

Poza Honda-Mancha Grande Diversion Tunnel(Manch Grande Outlet)

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		
	20		30.0	600.0		160.2	3,204.0
1		60.0			320.4		
	6.25		59.0	368.8		316.6	1,978.8
2		58.0			312.8		
	6.25		59.7	373.1		320.2	2,001.3
3		61.4			327.6		
	3.75		61.7	231.4		331.9	1,244.6
4		62.0			336.2		
	20		61.0	1,220.0		325.2	6,504.0
5		60.0			314.2		
	20		54.8	1,096.0		285.2	5,704.0
6		49.6			256.2		
	10		49.3	493.0		283.7	2,837.0
7		49.0			311.2		
	10		50.0	500.0		310.8	3,108.0
7+10		51.0			310.4		
	50		42.5	2,125.0		274.8	13,740.0
8		34.0			239.2		
	50		27.5	1,375.0		159.9	7,995.0
9		21.0			80.6		
	60		10.5	630.0		40.3	2,418.0
10		0.0			0.0		
			Total	9,012.3		Total	50,734.6

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		
	20		94.6	1,892.0		8.2	164.0
1		189.2			16.4		
	6.25		280.6	1,753.8		19.3	120.3
2		372.0			22.1		
	6.25		435.9	2,724.4		22.2	138.8
3		499.8			22.3		
	3.75		521.7	1,956.4		22.1	82.7
4		543.6			21.8		
	20		488.7	9,774.0		22.4	448.0
5		433.8			23.0		
	20		340.2	6,804.0		24.3	485.0
6		246.6			25.5		
	10		204.5	2,045.0		27.9	278.5
7		162.4			30.2		
	10		168.0	1,680.0		29.2	292.0
7+10		173.6			28.2		
	50		94.9	4,745.0		31.1	1,552.5
8		16.2			33.9		
	50		8.1	405.0		27.0	1,347.5
9		0.0			20.0		
	60		0.0	0.0		10.0	600.0
10		0.0			0.0		
			Total	33,779.5		Total	5,509.3

5-1-127

Sec No	Dis.(m)	8.4/21 Shotcrete		
		Length(m)	Mean(m)	Area(m2)
0		0.0		
	20		26.3	526.0
1		52.6		
	6.25		53.2	332.5
2		53.8		
	6.25		58.6	365.9
3		63.3		
	3.75		59.3	222.2
4		55.2		
	20		51.6	1,032.0
5		48.0		
	20		38.4	768.0
6		28.8		
	10		24.4	244.0
7		20.0		
	10		16.2	162.0
7+10		12.4		
	50		6.2	310.0
8		0.0		
	50		0.0	0.0
9		0.0		
	60		0.0	0.0
10		0.0		
			Total	3,962.6

5-1-120

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
105 Underground excavation, all classes, in tunnel and inlet structure	Inlet tunnel, transition part $V1 = \left\{ 5.4 \times 3.8 + (5.4^2 \times \pi \times 1/8 + 5.4 \times 1.1) \right\} \times 1/2 \times 6.0 = 113.7 \text{ m}^3$			
Inlet tunnel, tunnel	$V2 = (5.4^2 \times \pi \times 1/8 + 5.4 \times 1.1) \times 31.5$ $+ (5.8^2 \times \pi \times 1/8 + 5.8 \times 1.3) \times 1.0$ $= 568.6 \text{ m}^3$			
Inlet shaft	$V3 = 272.914 \text{ m}^3 \times (EL. 112.2 - EL. 88.7)$ $+ 6.3 \times 11.1 \times (EL. 88.7 - EL. 81.35)$ $+ 1.8 \times 3.2 \times 1.0 = 6,933.2 \text{ m}^3$			
Tunnel transition part	$V4 = 4.3 \times 4.2 \times 1.0 + (3.9 \times 3.8$ $+ 3.9^2 \times \pi \times 1/8 + 3.9 \times 1.85) / 2$ $\times 9.0 = 144.1 \text{ m}^3$			
Tunnel type II (L=474.938m)	$V5 = 10.242 \text{ m}^2 \times 474.938$ $= 4,864.3 \text{ m}^3$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Tunnel type III (L = 3,500 m)			
	$V_6 = 10.688 \text{ m}^2 \times 3,500 = 37,408 \text{ m}^3$			
	Tunnel type IV (L = 100.0 m)			
	$V_7 = 10.288 \text{ m}^2 \times 100 = 1,028.8 \text{ m}^3$			
	Tunnel outlet part			
	$V_8 = (3.9^2 \times \pi \times 1/8 + 3.9 \times 1.85) \times 10.0$			
	$= 131.9 \text{ m}^3$			
	Total volume			
	$V = 113.7 + 568.6 + 6,933.2 + 144.1$			
	$+ 4,864.3 + 37,408 + 1,028.8$			
	$+ 131.9 = 51,192.6 \text{ m}^3$	m^3	51,193	
	106 Trench excavation, all classes			
	Drain ditch (Poza Honda inlet)			
	$V_1 = (1.29 + 0.9)/2 \times 0.65 \times 76.0$			
	$+ (1.38 + 0.9)/2 \times 0.8 \times 9.0 = 62.3 \text{ m}^3$			
	Catch basin (Poza Honda inlet)			
	$V_2 = 1.3 \times 1.3 \times 1.05 = 1.8 \text{ m}^3$			
	Foundation of wire net fence			
	$V_3 = (0.45 \times 0.45 + 0.75 \times 0.75)/2 \times 0.5$			
	$\times 6 = 1.1 \text{ m}^3$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Drain ditch (Mancha Grande outlet)			
	$V_1 = (1.29 + 0.91) / 2 \times 0.65 \times 410.0 \text{ m}$			
	$= 219.8 \text{ m}^3$			
	Total volume			
	$V = 62.3 + 1.8 + 1.1 + 219.8 = 285.0 \text{ m}^3$	m^3	285	
107	Permanent steel supports			
	H-125 x 125			
	H-125 x 125 x 6.5 x 9 : 23.8 kg/m			
	R - 200 x 170 x 12 : 3.203 kg/no			
	R - 200 x 200 x 12 : 3.768 kg/no			
	Connection bolt D.19mm : 3.12 kg/no			
	Inlet tunnel			
	$W_1 = \{ (2.538 \times \pi \times 1/2 + 1.1 \times 2) \times 23.8$			
	$+ 2 \times 3.203 + 3.768 \times 2 + 3.12 \times 2 \}$			
	$\times 22 \text{ nos} = 3,683 \text{ kg}$			
	Tunnel			
	$W_2 = \{ (3.175 \times \pi \times 1/2 + 1.670 \times 2) \times 23.8$			
	$+ 2 \times 3.203 + 3.768 \times 2 + 3.12 \times 2 \}$			
	$\times (10.0 + 100.0 + 10.0) / 1.2 = 21,837 \text{ kg}$			
	Total weight			
	$W = 3,683 + 21,837 = 25,520 \text{ kg}$	ton	26	

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
108	Permanent steel supports			
	H-250 x 250 mm			
	H-250 x 250 x 9 x 14 : 72.4 kg/m			
	R-300 x 300 x 15 : 10.598 kg/no			
	Connection bolt $\varnothing 25$ mm : 6.6 kg/no			
	$N = \left[(15.025 \times 2 \times \pi \times 18.9246^\circ / 360^\circ \times 4 \right. \\ \left. + 7.625 \times 2 \times \pi \times 142.1507^\circ / 360^\circ \times 2 \right) \\ \times 72.4 + 10.598 \times 12 + 6.6 \times 10 \Big] \times 13 \\ = 56,805 \text{ kg}$	ton	57	
109	$\varnothing 25$ mm rock belts			
	Inlet tunnel			
	$L_1 = 8 \times 2.0 \times 15 \text{ sec.} + 7 \times 2.0 \times 15 \text{ sec.}$			
	$= 450 \text{ m}$			
	Inlet shaft			
	$L_2 = 20 \times 3.0 \times 6 + 18 \times 3.0 \times 2$			
	$+ 10 \times 3.0 \times 2 = 528 \text{ m}$			
	Tunnel			
	$L_3 = 6 \times 2.0 \times 1.706 \text{ sec.} + 5 \times 2.0$			
	$\times 1.706 \text{ sec.} = 37,532 \text{ m}$			
	Total length			
	$L = 450 + 528 + 37,532 = 38,510 \text{ m}$	m	38,510	

5-5-102

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
110 Backfilling for inlet and outlet structures and anchor block of trash room				
Inlet culvert				
V1 =	$(0.5 + 2.85) / 2 \times 4.7 \times 2 \times 2.5 = 39.4 \text{ m}^3$			
V2 =	$\{(0.5 + 2.85) / 2 \times 4.7 + (0.5 + 3.6) / 2 \times 6.2\} \times 1/2 \times 3.0 = 30.9$			
V3 =	$(0.5 + 3.6) / 2 \times 6.2 \times 2 \times 1.5 = 38.1$			
V4 =	$1.86 \times 6.2 \times 1/2 \times (0.5 + 3.6) / 2$			
x 2 =	23.6			
V5 =	$\{6.06 \times 1.0 + (6.06 + 2.2) / 2 \times 1.7\} \times 5.0 = 65.4$			
Drain ditch (Para Honda inlet)				
V6 =	$\{(1.29 + 0.9) / 2 \times 0.65 - 0.7 \times 0.65\} \times 76.0 + \{(1.38 + 0.9) / 2 \times 0.8 - 0.7 \times 0.8\} \times 9.0 = 22.7 \text{ m}^3$			
Wire net fence				
V7 =	$\{(0.45 \times 0.45 + 0.75 \times 0.75) / 2 \times 0.5 - 0.25 \times 0.25 \times 0.5\} \times 6 = 0.96 \text{ m}^3$			
Anchor block of trash boom				
V8 =	$\{(6.0 \times 6.0 + 10.0 \times 10.0) / 2 \times 4.0 - 5.0 \times 5.0 \times 4.0\} \times 2 = 344 \text{ m}^3$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Drain ditch (Mancha Grande outlet)			
	$V_1 = \frac{1}{2} \times (1.29 + 0.9) \times 2 \times 0.65 - 0.7 \times 0.65$			
	$\times 410m = 105.3m^3$			
	Total volume			
	$V = 670.4 m^3$	m^3	670	
/11	Gravel surfacing			
	$V = (1.578m^2 - 258.3m^2) \times 0.1 = 132.0$	m^3	132	
/12	Gravel bedding			
	Drain ditch & catch basin (Pora Honda inlet)			
	$V_1 = 0.8 \times 0.12 \times (9.0 + 10.0) + 1.2 \times 1.2 \times 0.15$			
	$= 2.0 m^3$			
	Drain ditch (Mancha Grande outlet)			
	$V_2 = 0.8 \times 0.12 \times 150m = 14.4 m^3$			
	Total volume	m^3	17	
	$V = 2.0 + 14.4 = 16.4 m^3$			
/13	Sed facing for inlet and outlet structures			
	$A = 406 + 5,509 = 5,915 m^2$	m^2	5,915	

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
8.3	DRILLING AND GROUTING WORKS			
	101 D.45 mm drain holes			
	Required number			
	$N = 4.095 / 5.0 \times 2 \approx 1.638$			
	$L = (1.5m + 0.3 + 0.1) \times 1.638 = 3.112$	m	3.112	
	102 Backfill grouting for tunnel			
	Inlet tunnel			
	$V1 = 5.2 \times \pi \times 120 / 360 \times 0.03 \times 38.5$			
	$+ 4.0 \times \pi \times 120 / 360 \times 0.03 \times 5.6 = 7.0 m^3$			
	Tunnel transition part			
	$V2 = (3.7 + 3.7 \times \pi \times 120 / 360) / 2 \times 0.03$			
	$\times 10.0 = 1.1 m^3$			
	Tunnel			
	$V3 = 3.3 \times \pi \times 120 / 360 \times 0.03 \times 4.074.9$			
	$= 422.5 m^3$			
	Tunnel outlet part			
	$V4 = 3.7 \times \pi \times 120 / 360 \times 0.03 \times 10.0 = 1.2 m^3$			
	Total volume			
	$V = 7.0 + 1.1 + 422.5 + 1.2 = 431.8 m^3$	m^3	432	

