.3 \text{ m} = 251.37 \text{ m}^2$	1. ① ~ ① $25.0 / 2 \times 13.3 \text{ m} = 166.25 \text{ m}^2$	$(15.0 \times 19.0) \times 4.0 / 2 = 68.0$	$18.0 / \cos(\tan^{-1} \frac{1}{0.5}) = 152.053 \text{ m}^2$
2. ① ~ ① $(37.8 \times 84.2) / 2 \times 22.5 \text{ m} = 1872.5 \text{ m}^2$	2. ① ~ ① $(25.0 \times 43.5) / 2 \times 22.5 = 770.625 \text{ m}^2$	$152.053 \text{ m} \times 0.3 \text{ m} = 45.616 \text{ m}^2$	$152.053 \text{ m} \times 0.3 \text{ m} = 45.616 \text{ m}^2$
3. ② ~ ② $(84.2 \times 87.2) / 2 \times 5.0 \text{ m} = 438.5 \text{ m}^2$	3. ② ~ ② $(43.5 \times 42.8) / 2 \times 5.0 = 215.75 \text{ m}^2$	$84.6 \text{ m} \times 0.1 \text{ m} = 8.46 \text{ m}^2$	$84.6 \text{ m} \times 0.1 \text{ m} = 8.46 \text{ m}^2$
4. ③ ~ ③ $87.2 / 2 \times 10.7 \text{ m} = 466.52 \text{ m}^2$	4. ③ ~ ③ $42.8 / 2 \times 10.7 = 228.98 \text{ m}^2$	Anchor bars for facing concrete Area = $88.1 \times 2 = 176.2 \text{ m}^2$	Anchor bars for facing concrete Area = $88.1 \times 2 = 176.2 \text{ m}^2$
Total: 2518.89 m ²	Total: 1361.605 m ²	$18.6 \times \frac{1}{2} \text{ m} = 9.3 \text{ m}$ $3 \text{ m} / 4 \times 15.4 = 45 \text{ m}$	$18.6 \times \frac{1}{2} \text{ m} = 9.3 \text{ m}$ $3 \text{ m} / 4 \times 15.4 = 45 \text{ m}$
Excavation - weathered rock	Sod facing	whelp hole for facing concrete	whelp hole for facing concrete
1. ① ~ ① $21.0 / 2 \times 13.3 \text{ m} = 139.65 \text{ m}^2$	Cd: 1: 1.0 Area = $140 \text{ m}^2 / \cos 45^\circ$ $= 192.970 \text{ m}^2$	$136 \text{ m}^2 \times \frac{1}{2} \text{ m} = 68 \text{ m}^2$	$136 \text{ m}^2 \times \frac{1}{2} \text{ m} = 68 \text{ m}^2$
2. ① ~ ① $(21.0 \times 96.4) / 2 \times 22.5 = 1320.75$	Berm = $15 \text{ m} \times 33.6 \text{ m}$ $= 504 \text{ m}^2$	$0.4 \text{ m} \times 13.6 \text{ m} = 5.44 \text{ m}^2$	$0.4 \text{ m} \times 13.6 \text{ m} = 5.44 \text{ m}^2$
3. ① ~ ① $(96.4 \times 93.8) / 2 \times 5.0 = 475.5$	Cd: 1: 0.5 Area = $40.8 \text{ m}^2 / \cos(\tan^{-1} \frac{1}{0.5})$ $= 91.237$	Form work for facing concrete front = 152.053 m^2 side = $0.3 \times (176.2 + 97.0) = 55.96 \text{ m}^2$ Tunnel = $1.37 \times 20.5 \times 4000 \text{ m}^2$	Form work for facing concrete front = 152.053 m^2 side = $0.3 \times (176.2 + 97.0) = 55.96 \text{ m}^2$ Tunnel = $1.37 \times 20.5 \times 4000 \text{ m}^2$
4. ① ~ ① $93.8 / 2 \times 10.7 \text{ m} = 501.83$	Total: 2437.73	2.025 m^2	2.025 m^2
Total: 2437.73	Total: 2339.622 m ²	Total: 160.794 m ²	Total: 160.794 m ²

