6. ESTIMACION DE COSTOS

6. ESTIMACION DE COSTOS

6.1 DESGLOSE DE COSTOS

6.1.1 Desglose de costos

El costo del proyecto fue desglosado como se muestra en la Figura 6.1-1 :

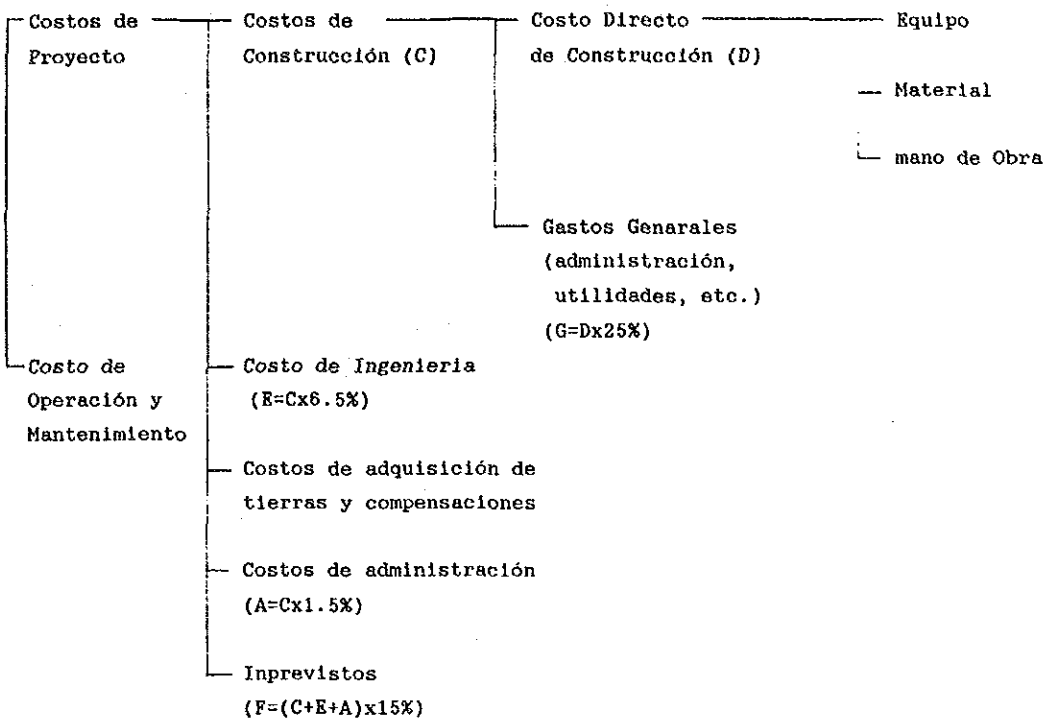


Fig. 6.1-1 Desglose de Costos

Los porcentajes indicados en la Fig. 6.1.1 fueron determinados considerando la magnitud del proyecto y el costo de proyectos anteriores, implementados en Bolivia por SNC.

6.1.2 Desglose en moneda nacional y extranjera

La porción en moneda local del costo de construcción incluye :

a) costo de materiales a ser adquiridos en Bolivia; por ejemplo, combustibles, lubricantes, cemento y ladrillos;
b) costos de mano de obra;
c) costos de adquisición y compensación de terrenos;
d) impuestos y derechos por materiales importados y equipo.

El monto restante de los costos de construcción serán financiados por moneda extranjera, excepto los costos de ingenieria y administración que serán financiados con moneda extranjera y local, respectivamente.

6.2 Costos de proyecto y costo de mantenimiento

6.2.1 Resumen de costo de proyecto

En base a los volúmenes de trabajo, y a los costos unitarios, que se describen más adelante en este inciso, el costo de proyecto fue estimado para cada sección, como se muestra en inciso 5.1.1, y luego sumado para obtener el costo total.

El costo total de proyecto se muestra en Tabla 6.2-1, mientras que los costos de construcción de cada sección se muestran en Tablas 6.2-2(1) a 6.2-2(6). Adicionalmente, el costo del proyecto fue estimado para camino de superficie asfáltica y camino con superficie ripiada.

Tabla 6.2-i Costo total del Proyecto
(L=108.63km)

Costo / Items			Unidad	Cantidad	Costo Unitario (US$) C.L Impuestos	C.L Otros	M.E	Costo (1000US$) C.L Impuestos	C.L Otros	C.L SubTotal	M.E	Total	Observ
Movimiento de tierras	Limpieza y desbroce		ha	182.49	2789	2599	9460	509	474	983	1726	2709	
	Excavacion A		m³	1596994	1.4	1.03	2.67	2236	1645	3881	4264	8145	
	Excavacion B		m³	8684325	1.42	1.38	4.72	12332	11984	24316	40990	65306	
	Terminado de subrasante con Compactacion		m²	1085401	0.01	0.02	0.04	11	22	33	43	76	
	Talud	Rociado de semilla	m²	233246	0.13	1.13		30	264	294	0	294	
		Rociado de hormigon	m²	95455	3.29	11.97	7.59	314	1143	1457	725	2182	
		Parrillas	m²	11544	6.95	24.58	15.71	80	284	364	181	545	
		Hormigon con enrocado	m²	2210	5.15	13.68	13.12	11	30	41	29	70	
	Muro de contencion	De gravedad(4m)	m	50	35.21	224.54	50.02	2	11	13	3	16	
		De mamposteria	m²	24754	4.12	27.66	4.69	102	685	787	116	903	
		Tipo parrilla	m²	45260	17.07	67.07	30.87	773	3036	3809	1397	5206	
	Alcantarilla	Cajon 3.0×3.0	m	375	202	488	523	76	183	259	196	455	
		Cajon 4.0×4.0	m	45	282	696	730	13	31	44	33	77	
		Tubo φ1.0	m	8560	17.58	131.21	12.43	150	1123	1273	106	1379	
	Desastre	Malla de retencion	m²	3840	2	1.59	5.95	8	6	14	23	37	
		Gavion	m	144	11.56	25.22	29.94	2	4	6	4	10	
		Rejilla de retencion	m	147	20.48	39.02	53.3	3	6	9	8	17	
		Dique de Gavion	m³	11154	12.78	28.54	35.45	143	318	461	395	856	
		Cubierta	m	62	1565	2904	4445	97	180	277	276	553	
		Drenaje frances	m	1010	3.54	7.63	10.44	4	8	12	11	23	
	Drenaje		km	107.1	4530	29637	5826	485	3174	3659	624	4283	
Pavimento	Capa sub-base		m²	1065264	0.36	0.3	1.28	383	320	703	1364	2067	
	Capa base		m²	1025095	0.74	1.17	2.4	759	1199	1958	2460	4418	
	Capa ligante		m²	996281	1.08	0.93	3.67	1076	927	2003	3656	5659	
	Capa superficie		m²	979571	1.28	0.88	4.04	1254	862	2116	3957	6073	
Puente	L≧50m		Jgo					387	602	989	1124	2113	
	L<50m		Jgo					254	474	728	741	1469	
Tunel	Revestimiento		m	120	1022	3180	2713	123	382	505	326	831	
	Sin soporte		m	625	751	2076	2038	469	1298	1767	1274	3041	
	Portal		Pzas	4	2827	9317	7176	11	37	48	29	77	
Otros	Senal de trafico y marcacion		km	107.1	5917	1762	14069	634	189	823	1507	2330	
	Guarda Carril		km	107.1	47.5	427.5		5	46	51	0	51	
Costo directo de construccion				(D)				22736	30947	53683	67588	121271	
Gastos generales				(G=Dx25%)				5684	7737	13421	16897	30318	
Total				(C=D+G)				28420	38684	67104	84485	151589	1395/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				394	3547	3941	5912	9853	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1, O=Ax0.9)				227	2047	2274	0	2274	
Adquisicion de tierras y costo de compensacion				(I)				0	146	146	0	146	
Contingencias				(F=(C+E+A)x15%)				4356	6642	10998	13560	24558	
Costos de Proyecto		Con Impuestos		(C+E+A+I+F)				33397	51066	84463	103957	188420	1735/Km
		Sin Impuestos							51066	51066	103957	155023	1427/Km

Tablas 6.2-2(1) Costo de Proyecto para cada sub-seccion
(Sub-Seccion 1, No.0+00 - No.25+300 L=25.30km)

Items	Costo		Unidad	Cantidad	Costo Unitario (US$) C.L Impuestos	C.L Otros	M.E	Costo (1000US$) C.L Impuestos	C.L Otros	C.L SubTotal	M.E	Total	Observ
Movimiento de tierras	Limpieza y desbroce		ha	48.13	2789	2599	9460	134	125	259	455	714	
	Excavacion A		m^3	120489	1.4	1.03	2.67	169	124	293	322	615	
	Excavacion B		m^3	2745026	1.42	1.38	4.72	3898	3788	7686	12957	20643	
	Terminado de subrasante con Compactacion		m^2	253756	0.01	0.02	0.04	3	5	8	10	18	
	Talud	Rociado de semilla	m^2	20527	0.13	1.13		3	23	26	0	26	
		Rociado de hormigon	m^2	18184	3.29	11.97	7.59	60	218	278	138	416	
		Parrillas	m^2	2627	6.95	24.58	15.71	18	65	83	41	124	
		Hormigon con enrocado	m^3		5.15	13.68	13.12	0	0	0	0	0	
	Muro de contencion	De gravedad(4m)	m	50	35.21	224.54	50.02	2	11	13	3	16	
		De mamposteria	m^2	2947	4.12	27.66	4.69	12	82	94	14	108	
		Tipo parrilla	m^2	6206	17.07	67.07	30.87	106	416	522	192	714	
	Alcantarilla	Cajon 3.0×3.0	m	50	202	488	523	10	24	34	26	60	
		Cajon 4.0×4.0	m	35	282	696	730	10	24	34	26	60	
		Tubo ϕ1.0	m	1997	17.58	131.21	12.43	35	262	297	25	322	
	Desastre	Malla de retencion	m^2		2	1.59	5.95	0	0	0	0	0	
		Gavion	m		11.56	25.22	29.94	0	0	0	0	0	
		Rejilla de retencion	m	51	20.48	39.02	53.3	1	2	3	3	6	
		Dique de Gavion	m^3		12.78	28.54	35.45	0	0	0	0	0	
		Cubierta	m		1565	2904	4445	0	0	0	0	0	
		Drenaje frances	m		3.54	7.63	10.44	0	0	0	0	0	
	Drenaje		km	25	4530	29637	5826	113	741	854	146	1000	
Pavimento	Capa sub-base		m^2	249048	0.36	0.3	1.28	90	75	165	319	484	
	Capa base		m^2	239657	0.74	1.17	2.4	177	280	457	575	1032	
	Capa ligante		m^2	232917	1.08	0.93	3.67	252	217	469	855	1324	
	Capa superficie		m^2	229010	1.28	0.88	4.04	293	202	495	925	1420	
Puente	L≧50m		Jgo					215	297	512	625	1137	
	L<50m		Jgo					108	203	311	316	627	
Tunel	Revestimiento		m		1022	3180	2713	0	0	0	0	0	
	Sin soporte		m		751	2076	2038	0	0	0	0	0	
	Portal		Pzas		2827	9317	7176	0	0	0	0	0	
Otros	Senal de trafico y marcacion		km	25	5917	1762	14069	148	44	192	352	544	
	Guarda Carril		km	25	47.5	427.5		1	11	12	0	12	
Costo directo de construcci				(D)				5858	7239	13097	18325	31422	
Gastos generales				(G=Dx25%)				1465	1810	3275	4581	7856	
Total				(C=D+G)				7323	9049	16372	22906	39278	1553/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				102	919	1021	1532	2553	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1, O=Ax0.9)				59	530	589	0	589	
Adquisicion de tierras y costo de compensacion				(I)				0	55	55	0	55	
Contingencias				(F=(C+E+A)x15%)				1123	1575	2698	3666	6364	
Costos de Proyecto		Con Impuestos		(C+E+A+I+F)				8607	12128	20735	28104	48839	1930/Km
		Sin Impuestos							12128	12128	28104	40232	1590/Km

Tablas 6.2-2(2) Costo de Proyecto para cada sub-seccion
(Sub-seccion 2, No. 25+300 - No. 46+760 L=21.46km)

Items	Costo		Unidad	Cantidad	Costo Unitario (US$) C.I. Impuestos	C.I. Ortos	M.E	Costo (1000US$) C.I. Impuestos	C.I. Ortos	C.I. SubTotal	M.E	Total	Observ
Movimiento de tierras	Limpieza y desbroce		ha	38.38	2789	2599	9460	107	100	207	363	570	
	Excavacion A		m³	143289	1.4	1.03	2.67	201	148	349	383	732	
	Excavacion B		m³	2483795	1.42	1.38	4.72	3527	3428	6955	11724	18679	
	Terminado de subrasante con Compactacion		m²	208162	0.01	0.02	0.04	2	4	6	8	14	
	Talud	Rociado de semilla	m²	15104	0.13	1.13		2	17	19	0	19	
		Rociado de hormigon	m²	37113	3.29	11.97	7.59	122	444	566	282	848	
		Parrillas	m²	3737	6.95	24.58	15.71	26	92	118	59	177	
		Hormigon con enrocado	m³		5.15	13.68	13.12	0	0	0	0	0	
	Muro de contencion	De gravedad(4m)	m		35.21	224.54	50.02	0	0	0	0	0	
		De mamposteria	m³	1230	4.12	27.66	4.69	5	34	39	6	45	
		Tipo parrilla	m³	5222	17.07	67.07	30.87	89	350	439	161	600	
	Alcantarilla	Cajon 3.0×3.0	m	50	202	488	523	10	24	34	26	60	
		Cajon 4.0×4.0	m	10	282	696	730	3	7	10	7	17	
		Tubo ϕ1.0	m	1643	17.58	131.21	12.43	29	216	245	20	265	
	Desastre	Malla de retencion	m²	800	2	1.59	5.95	2	1	3	5	8	
		Gavion	m	42	11.56	25.22	29.94	0	1	1	1	2	
		Rejilla de retencion	m	42	20.48	39.02	53.3	1	2	3	2	5	
		Dique de Gavion	m³		12.78	28.54	35.45	0	0	0	0	0	
		Cubierta	m	62	1565	2904	4445	97	180	277	276	553	
		Drenaje frances	m		3.54	7.63	10.44	0	0	0	0	0	
	Drenaje		km	20.5	4530	29637	5826	93	608	701	119	820	
Pavimento	Capa sub-base		m²	204300	0.36	0.3	1.28	74	61	135	262	397	
	Capa base		m²	196596	0.74	1.17	2.4	145	230	375	472	847	
	Capa ligante		m²	191071	1.08	0.93	3.67	206	178	384	701	1085	
	Capa superficie		m²	187867	1.28	0.88	4.04	240	165	405	759	1164	
Puente	L≧50m		Jgo					55	107	162	153	315	
	L<50m		Jgo					87	158	245	255	500	
Tunel	Revestimiento		m	120	1022	3180	2713	123	382	505	326	831	
	Sin soporte		m	625	751	2076	2038	469	1298	1767	1274	3041	
	Portal		Pzas	4	2827	9317	7176	11	37	48	29	77	
Otros	Senal de trafico y marcacion		km	20.5	5917	1762	14069	121	36	157	288	445	
	Guarda Carril		km		47.5	427.5		0	0	0	0	0	
Costo directo de construcci				(D)				5847	8308	14155	17961	32116	
Gastos generales				(G=Dx25%)				1462	2077	3539	4490	8029	
Total				(C=D+G)				7309	10385	17694	22451	40145	1871/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				104	940	1044	1565	2609	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1, O=Ax0.9)				60	542	602	0	602	
Adquisicion de tierras y costo de compensacion				(I)				0	36	36	0	36	
Contingencias				(F=(C+E+A)x15%)				1121	1780	2901	3602	6503	
Costos de Proyecto		Con Impuestos		(C+E+A+I+F)				8594	13683	22277	27618	49895	2325/Km
		Sin Impuestos							13683	13683	27618	41301	1925/Km