57-1-1057

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
103 Contact grouting for concrete plug				
	$W = 20 \text{ kg/m} \times 5.6 \text{ m} = 112 \text{ kg}$	kg	112	
104 D. 50 mm steel pipes for backfill grouting				
Inlet tunnel				
	$N = 38.5 / 5.0 = 8 \text{ nos}$			
	$W1 = (8 \times 0.6 + 6.0) \times 5.31 \text{ kg/m} = 57.3 \text{ kg}$			
Tunnel				
	$N = 4.095 / 5.0 = 819 \text{ nos}$			
	$W2 = 819 \times 0.4 \times 5.31 = 1,739.6 \text{ kg}$			
Total weight				
	$W = 57.3 + 1,739.6 = 1,796.9 \text{ kg}$	kg	1,797	
105 D. 40 mm steel pipes for contact grouting				
Plug				
	$W = (5.5 + 3.0) \times 4 + (5.5 + 1.0 + 0.3 \times 2)$			
	$\times 3.89 = 159.9 \text{ kg}$	kg	160	
106 D. 25 mm steel pipes for contact grouting				

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
8.4	CONCRETE WORKS			
101	Concrete, class A, for blockout concrete			
	Blockout for trash rack			
	$V = (0.25 + 0.325) / 2 \times 0.25 \times 4.0 + 0.4 \times 0.25$			
	$\times 0.25 \times 2 = 0.34$			
	$V = \{ (0.95 + 0.845) / 2 \times 0.35 \times 0.4 + (0.845 + 0.376) \times 1/2 \times 0.25 \times 0.4 + 0.376 \times 0.2 \times 0.6 \times 1/3 \} \times 2$			
	$= 0.40$			
	$V = (0.7 + 0.45) / 2 \times 0.25 \times 4.0 + (0.45 \times 0.25$			
	$\times 0.25 + 1/2 \times 0.25 \times 0.25 \times 0.45) \times 2$			
	$= 0.66 \text{ m}^3$			
	Subtotal $V_1 = 1.4 \text{ m}^3$			
	Blockout in partition wall			
	$V_2 = 2.0 \times 2.0 \times 1.0 \times 2 = 8.0 \text{ m}^3$			
	Foundation concrete of valves			
	$V_3 = 0.5 \times 0.35 \times 0.9 \times 2 = 0.3 \text{ m}^3$			
	Corner buffer in valve pit			
	$V_4 = \{ 1/2 \times 1.2 \times 1.2 \times 0.3 + 1.2 \times 1.2 \times 0.5 \times 1/3 \} \times 4 \times 2 = 3.6 \text{ m}^3$			
	Total volume	m^3		
	$V = 1.4 + 8.0 + 0.3 + 3.6 = 13.3 \text{ m}^3$		14	

21-11-13

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
102 Concrete, class C, for floor slab, beam and stair	Floor slab and beam at EL. 112.5m			
	Floor slab			
	$V = (38.784m^2 - 1.3 \times 3.02) \times 0.3$			
	+ $(38.784 - 1.0 \times 1.0 \times 2) \times 0.2$			
	+ $(50.26m^2 - 2.5 \times 2.5 \times 2 - 0.4 \times 3.6 \times 4)$			
	$\times 0.2 + (50.26 - 3.0 \times 3.0 \times 2 - 0.4 \times 3.6 \times 4)$			
	$\times 0.2 + 0.15 \times 0.10 \times 2.65 \times 4 \times 2$			
	+ $0.15 \times 0.10 \times 3.15 \times 4 \times 2 = 30.2m^3$			
	Beam			
	$V = 0.9 \times 1.1 \times 14.4 + 0.9 \times 1.1 \times 12.94 \times 2$			
	+ $1/2 \times 0.6 \times 0.3 \times 0.9 \times 2 \times 3$			
	+ $0.4 \times 0.55 \times 3.6 \times 4 \times 2 = 46.7m^3$			
	Subtotal $V_1 = 76.9m^3$			
	Floor slab and beam at EL. 104.0m			
	Floor slab			
	$V = (35.622m^2 - 1.3 \times 2.922) \times 0.2$			
	+ $35.622 \times 0.2 + (48.8m^2 - 2.5 \times 2.5 \times 2) \times 0.2$			
	+ $(48.8m^2 - 3.0 \times 3.0 \times 2) \times 0.2 = 26.9m^3$			
	Beam			
	$V = 0.9 \times 1.1 \times 14.0 + 0.9 \times 1.1 \times 12.51 \times 2$			
	+ $1/2 \times 0.6 \times 0.3 \times 0.9 \times 2 \times 3 = 39.1m^3$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Subtotal $V_2 = 66.0 \text{ m}^3$			
	Floor slab & beam at EL. 95.5 m			
	Floor slab			
	$V = (87.974 \text{ m}^2 - 1.3 \times 3.306 - 2.5 \times 2.5 \times 2)$			
	$\times 0.4 = 28.5 \text{ m}^3$			
	$V = \{46.878 \text{ m}^2 - 0.5^2 \times \pi \times 1/2 - 1.0 \times 0.25$			
	$- (1.4 + 1.1) / 2 \times 0.8 \times 2\} \times 0.2 = 8.8 \text{ m}^3$			
	$V = (2.7 + 2.3) / 2 \times 3.45 \times 2 \times 0.2$			
	$+ (3.45 \times 0.4 \times 0.5 + 3.0 \times 0.45 \times 0.5) \times 2$			
	$= 6.2 \text{ m}^3$			
	Beam			
	$V = 0.6 \times 0.8 \times 5.988 \times 2 + 0.4 \times 0.55$			
	$\times 3.45 \times 2 = 7.3 \text{ m}^3$			
	Ditch			
	$V = 0.2 \times 0.1 \times (49.99 - 1.0 \times 2 - 3.5 - 0.4)$			
	$= 0.9 \text{ m}^3$			
	Subtotal $V_3 = 51.7 \text{ m}^3$			
	Stair			
	$V = \{(0.15 + 0.35) / 2 \times 0.25 + (0.15 + 0.35) / 2$			
	$\times 0.295\} \times 1/2 \times 1.2 \times 4.2 + (1.0 + 1.18) / 2$			
	$\times 1.2 \times 0.2 + 4.0 \times 0.2 \times 1.5 = 4.9 \text{ m}^3$			
	$V = \{(0.15 + 0.35) / 2 \times 0.25 + (0.15 + 0.35) / 2$			
	$\times 0.295\} \times 1/2 \times 1.2 \times 4.2 + (1.0 + 1.18) / 2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$1.2 \times 0.2 + 4 \times 0.2 \times 1.5 = 4.9 \text{ m}^3$			
	$V = \frac{1}{2} \{ (0.15 + 0.35) / 2 \times 0.25 + (0.15 + 0.35) / 2 \times 0.295 \} \times 1/2 \times 1.2 \times 1.2 = 1.0 \text{ m}^3$			
	Subtotal $V_4 = 10.8 \text{ m}^3$			
	Total volume	m^3	206	
	$V = 76.9 + 66.0 + 51.7 + 10.8 = 205.4 \text{ m}^3$			
103 Concrete, class D, for inlet structure				
	Inlet culvert			
	$V = \frac{1}{2} \{ 1.5 \times 0.5 + 3.2 \times 0.56 + 2.8 \times 0.7 + (0.5 + 0.65) / 2 \times 0.3 \} \times 5.4 = 25.2 \text{ m}^3$			
	$V = 2.8 \times 4.1 \times 0.7 \times 2 = 16.1 \text{ m}^3$			
	$V = \frac{1}{2} \{ (0.8 + 4.9) / 2 \times 4.1 \times 0.5 + 1/2 \times 0.3 \times 0.3 \times 4.1 \} \times 2 = 12.1 \text{ m}^3$			
	$V = (4.1 + 4.35) / 2 \times 0.5 \times 0.7 \times 2 = 3.0 \text{ m}^3$			
	$V = 3.35 \times 4 \times 2.7 \times 0.5 \times 2 + (3.35 \times 3.0) / 2 \times 1.18 \times 2 = 16.6 \text{ m}^3$			
	$V = \frac{1}{2} \{ 0.5 \times 0.91 + 0.559 \times 3.29 + (0.5 + 0.84) / 2 \times 1.135 + 1/2 \times 0.84 \times 0.42 \} \times 4.0 = 12.9 \text{ m}^3$			
	Blockout for stoplog slot			
	$V = -1.4 - 0.15 \times 0.1 \times 4.1 \times 2 - 0.15 \times 0.1 \times 4.2 = -1.6 \text{ m}^3$			
	Subtotal $V_1 = 84.3 \text{ m}^3$			

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Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Inlet tunnel				
	$V = \frac{1}{2} \{ (5.2 \times 3.7 - 4.0 \times 2.5) + (5.2^2 \times \pi \times \frac{1}{8}) + 5.2 \times 1.1 - 4.0^2 \times \pi \times \frac{1}{8} - 4.0 \times 0.5 \}$			
	$\times \frac{1}{2} \times 6.0 = 51.9 \text{ m}^3$			
	$V = (5.2^2 \times \pi \times \frac{1}{8}) + 5.2 \times 1.1 - 4.0^2 \times \pi \times \frac{1}{8}$			
	$- 4.0 \times 0.5 \times 31.5 = 253.7 \text{ m}^3$			
	$V = (5.6^2 \times \pi \times \frac{1}{8}) + 5.6 \times 1.3 - 4.0^2 \times \pi \times \frac{1}{8}$			
	$- 4.0 \times 0.5 \times 1.0 = 11.3 \text{ m}^3$			
	Subtotal $V_2 = 316.9 \text{ m}^3$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Total Volume			
	$V = 84.3 + 316.9 + 1,938.4$			
	$= 2,339.6 \text{ m}^3$	m^3	2,340	
	10% Concrete, class D, for tunnel lining			
	Tunnel transition part			
	$V_1 = \left\{ (3.7 \times 3.7 - 2.5 \times 2.5) + (3.7^2 \times \pi \times 1/8) \right.$			
	$\left. + 3.7 \times 1.85 - 3.3173 \times 1.25^2 \right\} \times 1/2$			
	$\times 9.0 + (4.1 \times 4.1 - 2.5 \times 2.5) \times 1.0$			
	$= 75.7 \text{ m}^3$			
	Tunnel type II			
	$V_2 = 4.191 \text{ m}^2 \times 424.938 = 1,790.5 \text{ m}^3$			
	Tunnel type III			
	$V_3 = 4.191 \times 3,500 = 14,668.5 \text{ m}^3$			
	Tunnel type IV			
	$V_4 = 4.231 \times 100 = 423.1 \text{ m}^3$			
	Tunnel outlet part			
	$V_5 = \left\{ (3.7^2 \times \pi \times 1/8) + 3.7 \times 1.85 - 3.3173 \right.$			
	$\left. \times 1.25^2 \right\} + (3.7^2 \times \pi \times 1/8) + 3.7 \times 1.85$			
	$- 2.5^2 \times \pi \times 1/8 \times 2.5 \times 1.25 \left\} \times 1/2$			
	$\times 10.0 = 57.9 \text{ m}^3$			

57-1-153

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Total volume			
	$V = 75.7 + 1.990.5 + 14,668.5 + 423.1$			
	$+ 57.9 = 17,215.7 \text{ m}^3$	m^3	17,216	
105 Concrete, class E, for concrete facing wall				
	Inlet channel			
	$V1 = \{(1.074 + 0.5) / 2 \times 0.5 + 4.1 \times 0.424\}$			
	$\times 5.0 \times 2 = 21.3 \text{ m}^3$			
	$V2 = (26.2 + 16.2) / 2 \times 5.590 \times 0.3 = 35.6 \text{ m}^3$			
	Mancha Grande outlet channel			
	$V3 = (10.671 + 3.171) / 2 \times 8.385 \times 0.3$			
	$= 17.4 \text{ m}^3$			
	$V4 = (53.75 + 50.0) / 2 \times 8.385 \times 0.3 \times 2$			
	$= 261.0 \text{ m}^3$			
	$V5 = (8.385 + 10.607) / 2 \times 10.0 \times 0.3 \times 2$			
	$= 57.0 \text{ m}^3$			
	$V6 = 3.171 \times 0.5 \times 60.0 = 95.1 \text{ m}^3$			
	Total volume			
	$V = 21.3 + 35.6 + 17.4 + 261.0 + 57.0 + 95.1$	m^3	487	
	$= 487.4 \text{ m}^3$			
106 Concrete, class F, for drain ditch and catch basin				