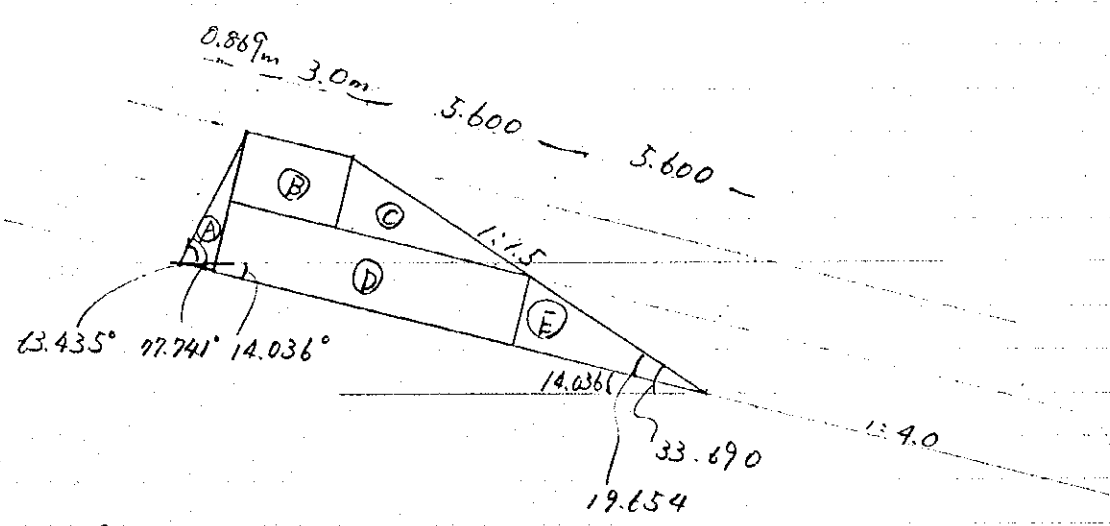
CRM CENTRO DE REHABILITACION DE MANABI	Estudio de Diseño Detallado de los Travesaños de Agua para las Cuenca de Los Rios Chone - Portoviejo The Detailed Design Study on the Water Traversesh Schemes for Chone - Portoviejo River Basins		LEVANTO : DIBUJO : DISEÑO : REVISO : ENTREGO :
	TITULO :		APROBADO : FECHA : DIBUJO N°
	REPUBLICA DEL ECUADOR		DISEÑO N°
	REPUBLICA DEL ECUADOR		REVISO N°

- Wet rubble masonry.



$$V = \frac{H \cdot B \cdot t}{2} = 5.0 \times 5.0 \times 0.4 = 10 \text{ m}^3$$

- Backfilling



- (A) $\{4.0 \times 2.0 + 2.0^2 \times \pi \times \frac{1}{2}\} \times 0.869 \text{ m} \times \frac{1}{2} = 6.206 \text{ m}^3$
- (B) $(2.0^2 \times \pi \times \frac{1}{2}) \times 3.0 = 18.850 \text{ m}^3$
- (C) $(2.0^2 \times \pi \times \frac{1}{2}) \times 5.6 \times \frac{1}{2} = 17.593 \text{ m}^3$
- (D) $2 \times 4.0 \times 8.6 = 68.8 \text{ m}^3$
- (E) $2 \times 4.0 \times 5.6 \times \frac{1}{2} = 22.4 \text{ m}^3$

Total 133.849 m³

Working Division: LOS CUYUYES WORK ADIT

Description	Calculation Details	Unit	Quantity	Remarks
10.1	EARTHWORK			
101	Clearing the site for adit portal	m ²	1,048	
102	Open-cut excavation, in common, for adit portal	m ³	2,244	
103	Open-cut excavation, in weathered rock, for adit portal	m ³	2,753	
104	Open-cut excavation, in rock	m ³	145	
105	Underground excavation, all classes, in adit	m ³		
	Total horizontal length of tunnel			
	L = 129.974 m			

VT 1111F

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Length of inclined part			
	Horizontal length			
	$L = (EL.111.0 - 99.88) \times 4$			
	$= 44.48 \text{ m}$			
	Inclined length			
	$L' = 44.48 / \cos 14.0362^\circ = 45.849 \text{ m}$			
	Length of horizontal part			
	$L = 129.974 - 44.48 = 85.494 \text{ m}$	m^3	2.676	
	10% Trench excavation, all classes, for drain ditch and catch basin			
	Required length of ditch (without cover, 0.3 x 0.3 m size)			
	$L = 25.0 \text{ m} + 28.0 \text{ m} = 53.0 \text{ m}$			
	(with cover, 0.5 x 0.5 m size)			
	$L = 8.0 \text{ m} + 8.0 \text{ m} = 16.0 \text{ m}$			
	Required number of catch basin $N = 2 \text{ nos}$			
	$39.17 \text{ m}^3 + 2.83 \text{ m}^3 \times 2 = 44.83$	m^3	45	