Tablas 6.2-2(3) Costo de Proyecto para cada sub-seccion
(Sub-seccion 3, No.46+760 - No.60+000 L=20.24km)

Items	Costo		Unidad	Cantidad	Costo Unitario (US$) C.I. Impuestos	C.I. Otros	M.E	Costo (1000US$) C.I. Impuestos	C.I. Otros	C.I. SubTotal	M.E	Observ	Observ
Movimiento de tierras	Limpieza y desbroce		ha	20.85	2789	2599	9460	58	54	112	197	309	
	Excavacion A		m^3	319514	1.4	1.03	2.67	447	329	776	853	1629	
	Excavacion B		m^3	514153	1.42	1.38	4.72	730	710	1440	2427	3867	
	Terminado de subrasante con Compactacion		m^2	132327	0.01	0.02	0.04	1	3	4	5	9	
	Talud	Rociado de semilla	m^2	41430	0.13	1.13		5	47	52	0	52	
		Rociado de hormigon	m^2	6660	3.29	11.97	7.59	22	80	102	51	153	
		Parrillas	m^2	890	6.95	24.58	15.71	6	22	28	14	42	
		Hormigon con enrocado	m^2	400	5.15	13.68	13.12	2	5	7	5	12	
	Muro de contencion	De gravedad(4m)	m		35.21	224.54	50.02	0	0	0	0	0	
		De mamposteria	m^2	14373	4.12	27.66	4.69	59	398	457	67	524	
		Tipo parrilla	m^2	2343	17.07	67.07	30.87	40	157	197	72	269	
	Alcantarilla	Cajon 3.0×3.0	m	75	202	488	523	15	37	52	39	91	
		Cajon 4.0×4.0	m		282	696	730	0	0	0	0	0	
		Tubo ϕ1.0	m	1045	17.58	131.21	12.43	18	137	155	13	168	
	Desastre	Malla de retencion	m^2		2	1.59	5.95	0	0	0	0	0	
		Gavion	m		11.56	25.22	29.94	0	0	0	0	0	
		Rejilla de retencion	m		20.48	39.02	53.3	0	0	0	0	0	
		Dique de Gavion	m^3	3764	12.78	28.54	35.45	48	107	155	133	288	
		Cubierta	m		1565	2904	4445	0	0	0	0	0	
		Drenaje frances	m		3.54	7.63	10.44	0	0	0	0	0	
	Drenaje		km	13.1	4530	29637	5826	59	388	447	76	523	
Pavimento	Capa sub-base		m^2	129872	0.36	0.3	1.28	47	39	86	166	252	
	Capa base		m^2	124975	0.74	1.17	2.4	92	146	238	300	538	
	Capa ligante		m^2	121463	1.08	0.93	3.67	131	113	244	446	690	
	Capa superficie		m^2	119426	1.28	0.88	4.04	153	105	258	482	740	
Puente	L≧50m		Jgo					0	0	0	0	0	
	L<50m		Jgo					0	0	0	0	0	
Tunel	Revestimiento		m		1022	3180	2713	0	0	0	0	0	
	Sin soporte		m		751	2076	2038	0	0	0	0	0	
	Portal		Pzas		2827	9317	7176	0	0	0	0	0	
Otros	Senal de trafico y marcacion		km	13.1	5917	1762	14069	78	23	101	184	285	
	Guarda Carril		km	13.1	47.5	427.5		1	6	7	0	7	
Costo directo de construcci				(D)				2012	2906	4918	5530	10448	
Gastos generales				(G=Dx25%)				503	727	1230	1383	2613	
Total				(C=D+G)				2515	3633	6148	6913	13061	986/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				34	306	340	509	849	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1.0=Ax0.9)				20	176	196	0	196	
Adquisicion de tierras y costo de compensacion				(I)				0	22	22	0	22	
Contingencias				(F=(C+E+A)x15%)				385	617	1002	1113	2115	
Costos de Proyecto		Con Impuestos		(C+E+A+I+F)				2954	4754	7708	8535	16243	1227/Km
		Sin Impuestos							4754	4754	8535	13289	1004/Km

Tablas 6.2-2(4) Costo de Proyecto para cada sub-seccion
(Sub-seccion 4, No. 60+000 - No. 79+550 L=19.55km)

Items	Costo		Unidad	Cantidad	Costo Unitario (US$) C.I. Impuestos	C.I. Otros	M.E	Costo (1000US$) C.I. Impuestos	C.I. Otros	SubTotal	M.E	Total	Observ
Movimiento de tierras	Limpieza y desbroce		ha	30.3	2789	2599	9460	85	79	164	287	451	
	Excavacion A		m³	204155	1.4	1.03	2.67	286	210	496	545	1041	
	Excavacion B		m³	1078869	1.42	1.38	4.72	1532	1489	3021	5092	8113	
	Terminado de subrasante con Compactacion		m²	196742	0.01	0.02	0.04	2	4	6	8	14	
	Talud	Rociado de semilla	m²	55703	0.13	1.13		7	63	70	0	70	
		Rociado de hormigon	m²	24475	3.29	11.97	7.59	81	293	374	186	560	
		Parrillas	m²	2500	6.95	24.58	15.71	17	61	78	39	117	
		Hormigon con enrocado	m²	1810	5.15	13.68	13.12	9	25	34	24	58	
	Muro de contencion	De gravedad(4m)	m		35.21	224.54	50.02	0	0	0	0	0	
		De mamposteria	m²	2623	4.12	27.66	4.69	11	73	84	12	96	
		Tipo parrilla	m²	3573	17.07	67.07	30.87	61	240	301	110	411	
	Alcantarilla	Cajon 3.0×3.0	m	40	202	488	523	8	20	28	21	49	
		Cajon 4.0×4.0	m		282	695	730	0	0	0	0	0	
		Tubo ϕ1.0	m	1553	17.58	131.21	12.43	27	204	231	19	250	
	Desastre	Malla de retencion	m²	2000	2	1.59	5.95	4	3	7	12	19	
		Gavion	m	102	11.56	25.22	29.94	1	3	4	3	7	
		Rejilla de retencion	m		20.48	39.02	53.3	0	0	0	0	0	
		Dique de Gavion	m³	5211	12.78	28.54	35.45	67	149	216	185	401	
		Cubierta	m		1565	2904	4445	0	0	0	0	0	
		Drenaje frances	m		3.54	7.63	10.44	0	0	0	0	0	
	Drenaje		km	19.4	4530	29637	5826	88	575	663	113	776	
Pavimento	Capa sub-base		m²	193092	0.36	0.3	1.28	70	58	128	247	375	
	Capa base		m²	185811	0.74	1.17	2.4	138	217	355	445	801	
	Capa ligante		m²	180589	1.08	0.93	3.67	195	168	363	663	1026	
	Capa superficie		m²	177550	1.28	0.88	4.04	227	156	383	717	1100	
Puente	L≧50m		Jgo					117	198	315	346	661	
	L<50m		Jgo					36	78	114	99	213	
Tunel	Revestimiento		m		1022	3180	2713	0	0	0	0	0	
	Sin soporte		m		751	2076	2038	0	0	0	0	0	
	Portal		Pzas		2827	9317	7176	0	0	0	0	0	
Otros	Senal de trafico y marcacion		km	19.4	5917	1762	14069	115	34	149	273	422	
	Guarda Carril		km	19.4	47.5	427.5		1	8	9	0	9	
Costo directo de construcci				(D)				3185	4408	7593	9447	17040	
Gastos generales				(G=Dx25%)				796	1102	1898	2362	4260	
Total				(C=D+G)				3981	5510	9491	11809	21300	1090/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				55	499	554	831	1385	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1, O=Ax0.9)				32	288	320	0	320	
Adquisicion de tierras y costo de compensacion				(I)				0	26	26	0	26	
Contingencias				(F=(C+E+A)x15%)				610	945	1555	1896	3451	
Costos de Proyecto	Con Impuestos			(C+E+A+I+F)				4678	7268	11946	14536	26482	1355/Km
	Sin Impuestos								7268	7268	14536	21804	1115/Km

Tablas 6.2-2(5) Costo de Proyecto para cada sub-seccion
(Sub-seccion 5, No.79+550 - No.101+300 L=21.75km)

Items	Costo		Unidad	Cantidad	Costo Unitario (US$)			Costo (1000US$)					Observ
					C.L		M.E	C.L			M.E	Total	
					Impuestos	Otros		Impuestos	Otros	SubTotal			
Movimiento de tierras	Limpieza y desbroce		ha	36.85	2789	2599	9460	103	96	199	349	548	
	Excavacion A		m^3	642126	1.4	1.03	2.67	899	661	1560	1714	3274	
	Excavacion B		m^3	1662497	1.42	1.38	4.72	2361	2294	4655	7847	12502	
	Terminado de subrasante con Compactacion		m^2	220139	0.01	0.02	0.04	2	4	6	9	15	
	Talud	Rociado de semilla	m^2	75375	0.13	1.13		10	85	95	0	95	
		Rociado de hormigon	m^2	8229	3.29	11.97	7.59	27	99	126	62	188	
		Parrillas	m^2	1790	6.95	24.58	15.71	12	44	56	28	84	
		Hormigon con enrocado	m^2		5.15	13.68	13.12	0	0	0	0	0	
	Muro de contencion	De gravedad(4m)	m		35.21	224.54	50.02	0	0	0	0	0	
		De mamposteria	m^2	2869	4.12	27.66	4.69	12	79	91	13	104	
		Tipo parrilla	m^2	26304	17.07	67.07	30.87	449	1764	2213	812	3025	
	Alcantarilla	Cajon 3.0×3.0	m	160	202	488	523	32	78	110	84	194	
		Cajon 4.0×4.0	m		282	696	730	0	0	0	0	0	
		Tubo ϕ1.0	m	1738	17.58	131.21	12.43	31	228	259	22	281	
	Desastre	Malla de retencion	m^2	1040	2	1.59	5.95	2	2	4	6	10	
		Gavion	m		11.56	25.22	29.94	0	0	0	0	0	
		Rejilla de retencion	m	54	20.48	39.02	53.3	1	2	3	3	6	
		Dique de Gavion	m^3		12.78	28.54	35.45	0	0	0	0	0	
		Cubierta	m		1565	2904	4445	0	0	0	0	0	
		Drenaje frances	m		3.54	7.63	10.44	0	0	0	0	0	
	Drenaje		km	21.7	4530	29637	5826	98	643	741	126	867	
Pavimento	Capa sub-base		m^3	216055	0.36	0.3	1.28	78	65	143	277	420	
	Capa base		m^3	207908	0.74	1.17	2.4	154	243	397	499	896	
	Capa ligante		m^2	202065	1.08	0.93	3.67	218	188	406	742	1148	
	Capa superficie		m^2	198675	1.28	0.88	4.04	254	175	429	803	1232	
Puente	L≧50m		Jgo					0	0	0	0	0	
	L<50m		Jgo					23	35	58	71	129	
Tunel	Revestimiento		m		1022	3180	2713	0	0	0	0	0	
	Sin soporte		m		751	2076	2038	0	0	0	0	0	
	Portal		Pzas		2827	9317	7176	0	0	0	0	0	
Otros	Senal de trafico y marcacion		km	21.7	5917	1762	14069	128	38	166	305	471	
	Guarda Carril		km	21.7	47.5	427.5		1	9	10	0	10	
Costo directo de construcci				(D)				4895	6832	11727	13772	25499	
Gastos generales				(G=Dx25%)				1224	1708	2932	3443	6375	
Total				(C=D+G)				6119	8540	14659	17215	31874	1465/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				83	746	829	1243	2072	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1, 0=Ax0.9)				48	430	478	0	478	
Adquisicion de tierras y costo de compensacion				(I)				0	2	2	0	2	
Contingencias				(F=(C+E+A)x15%)				938	1457	2395	2769	5164	
Costos de Proyecto		Con Impuestos		(C+E+A+I+F)				7188	11175	18363	21227	39590	1820/Km
		Sin Impuestos							11175	11175	21227	32402	1490/Km

Tablas 6.2-2(6) Cost de Proyecto para cada sub-seccion
(Sub-seccion 6, No. 101+300 - No. 108+630 L=7.33km)