57-1-18

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Drain ditch and catch basin (Pera Honda inlet)				
V1 =	$(0.7 \times 0.62 - 0.5 \times 0.5) \times 76.0$			
+	$(0.7 \times 0.62 - 0.5 \times 0.5 + 0.7 \times 0.15)$			
x	$9.0 = 16.6 \text{ m}^3$			
V2 =	$1.1 \times 1.1 \times 1.0 - 0.8 \times 0.8 \times 0.8$			
=	0.7 m^3			
Drain ditch (Mancha Grande outlet)				
V3 =	$(0.7 \times 0.62 - 0.5 \times 0.5) \times 410.0$			
=	75.4 m^3			
Total volume				
V =	$16.6 + 0.7 + 75.4 = 92.7 \text{ m}^3$	m^3	93	
107 Concrete, class G, for plug and secondary concrete				
Plug				
V1 =	$(4.0^2 \times \pi \times 1/8 + 4.0 \times 0.5) \times 6.0$			
-	$0.9^2 \times \pi \times 1/4 \times 2 \times 6.0 = 47.1 \text{ m}^3$			
Secondary concrete				
V2 =	$(87.974 \text{ m}^2 - 3.0 \times 8.6) \times (\text{EL. } 93.05$			
-	$\text{EL. } 89.8) - 0.9^2 \times \pi \times 1/4 \times 5.374 \times 2 = 195.2 \text{ m}^3$			
V3 =	$\{ 101.974 \text{ m}^2 - 8.6 \times 4.8 - (8.6 + 2.5)$			
x	$1/2 \times 3.05 - 2.5 \times 1.15 \} \times (\text{EL. } 93.05$			
-	$\text{EL. } 90.05) = 122.7 \text{ m}^3$			

VT 1-1-5T

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Total volume	$V = 42.1 + 195.2 + 122.7 = 360.0$	m ³	360	
108 Concrete, class G				
Anchor block of trash boom	$V_1 = 5.0 \times 5.0 \times 4.0 \times 2 = 200.0 \text{ m}^3$			
Foundation concrete of wire net fence	$V_2 = 0.25 \times 0.25 \times 0.5 \times 6 = 0.2$			
Total volume	$V = 200 + 0.2 = 200.2$	m ³	201	
109 Concrete, class H ₁ for levelling concrete				
Inlet culvert	$V_1 = 5.5 \times 0.1 \times 3.3 + 5.1 \times 0.1 \times 4.2$			
	$= 4.0 \text{ m}^3$			
Drain ditch and catch basin (Pozn Honda inlet)	$V_2 = 0.8 \times 0.03 \times (76.0 + 9.0) = 2.0 \text{ m}^3$			
	$V_3 = 1.2 \times 1.2 \times 0.03 = 0.4 \text{ m}^3$			
Drain ditch (Mansha Grande outlet)	$V_3 = 0.8 \times 0.03 \times 90 = 9.8 \text{ m}^3$			

5-1-146

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Total volume				
	$V = 4.0 \times 2.0 + 0.4 \times 9.8 = 16.2 \text{ m}^3$	m^3	17	
/10 Formwork, F1 finish, for concrete of Item 103, 104, 105 and 107				
Inlet culvert				
Wing wall				
	$a = 4.3 \times 4.8 \times \frac{1}{2} \times 2 = 20.6 \text{ m}^2$			
Culvert				
	$a = \{4.8 \times 2.8 + 3.914 \times 2.7 + (3.914 + 3.5) \frac{1}{2} \times 1.18 + 3.5 \times 0.32\} \times 2 = 59.0 \text{ m}^2$			
Culvert, contra. joint				
	$a = 5.0 \times 3.5 - 4.0 \times 2.5 = 7.5 \text{ m}^2$			
Culvert, blockout				
	$a = 0.25 \times 4.5 + (0.25 \times 0.25 + 0.4 \times 0.25) \times 2 = 1.95 \text{ m}^2$			
	$a = \{(0.95 + 0.845) \frac{1}{2} \times 0.35 + (0.845 + 0.376) \times \frac{1}{2} \times 0.25 + 0.376 \times 0.2 \times \frac{1}{2} + 0.35 \times 0.4 + 0.835 \times 0.4\} \times 2 = 7.0 \text{ m}^2$			
	$a = (0.25 + 0.354) \times 4.5 + 0.354 \times 0.45 \times 2 + \frac{1}{2} \times 0.25 \times 0.25 \times 2 \times 2 = 3.2 \text{ m}^2$			
Subtotal a.1	$a.1 = 93.8 \text{ m}^2$			
Inlet tunnel				
	$a = \frac{1}{2} \times 1.05 \times 5.0 \times 2 = 5.3 \text{ m}^2$			
	$a = 5.2^2 \times \pi \times \frac{1}{8} + 5.2 \times 1.1 - 4.0^2 \times \pi \times \frac{1}{8}$			

57 11147

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$- 4.0 \times 0.5 = 8.1 \text{ m}^2$			
	$a = 5.6^2 \times \pi \times \frac{1}{8} + 5.6 \times 0.8 - 4.0^2 \times \pi \times \frac{1}{8}$			
	$- 4.0 \times 0.5 = 8.5 \text{ m}^2$			
	$a = (\frac{1}{2} \times 4.0 \times \pi + 0.5 \times 2) \times 6.0 = 43.7 \text{ m}^2$			
	Subtotal $a_2 = 65.6 \text{ m}^2$			
	Inlet shaft			
	$a = 49.246 \times (\text{EL. } 93.05 - \text{EL. } 89.8)$			
	$- 4.0^2 \times \pi \times \frac{1}{8} - 4.0 \times 0.5 = 151.8 \text{ m}^2$			
	$a = 48.731 \times (\text{EL. } 93.05 - \text{EL. } 90.05)$			
	$= 146.2 \text{ m}^2$			
	$a = 2.7 \times (\text{EL. } 93.05 - \text{EL. } 89.8) \times 2$			
	$= 17.6 \text{ m}^2$			
	$a = 2.7 \times (\text{EL. } 93.05 - \text{EL. } 90.05)$			
	$= 16.2 \text{ m}^2$			
	$a = 2.5 \times 1.0 \times 3 \times 2 = 15.0 \text{ m}^2$			
	Subtotal $a_3 = 346.8 \text{ m}^2$			
	Tunnel			
	$a_4 = 4.1 \times 4.1 - 2.5 \times 2.5 + (3.7^2 \times \pi \times \frac{1}{8}$			
	$+ 3.7 \times 1.85 - 3.3173 \times 1.25^2) \times 2$			
	$= 24.6 \text{ m}^2$			
	Concrete facing wall			
	Inlet channel			
	$a = \{(0.074 + 0.5) \times \frac{1}{2} \times 0.5 + 4.1 \times 0.424\} \times 2$			

57-1-140

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$= 4.3 \text{ m}^2$			
	$a = 5.926 \times 0.3 = 1.8 \text{ m}^2$			
	Mancha Grande outlet			
	$a = (9.503 \times 0.3 \times 2 + 0.5 \times 2.5) \times 6$			
	$= 41.7 \text{ m}^2$			
	Subtotal $a_5 = 47.8 \text{ m}^2$			
	Concrete plug			
	$a_6 = 4.0^2 \times \pi \times 1/8 + 4.0 \times 0.5 = 8.3 \text{ m}^2$			
	Total area			
	$A = 93.8 + 65.6 + 346.8 + 24.6 + 47.8$	m^2	587	
	$+ 8.3 = 586.9 \text{ m}^2$			
	III Formwork, F1 finish, for concrete of Item 108			
	Drain ditch and catch basin (Pozo)			
	$a_1 = 0.62 \times 2 \times (76.0 + 9.0) + (0.15 \times 9 + 1.0$			
	$\times 0.9) \times 9 = 117.1$			
	$a_2 = 1.1 \times 4 \times 1.0 = 4.4 \text{ m}^2$			
	Drain ditch (Mancha Grande outlet)			
	$a_3 = 0.62 \times 2 \times 410 = 508.4 \text{ m}^2$			
	Total area			
	$A = 117.1 + 4.4 + 508.4 = 629.9 \text{ m}^2$	m^2	630	

UT 11179

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
112	Formwork, F1 finish, for concrete of Item 108			
	$A_1 = 5.0 \times 4 \times 4.0 \times 2 = 160.0 \text{ m}^2$			
	$A_2 = 0.25 \times 4 \times 0.5 \times 6 = 3.0 \text{ m}^2$			
	Total area	m^2	163	
	$A = 160.0 + 3.0 = 163.0 \text{ m}^2$			
113	Formwork, F2 finish, for concrete of Items 102, 103, 105 and 107			
	Floor slab and beam at EL. 112.5m			
	Floor slab			
	$A = 38.784 \text{ m}^2 = 1.3 \times 3.02 + (2.70 + 1.3) \times 0.3$			
	$= 36.1 \text{ m}^2$			
	$A = 38.784 \text{ m}^2 = 1.0 \times 1.0 \times 2 + 1.0 \times 0.2 \times 4 \times 2$			
	$= 38.4 \text{ m}^2$			
	$A = 50.26 \text{ m}^2 = 2.5 \times 2.5 \times 2 - 0.4 \times 3.6$			
	$\times 4 + 2.5 \times 0.3 \times 4 \times 2 + 2.8 \times 0.1 \times 4$			
	$\times 2 = 40.2 \text{ m}^2$			
	$A = 50.26 \text{ m}^2 = 3.0 \times 3.0 \times 2 - 0.4 \times 3.6 \times 4$			
	$+ 3.0 \times 0.3 \times 4 \times 2 + 3.3 \times 0.1 \times 4 \times 2$			
	$= 36.3 \text{ m}^2$			
	Beam			
	$A = (0.9 + 0.9 \times 2) \times 14.4 + (0.9 + 0.9 \times 2)$			
	$\times 12.94 \times 2 + 0.6 \times 0.3 \times \frac{1}{2} \times 4 \times 3 = 109.8 \text{ m}^2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$a = (0.4 + 0.35 \times 2) \times 3.6 \times 4 \times 2 = 31.7 \text{ m}^2$			
	Subtotal $a_1 = 292.5 \text{ m}^2$			
	Floor slab and beam at EL. 104.0m			
	Floor slab			
	$a = 35.622 \text{ m} \times 1.3 \times 2.922 + (2.603 + 1.3) \times 0.2 + 35.622 = 68.2 \text{ m}^2$			
	$a = 48.8 \text{ m}^2 \times 2 - 2.5 \times 2.5 \times 2$			
	$- 3.0 \times 3.0 \times 2 + 2.5 \times 0.2 \times 4 \times 2$			
	$+ 3.0 \times 0.2 \times 4 \times 2 = 75.9 \text{ m}^2$			
	$a = 0.2 \times 44.1 \text{ m} = 8.8 \text{ m}^2$ (ditch)			
	Beam			
	$a = (0.9 + 0.9 \times 2) \times 14.0 + (0.9 + 0.9 \times 2) \times 12.51 \times 2 + \frac{1}{2} \times 0.6 \times 0.3 \times 4 \times 3$			
	$= 106.4 \text{ m}^2$			
	Subtotal $a_2 = 259.3 \text{ m}^2$			
	Floor slab and beam at EL. 95.500			
	Floor slab			
	$a = 87.974 \text{ m} \times 1.3 \times 3.306 - 2.5 \times 2.5 \times 2$			
	$+ (1.3 + 2.944) \times 0.4 + 2.5 \times 0.4 \times 4 \times 2$			
	$= 80.9 \text{ m}^2$			
	$a = 46.878 \text{ m} \times 0.5^2 \times \pi \times \frac{1}{2} - 1.0 \times 0.25$			
	$- (1.4 + 1.1) / 2 \times 0.8 \times 2 + (1.4 + 1.1 + 0.8 + 0.8) \times 0.2 \times 2 = 45.9 \text{ m}^2$			