57-11-15

Section No.	Distance m	101 Clearing			102 Common			Remarks
		Sectional Area m ²	Mean m	Area Volume m ³	Sectional Area m ²	Mean m	Volume m ³	
0	13.4	13	25.5	341.7	26	54.5	730.3	
1	10.0	38	37.0	370.0	83	80.5	805.0	
2	11.7	36	27.0	315.9	78	57.0	666.9	
3	2.3	18	9.0	20.7	36	18.0	41.4	
4		0			0			
			Total	1,048.3 m ³			2,243.6 m ³	

5-1-116

Working Division: LOS CUYUYES WORK ADIT

Section No.	Distance m	<u>103 Weathered rock</u>						Remarks
		Sectional Area m ²	Mean m ²	Volume m ³	Sectional Area m ²	Mean m ²	Volume m ³	
0		20						
1	13.4		65.5	877.7				
2	10.0	111	108.5	1085.0				
3	11.7	106	75.5	883.4				
4	7.3	45	22.5	51.8				
		0						
			Total	2,897.9 m ³				

57-1-117

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
107	Permanent steel support H-12.5 x 12.5 mm	Ton	10.4	
108	D-25 mm rock bolts in adit tunnel	m	1.868	
109	Backfilling for adit portal	m ³	134	
110	Backfilling	m ³	18	
	drain ditch : 15.77 m ³			
	catch basin : 1.028 x 2 m ³			
	Total : 17.83 m ³			
111	Gravel surfacing (35.1 + 10.0) / 2 x 21.5 x 0.1 = 48.48	m ³	49	
112	Gravel bedding for drain and catch basin	m ³	3	
	drain ditch : 2.87 m ³			
	catch basin : 0.128 x 2 m ³			
	Total : 3.13 m ³			
113	Wet rubble masonry	m ³	10	

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
101	Sad facing	m ²	350	
2	CONCRETE WORKS			
101	Concrete class D, for lining concrete of adit tunnel	m ³	603	
102	Concrete, class E, for concrete facing walls and portal structure $(19.5 + 10.0) / 2 \times 8.944 \times 0.3 - (4.0^2 \times \pi \times 1/8) + 4.0 \times 2.0 \times 0.335 = 28.1$	m ³	28	
103	Concrete class E, for drain ditch and catch basin drain ditch : 10.42 m ³ catch basin : 0.364 x 2 m ³ Total : 11.15 m ³	m ³	11	
104	Concrete, Class H, for levelling of drain ditch and catch basin drain ditch : 1.34 m ³ catch basin : 0.038 x 2 m ³ Total : 1.42 m ³	m ³	2	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
105	Formwork, F1 finish, for concrete of Item 102	m ²	3	
	$8.946 \times 0.3 = 2.68 \text{ m}^2$			
106	Formwork, F1 finish, for concrete of Item 103	m ²	88	
	drain ditch : 80.36 m^2			
	catch basin : $3.524 \times 2 \text{ m}^2$			
	Total : 87.41 m^2			
107	Formwork, F2 finish, for concrete of Item 102	m ²	97	
	$(14.5 + 10.0) / 2 \times 8.946 - (4.0^2 \times \pi / 8 + 4.0 \times 2) \times 1.118 + (4.0 \times \pi / 2 + 2.0 \times 2) \times 0.335 = 97.0$			
108	Formwork, F3 finish, for concrete of Item 103	m ²	51	
	drain ditch : 47.8 m^2			
	catch basin : $1.3 \times 2 \text{ m}^2$			
	Total : 50.4 m^2			
109	Formwork, F4 finish, for concrete of Item 101	m ²	879	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
10	Reinforcing bars for concrete works	Ton	1	
	Facing concrete 30 kg/m^3			
	$\therefore 28 \times 30 = 840 \text{ kg}$			
11	Shotcrete in adit tunnel	m^3	168	
12	Steel wire mesh for stem 111	m^2	1554	
13	Anchor bars, D 25 mm for concrete facing wall $970/9.0 = 11 \text{ nos } 11 \times 3.0 = 33.0$	m	33	
14	P.V.C pipe D 50 mm for weephole $97/4.0 = 24 \text{ nos } 24 \times 0.4 = 9.6$ Adit portal: 9.6 m Adit tunnel: 17 m Total: 26.6 m	m	27	