Items			Unidad	Cantidad	Costo Unitario (US$) C.L. Impuestos	C.L. Otros	M.E	Costo (1000US$) C.L. Impuestos	C.L. Otros	C.L. SubTotal	M.E	Total	Observ
Movimiento de tierras	Limpieza y desbroce		ha	7.98	2789	2599	9460	22	21	43	75	118	
	Excavacion A		m^3	167421	1.4	1.03	2.67	234	172	406	447	853	
	Excavacion B		m^3	199985	1.42	1.38	4.72	284	276	560	944	1504	
	Terminado de subrasante con Compactacion		m^2	74275	0.01	0.02	0.04	1	1	2	3	5	
	Talud	Rociado de semilla	m^2	25107	0.13	1.13		3	28	31	0	31	
		Rociado de hormigon	m^2	794	3.29	11.97	7.59	3	10	13	6	19	
		Parrillas	m^2		6.95	24.58	15.71	0	0	0	0	0	
		Hormigon con enrocado	m		5.15	13.68	13.12	0	0	0	0	0	
	Muro de contencion	De gravedad(4m)	m^2		35.21	224.54	50.02	0	0	0	0	0	
		De mamposteria	m^2	712	4.12	27.66	4.69	3	20	23	3	26	
		Tipo parrilla	m^2	1612	17.07	67.07	30.87	28	108	136	50	186	
	Alcantarilla	Cajon 3.0×3.0	m		202	488	523	0	0	0	0	0	
		Cajon 4.0×4.0	m		282	696	730	0	0	0	0	0	
		Tubo ϕ1.0	m	584	17.58	131.21	12.43	10	77	87	7	94	
	Desastre	Malla de retencion	m^2		2	1.59	5.95	0	0	0	0	0	
		Gavion	m		11.56	25.22	29.94	0	0	0	0	0	
		Rejilla de retencion	m		20.48	39.02	53.3	0	0	0	0	0	
		Dique de Gavion	m^3	2179	12.78	28.54	35.45	28	62	90	77	167	
		Cubierta	m		1565	2904	4445	0	0	0	0	0	
		Drenaje frances	m	1010	3.54	7.63	10.44	4	8	12	11	23	
	Drenaje		km	7.4	4530	29637	5826	34	219	253	43	296	
Pavimento	Capa sub-base		m^2	72897	0.36	0.3	1.28	26	22	48	93	141	
	Capa base		m^2	70148	0.74	1.17	2.4	52	82	134	168	302	
	Capa ligante		m^2	68176	1.08	0.93	3.67	74	63	137	250	387	
	Capa superficie		m^2	67033	1.28	0.88	4.04	86	59	145	271	416	
Puente	L≧50m		Jgo					0	0	0	0	0	
	L<50m		Jgo					0	0	0	0	0	
Tunel	Revestimiento		m		1022	3180	2713	0	0	0	0	0	
	Sin soporte		m		751	2076	2038	0	0	0	0	0	
	Portal		Pzas		2827	9317	7176	0	0	0	0	0	
Otros	Senal de trafico y marcacion		km	7.4	5917	1762	14069	44	13	57	104	161	
	Guarda Carril		km		47.5	427.5		0	0	0	0	0	
Costo directo de construcci				(D)				936	1241	2177	2552	4729	
Gastos generales				(G=Dx25%)				234	310	544	638	1182	
Total				(C=D+G)				1170	1551	2721	3190	5911	806/Km
Costo de ingenieria				(E=Cx6.5%) L.C=40%, F.C=60%				15	139	154	230	384	
Costo de administracion				(A=C.TOTALx1.5%, D=Ax0.1.0=Ax0.9)				9	80	89	0	89	
Adquisicion de tierras y costo de compensacion				(I)				0	5	5	0	5	
Contingencias				(F=(C+E+A)x15%)				179	266	445	513	958	
Costos de Proyecto		Con Impuestos		(C+E+A+I+F)				1373	2041	3414	3933	7347	1002/Km
		Sin Impuestos							2041	2041	3933	5974	815/Km

Tabla 6.2-3(1) Costo Directo de Construcción de Puentes

Unit : $

Name of Bridges		L. C.		F. C.	Total
		Duties	Others		
Point A Br.	ℓ = 132.5m	215313	296855	624590	1136758
Putini Br.	ℓ = 40.0m	29482	62576	84723	176781
Challa Br.	ℓ = 20.0m	16126	32476	45374	93976
Cascada Br.	ℓ = 18.0m	12850	27484	35272	75606
Alto Choro Br.	ℓ = 50.0m	50155	79609	151110	280874
Pto Leon Br.	ℓ = 75.0m	54932	107137	152700	314769
Cajones Br.	ℓ = 25.0m	18337	36256	52061	106654
Chojna Br.	ℓ = 22.0m	14020	27763	39109	80892
San Silverio Br.	ℓ = 50.0m	55234	93914	163853	313001
San Lorenzo Br.	ℓ = 52.0m	58618	98708	173469	330795
Espiritu Br.	ℓ = 52.0m	58231	98680	172688	329599
Carrasco Br.	ℓ = 30.0m	36275	78285	98843	213403
Avaroa Br.	ℓ = 25.0m	23232	34578	71059	128869
Total		642805	1074321	1864851	3581977

note Spr.S : Superstructure
Sub.S : Substructure
I : PCI-compsite Girder
B : Box Girder
A : Abutment
P : Pier

Tabla 6.2-3(2) Costo Directo de Construcción de Puentes

1.

Unit : $

Name of Bridges		L. C.		F. C.	Total
		Duties	Others		
Point A Br.	Spr.S (B)	174074	195257	516789	886120
	Sub.S (A)	4125	12273	10146	26544
(ℓ =132.5m)	(P)	37114	89325	97655	224094
	Subtotal	215313	296855	624590	1136758
Putini Br.	Spr.S (B)	21502	34974	62124	118600
	Sub.S (A)	4612	18446	14121	37179
(ℓ = 40.0m)	(P)	3368	9156	8478	21002
	Subtotal	29482	62576	84723	176781
Challa Br.	Spr.S (I)	10839	17006	31660	59505
	Sub.S (A)	5287	15470	13714	34471
(ℓ = 20.0m)	Subtotal	16126	32476	45374	93976
Cascada Br.	Spr.S (I)	8877	14953	25813	49643
	Sub.S (A)	3973	12531	9459	25963
(ℓ = 18.0m)	Subtotal	12850	27484	35272	75606
Alto Choro	Spr.S (B)	41236	53891	128976	224103
Br.	Sub.S (A)	5930	17769	14547	38246
(ℓ = 50.0m)	(P)	2989	7949	7587	18525
	Subtotal	50155	79609	151110	280874
Pto Leon Br.	Spr.S (B)	40733	65842	117659	224234
	Sub.S (A)	8169	24891	19871	52931
(ℓ = 75.0m)	(P)	6030	16404	15170	37604
	Subtotal	54932	107137	152700	314769
Cajones Br.	Spr.S (I)	13612	21701	39678	74991
	Sub.S (A)	4725	14555	12383	31663
(ℓ = 25.0m)	Subtotal	18337	36256	52061	106654
Chojna Br.	Spr.S (I)	9528	15165	27768	52461
	Sub.S (A)	4492	12598	11341	28431
(ℓ = 22.0m)	Subtotal	14020	27763	39109	80892
San Silverio	Spr.S (B)	41236	53891	128976	224103
Br.	Sub.S (A)	9740	28516	24135	62391
(ℓ = 50.0m)	(P)	4258	11507	10742	26507
	Subtotal	55234	93914	163853	313001
San Lorenzo	Spr.S (B)	43347	56709	135550	235606
Br.	Sub.S (A)	7669	23526	18614	49809
(ℓ = 52.0m)	(P)	7602	18473	19305	45380
	Subtotal	58618	98708	173469	330795

2. Unit : $

Name of Bridges		L. C.		F. C.	Total
		Duties	Others		
Espiritu Br.	Spr.S (B)	43347	56709	135550	235606
	Sub.S (A)	6245	19416	15069	40730
(ℓ = 52.0m)	(P)	8639	22555	22069	53263
	Subtotal	58231	98680	172688	329599
Carrasco Br.	Spr.S (I)	21917	34423	64125	120465
	Sub.S (A)	14358	43862	34718	92938
(ℓ = 30.0m)	Subtotal	36275	78285	98843	213403
Avaroa Br.	Spr.S (I)	20878	27006	65476	113360
	Sub.S (A)	2354	7572	5583	15509
(ℓ = 25.0m)	Subtotal	23232	34578	71059	128869

note Spr.S : Superstructure
Sub.S : Substructure
I : PCI-compsite Girder
B : Box Girder
A : Abutment
P : Pier

6.2.2 Costo de mantenimiento

El costo de mantenimiento requerido después de terminar el proyecto fue estimado en base a los trabajos mencionados en inciso 5.5. Este costo se resume en Tabla 6.2-3. El proceso detallado de estimación de costos se muestra en el Anexo 6-5.

Tabla 6.2-4 Costo de mantenimiento
(miles de dólares, a precios de 1990)
(unidad : 1000 $US)

	Gravel Road Maintenance				Asphalt Road Maintenance				Macadam Road Maintenance			
Year	L.C		F.C	Total	L.C		F.C	Total	L.C		F.C	Total
	C.D	Other			C.D	Other			C.D	Other		
1st Year	63	124	191	378	26	84	63	173	53	84	140	320
				(315)				(147)				(267)
2nd Year	63	124	191	378	26	84	63	173	53	127	140	320
				(315)				(147)				(267)
3rd Year	63	124	191	378	26	84	63	173	53	127	140	320
				(315)				(147)				(267)
4th Year	127	247	381	755	26	84	63	173	106	254	280	640
				(628)				(147)				(534)
5th Year	127	247	381	755	26	84	63	173	106	254	280	640
				(628)				(147)				(534)
6th Year	127	247	381	755	53	168	126	347	106	254	280	640
				(628)				(294)				(534)
7th Year	127	247	381	755	53	168	126	347	106	254	280	640
				(628)				(294)				(534)
:	:	:	:	:	:	:	:	:	:	:	:	:

Nota : ( ) : no incluye impuestos

6.2.3 Cómputos mètricos de Cantidades

En base al diseño preliminar, se estimaron los volúmenes de construcción, como se muestra en Tablas 6.2-1 y 6.2-2. La estimación detallada se muestra en el Anexo 6-1.

6.2.4 Costos unitarios

A través de deliberaciones con SNC, se determinaron los costos unitarios, que están representados en términos de precios a 1990.

El precio unitario se dividió en tres categorias, es decir, moneda local, moneda extranjera e impuestos. Los costos en moneda local consisten en los siguientes items :

a) materiales de construcción producidos en Bolivia, como cemento, bloques de hormigón, aceites, pinturas y maderas;
b) gastos en personal local;
c) costos de adquisición y compensación de tierras;
d) impuestos.

La parte restante de los costos es en moneda extranjera.

Para excluir impuestos del costo de proyecto, se aplicaron las siguientes relaciones :

a) equipo de construcción importado : 26.3 %
b) materiales de construcción importados : 33.3 %
c) materiales de construcción locales : 10.0 %

Los costos unitarios por item se muestran en Tabla 6.2-1. En Tabla 6.2-5, se muestran materiales y trabajos incluidos en cada item.

Tabla 6.2-5 Materiales Principales y Trabajos Incluidos en Costos Unitarios

Work Items		Unit	Material and Works
Clearing & Gruffing		ha	Cleaning and gruffing (t=30cm) Waste soil transport (L=2.0km)
Excavation A		m^3	Excavation, transportation(distance=2km), spreading and compaction for embankment. Unit price is the weighted average by expected excavation volume of common soil, soft rock and hard rock.
Excavation B		m^3	Excavation, transportation (distance=1km) to spoilbank and disposing. Unit price is the weighted average by expected excavation volume of soil, soft rock and hard rock.
Finished Rolling of Subgrade		m^3	Compacted by motor grader (3 times) and Rubber tired roller (3 times)
Slop	Seed Spraying	m^2	Speed spraying by manpower
	Concrete Spraying	m^2	Concrete t=15cm, wire netting, Anchor (L=40cm, 0.5m^2 per unit)
Retaining wall	Gravity	m	4.0 m hight
	Stone Masonry	m^2	Counterfort width B=35cm, Backfilling with concrete t=15cm, Backfilling with cobblestone t=20cm
	Grid type	m^2	Counterfort width B=1.0m
Cul-	Box	m	Concrete 2.0 x 2.0
vert	Pipe	m	Concrete pipe(600) with in-let & out-let
Pave- ment	Subbase Course	m^2	Crushed stone (t=150cm) including compaction
	Base Course	m^2	Mechanical stabilization (t=15cm) including compaction
	Binder Course	m^2	Hot-mixed asphalt t=7cm
	Surface Course	m^2	Hot-mixed asphalt t=5cm
Tunnel	Lining	m	Excavation of hard rock, concrete lining, much transport, pavement
	Unsup- ported	m	Excavation of hard rock, shotcrete, much transport, pavement
	Portal	pcs.	Potal concrete

7. EVALUACION GENERAL Y PROGRAMA DE IMPLEMENTACION

7. EVALUACION GENERAL Y PROGRAMA DE IMPLEMENTACION

7.1 Evaluación general del Proyecto

En base al amplio rango de estudios de ingenieria y economia, elaborados por el equipo de estudio del Proyecto de Mejora de 115.50 km de carretera desde Santa Bárbara hasta Bella Vista, el Proyecto fue evaluado como sigue:

(1) La Red Fundamental No. 3 (incluida la sección objeto del presente proyecto), además de ser una via troncal de la red nacional, es también una parte importante de la infraestructura necesaria para la penetración y explotación de las tierras bajas del norte.

La necesidad de desarrollar esta región del norte es una de las principales políticas nacionales, y viendo desde esta perspectiva, la región entera (excluyendo el tramo de este proyecto) ha sido o está siendo mejorada a un nivel de camino de dos vias, con buen alineamiento geométrico. Esto garantiza que los vehículos pueden transitarse en cualquier momento, a lo largo de todo el camino, incrementando eficiencia y seguridad.

Por lo tanto, el tramo en Proyecto se constituiría en un "cuello de botella", después de que estén terminados los trabajos de mejoramiento en los otros tramos, en un futuro cercano.

Por lo expuesto, se confirma que el mejoramiento del tramo en Proyecto, es esencial.

(2) Después de realizar varios estudios comparativos, se concluye que el Proyecto (por ejemplo, el alcance y método de trabajos de mejoramiento) debería ser como se describe en el siguiente inciso, "7.2 - Descripción del Proyecto".

El costos total del Proyecto, y de la construcción en este caso, han sido estimados en US$ 188 millones y US$ 152 millones, respectivamente.

Se debe prestar especial atención a los siguientes puntos en el Proyecto :

1) El alcance de las mejoras (por ejemplo, incremento de ancho del camino existente, y construcción de variantos) es como sigue :

longitud total	:	108.63 km (camino existente : 115.5 km)
por incremento de ancho	:	92.29 km (85 %)
por construcción	:	16.34 km (15 %)

2) El volumen de movimiento de tierras será considerablemente grande, y su costo contará por más de 60 % del total. Sobre todo, deben ser desechados 8.7 millones de metros cúbicos de suelo, que equivalen al 85 % del volumen total de corte.

   En el estudio se ha confirmado que es posible encontrar suficientes bancos de desecho para depositar tal volumen de material. Esto sería en las inmediaciones del camino, minimizando perturbaciones en el medio ambiente, mediante cuidadosa planificación y su habilidosa utilización.

3) Como el Proyecto incluye grandes volúmenes de excavación, se considera que desastres inevitables, como fallas de talud, ocurrirán con frecuencia después de terminar las operaciones de movimiento de tierras. Se requiere un periodo de algunos años, hasta que se pueda considerar al camino mejorado como estabilizado.

(3) Por las razones que se indican a continuación, se recomienda que el Proyecto sea implementado en dos etapas. Es decir, que el pavimento de concreto asfáltico debe ser construido en una segunda etapa, tres años después de la terminación de la primera etapa de construcción. Esto se debe hacer, a pesar de que el resultado de la evaluación económica indica que es mejor la construcción temprana de la capa de superficie.

   1) es probable que trabajos de reparación de desastres causen daños al pavimento, por lo que sería mejor tener una superficie de grava por algunos años después de terminar el movimiento de tierras, etapa en la que los desastres son más probables.

   2) asumiendo que el mejoramiento estaría terminado en el año 2000 (como se describe más adelante), en base al AASHTO Pavement Design Manual, se ha confirmado que un camino ripiado, sin capa asfáltica, abastecería a la carga esperada de tráfico, por un total de tres años, hasta 2003.