5-11-57

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$a = (2.7 + 2.3) / 2 \times 3.45 \times 2$			
	$+ 0.4 \times 3.45 \times 2 + 0.45 \times 3.0 \times 2$			
	$+ 0.5 \times 3.0 \times 2 \times 2 = 28.7 m^2$			
	Beam			
	$a = (0.6 + 0.6) \times 5.988 m \times 2 + 0.6 \times 2.3 \times 2$			
	$+ 0.25 \times 0.8 \times 2 + 0.8 \times 3.0 \times 2 = 27.3 m^2$			
	Subtotal a3 = 177.8 m²			
	Stair			
	$a = \{ 0.20 \times 1.2 \times 43 + (0.15 + 0.35) / 2 \times 0.25$			
	$\times 42 + 1.2 \times 12.73 m + 4.0 \times 1.5 \times 2 + 4.0 \times 0.2$			
	$\times 2 \} \times 2 = 83.6 m^2$			
	$a = 0.2 \times 1.2 \times 13 + (0.15 + 0.35) / 2 \times 0.25 \times 12$			
	$+ 1.2 \times 3.33 m = 7.9 m^2$			
	Subtotal a4 = 91.5 m²			
	Inlet shaft			
	$a = 52.502 m \times 8.3 - 1.7 \times 0.9 \times 2 \times 3$			
	$= 429.3 m^2$			
	$a = 51.246 m \times 8.3 - 1.2 \times 0.9 \times 2 \times 3$			
	$= 418.9 m^2$			
	$a = 51.246 m \times 2.45 - 23.623 \times 0.4$			
	$- 25.623 \times 0.2 - 1.0 \times 2.45 \times 2$			
	$- 0.6 \times 0.6 \times 2 = 105.4 m^2$			
	<small>Partition wall</small> $a = 14.0 \times 2.05 + 8.6 \times 3.25 + 13.0 \times 1.95$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$+ 4.3 \times 1.95 \times 2 + \frac{1}{2} \times 1.0 \times \pi \times 2.25 - 0.3 \times 0.6$			
	$\times 2 - 0.9^2 \times \pi \times \frac{1}{4} \times 2 = 100.7 \text{ m}^2$			
	$a = 1.0 \times 4 \times 1.0 = 4.0 \text{ m}^2$ (drain pit)			
	Subtotal a5 = 1,058.3 m ²			
	Concrete facing wall			
	Inlet channel			
	$a = (26.2 + 16.2) / 2 \times 5.590 = 118.5 \text{ m}^2$			
	Mancha Grande outlet			
	$a = (10.671 + 3.171) / 2 \times 8.385 = 58.0 \text{ m}^2$			
	Subtotal a6 = 176.5 m ²			
	Secondary concrete in inlet shaft			
	$a7 = (3.0 + 8.6 + 3.0) \times 3.25 = 47.5 \text{ m}^2$			
	Total			
	$A = 292.5 + 259.3 + 177.8 + 91.5 + 1,058.3$			
	$+ 176.5 + 47.5 = 2,103.4 \text{ m}^2$	m ²	2,103	
	1/4 Formwork, F3 finish, for concrete of Items 101, 103, 105 and 107			
	Inlet culvert			
	Wing wall			
	$a = (\frac{1}{2} \times 4.1 \times 4.1 + \frac{1}{4} \times 0.5 \times \pi) \times 2 = 17.6 \text{ m}^2$			
	Culvert			
	$a = \frac{1}{4} \times 0.5 \times 4.5 = 0.6 \text{ m}^2$			

57-11-1570

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$a = \{4.1 \times 2.3 + (0.1 \times 2 + 0.15) \times 4.1 - \frac{1}{2} \times 1.306 \times 0.341\} \times 2 + 0.1 \times 2 \times 4.0 = 22.1 \text{ m}^2$			
	$a = \{2.795 \times 3.2 + (2.795 + 2.5) / 2 \times 0.590 + 2.5 \times 0.910\} \times 2 = 25.6 \text{ m}^2$			
	$a = (0.320 + 1.159 + 3.608 + 0.699 + 0.765) \times 4.0 = 26.2 \text{ m}^2$			
	Subtotal $a_1 = 92.1 \text{ m}^2$			
	Inlet tunnel (Form, F4 finish)			
	$a = (2.5 \times 2 + 4.0 + 4.0 \times \pi \times \frac{1}{2} + 0.5 \times 2) / 2 \times 6.0 = 48.8 \text{ m}^2$			
	$a = (4.0 \times \pi \times \frac{1}{2} + 0.5 \times 2) \times 27.5 = 100.3 \text{ m}^2$			
	Subtotal $a_2 = 249.1 \text{ m}^2$			
	Inlet shaft			
	$a = (4.3 \times 2 + \frac{1}{2} \times 1.0 \times \pi) \times 3.0 + 3.8 \times 3.0 \times 2 - 0.9^2 \times \pi \times 2 = 48.2 \text{ m}^2$			
	$a = 3.8 \times 4 \times (EL. 90.05 - EL. 82.45) = 115.5 \text{ m}^2$			
	$a = (2.5 \times 2 + 2.5) \times 1.0 = 7.5 \text{ m}^2$			
	Subtotal $a_3 = 171.2 \text{ m}^2$			
	Concrete facing wall			
	Inlet channel			
	$a = 6.505 \times 5.0 \times 2 = 65.1 \text{ m}^2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Mancha Grande outlet	$A = (53.75 + 50.0) / 2 \times 8.385 \times 2 = 869.9 \text{ m}^2$			
	$A = (8.385 + 10.607) / 2 \times 10.0 \times 2 = 189.9 \text{ m}^2$			
	Subtotal $A_4 = 1,124.9 \text{ m}^2$			
Plug and secondary concrete	$A = 4.0^2 \times \pi \times 1/8 + 4.0 \times 0.5 - 0.9^2 \times \pi \times 1/4 \times 2 = 7.0 \text{ m}^2$			
	$A = (3.8 + 0.379 + 1.178 + 3.071 + 1.178 + 0.4) \times (6.93 - 0.5 - 1/2 \times 1.697 \times 0.938) \times 2 = 60.0 \text{ m}^2$			
	$\times 4 \times 2 = 10.4 \text{ m}^2$			
	Subtotal $A_5 = 77.4 \text{ m}^2$			
Total Area	$A = 92.1 + 171.2 + 1,124.9 + 77.4 = 1,465.6 \text{ m}^2$	m^2	1,466	
1/5 Formwork, F3 finish, for concrete of Item 106				
Drain ditch and catch basin (Peza Honda inlet)	$A = 0.5 \times 2 \times (76.0 + 9.0) + 0.8 \times 4 \times 0.8 = 87.6 \text{ m}^2$			

57-1-1355

153

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Drain ditch (Manche Grande outlet)	$A_2 = 0.5 \times 2 \times 410.0 = 410.0 \text{ m}^2$			
Total area	$A = 877.6 + 410.0 = 497.6 \text{ m}^2$	m^2	498	
116 Formwork, F4 finish, for concrete of Item 104				
Tunnel transition part	$A_1 = (2.5 + 2.5 \times 2 + 6.047 \text{ m}) / 2 \times 10.0 \text{ m}$ $= 67.7 \text{ m}^2$			
Tunnel	$A_2 = 6.047 \times 4,074.938 = 24,641.2 \text{ m}^2$			
Tunnel outlet part	$A_3 = (6.047 + 2.5 \times \pi \times 1/2 + 1.25 \times 2) / 2$ $\times 10.0 = 62.4 \text{ m}^2$			
Total area	$A = 67.7 + 24,641.2 + 62.4$ $= 24,771.3 \text{ m}^2$	m^2	24,771	
117 Formwork, F4 finish, for concrete of Item 103				
A =	$(2.5 \times 2 + 4.0 + 4.0 \times \pi \times 1/2 + 0.5 \times 2) / 2$			

57 11-156

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$4.0 + (4.0 \times \pi \times \frac{1}{2} + 0.5 \times 2) \times 27.5$			
	$= 249.1 \text{ m}^2$	m^2	249	
<i>1/8 Reinforcing bars for concrete works</i>				
<i>Concrete Works of Item/01</i>				
<i>Foundation concrete of valves</i>				
	$w = 0.3 \text{ m}^3 \times 40 \text{ kg/m}^3 = 12.0 \text{ kg}$			
<i>Corner buffer</i>				
	$w = 3.6 \text{ m}^3 \times 30 \text{ kg/m}^3 = 108.0 \text{ kg}$			
	<i>Subtotal w1 = 120 kg</i>			
<i>Concrete Works of Item/02</i>				
<i>Floor slab</i>				
	$w = (30.2 + 26.9 + 6.2) \times 80 \text{ kg/m}^3$			
	$= 5,064 \text{ kg}$			
<i>Beam</i>				
	$w = (76.9 + 39.1 + 7.3) \times 120 \text{ kg/m}^3$			
	$= 14,796 \text{ kg}$			
<i>Stair</i>				
	$w = 10.8 \times 100 \text{ kg/m}^3 = 1,080 \text{ kg}$			
	<i>Subtotal w2 = 20,940 kg</i>			

57-1-157

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Concrete Works of Item /03			
	Inlet culvert			
	$W = 84.3 \times 60 \text{ kg/m}^3 = 5,058 \text{ kg}$			
	Inlet tunnel			
	$W = 316.9 \times 70 \text{ kg/m}^3 = 22,183 \text{ kg}$			
	Inlet shaft			
	$1,938.4 \times 60 \text{ kg/m}^3 = 116,304 \text{ kg}$			
	Subtotal $w_3 = 143,545 \text{ kg}$			
	Concrete Works of Item /04			
	Tunnel inlet and outlet part			
	$W = (75.7 + 57.9) \times 70 \text{ kg/m}^3 = 9,352 \text{ kg}$			
	Tunnel			
	$W = 0$			
	Subtotal $w_4 = 9,352 \text{ kg}$			
	Concrete Works of Item /05			
	Peza Honda inlet			
	$W = (21.3 + 35.6) \times 30 \text{ kg/m}^3 = 1,707 \text{ kg}$			
	Mancha Grande outlet			
	$W = (17.4 + 261.0 + 57.0 + 95.1) \times 30 \text{ kg/m}^3$ $= 12,915 \text{ kg}$			
	Subtotal $w_5 = 14,622 \text{ kg}$			

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11
1158

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	Concrete Works of Item /06			
	Drain ditch and catch basin			
	$W6 = 92.7 \times 30 \text{ kg/m} = 2,781 \text{ kg}$			
	Concrete Works of Item /07			
	Plug and secondary concrete			
	$W7 = 0 \text{ kg}$			
	Concrete Works of Items /08 and /09			
	$W8 = 0 \text{ kg}$			
	Total weight			
	$W = 120 + 20,940 + 143,545$			
	$+ 9,352 + 14,622 + 2,781$			
	$= 191,360 \text{ kg}$	ton	192	
	1/9 Shotcrete in tunnel and inlet structure			
	Inlet tunnel			
	$V1 = (1.28^2 \times 1.053) / 2 \times 6.0 + 1.053 \times 31.5$			
	$+ 1.155^2 \times 1.0 = 41.3 \text{ m}^3$			
	Inlet shaft			
	$V2 = 8.794 \text{ m}^2 \times (\text{EL. } 112.2 - \text{EL. } 88.7)$			