Type (0.3x0.3) without gravel
L= 26.5 m

Item	Unit	Qty
Excavation	0.371 m3	9.832 m3
Concrete	0.12 m3	3.180 m3
F1 formwork	0.84 m2	22.260 m2
F3 formwork	0.6 m2	15.900 m2
Leveling conc.	0.018 m3	0.477 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.143 m3	3.790 m3

Type (0.3x0.3) with gravel
L= 26.5 m

Item	Unit	Qty
Excavation	0.481 m3	12.747 m3
Concrete	0.12 m3	3.180 m3
F1 formwork	0.84 m2	22.260 m2
F3 formwork	0.6 m2	15.900 m2
Leveling conc.	0.018 m3	0.477 m3
Gravel bedding	0.06 m3	1.590 m3
Backfilling	0.193 m3	5.115 m3

Type (0.5x0.5) without gravel, with cover
L= 0 m

Item	Unit	Qty
Excavation	0.878 m3	0.000 m3
Concrete	0.254 m3	0.000 m3
F1 formwork	2.24 m2	0.000 m2
F3 formwork	1 m2	0.000 m2
Leveling conc.	0.024 m3	0.000 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.35 m3	0.000 m3

Type (0.3x0.3) with gravel, with cover
L= 16 m

Item	Unit	Qty
Excavation	1.037 m3	16.592 m3
Concrete	0.254 m3	4.064 m3
F1 formwork	2.24 m2	35.840 m2
F3 formwork	1 m2	16.000 m2
Leveling conc.	0.024 m3	0.384 m3
Gravel bedding	0.08 m3	1.280 m3
Backfilling	0.429 m3	6.864 m3

Total

Item	Qty
Excavation	39.170 m3
Concrete	10.424 m3
F1 formwork	80.360 m2
F3 formwork	47.800 m2
Leveling conc.	1.338 m3
Gravel bedding	2.870 m3
Backfilling	15.768 m3

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Type II Item	L=	Unit	Qty
Excavation	17.685	m ³	810.840
Concrete	-	m ³	0.000
Shotcrete	1.369	m ³	62.767
Wire mesh	10.952	m ²	502.138
Rockbolt	34	m/2.4m	662.000
Steel support	0.273	ton/1.2m	10.374
Weephole	-	m/2.5m	0.000

Type I Item	L=	Unit	Qty
Excavation	16.843	m ³	0.000
Concrete	-	m ³	0.000
Shotcrete	1.076	m ³	0.000
Wire mesh	10.76	m ²	0.000
Rockbolt	34	m/2.4m	0.000
Steel support	-	ton/1.2m	0.000
Weephole	-	m/2.5m	0.000

Type II with concrete Item	L=	Unit	Qty
Excavation	22.54	m ³	0.000
Concrete	5.885	m ³	0.000
Form	10.283	m ²	0.000
Shotcrete	1.55	m ³	0.000
Wire mesh	10.333	m ²	0.000
Rockbolt	34	m/2.4m	0.000
Steel support	-	ton/1.2m	0.000
Weephole	0.5	m/2.5m	0.000

Type I with concrete Item	L=	Unit	Qty
Excavation	21.817	m ³	1,865.223
Concrete	5.885	m ³	503.132
Form	10.283	m ²	879.135
Shotcrete	1.23	m ³	105.158
Wire mesh	12.3	m ²	1,051.576
Rockbolt	34	m/2.4m	1,206.000
Steel support	-	ton/1.2m	0.000
Weephole	0.5	m/2.5m	17.000

Total Item	Qty
Excavation	2,676.062 m ³
Concrete	503.132 m ³
Form	879.135 m ²
Shotcrete	167.925 m ³
Wire mesh	1,553.714 m ²
Rockbolt	1,868.000 m
Steel support	10.374 ton
Weephole	17.000 m

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Working Division: POZA HONDA ~ MANCHA GRANDE DIVERSION TUNNEL

Description	Calculation Details	Unit	Quantity	Remarks
8.2	EARTHWORK			
101	Clearing the site for the inlet and outlet structures			
	$A = 706.0 + 3.132.9 + 9.012.3$ $= 12,851.2 \text{ m}^2$	m^2	12,851	
102	Open-cut excavation, in common			
	$V = 1.330 + 5.938 + 50.735$ $= 58.003 \text{ m}^3$	m^3	58.003	
103	Open-cut excavation, in weathered rock			
	$V = 1,282 + (17,462 \times 0.95) + 33,780$ $= 51,651 \text{ m}^3$	m^3	51,651	
104	Open-cut excavation, in rock			
	$V = 17,462 \times 0.05 = 873$	m^3	873	