   3) Otros tramos de la Red Fundamental No. 3, adyacentes al

tramo en Proyecto, serán mejoradas usando capa de tratamiento superficial asfaltico o superficie ripiada. Considerando la continuidad y consistencia con estos tramos, no sería satisfactorio que solo este tramo tenga un pavimento de carpeta asfáltica.

En el estudio, no se ha aceptado la adopción de la capa de superficie con tratamiento superficial asfaltico, por las siguientes razones:

a) Refiriéndose a manuales comunes de diseño de pavimentos, como AASHTO, es aparente que un pavimento solo con superficie de tratamiento superficial asfaltico, no puede soportar satisfactoriamente la carga de tráfico esperada.

b) Además, la durabilidad de una capa de tratamiento superficial asfaltica es corta. En el caso del tramo en Proyecto, que está sometida a mucha lluvia (la precipitación anual estimada está entre 1,800 y 2,500 mm), una capa de tratamiento superficial asfaltico, de 3 - 3.5 cm de espesor, quedaría destruida dentro de un periodo de 5 - 7 años de su construcción, y sería necesario colocar otra capa de carpeta asfálticica en ese tiempo.

c) Comparando dos casos : 1) construyendo una superficie de tratamiento superficial asfaltico (3-3.5 cm de espesor) en el inicio, y luego colocando una nueva capa de carpeta asfáltica (espesor 12.5 cm), 5 años después, y 2) construyendo una capa de carpeta asfáltica (espesor 12.5 cm) en el inicio.

   En el estudio económico se ha confirmado que el primer caso no es necesariamente el más ventajoso, aún desde un punto de vista socio-económico. Además, a pesar de que el monto de inversión inicial sería de 7.1 % menor que en el segundo caso, el monto acumulado de inversión, hasta la construcción de la nueva superficie, sería 4.2 % más. Esto también indica que el primer caso no siempre sería más beneficioso que el segundo.

(4) En el caso de construcción en dos etapas, como se describe en la cláusula anterior, (3), el efecto socio-económico ha sido estimado como sigue:

- IRR (tasa interna de retorno) = 19.7 %
- NPV (valor actual neto - 1990) = US$ 97,625,000

Se puede considerar que estos valores indican que el Proyecto es factible para el país.

7.2 Descripción del Proyecto

El lineamiento del Proyecto recomendado, derivado como resultado del estudio, es como sigue:

(1) Generalidades

* punto de partida del Proyecto : Santa Bárbara
* punto final : Bella Vista
  (Nor Yungas, Dpto. La Paz)

* longitud de la carretera de Proyectada

camino abierto	:	107.11 km
puentes	:	0.77 km (14 puentes)
túneles	:	0.75 km (2 túneles)
Total	:	108.63 km

* características de la carretera

categoria	: Clase I.B
velocidad de diseño	: 40 km/h
ancho del camino	: 9.0 - 10.4 m (variable)
número y ancho del carril	: 2 carriles x 3.5m = 7.0m
pavimento	: con capa superficial de
capa de carpeta	carrpeta asfáltica

(2) Principales items de trabajo

* movimiento de tierras

volumen de corte	:	10,220,000 m3 (C)
volumen de relleno	:	1,513,000 m3 (E)
volumen excedente	:	8,707,000 m3 (S=C-E)

* puentes : 13 puentes

* túneles : 2 túneles

* pavimento

sub-base	: t = 15 cm;	v = 159,800 m3
base	: t = 15 cm;	v = 153,800 m3
superficie	: t = 12.5 cm;	v = 123,500 m3

* drenaje

alcantarilla cajón : 11 lugares
alcantarilla de tubo : 428 lugares
(x 20 m = 8560 m)

* muros de contención y otras estructuras

(3) Costo estimado

Tabla 7.2-1 Resumen de estimación de costos
(unid.: US$ 1,000)

	Foreign Currency	Local Currency	Total	RATE
Construction Cost	84,485	67,104	151,589	80 %
Others	19,472	17,364	36,831	20 %
Project Cost	103,957	84,468	188,420	100 %
RATE	55 %	45 %	100 %	

Un desglose de costos de Proyecto, para cada sub-sección, se muestra a continuación :

Tabla 7.2-2 Costo estimado por sub-sección

Sub-section	distance (km)	Project Cost (US$1000)	(%)	(1000$/km)
Santa Bárbara				
- Point F	25.30	48,839	25.9	1,930
- Point K	21.46	49,895	26.5	2,325
- Caranavi	13.24	16,243	8.6	1,227
- Point Q	19.55	26,482	14.1	1,355
- Point V	21.75	39,590	21.0	1,820
- Bella Vista	7.33	7,347	3.9	1,002
Total	108.63	188,420	100.0	1,735

7.3 Programa de implementación

(1) Inicio de construcción

Se asume que el inicio de los trabajos de construcción para

el Proyecto será en 1996, en base al siguiente cronograma :

- 1991 - 1993 : 2.5 años, para diseño final y estudio de impacto ambiental.
- 1994 - 1995 : 2 años, para trámites de financiamiento y licitaciones de construcción.
- 1996 : inicio de construcción.

(2) Periodo de construcción

Como se describió previamente, el Proyecto incluye un gran volumen de operaciones de movimiento de tierras. Por lo tanto, se considera que el tiempo requerido para terminar la Etapa 1 de construcción del Proyecto sería de 5 años. Asumiendo que la eficiencia de la construcción en los cinco años iniciales sea una mitad que en los otros años, para asegurar la terminación dentro de cinco años, la productividad mensual promedio sería :

* longitud de camino terminado	:	2.25 km/mes
* movimiento de tierras	:	212,000 m3/mes (aprox. 10,000 m3/dia)
* producción (costo de construcción)	:	3,925,000 US$/mes

Si la construcción se ejecuta dividiendo cada etapa del Proyecto en varias sub-secciones, las cifras indicadas serían posibles, pero no necesariamente fáciles de obtener.

(3) Cronograma de implementación

En base a las consideraciones indicadas, y asumiendo algunos hechos hasta este punto, el siguiente diagrama ha sido derivado como un cronograma de implementación:

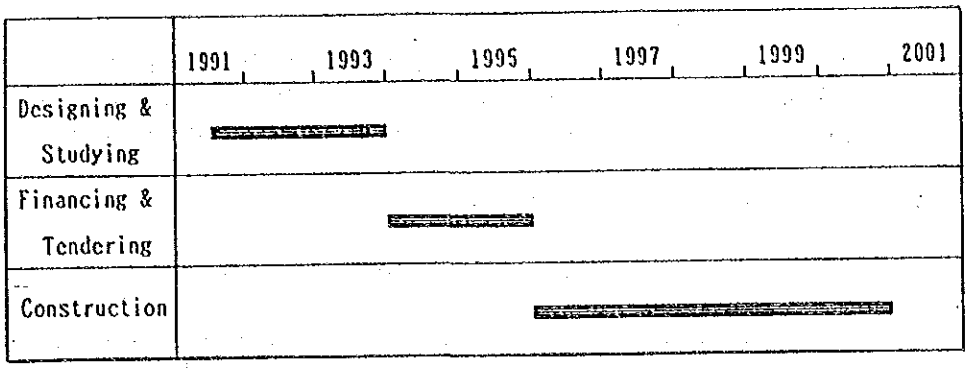


Fig. 7.3-1 Cronograma de implementación

(4) Requerimiento anual de fondos

En base al cronograma de implementación indicado, el requerimiento anual de fondos para construcción, se ha estimado como sigue :

- 1996	20.934	Millones US$
- 1997	41.872	Millones US$
- 1998	41.872	Millones US$
- 1999	41.872	Millones US$
- 2000	41.872	Millones US$
Total	188.420	Millones US$

7.4 Estudios posteriores recomendados

El diseño final del Proyecto, a ser elaborado después de este estudio, debe incluir los siguientes estudios:

(1) Levantamiento topográfico

En vista de que la topografia del area del Proyecto es accidentada y complicada, se debe preparar un mapa topográfico de precisión antes del diseño final. Como mínimo, se requieren un mapa general a escala 1:1000, y mapas en escala 1:500 de algunos sectores específicos.
Para este propósito, es necesario realizar levantamientos del terreno, detallados y suficientes, para complementar y verificar el mapa elaborado mediante fotografia aerea.

(2) Investigación de condiciones de sub-suelo

Para una estimación precisa de costo de movimiento de tierras, se debe obtener la información disponible para el diseño de la sub-estructura en los sitios de construcción de puentes, así como información fundamental para determi-

nar diseño y métodos de construcción de túneles. Además, en el curso del diseño final, se deben realizar investigaciones detalladas de las condiciones del sub-suelo.

(3) Investigación de materiales

En este estudio se ha considerado que se pueden utilizar grava y arena de los Rios Alto Beni y Suwapi, mientras que de los Rios Coroico y Yara se puede obtener material para agregados, sub-base y base, respectivamente. Parte de la roca obtenida en el movimiento de tierras también puede ser usada en las capas de sub-base y base.
Es necesario verificar que esta idea de empleo de materiales es adecuada, tanto en cantidad como en calidad, para lo cual se deben efectuar investigaciones y análisis más detallados.

(4) División de las etapas del Proyecto en sub-secciones

Como se indicó previamente, una de las características distintivas de este Proyecto es que se requiere enorme volumen de movimiento de tierras requerido. Con el objeto de terminar los trabajos en un periodo de tiempo menor, podría ser conveniente dividirlo en un limitado número de sub-secciones, y ejecutarlo empleando varios grupos de contratistas.
Cuando se disponga de un resumen del contenido del diseño final, se debe estudiar y examinar profundamente la división en sub-secciones.

(5) Determinación de areas para depósito de excedentes

Para el Proyecto se ha estimado un volumen de ocho millones de metros cúbicos de suelo excedente. Desde un punto de vista de preservación del medio ambiente, este material excedente debe ser depositado en areas pre-especificadas. Con este objeto, en el curso del diseño, se deben buscar y estudiar un suficiente número de posibles areas para este propósito.

APENDICES

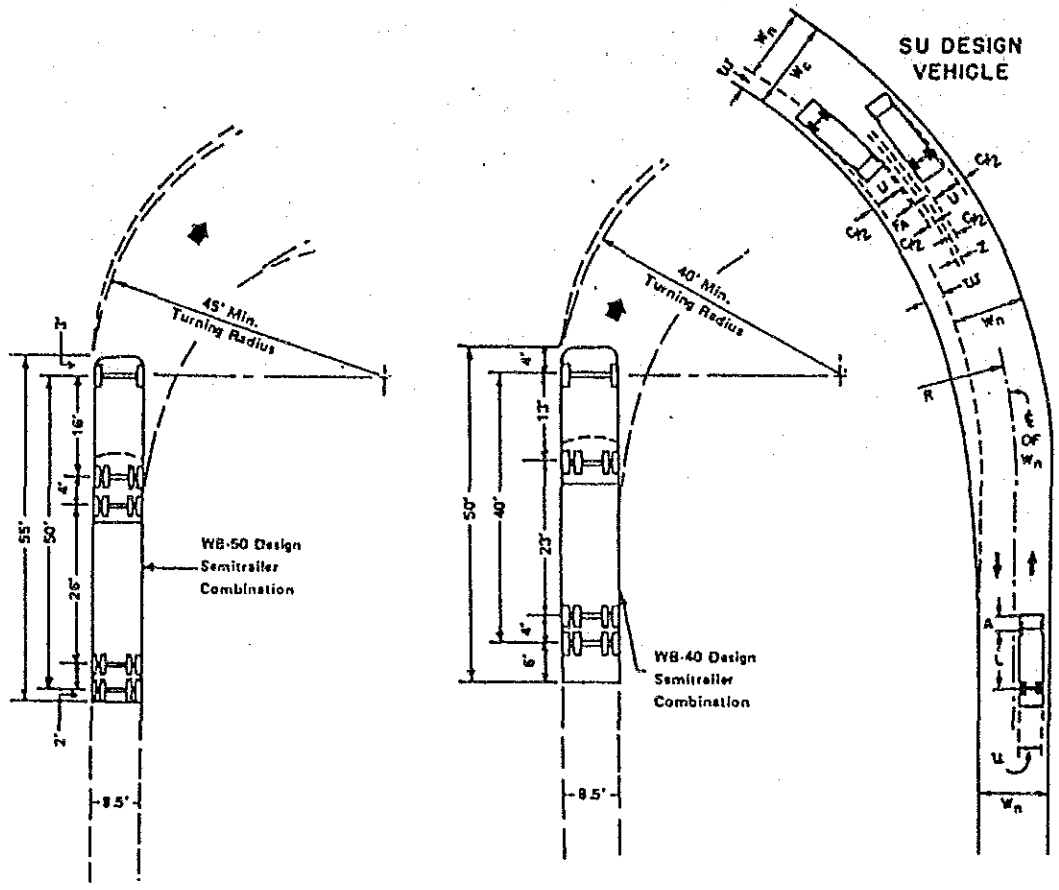
Apèndice 1-1 Lista de los Proyectos Camineros en Ejecuciòn (1984-1991)

No.	Name of Project	Location or Road No.	Length (km)	Type of Project	Cost (1000US$)	Foreign Finance	Compl. Year	Remarks
1	Approach of Chimore-Yapacani	No. 7	261	Maintenance	129100	IDB-CAF	1990	just started
* 2	Bella Vista-Quiquibey	No. 3	141	Construction	25400	Brazil	1988	finished
3	Secondary Road Phase I	LPB,Chuq.,S/Cru	1200	Const.,Improve.	17283	USAID	1991	
4	ditto Phase II	Cochabamba	260	ditto	13031	USAID	1989	
5	ditto Santa Cruz	Santa Cruz	500	ditto	24543	IDB-CAF	1990	
6	ditto Yungas	La Paz	250	ditto	5122	US	1990	
* 7	Cotapata-Santa Barbara	No. 3	38	Final Design	7120	IDB	1989	
8	Challapata-Tarapaya	No. 1	184	ditto	800	FONPLATA	1989	
9	Chimore-Yapacani	No. 7	151	Construction	139556	IDB-CAF	1988	
10	Agricultural Area,North Chuqui	Chuquisaca	72	Const.,Improve.	1087	FIDA	1988	
*11	Guayaramerin-Santa Rosa	No. 8	410	Maintenance	2500	JICA		starting
12	Padcaya-Bermejo	No. 1	160	Final design	596	FONPLATA	1988	
*13	Pave.,La Paz-Cotapata	No. 3	10	Construction	1661		1989	
*14	Porvenir-Chive	No. 2	180	ditto	5010		1989	
15	Maintenance, South Region		3250	Maintenance	36539	CAF	1990	
16	Puerto Rico-Nueva Ethea	Pando, Beni	81	Construction	648		1989	
17	Cotagaita-San Juan del Oro	Potosi	90	Const.,Improve.	2058	FIDA	1991	
18	Parnar Grande-Yacuiba	No. 9	60	Construction	22540	FONPLATA	1990	
*19	Yucumo-Rurrenabaque	No. 2	102	ditto	25300	OECF	1988	
20	Confital-Caihuasi	No. 4	50	ditto	55350	IDB	1992	tendering now
21	Sanaipata-Taruma	Santa Cruz	70	Maintenance	7882	IDB	1991	
*22	San Borja-Trinidad	No. 3	228	Feasib. Study	2924	JICA	1988	
23	San Julian	Santa Cruz	250	Maintenance	3869	Germany	1991	
24	Santa Cruz-Trinidad	No. 9	544	Construction	47815	FONPLATA	1993	
*25	San Buenaventura-Cobija	No. 2	540	Feasib. Study	1177	CAF	1990	
*26	Santa Ana-Santa Rosa	Beni	150	Final design	600		1989	
*27	Santa Rosa-Riberalta	No. 8	410	Construction	4100		1989	
*28	San Buenaventura-Ixiamas	No. 2	110	Improvement	4853		1993	
29	Sucre-Ipati	No. 6	440	Final Design	1500	IDB	1990	
*30	Quiquibey-Yucumo	No. 3	41	Const.,Improve.	46757	IDB	1992	
31	Totacoa-Puente Mendez	Chuquisaca	30	Construction	12975	FONPLATA	1991	tendering now
*32	Cobija-Conquista	Pando	225	Maintenance	2500	JICA		

Note : 1) The Projects marked with an asterisk are considered to be related with this Study.
2) Bridge construction projects are not included in this table.