57 11159

151

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$+ 6.15 \times (EL. 88.7 - EL. 81.35) \times 0.15 \times 2$			
	$+ 10.95 \times (EL. 88.7 - EL. 81.35) \times 0.15 \times 2$			
	$- (5.8^2 \times \pi \times 1/8 + 5.8 \times 1.3) \times 0.15$			
	$- 4.3 \times 4.2 \times 0.15 = 238.5 m^3$			
	Tunnel transition part			
	$V3 = 1.25 m^2 \times 1.0 + (1.13 m^2 + 0.967 m^2) / 2$			
	$\times 9.0 = 10.7 m^3$			
	Tunnel type II			
	$V4 = 0.868 m^2 \times 474.938 = 412.2 m^3$			
	Tunnel type III			
	$V5 = 1.318 m^2 \times 3,500 = 4,599 m^3$			
	Tunnel type IV			
	$V6 = 0.873 m^2 \times 100 = 87.3 m^3$			
	Tunnel outlet part			
	$V7 = 0.967 m^2 \times 10.0 = 9.7 m^3$			
	Total volume			
	$V = 41.3 + 238.5 + 10.7 + 412.2$			
	$+ 4,599.0 + 87.3 + 9.7 = 5,398.7$	m^3	5,399	
	20 Steel wire mesh for Item/019			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
Inlet tunnel				
	$a_1 = (12.8 + 10.53) / 2 \times 6.0$			
	$+ 10.53 \times 3 / 5 + 11.55 \times 1.0$			
	$= 413.2 \text{ m}^2$			
Inlet shaft				
	$a_2 = 58.629 \text{ m} \times 23.5 + 6.15 \times 7.35 \times 2$			
	$+ 10.95 \times 7.35 \times 2 - 5.8^2 \times \pi \times 1/8$			
	$- 5.8 \times 1.3 - 4.3 \times 4.2 = 1,590.3 \text{ m}^2$			
Tunnel transition part				
	$a_3 = 12.5 \times 1.0 + (11.3 + 9.67) / 2 \times 9.0$			
	$= 106.9 \text{ m}^2$			
Tunnel type II				
	$v_4 = 8.681 \times 474.938 = 4,122.9 \text{ m}^2$			
Tunnel type III				
	$v_5 = 8.76 \times 3,500 = 30,660 \text{ m}^2$			
Tunnel type IV				
	$v_6 = 8.732 \times 100 = 873.2 \text{ m}^2$			
Tunnel outlet part				
	$v_7 = 9.67 \times 10.0 = 96.7 \text{ m}^2$			
Total area	$A = 37,863.2 \text{ m}^2$	m^2	37,863	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
121	Shotcrete with wire mesh $t = 100 \text{ mm}$			
	$A = 1,483 + 3,963 = 5,446$	m^2	5,466	
122	Shotcrete with wire mesh $t = 50 \text{ mm}$			
	$A = 148 \text{ m}^2$	m^2	148	
123	Anchor bars, $\Phi 25 \text{ mm}$ for concrete facing wall			
	Inlet channel $N = (65.1 + 118.5) / 9.0 = 20 \text{ nos}$ $\ell 1 = 20 \times 3.0 = 60 \text{ m}$			
	Mancha Grande Outlet $N = (58.0 + 869.9 + 189.9) / 9.0 = 124 \text{ nos}$ $\ell 2 = 124 \times 3.0 = 372 \text{ m}$			
	Total length $L = 60 + 372 = 432 \text{ m}$	m	432	
124	P.V.C. meter stop, type B			
	Inlet tunnel $\ell 1 = 4.4 \times 2 + 2.9 \times 2 + (4.4 \times 10 \times 1/2 + 0.7 \times 2 + 4.4)$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$x 2 + (4.0 \times \pi \times 1/2 + 0.5 \times 2 + 4.0)$			
	$x 2 = 62.6 \text{ m}$			
	<u>Inlet shaft</u>			
	$L = 2.5 \times 4 \times 2 = 20.0 \text{ m}$			
	<u>Total length</u>			
	$L = 62.6 + 10.0 = 72.6 \text{ m}$	m	73	
	<u>125 Bituminous coating for contraction joint</u>			
	<u>Inlet tunnel</u>			
	$a_1 = 5.0 \times 3.5 - 4.0 \times 2.5$			
	$+ 5.2^2 \times \pi \times 1/8 + 5.2 \times 1.1 - 4.0^2 \times \pi \times 1/8$			
	$- 4.0 \times 0.5 + 5.4^2 \times \pi \times 1/8 + 5.4 \times 1.3$			
	$- 4.0^2 \times \pi \times 1/8 - 4.0 \times 0.5$			
	$= 25.7 \text{ m}^2$			
	<u>Tunnel transition part and outlet part</u>			
	$a_2 = 4.1 \times 4.1 - 2.5 \times 2.5 + (3.7^2 \times \pi$			
	$\times 1/8 + 3.7 \times 1.85 - 3.3173 \times (2.5^2)$			
	$\times 2 = 24.6 \text{ m}^2$			
	<u>Facing wall</u>			
	<u>Inlet channel</u>			
	$a = \{ (0.074 + 0.5) / 2 \times 0.5 + 4.1 \times 0.424 \} \times 2$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
	$+ 5.926 \times 0.3 = 6.0 \text{ m}^2$			
	Mancha Grande outlet			
	$a = (2.503 \times 0.3 \times 2 + 0.5 \times 2.5) \times 6$			
	$= 41.7 \text{ m}^2$			
	Subtotal $a_3 = 47.7 \text{ m}^2$			
	Total area	m^2	98	
	$A = 25.7 + 24.6 + 47.7 = 98.0 \text{ m}^2$			
	126 P.V.C. pipe ϕ .50 mm for weaphole			
	Facing concrete			
	Inlet channel			
	$N_1 = 118.5 / 4.0 \text{ m} = 30 \text{ nos}$			
	Mancha Grande outlet			
	$N_2 = (10.671 + 5.171) / 2 \times 6.149 / 4.0 \text{ m}^2$			
	$= 12 \text{ nos}$			
	$N_3 = (869.9 + 189.9) \times 0.75 / 4.0 = 198 \text{ nos}$			
	$L_1 = (30 + 12 + 198) \times 0.4 = 96 \text{ m}$			
	Shotcrete			
	$N = (5.446 + 148) / 4.0 \text{ m}^2 = 1398 \text{ nos}$			
	$L = 1398 \times 0.2 \text{ m/nos} = 279.6 \text{ m}$			

07-11-164

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
B.S	MISCELLANEOUS METAL WORKS			
	101 Embedded metal			
	D.16mm anchor bars			
	$N_1 = (2.5 \times 4 \times 2 + 3.0 \times 4 \times 4) / 0.5 = 136 \text{ nos}$			
	$N_2 = (8.6 \times 2 + 3.0 \times 2) / 0.5 = 46 \text{ nos}$			
	$W_1 = (136 + 46) \times 0.4 \times 1.56 \text{ kg/m} = 113.6 \text{ kg}$			
	Joint bar			
	$N = 2.0 \times 4 \times 2 / 0.3 \times 2 = 106 \text{ nos}$			
	$W_2 = 106 \times 1.0 \times 1.56 = 165.4 \text{ kg}$			
	Embedded hook			
	$W_3 = 0.8 \times 2.984 \text{ kg/m} \times 5 \text{ nos}$			
	$+ (0.25 \times 0.15 \times 0.01 \times 7.850) \times 5 \text{ nos}$			
	$= 26.7 \text{ kg}$			
	Total weight	kg	306	
	$W = 113.6 + 165.4 + 26.7 = 305.7 \text{ kg}$			
	102 Steel pipe handrail			
	$W_1 = (2.8 + 1.3) \times 17.0 \text{ kg/m} = 69.7 \text{ kg}$			
	$W_2 = (2.9 \times 4 \times 4 + 3.4 \times 4 \times 2) \times 17.0$			
	$= 1,251.2 \text{ kg}$			
	Stair			
	$W_3 = (14.3 + 14.3 + 3.9) \times 17.0 = 552.5 \text{ kg}$			
	Total weight	kg	1,874	
	$W = 69.7 + 1,251.2 + 552.5 = 1,873.4 \text{ kg}$			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
103 Steel ladder	$N = (EL. 95.5 - EL. 93.05) \times 15.0 \text{ kg/m}$ $\times 2 = 73.5 \text{ kg}$	kg	74	
104 Steel step	(2.69 kg/no) $N = (EL. 93.05 - EL. 90.05) / 0.35$ $= 8 \text{ nos}$ $N = (EL. 93.05 - EL. 82.45) / 0.35$ $= 30 \text{ nos}$ $N = (EL. 93.05 - EL. 89.8) / 0.35$ $= 9 \text{ nos}$			
105 Steel pipes for water level gauge	$W = (8 \times 2 + 30 \times 2 + 9) \times 2.69$ $= 228.7 \text{ kg}$	kg	229	
D. 400 mm	$W_1 = (EL. 96.0 - EL. 89.05) \times 77.6 \text{ kg/m}$ $= 539.3 \text{ kg}$			
D. 200 mm	$W_2 = 0.35 \times 2 \times 30.1 \text{ kg/m} = 21.07 \text{ kg}$			
Total weight	$W = 539.3 + 21.07 = 560.4 \text{ kg}$	kg	561	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
106 Grating and hatch cover				
Hatch cover (2.5 x 2.5 m size)				
R - 2,600 x 2,650 x 4.5	: W1 = 243.4			
H - 150 x 150 x 7 x 10 x 2,650	: W2 = 83.5			
L - 6 x 75 x 75 x 2,650 x 2	: W3 = 36.3			
L - 4 x 50 x 50 x 2,600 x 2	: W4 = 15.9			
L - 4 x 50 x 50 x 2,550 x 4	: W5 = 31.2			
L - 4 x 50 x 50 x 2,300 x 3	: W6 = 21.1			
R - 200 x 75 x 9 x 2 nos	: W7 = 2.1			
	433.5 kg			
Hatch cover (3.0 m x 3.0 m size)				
R - 3,100 x 3,150 x 4.5	: W1 = 344.9			
H - 150 x 150 x 7 x 10 x 3,150	: W2 = 99.2			
L - 6 x 75 x 75 x 3,150 x 2	: W3 = 43.2			
L - 4 x 50 x 50 x 3,100 x 2	: W4 = 19.0			
L - 4 x 50 x 50 x 2,950 x 4	: W5 = 36.1			
L - 4 x 50 x 50 x 2,800 x 5	: W6 = 42.8			
R - 200 x 75 x 9 x 2 nos	: W7 = 2.1			
	587.3 kg			
Grating (w = 4.3 m)				
H - 150 x 150 x 7 x 10 x 3,100 x 1	: W1 = 97.7			
L - 4 x 50 x 50 x 3,100 x 2 nos	: W2 = 19.0			
L - 4 x 50 x 50 x 4,600	: W3 = 14.1			
R - 100 x 9 x 4,600 x 2 nos	: W4 = 15.0			
FB - 50 x 5 x 3,100 x 152 nos	: W5 = 924.7			
FB - 70 x 3 x 4,600 x 30 nos	: W6 = 65.0			
	1,185.5 kg			

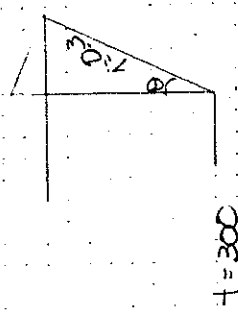
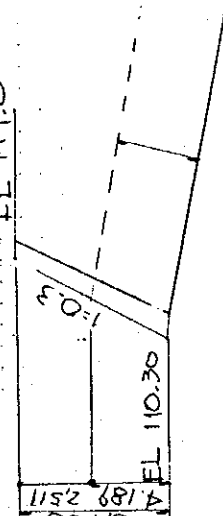
Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
8.6	CONVERGENCE MEASUREMENT			
101	Measurement of horizontal convergence			
	Required number of measurement point $n = 4,095m / (116.91/3) \approx 105$ points			
	Required number of measurement $N = 105 \times 20 = 2,100$ nos	nos	2,100	
102	Measurement of diagonal convergence	nos	2,100	
103	Measurement of roof settlement	nos	2,100	
104	Measurement of invert upheaval	nos	2,100	
105	Stress measurement of rock bolts			
	Required number of measurement point			

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
107	Permanent steel support H-125 x 125 mm	Ton	9.282	
108	D.25 mm rock bolts in adit tunnel	m	2428	
109	Backfilling for adit portal	m ³	133.849	
110	Backfilling	m ³	14.184	
	drain ditch : 13.670 m ³			
	catch basin : 0.514 m ³			
	Total : 14.184 m ³			
111	Gravel surfacing	m ³	75	t=0.1m $\frac{14+29}{2} + \frac{9.29+25}{2} + \frac{25+20}{2} \times 10$ $= 75 \text{ m}^3$
112	Gravel bedding for drain and catch basin	m ³	1.804	
	drain ditch : 1.740 m ³			
	catch basin : 0.064 m ³			
	Total : 1.804 m ³			
113	Wet rubble masonry	m ³	10.000	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
★ 104 Sod facing		m ²	516	see DWG 
2 CONCRETE WORKS				
101 Concrete, class D, for lining concrete of adit tunnel		m ³	609.617	
★ 102 Concrete, class E, for concrete facing walls and ported structure		m ³	48	
103 Concrete class E, for drain ditch and catch basin		m ³	10.057	
drain ditch :	2.875 m ³			
catch basin :	0.182 m ³			
Total :	10.057 m ³			
104 Concrete, Class H, for levelling concrete of drains ditch and catch basin		m ³	1.405	
drain ditch :	1.386 m ³			
catch basin :	0.019 m ³			
Total :	1.405 m ³			

$$V = \frac{1}{\cos \theta} \{ 6.7 \times (5.0 + 5.0 + 2.0(10 + 8.0)) + 2.511 \times 8.0 \} \times 0.3 = 48.3 \text{ m}^3$$

51 1 1 175

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
★ 105	Formwork, F1 finish, for concrete of Item 102	m ²	2.1	$0.3 \times 6.7 \times \frac{1}{\cos 90} = 2.1 \text{ m}^2$
106	Formwork, F1 finish, for concrete of Item 103	m ²	73.602	
	dram ditch : 71.840 m ²			
	catch basin : 1.762 m ²			
	Total : 73.602 m ²			
★ 107	Formwork, F2 finish, for concrete of Item 102	m ²	161	$A = \frac{\sqrt{L}}{0.3} = 48.3 / 0.3 = 161$
108	Formwork, F3 finish, for concrete of Item 103	m ²	48.350	
	dram ditch : 47.7 m ²			
	catch basin : 0.65 m ²			
	Total : 48.35 m ²			
109	Formwork, F4 finish, for concrete of Item 101	m ²	890.967	

Working Division:

Description	Calculation Details	Unit	Quantity	Remarks
★ /10	Reinforcing bars for concrete works	ton	1.4	$48 \times 0.03 = 1.4$ ton
	Facing concrete			
/11	Shotcrete in adit tunnel	m ³	208.911	
/12	Steel wire mesh for stem /11	m ²	1974.440	
★ /13	Anchor bars, D.25 mm for concrete facing wall	m	54	$Q = 3,000$ 1 no/9m ² $L = 16\frac{1}{9} \times 3.0 = 54$ m
★ /14	P.V.C pipe D.50 mm for weephole	m	38	$1\text{ no}/4\text{ m}^2$ $Q = 40\text{ cm}$ for concrete facing $1\text{ no}/4\text{ m}^2$ $L = 20\text{ cm}$ for shotcrete $16\frac{1}{4} \times 0.4 + 9\frac{1}{2} \times 0.2 = 21\text{ m}$
	Adit portal: 21 m			
	Adit tunnel: 17 m			
	Total: 38 m			
★ /15	Shotcrete, T=100 mm	m ²	96	see dwg

07 1 1 1 72

Type (0.3x0.3) without gravel

Item	Unit	Qty
Excavation	0.371 m3	17.808 m3
Concrete	0.12 m3	5.760 m3
F1 formwork	0.84 m2	40.320 m2
F3 formwork	0.6 m2	28.800 m2
Leveling conc.	0.018 m3	0.864 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.143 m3	6.864 m3

Type (0.3x0.3) with gravel

Item	Unit	Qty
Excavation	0.481 m3	9.139 m3
Concrete	0.12 m3	2.280 m3
F1 formwork	0.84 m2	15.960 m2
F3 formwork	0.6 m2	11.400 m2
Leveling conc.	0.018 m3	0.342 m3
Gravel bedding	0.06 m3	1.140 m3
Backfilling	0.193 m3	3.667 m3

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

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 (0.5x0.5) with gravel, with cover

Item	Unit	Qty
Excavation	1.037 m3	6.741 m3
Concrete	0.254 m3	1.651 m3
F1 formwork	2.24 m2	14.560 m2
F3 formwork	1 m2	6.500 m2
Leveling conc.	0.024 m3	0.156 m3
Gravel bedding	0.08 m3	0.520 m3
Backfilling	0.429 m3	2.789 m3

Type (0.5x0.5) without gravel, without cover

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 (0.5x0.5) with gravel, without cover

Item	Unit	Qty
Excavation	0.878 m3	0.878 m3
Concrete	0.184 m3	0.184 m3
F1 formwork	1.34 m2	1.340 m2
F3 formwork	1 m2	1.000 m2
Leveling conc.	0.024 m3	0.024 m3
Gravel bedding	0.08 m3	0.080 m3
Backfilling	0.35 m3	0.350 m3

Total

Item	Qty
Excavation	34.566 m3
Concrete	9.875 m3
F1 formwork	71.840 m2
F3 formwork	47.700 m2
Leveling conc.	1.386 m3
Gravel bedding	1.740 m3
Backfilling	13.670 m3

AP-2

Adit Tunnel

57-1-181

199

$$y = -\frac{9128.683}{5317.883}x + 6666.399$$

A-C, E-F 式の交点。

$$\frac{5317.883}{9128.683}x = -\frac{9128.683}{5317.883}x + 6666.399$$

$$\frac{5317.883^2 + 9128.683^2}{9128.683 \times 5317.883}x = 6666.399$$

$$x = 6666.399 \times \frac{9128.683 \times 5317.883}{5317.883^2 + 9128.683^2}$$

$$= 2899.509$$

$$y = 1689.099$$

$$C \begin{pmatrix} 2899.509 \\ 1689.099 \end{pmatrix}$$

次に D 点の座標

E-F 間で C 7' 30.000 離れた点があるの?

$$(2899.509 - x)^2 + (1689.099 - \frac{5317.883}{9128.683}x)^2 = 900$$

$$D \begin{pmatrix} 2873.587 \\ 1673.998 \end{pmatrix}$$

$$B \begin{pmatrix} 2884.408 \\ 1715.021 \end{pmatrix}$$

← 1/2 Program 7'

A-B 距離

$$\sqrt{\{(2646.876 - 2884.408)^2 + (2122.769 - 1715.021)^2\}}$$

$$= 471.890 \text{ m}$$

B-D 距離

$$60.000 \times \pi \times \frac{1}{4} = 47.124 \text{ m}$$

拾点より D 点までの距離

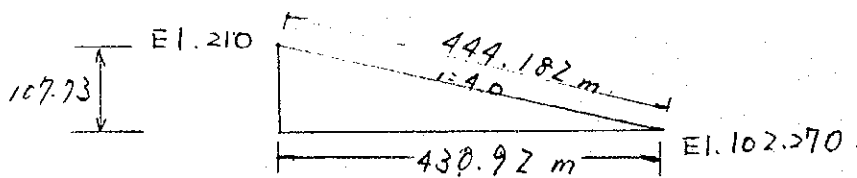
$$436.196 + 193732 + 3225.245 = 3855.173$$

拾点 EL. 99.7 m より $\frac{1}{1,500}$ 勾配にて掘削する

D 点 EL. 102.270

A 点 (Work Adit 拾点) EL. 210.0 m

1:4 勾配にて掘削する



Level に沿って掘削する距離 A 点より 430.92 m

Adit 長さは 444.182 m

より Work Adit 全長

$$444.182 + (471.890 - 430.920) + 47.124$$

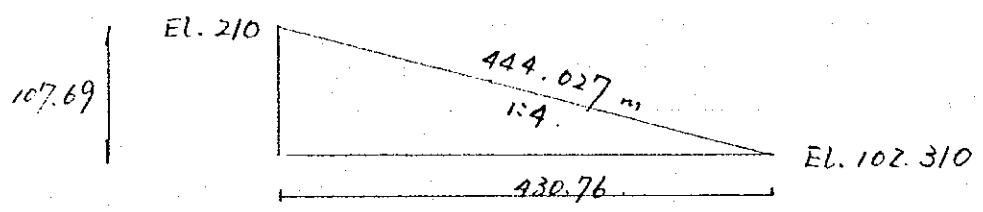
$$= 532.276 \text{ m}$$

始点より G 点までの距離

$$\begin{aligned}
 (\text{D 点までの距離}) + 60.0 \text{ m} &= 3855.173 + 60.0 \\
 &= 3915.173 \text{ m}
 \end{aligned}$$

G 点 EL 17

$$99.7 + 3915.173 / 1.500 = 102.310 \text{ m}$$



Level 1:1.83 までの距離 A 点より 430.76 m
 Adit 長さ 444.027 m

全長

$$\begin{aligned}
 444.027 + (471.890 - 430.76) + 47.124 \\
 = 532.281 \text{ m}
 \end{aligned}$$

Type の 振り分け

Type I : 222.014 m

Type II : 222.014 m

Type I with concrete : 88.253 m

Type II with concrete : X

Type I

- Excavation

$$\begin{aligned} \text{Rectangular part} &: \{(2,000 + 100 \times 2) \times 2\} \times (2000 + 100) \\ &= 9,24 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Circular part} &: 2.2^2 \times \pi \times \frac{1}{2} \\ &= 7.603 \text{ m}^3 \end{aligned}$$

$$\text{Total} : 9.24 + 7.603 = \underline{16.843 \text{ m}^3}$$

- Shotcrete

$$\begin{aligned} \text{Rec. part} &: (0.1 \times 2.0) \times 2 \\ &= 0.4 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Cir. part} &: 0.1 \times \{(2.15 \times 2) \times \pi \times \frac{1}{2}\} \\ &= 0.676 \text{ m}^3 \end{aligned}$$

$$\text{Total} : 1.076 \text{ m}^3$$

- Rock bolt (per 1.2 m)

$$9 \text{ nos} : 2.0 \text{ m} \times 9 \text{ nos} = 18.0 \text{ m}$$

$$8 \text{ nos} : 2.0 \text{ m} \times 8 \text{ nos} = 16.0 \text{ m}$$

$$34.0 \text{ m} / 2.4 \text{ m}$$

- steel wire mesh

$$1.076 \text{ m}^3 \times \frac{1}{0.1 \text{ m}} = 10.76 \text{ m}^2$$

Type II.

- Excavation.

$$\text{Rec. part : } \{(2.0 + 0.05 + 0.125 + 0.1) \times 2\} \times (2.0 + 0.1) \\ = 9.555 \text{ m}^3$$

$$\text{Cir. part : } 2.275^2 \pi \times \frac{1}{2} \\ = 8.130 \text{ m}^3$$

$$\text{Total : } 17.685 \text{ m}^3$$

- Shotcrete

$$\text{Rec. part : } 0.125 \times 2.0 \times 2 = 0.5 \text{ m}^3$$

$$\text{Cir. part : } (2.275 - 0.125/2) \times 2 \times \pi \times \frac{1}{2} \times 0.125 \\ = 0.869 \text{ m}^3$$

$$\text{Total : } 1.369 \text{ m}^3$$

- Rock bolt

$$9 \text{ nos : } 18.0 \text{ m}$$

$$8 \text{ nos : } 16.0 \text{ m}$$

- Steel support

$$\text{H125. Rec. part : } 2.0 \times 2 = 4.0$$

$$\text{Cir. part : } (2.0 + 0.05 + 0.125/2) \times 2 \times \pi \times \frac{1}{2} = 6.637$$

$$\text{Sub Total : } 10.637 \text{ m} \times 23.8 \text{ kg/m} = 253.161$$

$$\text{R. } 3.203 \times 2 = 6.406$$

$$\text{R. } 3.768 \times 2 = 7.536$$

$$\text{Bolt } 3.12 \times 2 = 6.24$$

$$\text{Grand Total} = 273.343 \text{ kg}$$

- Steel wire mesh

$$1.369 \text{ m}^3 \times \frac{1}{0.125 \text{ m}} = 10.952 \text{ m}^2$$

Type I with concrete

- Excavation

$$\text{Rec. part : } \left\{ (2.0 + 0.3 + 0.1 \times 2) \times 2 \right\} \times (2.0 + 0.3 + 0.1) \\ = 12.0 \text{ m}^3$$

$$\text{Cir. part : } 2.5^2 \times \pi \times \frac{1}{2} = 9.817 \text{ m}^3$$

$$\text{Total : } \underline{21.817 \text{ m}^3}$$

- Shotcrete

$$\text{Rec. part : } 0.1 \times 2.3 \times 2 = 0.46 \text{ m}^3$$

$$\text{Cir. part : } (2.5 - 0.05) \times 2 \times \pi \times \frac{1}{2} \times 0.1 = 0.770 \text{ m}^3$$

$$\text{Total : } 1.23 \text{ m}^3$$

- Steel wire mesh

$$1.23 \text{ m}^3 \times \frac{1}{0.1 \text{ m}} = 12.3 \text{ m}^2$$

- concrete

$$\text{Rec part : } 0.4 \times 2.0 \times 2 = 1.2 \text{ m}^3$$

$$0.4 \times (2.4 \times 2) = \frac{1.92 \text{ m}^3}{3.12 \text{ m}^3}$$

$$\text{Cir. part : } (2 + 0.2) \times 2 \times \pi \times \frac{1}{2} \times 0.4 = 2.765 \text{ m}^3$$

$$\text{Total : } 5.885 \text{ m}^3$$

- Rock bolt

$$9 \text{ nos} : 18.0 \text{ m}$$

$$8 \text{ nos} : 16.0 \text{ m}$$

whelp hole

$$0.5 \text{ m} / 2.5 \text{ m}$$

- Formwork

$$2.0 \text{ m} \times 2 + 4.0 \times \pi \times \frac{1}{2} = 10.283 \text{ m}^2$$

Type II. with concrete

- Excavation

$$\begin{aligned} \text{Rec. part} &: \{(2.0 + 0.3 + 0.15 + 0.1) \times 2\} \times (2.0 + 0.3 + 0.1) \\ &= 12.24 \text{ m}^3 \end{aligned}$$

$$\text{Cir. part} : 2.55^2 \times \pi \times \frac{1}{2} = 10.214$$

$$\text{Total} = 22.454 \text{ m}^3$$

- Shotcrete

$$\text{Rec. part} : 0.15 \times 2.3 \times 2 = 0.69 \text{ m}^3$$

$$\begin{aligned} \text{Cir. part} &: \{(2.55 - \frac{0.15}{2}) \times 2\} \times \pi \times \frac{1}{2} \times 0.15 \\ &= 0.860 \text{ m}^3 \end{aligned}$$

$$\text{Total} : 1.55 \text{ m}^3$$

$$\left. \begin{array}{l} \text{steel wire mesh} \\ 1.55 \text{ m}^3 \times \frac{1}{0.15 \text{ m}} = 10.333 \text{ m}^2 \end{array} \right\}$$