Poza Honda-Mancha Grande Diversion Tunnel(Poza Honda Inlet(1))

Sec No	Dis.(m)	8.2/01 Clearing			8.2/02 Common		
		Length(m)	Mean(m)	Area(m ²)	Sec.area(m ²)	Mean(m ²)	Volume(m ³)
0		0.0			0.0		
	22		7.2	157.3		13.3	291.5
1		14.3			26.5		
	5		17.5	87.3		33.3	166.3
2		20.6			40.0		
	7.5		22.1	165.8		44.6	334.5
3		23.6			49.2		
	1.9		25.8	49.0		53.2	101.1
4		28.0			57.2		
	2.1		28.2	59.2		59.5	125.0
5		28.4			61.8		
	2.5		30.2	75.5		55.6	139.0
6		32.0			49.4		
	7		16.0	112.0		24.7	172.9
7		0.0			0.0		
			Total	706.0		Total	1,330.2

Sec No	Dis.(m)	8.2/03 Weathered rock			8.2/13 Sod facing		
		Sec.area(m ²)	Mean(m ²)	Volume(m ³)	Length(m)	Mean(m)	Area(m ²)
0		0.0			0.0		
	22		9.9	217.8		0.0	0.0
1		19.8			0.0		
	5		31.7	158.5		0.0	0.0
2		43.6			0.0		
	7.5		70.4	528.0		0.0	0.0
3		97.2			0.0		
	1.9		77.8	147.8		0.0	0.0
4		58.4			0.0		
	2.1		65.8	138.2		0.0	0.0
5		73.2			0.0		
	2.5		36.6	91.5		0.0	0.0
6		0.0			0.0		
	7		0.0	0.0		0.0	0.0
7		0.0			0.0		
			Total	1,281.8		Total	0.0

Sec No	Dis.(m)	8.4/21 Shotcrete		
		Length(m)	Mean(m)	Area(m ²)
0		0.0		
	22		0.0	0.0
1		0.0		
	5		0.0	0.0
2		0.0		
	7.5		4.8	35.6
3		9.5		
	1.9		16.0	30.4
4		22.5		
	2.1		24.0	50.4
5		25.5		
	2.5		12.8	31.9
6		0.0		
	7		0.0	0.0
7		0.0		
			Total	148.3

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Poza Honda-Mancha Grande Diversion Tunnel(Poza Honda Inlet(2))

Sec No	Dis.(m)	8.2/01 Clearing			8.2/02 Common		
		Length(m)	Mean(m)	Area(m2)	Sec.area(m2)	Mean(m2)	Volume(m3)
0		0.0			0.0		
	29		33.7	977.3		63.5	1,840.1
1		67.4			126.9		
	15		66.7	1,000.5		128.2	1,922.3
2		66.0			129.4		
	5.5		65.2	358.6		125.5	690.3
3		64.4			121.6		
	7.5		62.2	466.5		116.5	873.4
4		60.0			111.3		
	11		30.0	330.0		55.7	612.2
5		0.0			0.0		
	0		0.0	0.0		0.0	0.0
6		0.0			0.0		
	0		0.0	0.0		0.0	0.0
7		0.0			0.0		
			Total	3,132.9		Total	5,938.1

Sec No	Dis.(m)	8.2/03 Weathered rock			8.2/13 Sod facing		
		Sec.area(m2)	Mean(m2)	Volume(m3)	Length(m)	Mean(m)	Area(m2)
0		0.0			0.0		
	29		191.7	5,559.3		4.9	140.7
1		383.4			9.7		
	15		417.1	6,256.5		7.8	117.0
2		450.8			5.9		
	5.5		416.8	2,292.4		6.2	33.8
3		382.8			6.4		
	7.5		295.1	2,213.3		8.1	60.8
4		207.4			9.8		
	11		103.7	1,140.7		4.9	53.9
5		0.0			0.0		
	0		0.0	0.0		0.0	0.0
6		0.0			0.0		
	0		0.0	0.0		0.0	0.0
7		0.0			0.0		
			Total	17,462.2		Total	406.1

Sec No	Dis.(m)	8.4/21 Shotcrete		
		Length(m)	Mean(m)	Area(m2)
0		0.0		
	29		13.5	390.1
1		26.9		
	15		30.6	458.3
2		34.2		
	5.5		34.1	187.3
3		33.9		
	7.5		34.3	256.9
4		34.6		
	11		17.3	190.3
5		0.0		
	0		0.0	0.0
6		0.0		
	0		0.0	0.0
7		0.0		
			Total	1,482.8

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