Apèndice 4-1 Càlculo del Sobrcancho en Curvas

AASHTO's Formula (WB 50/40)



(1) $w = W_c - W_n$

(2) $W_c = N(U+C) + (N-1)F_A + Z$

N = Number of lanes
w = widening for pavement on curve, ft.
W_c = width of pavement on curve, ft.

W_n = width of pavement on tangent, ft.
U = track width of vehicle (out-to-out tires), ft.
C = lateral clearance per vehicle; assumed 2,2.5 & 3 ft for W_n of 20, 22 & 24 ft, respectively.
F_A = width of front overhang, ft.
Z = extra width allowance for difficulty of driving on curves, ft.

(3) $U = u + R - \sqrt{R^2 - L^2}$

(4) $F_A = \sqrt{R^2 + A(2L + A)} - R$

(5) $Z = .V/\sqrt{R}$

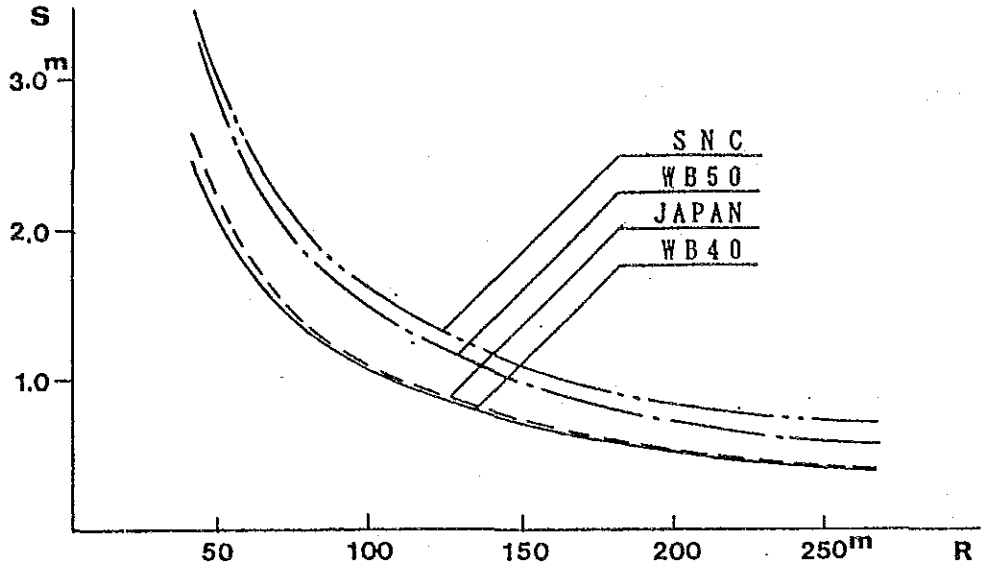
u = track width on tangent (out-to-out) 8.5 ft
R = radius on centerline of 2-lane pavement, ft
L = wheelbase
A = front overhang
V = design speed of highway, mph

SNC's Formula (SR=WB50)

$$S = 2\left(R - \sqrt{R^2 - (L_1^2 + L_2^2)}\right) + \left(\sqrt{R^2 + A(2L_1 + A)} - R\right) + \frac{V}{10\sqrt{R}}$$

$$= 2(U - u) + F_A + Z \qquad = W + (Wn - 2(u + C))$$

R=45 → (WB50) 2.56 + 0.12 + 0.62 = 3.26



Pavement Widening on Curves (See Table 6.1-5)

Apéndice 4-2 Estimaciones del Costo de las Alternativas (Alineamiento Geométrico)

Comparison of Cost Estimation of Construction for Road Improvement

Item			Unit	Unit Cost	Improvement of Existing Road		New Alignment		Dual Carriage Way Road	
					Volume	Cost	Volume	Cost	Volume	Cost
Clearing and Grubbing			m^2	3.94	27,500	108,350	33,000	130,020	38,000	149,720
Excavation of Road	Soil		m^3	3.04	29,525	89,756	57,750	175,560	35,475	107,844
	Soft Rock		m^3	12.13	17,715	214,883	35,650	420,304	21,285	258,187
	Hard Rock		m^3	15.03	11,810	177,504	23,100	347,193	14,190	213,276
Embankment			m^3	5.03	0	0	0	0	0	0
Pavement			m^2	16.68	9,000	150,120	9,000	150,120	11,000	183,480
Slope	Cut	Soil	m^2	1.31	11,500	15,065	14,000	18,340	15,825	20,731
		Rock	m^2	21.10	11,500	242,650	14,000	295,400	15,825	333,907
	Embankment		m^2	1.31	0	0	0	0	0	0
Drainage			Km	23,266	1.0	23,266	1.0	23,266	2.0	40,942
Direct Cost						1,021,594		1,560,203		1,308,087
Indirect Cost(25%)						255,399		390,051		327,022
Construction Cost						1,276,993		1,950,254		1,635,109

Cost Estimation around Point (L) (Santa Ana)

Item			Unit	Unit Cost	Improvement of Existing Road		New Alignment	
					Volume	Cost	Volume	Cost
Clearing and Grubbing			m^2	3.94	70,770	278,834	67,600	266,344
Excavation of Road	Soil		m^3	3.04	152,285	462,946	122,378	372,029
	Soft Rock		m^3	12.13	65,265	791,664	52,447	636,182
	Hard Rock		m^3	15.03	—	—	—	—
Embankment			m^3	5.03	31,500	158,445	44,625	224,464
Pavement			m^2	16.68	27,000	450,360	21,600	360,288
Slope	Cut	Soil	m^2	1.31	31,563	41,348	26,460	34,663
		Rock	m^2	21.10	13,527	285,420	11,340	239,274
	Embankment		m^2	1.31	5,700	7,467	9,180	12,026
Drainage			Km	23,266	3.0	69,798	2.4	55,838
Direct Cost						2,546,282		2,221,108
Indirect Cost(25%)						636,571		555,727
Construction Cost						3,182,853		2,776,385

Cost Estimation from Point (H) +2.5Km to (I) +0.35Km

Item			Unit	Unit Cost	Improvement of Existing Road (Earth-Work)		New Alignment (Tunnel)		Improvement of Existing Road (Semi-Tunnel)		Dual Carriage Way Road (One-lane Tunnel+Steg)	
					Volume	Cost	Volume	Cost	Volume	Cost	Volume	Cost
Clearing and Grubbing			m^2	3.94	–	–	–	–	–	–	–	–
Excavation of Road	Soil		m^3	3.04	–	–	–	–	–	–	–	–
	Soft Rock		m^3	12.13	–	–	–	–	–	–	–	–
	Hard Rock		m^3	15.03	587,195	8,825,541	13,394	201,312	84,450	1,269,284	13.069	196,427
Embankment			m^2	5.03	–	–	475	2,389	–	–	475	2,389
Pavement			m^2	15.68	8,235	137,360	1,710	28,523	7,105	118,511	2,708	45,169
Slope	Cut	Soil	m^2	1.31	–	–	–	–	–	–	–	–
		Rock	m^2	21.10	–	–	–	–	–	–	–	–
	Embankment		m^2	1.31	–	–	–	–	–	–	–	–
Drainage			Km	23,266	0.915	21,288	0.19	4,421	0.25	5,817	0.19	4,421
Bridge	50m <	Superstructure	m^2	1,730	620.5	850,085	–	–	620.5	850,085	446.25	604,513
		Substructure	m^3	278	627.8	174,528	–	–	627.8	174,528	508.5	141,363
	50m >	Superstruture	m^2	584	–	–	225.0	131,400	–	–	131.25	76,650
		Substruture	m^3	278	–	–	179.5	49,901	–	–	127.5	35,445
Tunnel	Lining		m	5,833	–	–	120	705,960	–	–	–	–
	Excavation without Timbering		m	4,547	–	–	615	2,796,405	–	–	–	–
One-lane Tunnel	Lining		m	4,309	–	–	–	–	–	–	120	517,080
	Excavation without Timbering		m	3,331	–	–	–	–	–	–	615	2,048,565
Semi-Tunnel			m	6,846	–	–	–	–	665	2,215,115	–	–
Steg			m	890	–	–	–	–	–	–	765	680,850
Retaining wall (H=6.8m)			m	670	–	–	95	63,650	–	–	95	63,650
Direct Cost						10,008,802		3,983,961		4,633,342		4,416,522
Indirect Cost(25%)						2,502,201		995,990		1,158,336		1,104,131
Construction Cost						12,511,003		4,979,951		5,791,678		5,520,653

Cost Estimation around Point (O) +1.8Km

Item			Unit	Unit Cost	Improvement of Existing Road		New Alignment	
					Volume	Cost	Volume	Cost
Clearing and Grubbing			m²	3.94	17,370	68,438	13,335	52,540
Excavation of Road	Soil		m³	3.04	65,363	195,664	21,000	63,840
	Soft Rock		m³	12.13	28,012	339,786	9,000	109,170
	Hard Rock		m³	15.03	—	—	—	—
Embankment			m³	5.03	—	—	6,188	31,126
Pavement			m²	16.68	5,400	90,072	4,860	81,065
Slope	Cut	Soil	m²	1.31	10,962	14,360	4,069	5,330
		Rock	m²	21.10	4,698	99,128	1,744	36,798
	Embankment		m²	1.31	—	—	2,475	3,242
Drainage			Km	23,266	0.60	13,956	0.54	12,560
Direct Cost						821,404		395,671
Indirect Cost(25%)						205,351		98,918
Construction Cost						1,026,755		494,589

Cost Estimation Around Point (Q) +5Km

Item			Unit	Unit Cost	Improvement of Existing Road		New Alignment	
					Volume	Cost	Volume	Cost
Clearing and Grubbing			m²	3.94	22,360	88,098	21,300	83,922
Excavation of Road	Soil		m³	3.04	33,677	102,378	17,750	53,960
	Soft Rock		m³	12.13	33,677	408,502	17,750	215,308
	Hard Rock		m³	15.03	-	-	-	-
Embankment			m³	5.03	9,675	48,965	22,137	111,349
Pavement			m²	16.68	10,800	180,144	10,800	180,144
Slope	Cut	Soil	m²	1.31	10,815	14,168	4,200	5,502
		Rock	m²	21.10	10,815	228,197	4,200	88,620
	Embankment		m²	1.31	1,100	1,441	6,050	7,926
Drainage			Km	23,266	1.2	27,919	1.2	27,919
Direct Cost						1,099,512		774,650
Indirect Cost(25%)						274,878		193,663
Construction Cost						1,374,390		968,313

Cost Estimation from Point ② to ④

Item	Unit	Unit Cost	Earthwork		Tunnel	
			Volume	Cost	Volume	Cost
Length of Earthwork	m	1,675	4,600	7,705,000	3,640	6,097,000
Tunnel	m	7,354	-	-	500	3,677,000
Total				7,705,000		9,774,000

Cost Estimation from Point ⑤ to ⑦

Item			Unit	Unit Cost	New Alignment (Earth-Work)		New Alignment (Tunnel)	
					Volume	Cost	Volume	Cost
Clearing and Grubbing			m^2	3.94	33,047	130,205	21,311	83,965
Excavation of Road	Soil		m^3	3.04	36,070	109,653	23,994	72,942
	Soft Rock		m^3	12.13	72,141	875,070	47,987	582,082
	Hard Rock		m^3	15.03	72,141	1,084,279	47,987	721,245
Embankment			m^3	5.03	33,616	169,088	47,952	241,199
Pavement			m^2	16.68	12,105	201,911	6,075	101,331
Slope	Cut	Soil	m^2	1.31	3,756	4,920	1,636	2,143
		Rock	m^2	21.10	33,808	713,349	14,724	310,676
	Embankment		m^2	1.31	2,271	2,975	4,108	5,381
Drainage			Km	23,266	1.3	30,246	1.1	25,593
Tunnel	Lining		m	5,833	-	-	60	705,960
	Excavation without Timbering		m	4,547	-	-	390	2,796,405
Retaining wall (H=7.0m)			m	670	35	-	-	-
Direct Cost						3,345,146		4,272,867
Indirect Cost(25%)						836,287		1,068,217
Construction Cost						4,181,433		5,341,084

Cost Estimation from Point ⑥ to ⑧

Item	Unit	Unit Cost	Earthwork		Long-span Bridge	
			Volume	Cost	Volume	Cost
Length of Earthwork	m	1,675	1,800	3,015,000	710	1,189,250
Long-span Bridge	m^2	5,400	-	-	1,825	9,855,000
Total				3,015,000		11,044,250

Cost Estimation from Point (S) to (V)

Item			Unit	Unit Cost	Improvement of Existing Road		New Alignment	
					Volume	Cost	Volume	Cost
Clearing and Grubbing			m^2	3.94	307,180	1,210,289	293,650	1,156,981
Excavation of Road	Soil		m^3	3.04	468,600	1,424,544	329,840	1,002,714
	Soft Rock		m^3	12.13	351,450	4,263,089	247,380	3,000,719
	Hard Rock		m^3	15.03	351,450	5,282,294	247,380	3,718,121
Embankment			m^3	5.03	377,100	1,896,813	259,875	1,307,171
Pavement			m^2	16.68	123,930	2,067,152	116,550	1,944,054
Slope	Cut	Soil	m^2	1.31	105,874	138,695	59,584	78,055
		Rock	m^2	21.10	158,811	3,350,912	89,376	1,885,833
	Embankment		m^2	1.31	31,500	41,265	50,820	66,574
Drainage			Km	23,266	13.77	320,373	12.95	301,295
Direct Cost						19,995,426		14,461,517
Indirect Cost (25%)						4,998,857		3,615,379
Construction Cost						24,994,283		18,076,896