- concrete

$$\text{Rec. part} : 0.4 \times 2 \times 2 = 1.6 \text{ m}^3$$

$$0.4 \times (2.55 - 0.15) \times 2 = 1.92 \text{ m}^3$$

$$3.12 \text{ m}^3$$

$$\text{Cir part} : 0.4 \times (2.0 + 0.2) \times 2 \times \pi \times \frac{1}{2} = 2.765 \text{ m}^3$$

$$\text{Total} : 5.885 \text{ m}^3$$

- Rock bolt

$$9 \text{ nos} : 18.0 \text{ m}$$

$$8 \text{ nos} : 16.0 \text{ m}$$

- Form work. 10.283 m²

Type I Item	Unit	L= 222.014 m	Qty
Excavation	m ³	17,885	3,926,316
Concrete	m ³	-	0,000
Shotcrete	m ³	1,369	303,937
Wire mesh	m ²	10,952	2,431,497
Rockbolt	m/2.4m	34	3,144,000
Steel support	ton/1.2m	0,273	50,505
Weephole	m/2.5m	-	0,000

Type II Item	Unit	L= 222.014 m	Qty
Excavation	m ³	17,885	3,926,316
Concrete	m ³	-	0,000
Shotcrete	m ³	1,369	303,937
Wire mesh	m ²	10,952	2,431,497
Rockbolt	m/2.4m	34	3,144,000
Steel support	ton/1.2m	0,273	50,505
Weephole	m/2.5m	-	0,000

Type I Item	Unit	L= 86.253 m	Qty
Excavation	m ³	21,817	1,925,416
Concrete	m ³	5,885	519,369
Form	m ²	10,283	907,506
Shotcrete	m ³	1,23	108,551
Wire mesh	m ²	12,3	1,085,512
Rockbolt	m/2.4m	34	1,240,000
Steel support	ton/1.2m	-	0,000
Weephole	m/2.5m	0,5	17,500

Type II Item	Unit	L= 86.253 m	Qty
Excavation	m ³	21,817	1,925,416
Concrete	m ³	5,885	519,369
Form	m ²	10,283	907,506
Shotcrete	m ³	1,23	108,551
Wire mesh	m ²	12,3	1,085,512
Rockbolt	m/2.4m	34	1,240,000
Steel support	ton/1.2m	-	0,000
Weephole	m/2.5m	0,5	17,500

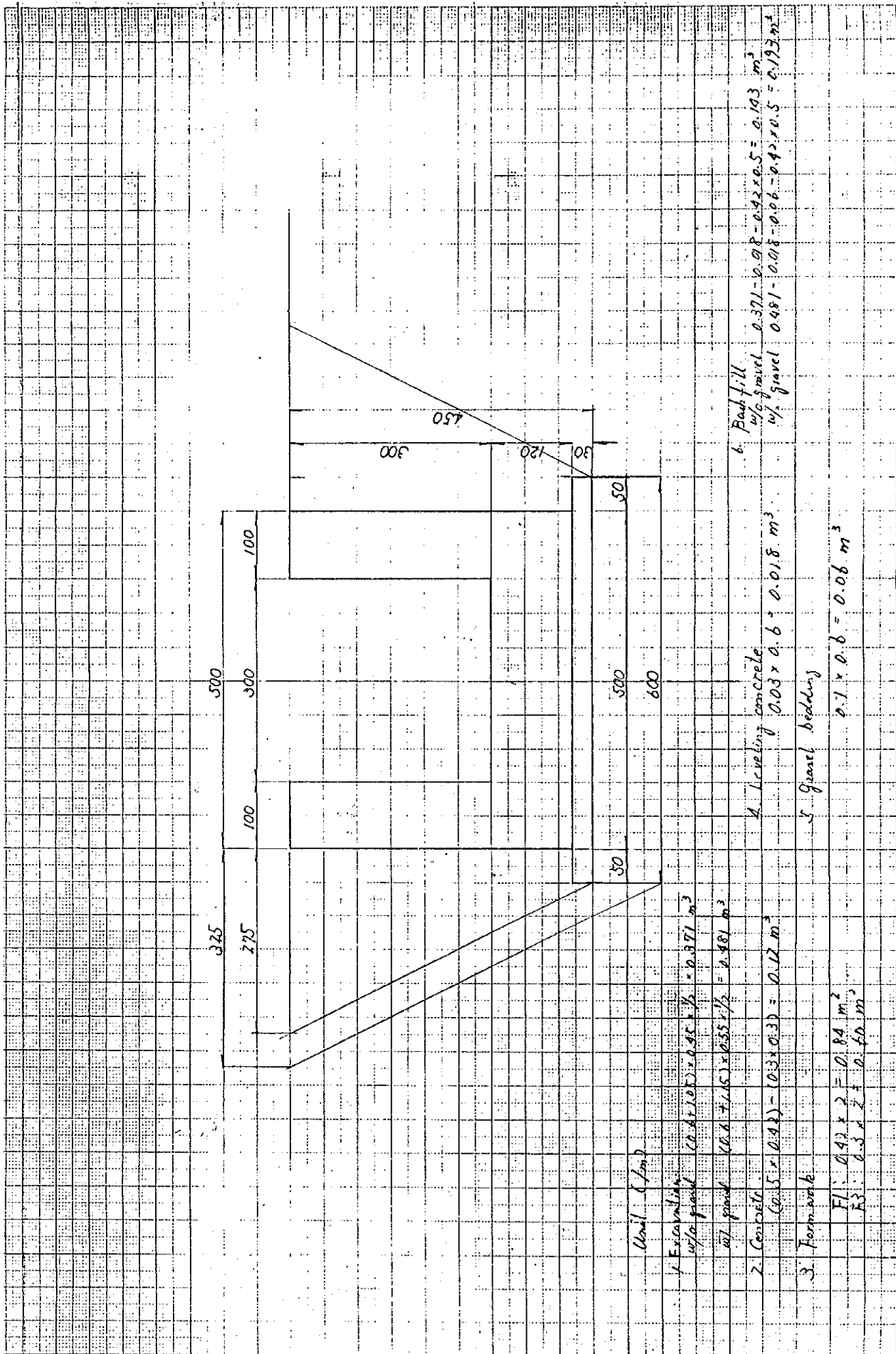
Total Item	Unit	Qty
Excavation	m ³	9,591,115
Concrete	m ³	519,369
Form	m ²	907,506
Shotcrete	m ³	651,375
Wire mesh	m ²	5,905,880
Rockbolt	m	7,528,000
Steel support	ton	50,505
Weephole	m	17,500

7-1-190

AP-3

Drain ditch and catch basin

5-1-191



Unit (m²)

1. Excavation w/o gravel $(0.4 \times 1.0) \times 0.95 \times \frac{1}{2} = 0.193 \text{ m}^3$
 w/ gravel $(0.4 + 1.0) \times 0.95 \times \frac{1}{2} = 0.481 \text{ m}^3$

2. Concrete $(0.5 \times 0.42) - (0.3 \times 0.3) = 0.12 \text{ m}^2$

3. Formwork
 $FL: 0.42 \times 2 = 0.84 \text{ m}^2$
 $FS: 0.3 \times 2 = 0.60 \text{ m}^2$

4. Leveling concrete $0.03 \times 0.6 \times 0.018 \text{ m}^3$

5. Gravel bedding $0.1 \times 0.6 = 0.06 \text{ m}^3$

6. Backfill w/o gravel $0.371 - 0.98 - 0.42 \times 0.5 = 0.193 \text{ m}^3$
 w/ gravel $0.481 - 0.06 - 0.42 \times 0.5 = 0.193 \text{ m}^3$

Type (0.3x0.3) without gravel
L= 51.8 m

Item	Unit	Qty
Excavation	0.371 m3	19.218 m3
Concrete	0.12 m3	6.216 m3
F1 formwork	0.84 m2	43.512 m2
F3 formwork	0.6 m2	31.080 m2
Leveling conc.	0.018 m3	0.932 m3
Gravel bedding	0 m3	0.000 m3
Backfilling	0.143 m3	7.407 m3

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

Item	Unit	Qty
Excavation	0.481 m3	5.772 m3
Concrete	0.12 m3	1.440 m3
F1 formwork	0.84 m2	10.080 m2
F3 formwork	0.6 m2	7.200 m2
Leveling conc.	0.018 m3	0.216 m3
Gravel bedding	0.06 m3	0.720 m3
Backfilling	0.193 m3	2.316 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) without gravel, with cover
L= 6 m

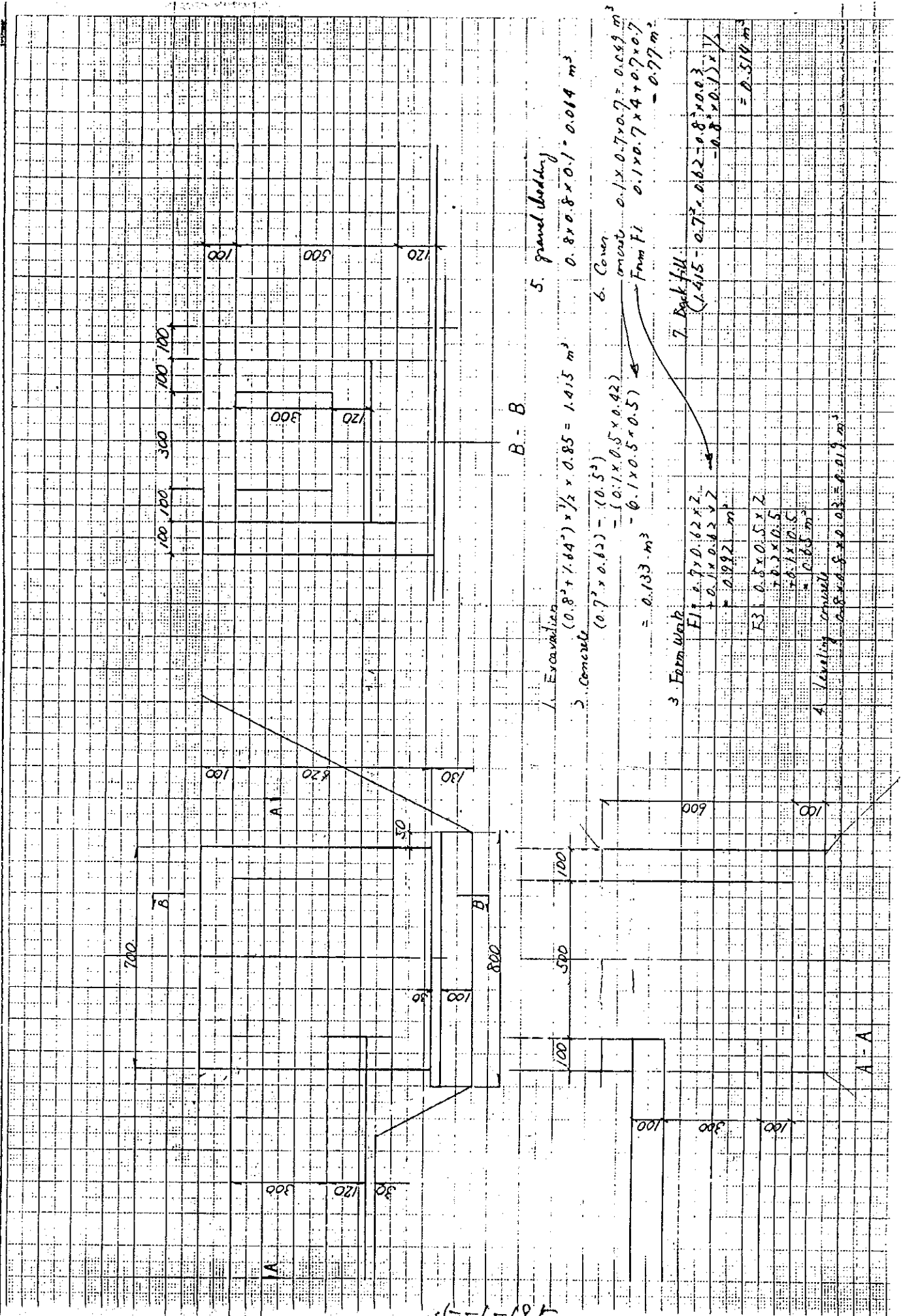
Item	Unit	Qty
Excavation	1.037 m3	6.222 m3
Concrete	0.254 m3	1.524 m3
F1 formwork	2.24 m2	13.440 m2
F3 formwork	1 m2	6.000 m2
Leveling conc.	0.024 m3	0.144 m3
Gravel bedding	0.08 m3	0.480 m3
Backfilling	0.429 m3	2.574 m3

Total

Item	Qty
Excavation	31.212 m3
Concrete	9.180 m3
F1 formwork	67.032 m2
F3 formwork	44.280 m2
Leveling conc.	1.292 m3
Gravel bedding	1.200 m3
Backfilling	12.297 m3