Apèndice 4-3 Estimaciones del Costo de las Alternativas (Puentes)

B- 1

Point A (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	5,095	8.48	43,206	
(Soft Rock)		m^3	20,379	12.13	247,197	$\Sigma V=25,474m^2$
(Hard Rock)		m^3		-	-	
Pavement (Carriage Way)		m^2	1,555	16.68	25,937	
Sub-Total					316,340	
Bridge (Superstructure)		m^2	1,235	1,370	1,691,950	ℓ=130m
(Abutment)		m^3	130.2	278.4	36,248	
(Pier)		m^3	738.8	251.5	185,808	
Sub-Total					1,914,006	
Total					2,230,346	

B- 2

Point A (Poute ②) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	591	8.48	5,012	
(Soft Rock)		m^3	2,366	12.13	28,700	$\Sigma V=2,957m^2$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	808	16.68	13,477	
Sub-Total					47,189	
Bridge (Superstructure)		m^2	1,283	1,370	1,751,710	ℓ=135m
(Abutment)		m^3	130.2	278.4	36,248	
(Pier)		m^3	996.0	251.5	250,494	
Sub-Total					2,044,452	
Total					2,091,641	

B－ 3

Patuni (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	17,220	8.48	146,026	
(Soft Rock)		m^3	43,050	12.13	522,197	$\Sigma V=86,100m^3$
(Hard Rock)		m^3	25,870	15.03	388,826	
Pavement (Carriage Way)		m^2	7,015	16.68	117,010	
Sub-Total					1,174,059	
Bridge (Superstructure)		m^2	312	830	258,960	ℓ=30m
(Abutment)		m^3	215.6	278.4	60,023	
(Pier)		m^3	-	-	-	
Sub-Total					318,983	
Total					1,493,042	

B－ 4

Patuni (Poute ②) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	7,820	8.48	66,314	
(Soft Rock)		m^3	19,550	12.13	237,142	
(Hard Rock)		m^3	11,730	15.03	176,302	$\Sigma V=39,100m^3$
Pavement (Carriage Way)		m^2	6,325	16.68	105,501	
Sub-Total					585,259	
Bridge (Superstructure)		m^2	468	830	398,440	ℓ=45m
(Abutment)		m^3	215.6	278.4	60,023	
(Pier)		m^3	221.5	251.5	55,707	
Sub-Total					514,170	
Total					1,099,429	

B－ 5

Patuni (Poute ③) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	3,449	8.48	29,248	
(Soft Rock)		m^3	8,623	12.13	104,597	$\Sigma V=17,246m^3$
(Hard Rock)		m^3	5,174	15.03	77,765	
Pavement (Carriage Way)		m^2	3,335	16.68	55,628	
Sub-Total					267,238	
Bridge (Superstructure)		m^2	797	1,370	1,091,890	$\ell=90m$
(Abutment)		m^3	118.8	2778.4	33,074	
(Pier)		m^3	1,045.0	251.5	262,818	
Sub-Total					1,387,782	
Total					1,655,020	

B－ 6

Challa (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	23,740	8.48	201,315	
(Soft Rock)		m^3	12,002	12.13	145,584	$\Sigma V=35,742m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	6,785	16.68	113,174	
Sub-Total					460,073	
Bridge (Superstructure)		m^2	312	830.0	258,960	$\ell=30m$
(Abutment)		m^3	118.8	278.4	33,074	
(Pier)		m^3	-	-	-	
Sub-Total					292,034	
Total					752,107	

B－ 7

Challa (Poute ②) Unit :US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	12,220	8.48	103,626	
(Soft Rock)		m^3	10,137	12.13	122,962	$\Sigma V=22,357m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	5,980	16.68	99,746	
Sub-Total					326,334	
Bridge (Superstructure)		m^2	570	830	473,100	$\ell=60m$
(Abutment)		m^3	143.4	278.4	39,922	
(Pier)		m^3	150.9	251.5	37,951	
Sub-Total					550,973	
Total					877,307	

B－ 8

Challa (Poute ③) Unit :US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	15,480	8.48	131.270	
(Soft Rock)		m^3	5,834	12.13	70.766	$\Sigma V=21,314m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	3,196	16.68	53,209	
Sub-Total					255,245	
Bridge (Superstructure)		m^2	946	1,370.0	1,296,020	$\ell=110m$
(Abutment)		m^3	115.4	278.4	32,127	
(Pier)		m^3	351.2	251.5	88,327	
Sub-Total					1,416,474	
Total					1,671,719	

B－ 9

San Silverio (Poute ①) Unit :US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	1,030	8.48	8,734	
(Soft Rock)		m^3	8,950	12.13	108,563	$\Sigma V=9,980m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	2,280	16.68	38,030	
Sub-Total					155,327	
Bridge (Superstructure)		m^2	380	830	315,400	$\ell=60m$
(Abutment)		m^3	118.8	278.4	33,074	
(Pier)		m^3	150.9	251.5	37,951	
Sub-Total					386,425	
Total					541,752	

B－ 10

San Silverio (Poute ②) Unit :US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	680	8.48	5,766	
(Soft Rock)		m^3	3,584	12.13	43,474	$\Sigma V=4,264m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	1,805	16.68	30,107	
Sub-Total					79,347	
Bridge (Superstructure)		m^2	760	830.0	361,000	$\ell=50m$
(Abutment)		m^3	143.4	278.4	39,923	
(Pier)		m^3	150.9	251.5	37,951	
Sub-Total					438,874	
Total					518,221	

B- 11

San Lorenzo (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	87,300	8.48	740,304	
(Soft Rock)		m^3	52,380	12.13	635,369	
(Hard Rock)		m^3	34,920	15.03	524,848	$\Sigma V=174,600m^3$
Pavement (Carriage Way)		m^2	7,125	12.90	91,913	
Sub-Total					1,992,434	
Bridge (Superstructure)		m^2	475	830	394,250	$\ell=50m$
(Abutment)		m^3	129.0	278.4	35,914	
(Pier)		m^3	183.8	251.5	46,226	
Sub-Total					476,390	
Total					2,468,824	

B- 12

Sqan Lorengo (Poute ②) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	56,330	8.48	477,678	
(Soft Rock)		m^3	33,798	12.13	409,970	
(Hard Rock)		m^3	22,532	15.03	338,656	$\Sigma V=112,660m^3$
Pavement (Carriage Way)		m^2	6,650	12.90	85,785	
Sub-Total					1,312,089	
Bridge (Superstructure)		m^2	570	830	473,100	$\ell=60m$
(Abutment)		m^3	167.3	278.4	46,576	
(Pier)		m^3	183.8	251.5	42,226	
Sub-Total					565,902	
Total					1,877,991	

B- 13

San Lorenzo (Poute ③) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	33,669	8.48	285,513	
(Soft Rock)		m^3	20,201	12.13	245,038	
(Hard Rock)		m^3	13,467	15.03	202,409	$\Sigma V=67,337m^3$
Pavement (Carriage Way)		m^2	2,850	12.90	36,765	
Sub-Total					769,725	
Bridge (Superstructure)		m^2	1,118	1,370	1,531,660	ℓ=130m
(Abutment)		m^3	167.3	278.4	46,576	
(Pier)		m^3	630.3	251.5	158,520	
Sub-Total					1,736,756	
Total					2,506,481	

B- 14

Espiritú (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	15,500	8.48	131,440	
(Soft Rock)		m^3	15,792	12.13	191,552	$\Sigma V=31,292m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	2,871	12.90	37,035	
Sub-Total					360,027	
Bridge (Superstructure)		m^2	364.0	830.0	302,120	ℓ=35m
(Abutment)		m^3	105.8	278.4	29,455	
(Pier)		m^3	164.0	251.5	41,246	
Sub-Total					372,821	
Total					732,848	

B- 15

Espiritú (Poute ②) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	5,248	8.48	44,503	
(Soft Rock)		m^3	5,100	12.13	61,863	$\Sigma V=10,348m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	2,876.6	12.90	37,109	
Sub-Total					143,475	
Bridge (Superstructure)		m^2	475	830	394,250	$\ell=50m$
(Abutment)		m^3	123.0	278.4	34,243	
(Pier)		m^3	286.5	251.5	72,055	
Sub-Total					500,548	
Total					643,220	

B- 16

Espiritú (Poute ③) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	1,300	8.48	11,024	
(Soft Rock)		m^3	1,100	12.13	13,343	$\Sigma V=2,400m^3$
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	1,490	12.90	19,217	
Sub-Total					43,584	
Bridge (Superstructure)		m^2	920	1,370	1,260,400	$\ell=100m$
(Abutment)		m^3	123.0	278.4	34,243	
(Pier)		m^3	351.2	251.5	88,327	
Sub-Total					1,382,970	
Total					1,426,554	

B- 17

Pto Leon (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	-	-	-	
(Soft Rock)		m^3	8,647	12.13	104,888	
(Hard Rock)		m^3	-	-	-	
Stone Masonry		m^2	532	28.56	15,208	
Pavement (Carriage Way)		m^2	1,155	16.68	19,265	
Sub-Total					139,361	
Bridge (Superstructure)		m^2	523	730	381,790	I -Section ℓ=55m
(Abutment)		m^3	118.8	278.4	33,073	
(Pier)		m^3	-		414,863	
Sub-Total					554,224	
Total						

B- 18

Pto Leon (Poute ②) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	-	-	-	
(Soft Rock)		m^3	23,060	12.13	279,718	
(Hard Rock)		m^3	-	-	-	
Pavement (Carriage Way)		m^2	1,710	16.18	28,523	
Sub-Total					308,241	
Bridge (Superstructure)		m^2	312.0	830.0	258,960	ℓ=30m
(Abutment)		m^3	135.8	278.4	37,806	
(Pier)		m^3	-	-	-	
Sub-Total					296,766	
Total					605,007	

B- 19

Carrasco (Poute ①) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m³	41,123	8.48	348,723	
(Soft Rock)		m³	-	12.13	-	
(Hard Rock)		m³	-	15.03	-	
Seed Spraying		m²	6,388	1.31	8,368	
Pavement (Carriage Way)		m²	2,647	12.90	34,151	
Sub-Total					391,242	
Bridge (Superstructure)		m²	126.5	584.0	73,876	ℓ=65m
(Abutment)		m³	281.4	278.4	78,342	
(Pier)		m³	-	-	-	
Sub-Total					152,218	
					543,460	

B- 20

Carrasco (Poute ②) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m³	5,473	8.48	46,411	
(Soft Rock)		m³	-	12.13	-	
(Hard Rock)		m³	-	15.03	-	
Seed Spraying		m²	1,254	1.31	1,643	
Pavement (Carriage Way)		m²	1,980	12.90	25,543	
Sub-Total					73,597	
Bridge (Superstructure)		m²	354.0	584.0	206,736	ℓ=30m
(Abutment)		m³	316.2	278.4	88,030	
(Pier)		m³	-	251.5	-	
Sub-Total					294,766	
					368,363	

B- 21

Carrasco (Poute ③) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3	4,289	8.48	36,371	
(Soft Rock)		m^3	-	12.13	-	
(Hard Rock)		m^3	-	15.03	-	
Seed Spraying		m^2	1,026	1.31	1,344	
Pavement (Carriage Way)		m^2	1,547	12.90	19,959	
Sub-Total					57,674	
Bridge (Superstructure)		m^2	585.0	584.0	341,640	ℓ=23m
(Abutment)		m^3	281.4	278.4	78,342	
(Pier)		m^3	39.3	251.5	9,884	
Sub-Total					429,866	
Total					487,540	

B-

(Poute) Unit : US$

Name of Work	Type	Unit	Volume	Unit Cost	Cost	Remarks
Excavation (Soil)		m^3				
(Soft Rock)		m^3				
(Hard Rock)		m^3				
Pavement (Carriage Way)		m^2				
Sub-Total						
Bridge (Superstructure)		m^2				
(Abutment)		m^3				
(Pier)		m^3				
Sub-Total						
Total						

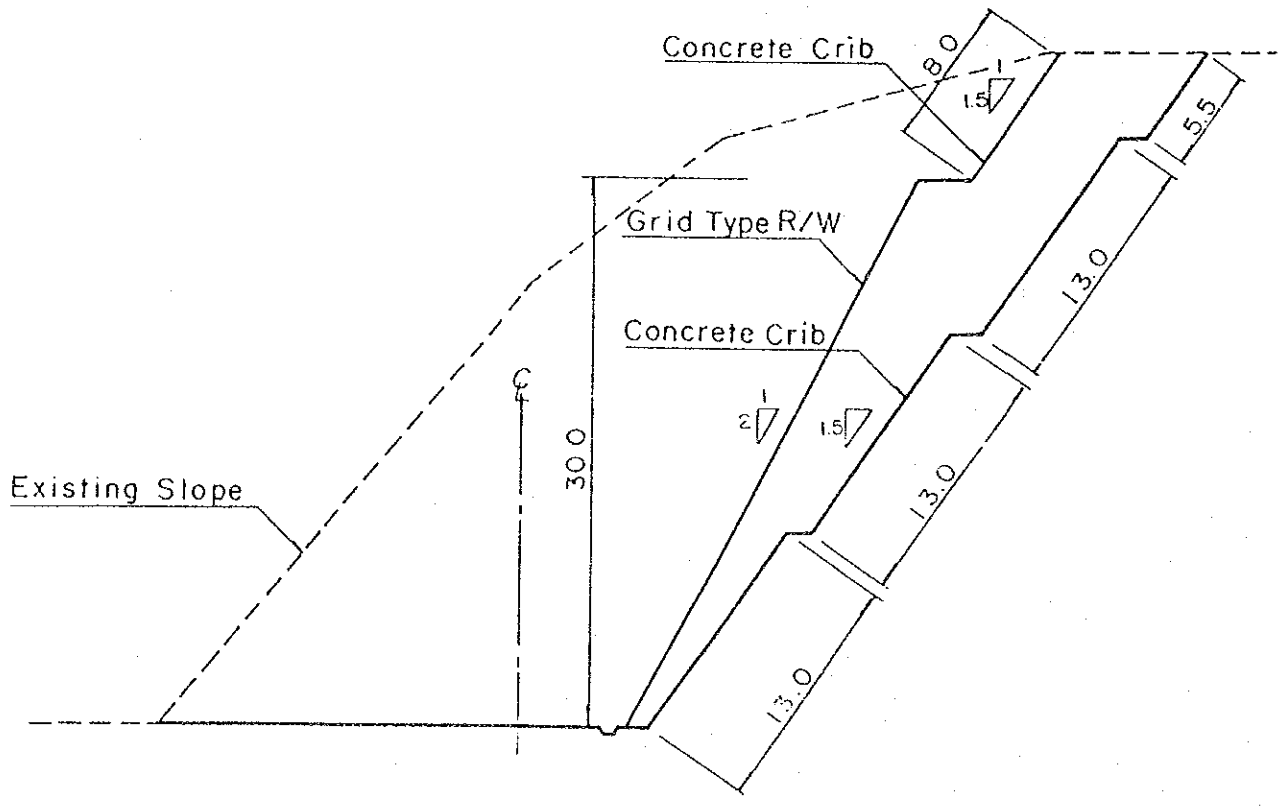
Apêndice 4-4 Prevenciones(s) Optimas

(1) Selection for S.B. + 0.8 / No.0 + 700

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring 1)
- Grid Type Concrete Retaining Wall + Concrete Crib 2)

Optimum Countermeasure:
As described below, Grid Type Concrete Retaining Wall (+) Concrete Crib is advantageous to the location in economical view point.

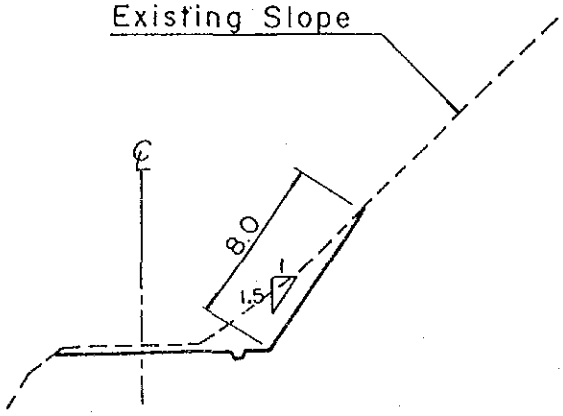
		Unit	Quantity	Unit Cost	Cost	Remarks
1)	Concrete Crib	m^2	2,225	51.08 US	113,653 US	
	Excavation	m^3	46,362	12.13	562,371	
	Total				676,024	
2)	Retaining Wall	m^2	1,677	124.95	209,541	
	Concrete Crib	m^2	400	51.08	20,432	
	Excavation	m^3	36,150	12.13	438,499	
	Total				668,472	



(2) Selection for S.B. + 2.3 / No.2 + 200

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

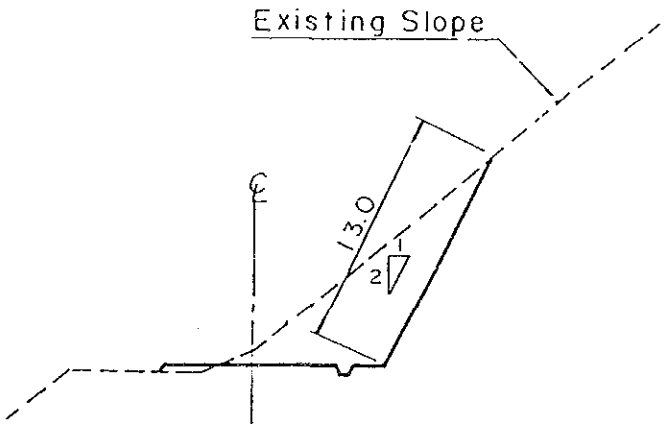
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(3) Selection for B + 1.9 / No.8 + 100

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

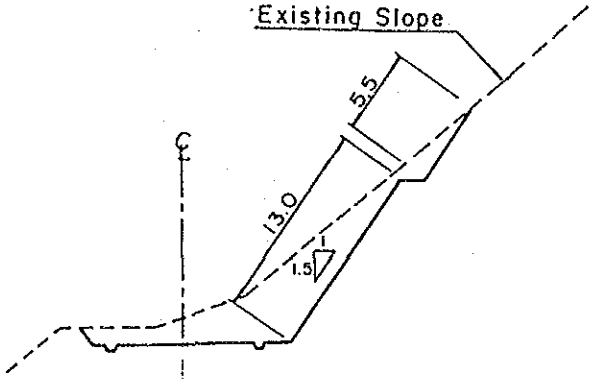
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(4) Selection for C + 0.4 / No.10 + 900

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

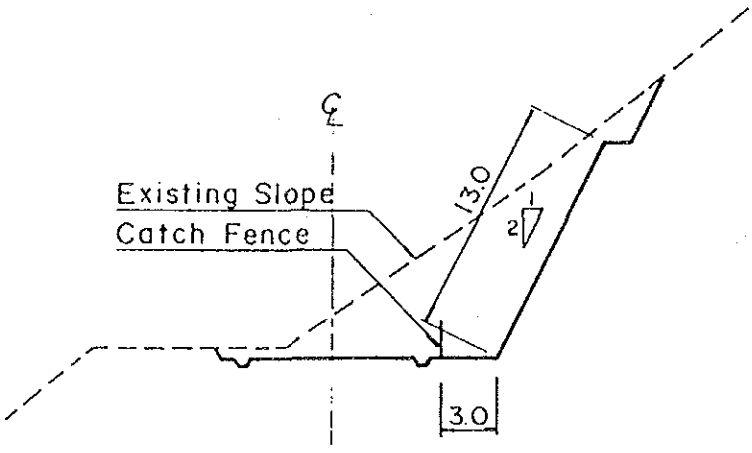
Optimum Countermeasures:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(5) Selection for C + 2.6 / No.12 + 780

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring + Catch Fence installed at road side
- Grid Type Concrete Retaining Wall + Catch Fence installed at road side

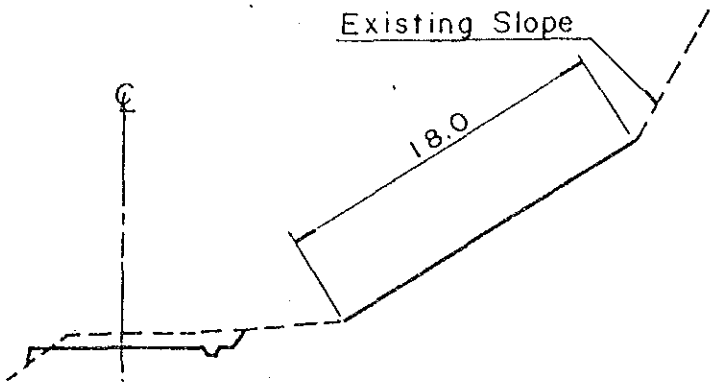
Optimum Countermeasures:
As illustrated below, Concrete Crib + Catch Fence is adaptable to the location in topographical view point.



(6) Selection for F + 4.2 / No.29 + 500

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.

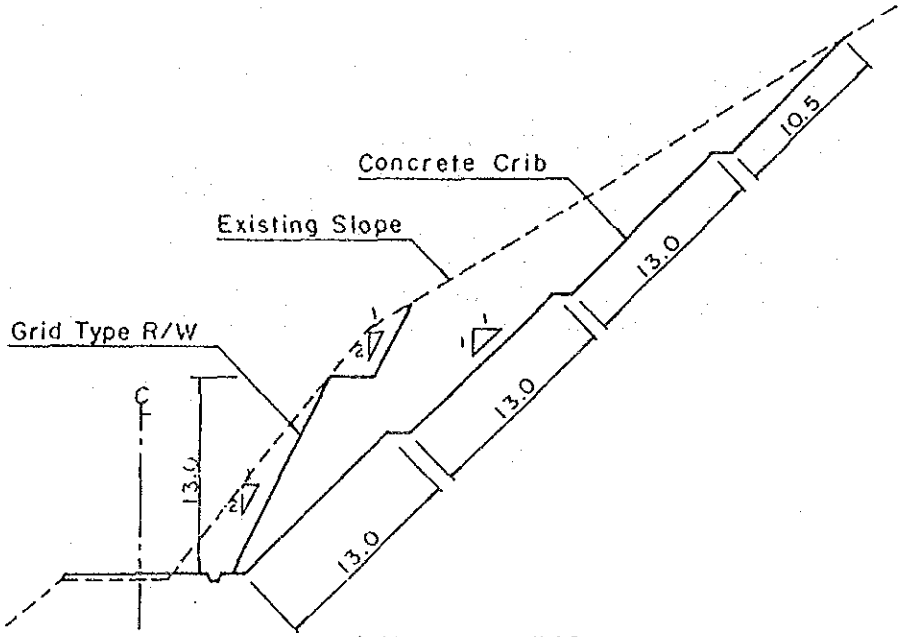


(7) Selection for H + 1.0 / No.33 + 700

Applicable Countermeasures:
- Concrete Crib with stone pitching and Anchoring + Gabion Catch Wall
- Grid Type Concrete Retaining Wall + Gabion Catch Wall

Optimum Countermeasure:
As described below, Grid Type Concrete Retaining Wall + Gabion Catch Wall is advantageous to the location in economical and topographical view points.

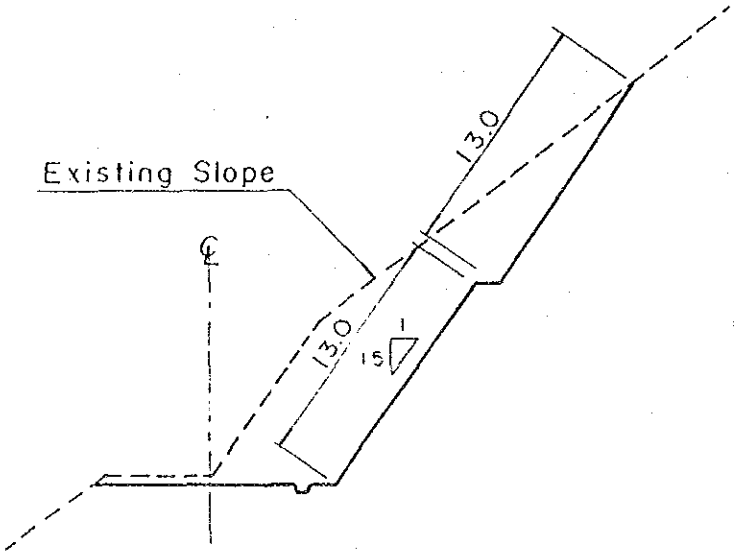
	Unit	Quantity	Unit Cost	Cost	Remarks
Concrete Crib	m^2	1,980	52.40 US	103,752 US	
Excavation	m^3	7,340	12.13	89,034	
Total				192,786	
Retaining Wall	m^2	581	124.95	72,595	
Excavation	m^3	1,539	12.13	18,668	
Total				91,263	



(8) Selection for I + 3.0 / No.38 + 740

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.

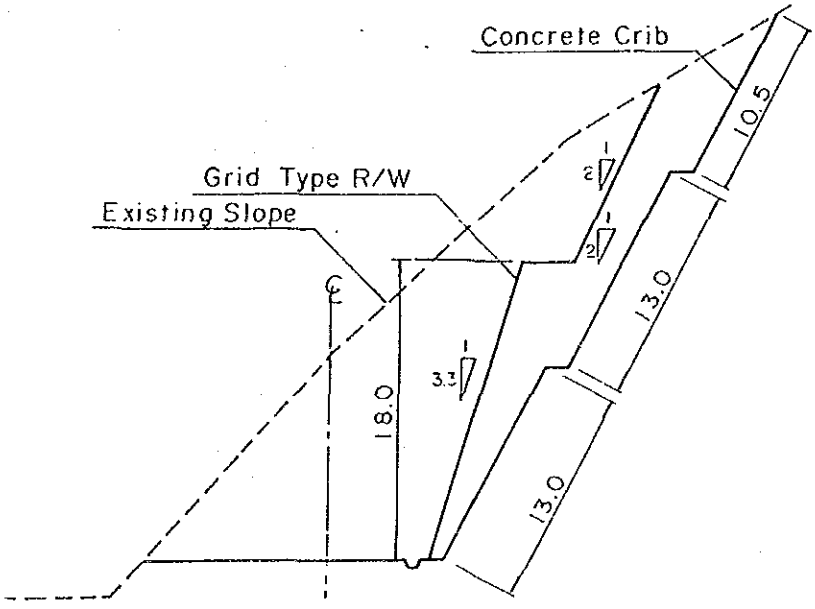


(9) Selection for I + 3.3 / No.39 + 30

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As described below, Grid Type Concrete Retaining Wall is advantageous to the location in economical view point.

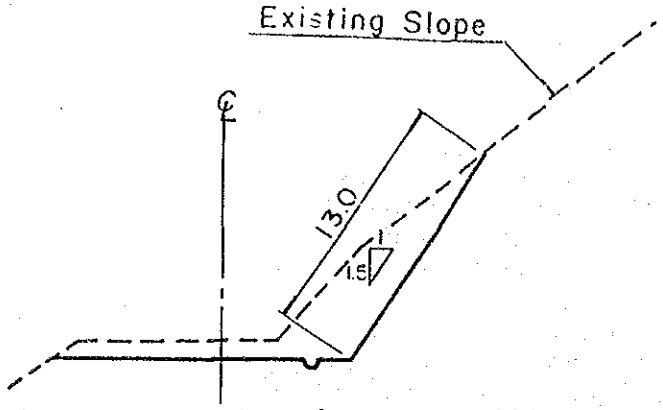
	Unit	Quantity	Unit Cost	Cost	Remarks
Concrete Crib	m^2	2,555	51.08 US	130,509 US	
Excavation	m^3	25,182	12.13	305,457	
Total				435,966	
Grid Type R/W	m^2	1,408	124.95	175,929	
Excavation	m^3	17,290	12.13	209,727	
Total				385,656	



(10) Selection for J + 4.9 / No.44 + 400

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

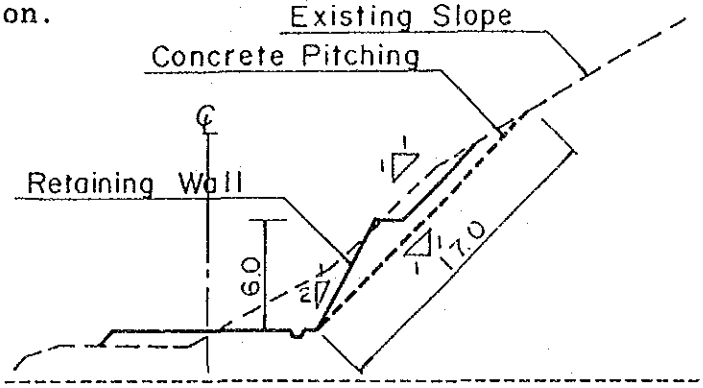
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(11) Selection for L + 3.0 / No.52 + 200

Applicable Countermeasures:
- Stone Masonry Retaining Wall
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, since Concrete Pitching is not adaptable to the location in topographical view point, Stone Masonry Retaining Wall or Grid Type Concrete Retaining Wall should be applied. Comparing those retaining walls with the cost, Stone Masonry Retaining Wall is advantageous to the location.