4-1-194

191-1-1



1. Excavation

3. Concrete $(0.8^2 + 1.64) \times \frac{1}{2} \times 0.85 = 1.415 \text{ m}^3$

$(0.7 \times 0.62) - (0.5^2)$
 $= (0.1 \times 0.5 \times 0.42)$
 $= 0.1 \times 0.5 \times 0.5$

$= 0.133 \text{ m}^3$

3. Formwork

$F1: 0.7 \times 0.62 \times 2$
 $+ 0.1 \times 0.62 \times 2$
 $= 0.992 \text{ m}^2$

$F3: 0.5 \times 0.5 \times 2$
 $+ 0.1 \times 0.5$
 $= 0.65 \text{ m}^2$

4. Leveling concrete

$0.8 \times 0.8 \times 0.03 = 0.019 \text{ m}^3$

5. gravel bedding

$0.8 \times 0.8 \times 0.1 = 0.064 \text{ m}^3$

6. Cover

amount $0.1 \times 0.7 \times 0.7 = 0.069 \text{ m}^3$
 Form Fi $0.1 \times 0.7 \times 4 + 0.7 \times 0.7 = 0.77 \text{ m}^3$

7. Backfill

$(1.415 - 0.77 - 0.062 - 0.069) \times 1.7$
 $= 0.518 \text{ m}^3$

5.2 Superestructura

Superstructure

Working Division: *Cengizillo Inlet*

Description	Calculation Details	Unit	Quantity	Remarks
101 Concrete slab C	(From sheet 2.)	m ³	44.92	
102 Concrete slab H	(")	m ³	4.89	
103 Formwork F ₁	(")	m ²	146.06	
104 Formwork F ₃	(")	m ²	223.42	
105 Reinforcing bars		Ton	4.56	
106 Hollow concrete block to parapet		m ²	12.84	$0.4 \times (12.71 + 17.4) = 12.84$
107 Sply fill up roofing.		m ²	72.72	$61.88 + 0.4 \times 82.11 = 74.724$
108 Cement mortar on floor	44.19 - 1.2 x 3.5	m ²	39.99	$(8.1 \times 8.1 \times \pi \times \frac{90}{360}) - (8.1 \times 8.1 \times \frac{1}{3}) + (4.85 \times 10.5 \times \frac{1}{3}) = 44.19$
109 Base cement mortar	(see 107)	m ²	81.88	
110 Cement mortar skirting	$h=100$	m	34.57	$(8.1 \times 2 \times \pi \times \frac{90}{360}) + (4.85 \times 1.6) + (5.4 \times 0.9 \times \frac{2}{3} \times (10.5 - 0.7))$
111 Cement skirting exterior	$h=200$	m	27.09	$(8.1 \times 2 \times \pi \times \frac{90}{360}) + (5.1 \times 5 - 1.6) + (11.1 - 0.9) =$
112 Cement mortar to wall	(From sheet 2. same area as F ₁)	m ²	146.06	

Quantity of Reinforcement Superstructure Tansa Conquillo

Members	Ø	N ^o	N ^o Elements	A m	B m	Sample	Spaced	L Total	Ø per m	Area Total
- Column										
long. Reinf.	25	8	6	4.5		0.20	4.70	225.6	3.85	868.6
stirrups □	12	30		2x0.55	2x0.55	2x0.12	2.24	437.2	0.89	390.9
stirrups ◇	12	30		2x0.35	2x0.35	2x0.12	1.64	295.2		262.7
- Beams										
curved beam 1	18	6	1	10.6	0.30		10.90	65.4	2.0	130.8
curved beam 2	18	6	1	3.2	0.30		3.70	22.2		44.4
straight beam	18	6		10.90	2x0.30		11.50	69.0		138.0
transverse beam 1	18	6		5.90	2x0.30		6.50	39.0		78.0
transverse beam 2	18	6		5.35	2x0.30		5.95	35.7		71.4
total reinforcement	12	2					35.3	70.6	0.89	62.8
stirrups □	10	170		2x0.55	2x0.35	2x0.10	2.0	340.0	0.62	210.8
- Slab 15.1 kg/m ²	10x12	58.4m ²								881.9
- Parapets	12	3					31.5	94.5	0.69	84.1
	10	150					2.7	379.2	0.62	235.1
	10	6					31.5	189.0		117.2
										3576.7

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W

Compuillo

11/20/08

Area	29.3 x 3.05	=	89.4	m ²
Windows	1.7 x 1.2 x 2	=	-	4.4
	1.3 x 1.2	=	-	1.7
Partitions	2 x 1.0 x 2.2	=	-	4.4
	1.6 x 2.2	=	-	3.5
			<u>75.4</u>	m ²

A = 12.4 kg/m²

5% excess for windows

935.0

46.7

Total

4558.4 kg

ST
L
if

Summary

Columns	1522.2
Beams	736.2
S/S	881.9
Partitions	436.4
Walls	981.7
	<u>4558.4</u>

kg

Working Division:

Description	Calculation Details						Remarks
	Symbol	Dimensions	No. Area	Painting	Glass	Area m ²	
				TYPE Fac. Area	Dimensions	TYPE	TYPE Caulking
<i>Actual area and number</i>						<i>Wich?</i>	
SD-1	0.9	2.1	2	OP 2.5 9.45			12.0
SD-2	1.6	2.1	1	3.36 " 2.5 8.5			7.4
SL-1	1.0	1.0	8	8.0 " 3.5 28.0			32
<i>Aluminium window</i>							
AW-1	1.8	1.2	2	4.32	1.8 x 1.2 x 2	4.32	12.0
<i>Aluminium doors</i>							
AL-1	1.2	1.2	1	1.44			4.8

8.7 Working Division: Poza Honda Jalat

Description	Calculation Details	Unit	Quantity	Remarks
101 Concrete class C	(from sheet 2)	m ³	56.66	
102 Concrete class F1	(from sheet 2)	m ³	4.74	
103 Formwork F1	(from sheet 2)	m ²	133.86	
104 Formwork F2	(from sheet 2)	m ²	214.71	
105 Reinforcing bars	(from sheet 5.6)	t	4.3	
106 Block masonry to roof	$1 \left(8' \times 2 \times \pi \times \frac{100}{360} \right) (5 + 5.0 + 11.0) \times 0.2 = 31.25 \times 0.2$	m ²	6.25	
107 3-ply built-up asphalt roofing	$59.22 + 31.22 \times 0.4 = 36.84 - 12 \times 3.5$	m ²	71.71	
108 Cement mortar plaster on floor		m ²	32.64	$(7' \times 7' \times \pi \times \frac{100}{360} - 7' \times 7' \times \frac{1}{2}) + 3.8 \times 7.5 \times \frac{1}{2} = 36.84$
109 Base cement mortar (see top)		m ²	59.22	
110 Cement abutting. A=100.		m	30.99	$(7' \times 2 \times \pi \times \frac{100}{360}) + (3.5 \times 1.6) + 3.0 + (4.8 - 0.9) \times 2 = 16.509$
111 Cement abutting. A=200.		m	24.94	$(7.5 \times 2 \times \pi \times \frac{100}{360}) + (4.4 - 1.6) + (10.1 - 0.9)$

07-12-17

Working Division:

Description	Concrete			Formwork			Remarks
	Dimensions	Nos.	Volume m ³	Dimensions	Nos.	Area F ₁ m ²	
Column	0.64	3.4	8.35	2.16	3.4	5.2	0.64 x 4 = 2.56 (7.1 x 2.09 x 360 / 360) = 12.39
Columns	0.5	13.9	2.48	0.7	12.9	8.167	0.5 x 2.09 - 6.20 (0.5 x 0.2) x 12.39 = 5.67
	0.5	12.5	2.30	0.8	12.5	8.75	(3.2 x 2.9 x 6.9) = 12.5 · 0.5 x 12.5 = 6.25
	0.5	4.2	0.84	1.2	4.2	5.04	7.2 x 2.7 x 5.18 = 12.57
Walls	0.2	12.57	7.29	3.645	1	36.45	22.57 x 2.9 = 36.45
Alms	0.2	3.2	1.86		1	4.64	(3.2 x 2.9) - (1.6 x 2.41 x 1.2) = 4.64
② base	0.2	21.63	12.55			21.63	(9.6 x 2.9) - (1.8 x 2.52 + 0.9 x 2.1) = 21.63
B. Sinc.	0.75	10.27	1.54	10.29	2	20.58	4.2 x 2.7 - 0.9 x 2.1 = 10.29
Parapet	0.9	21.72	2.29	12.72	0.9	11.45	8.1 x 2.7 x 360 / 360 = 12.72
	0.9	18.5	3.33	18.5	0.9	16.65	5.0 + 11.0 + 2.5 = 18.5 (5.153) (3.2 x 1.872)
Slab	0.15	59.22	8.88			59.22	(8.1 x 8.1 x π x 360 / 360 - 8.1 x 8.1 x 5/6) + (25.5 x 0.15 x 10.8 x 2) = 18.72 + 40.5 = 59.22
Concrete Clear	0.08	59.22	4.74				
			51.87			133.86	214.71

57-1-20

Working Division: Poza Honda Inlet

Description	Calculation Details	Unit	Quantity	Remarks
112	Cement mortar plaster to interior walls From sheet 2 same area as for F ₁ formwork	m ²	105.76	8.67 + 8.75 + 5.04 + 36.45 + 4.64 + 21.63 + 20.58
113	Waterproof cement mortar gutter	m ²	7.63	(8.1 x 2 x π x $\frac{90}{360}$) x 0.6 = 7.63 0.95
114	Waterproof cement mortar to parapet	m ²	102.09	(8.1 x 2 x π x $\frac{90}{360}$) x (0.2 + 0.35 + 0.4)
115	Cement mortar border to horizontal	m	4.4	1.2 + 3.2 = 4.4
116	Spray tile on expanded concrete (from sheet 2 same area as for F ₁ formwork)	m ²	166.92	53.2 + 6.20 + 6.25 + 36.45 + 4.64 + 21.63 + 11.45 + 16.15 + (8.1 x 2 x π x $\frac{90}{360}$) x 0.9
117	Oil paint metal surfaces (from sheet 4)	m ²	45.85	(9.45 + 7.4 + 28.0)
118	Steel door leaves and frames (from sheet 4)	m ²	15.14	(3.78 + 3.36 + 8.0)
119	Aluminum windows and doors	m ²	5.76	

Contadores de Refuerzo Superestructura Tomas Pozo Honda.

Miembro.	φ	Nº	Nº Elemento	A m ²	B m ²	Grutas m ²	Upricial m ²	Líbel m	φ peso Kg	Peso total Kg
- Columna	25	8	6	4.5		0.20	4.70	225.6	3.85	868.6
longit. Reinforcement										
Stirrups □	12	30		2 x 0.55	2 x 0.55	2 x 0.12	2.44	439.2	0.89	390.9
stirrups ◇	12	30		2 x 0.35	2 x 0.35	2 x 0.12	1.64	295.2	0.89	262.7
- Beams										
curved beam 1	18	6	1	10.6	0.20	—	10.90	65.4	2.0	140.6
curved beam 2	18	6	1	3.2	0.30	—	3.50	21.0		42.0
straight beam	18	6	1	9.90	2 x 0.3	—	10.50	63.0		126.0
transversal beam ①	18	6	1	5.20	2 x 0.3		5.80	34.8		69.6
transversal beam ②	18	6	1	4.20	2 x 0.3		4.80	28.8		57.6
lateral reinforcement	12	2					32.30	64.6	0.82	57.5
stirrups □	10	160	1	2 x 0.55	2 x 0.35	2 x 0.10	2.00	320.0	0.62	198.4
- S/26	10 x 12	52.1 m ²								786.7
15.1 Kg/m ²										
- Parapets	12	3	—				30.5	91.5	0.89	81.4
	10	150		2.4			2.40	360	0.62	223.2
	10	6					30.5	183		113.5

3418.7

57
12
11

Materiales	Q	Nº	Nº Elementos	A m	B m	Hook m	L parcial	L Total	P peso Kg	Peso total
- Muros.										
L 4										
Area = 27.3 x 3.05		83.3 m ²								
Ventanas 2 x 1.7 x 1.3		- 4.4								
1.3 x 1.3		- 1.7								
puercos 2 x 1.0 x 2.2		- 4.4								
1.6 x 2.2		- 3.5								
As = 12.4 kg/m ²		69.3 m ²								859.3
carriles and windows										
- %										43.0
Summary.										4321.0 kg
Col. mms.	1522.2	kg								
Beams.	691.7									
Slab	786.7									
portal	418.1									
Walls	902.3									
Total	4321.0	kg								

57-2-12