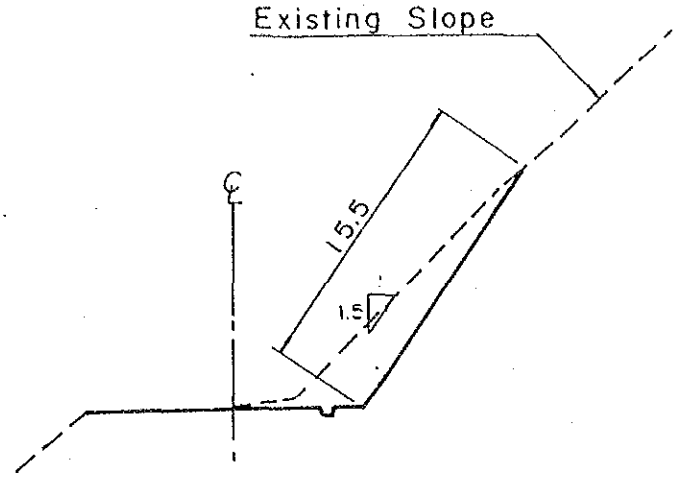


	Unit	Quantity	Unit Cost	Cost
Stone Masonry R/W	m^2	313	54.38 US	17,020 US
Grid Type R/W	m^2	268	124.95	33,486

(12) Selection for L + 6.1 / No.55 + 500

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

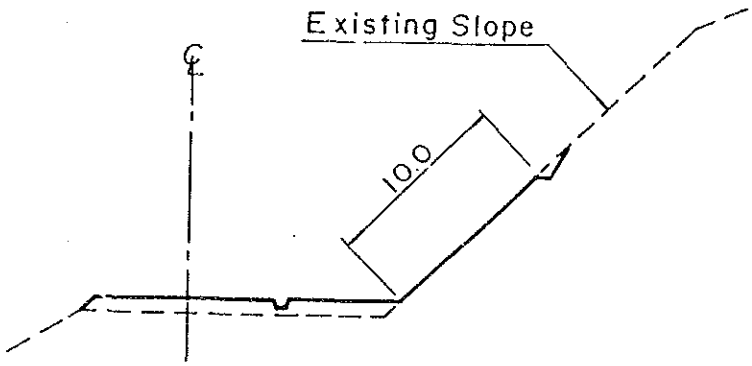
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(13) Selection for M + 1.6 / No.58 + 200

Applicable Countermeasures:
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall
- Supported Type Concrete Retaining Wall

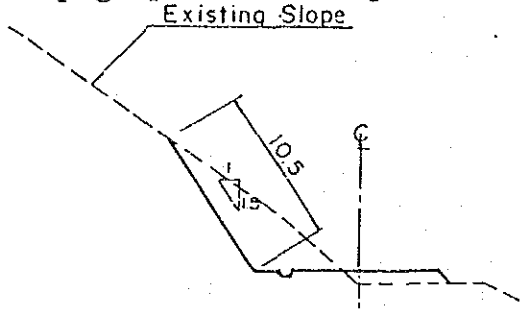
Optimum Countermeasure:
As illustrated below, Concrete Pitching and Anchoring is adaptable to the location in topographical view point.



(14) Selection for N + 2.0 / No.66 + 500

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

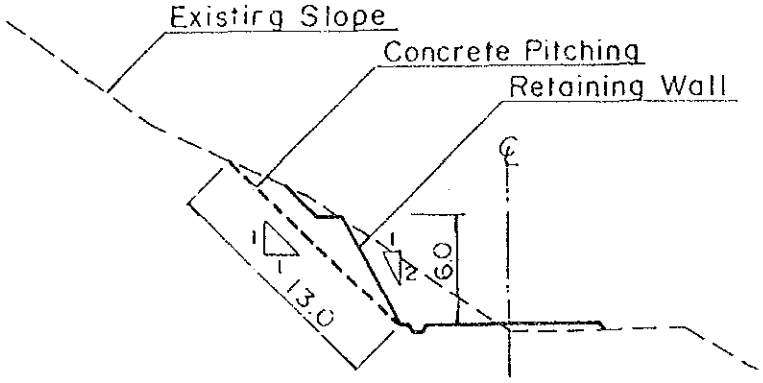
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(15) Selection for N + 3.0 / No.68 + 440

Applicable Countermeasures:
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall
- Supported Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, since Concrete Pitching is not adaptable to the location in topographical view point, Grid Type Concrete Retaining Wall or Supported Type Concrete Retaining Wall should be applied. Comparing those retaining walls with the cost, Grid Type Concrete Retaining Wall is advantageous to the location.

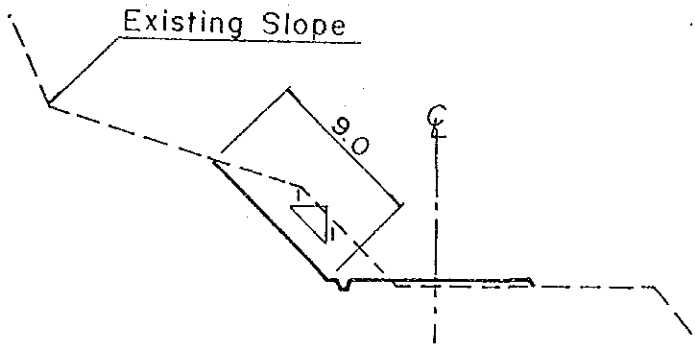


	Unit	Quantity	Unit Cost	Cost	Remarks
Grid Type R/W	m^2	1,006	124.95 US	125,699 US	
Supported Type R/W	m^2	1,173	216.42	253,860	

(16) Selection for N + 4.7 / No.70 + 100

Applicable Countermeasures:
- Stone Masonry Retaining Wall
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall

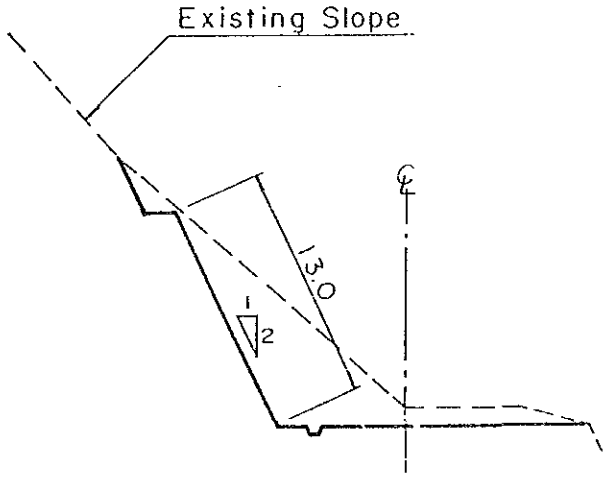
Optimum Countermeasure:
As illustrated below, Concrete Pitching is adaptable to the location in topographical view point.



(17) Selection for P + 0.9 / No.75 + 570

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

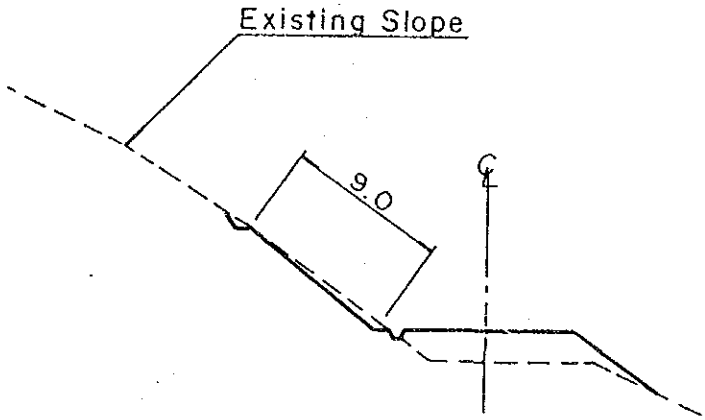
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(18) Selection for P + 3.6 / No.77 + 800

Applicable Countermeasures:
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall
- Supported Type Concrete Retaining Wall

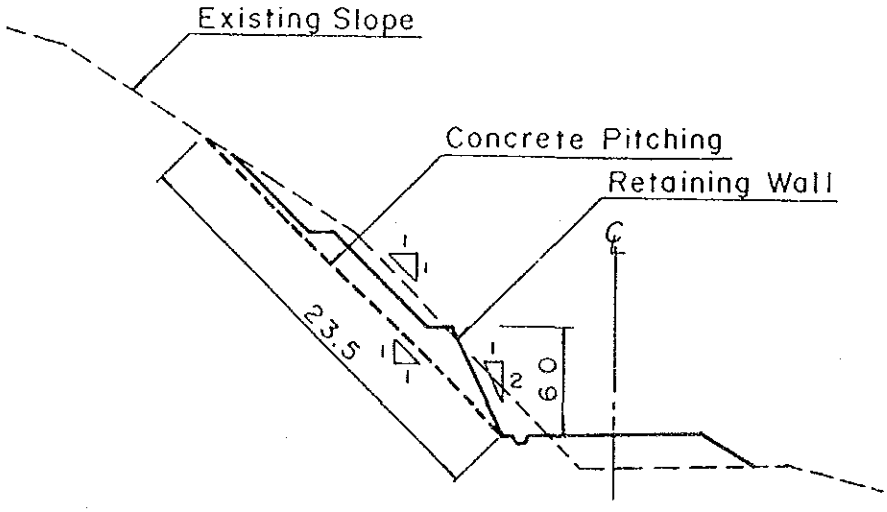
Optimum Countermeasure:
As illustrated below, Concrete Pitching is adaptable to the location in topographical view point.



(19) Selection for P + 3.7 / No.78 + 100

Applicable Countermeasures:
- Stone Masonry Retaining Wall
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, since Concrete Pitching is not adaptable to the location in topographical view point, Stone Masonry Retaining Wall or Grid Type Retaining Wall should be applied. Comparing those retaining walls with the cost, Stone Masonry Retaining Wall is advantageous to the location.

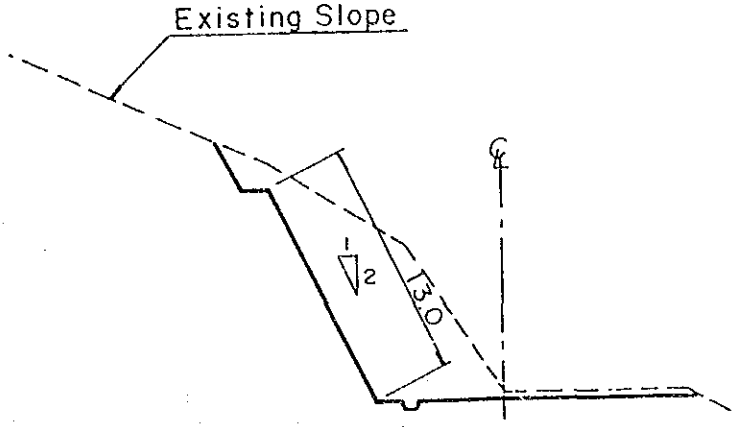


	Unit	Quantity	Unit Cost	Cost	Remarks
Stone Masonry R/W	m^2	626	54.38 US	34,041 US	
Grid Type R/W	m^2	536	124.95	66,973	

(20) Selection for P + 4.0 / No.78 + 600

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

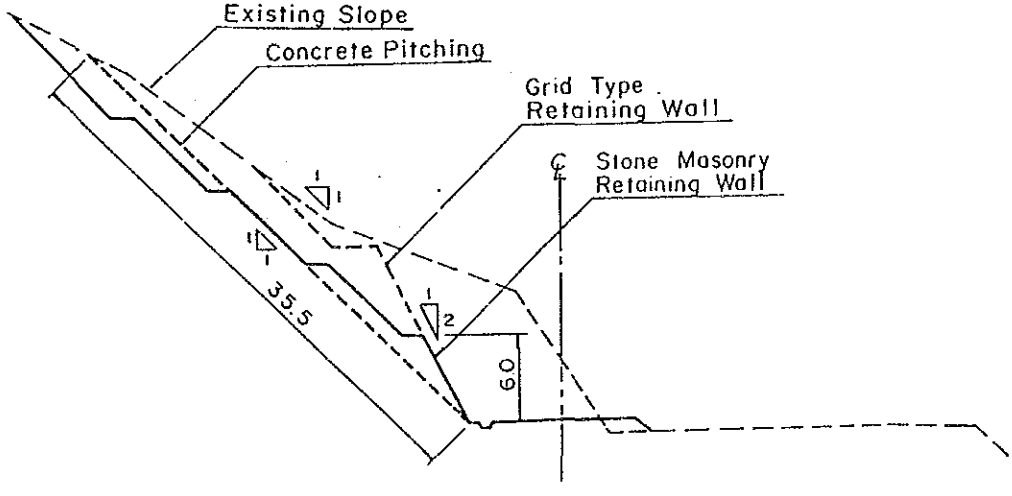
Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



(21) Selection for P + 4.9 / No.79 + 500

Applicable Countermeasures:
- Stone Masonry Retaining Wall
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, since Concrete Pitching is not adaptable to the location in topographical view point. Stone Masonry Retaining Wall or Grid Type Retaining Wall should be applied. Comparing those retaining walls with the cost, Stone Masonry Retaining Wall is Advantageous to the location.

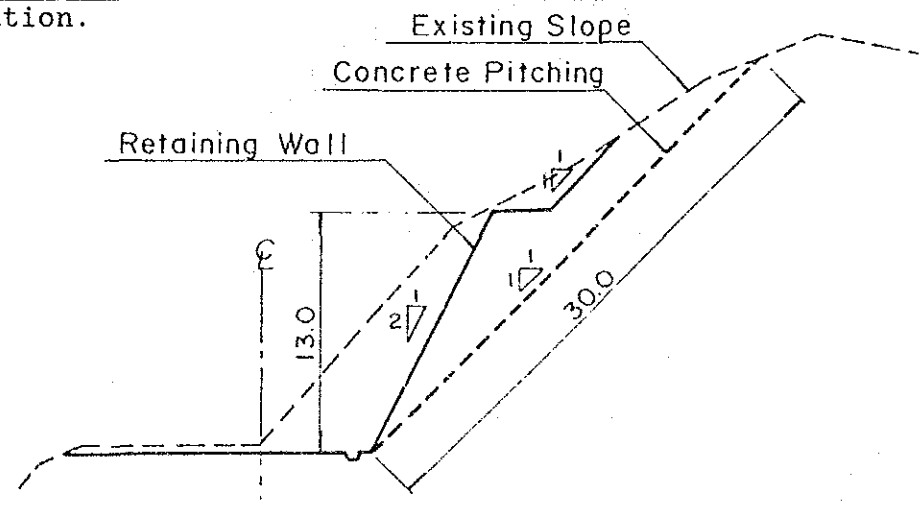


	Unit	Quantity	Unit Cost	Cost	Remark
Stone Masonry R/W	m2	355	54.38us	18.217us	
Excavation	m3	8,137	3.04	24.736	
Total				42.953	
Grid Type R/W	m2	670	124.95us	83.716	
Excavation	m3	4,447	3.04	13.518	
Total				97.234	

(22) Selection for Q + 0.6 / No.80 + 350

Applicable Countermeasures:
- Concrete Pitching and Anchoring
- Grid Type Concrete Retaining Wall
- Supported Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, since Concrete Pitching is not adaptable to the location in topographical view point, Grid Type Retaining Wall or Supported Type Retaining Wall should be applied. Comparing those retaining walls with the cost, Grid Type Concrete Retaining Wall is advantageous to the location.



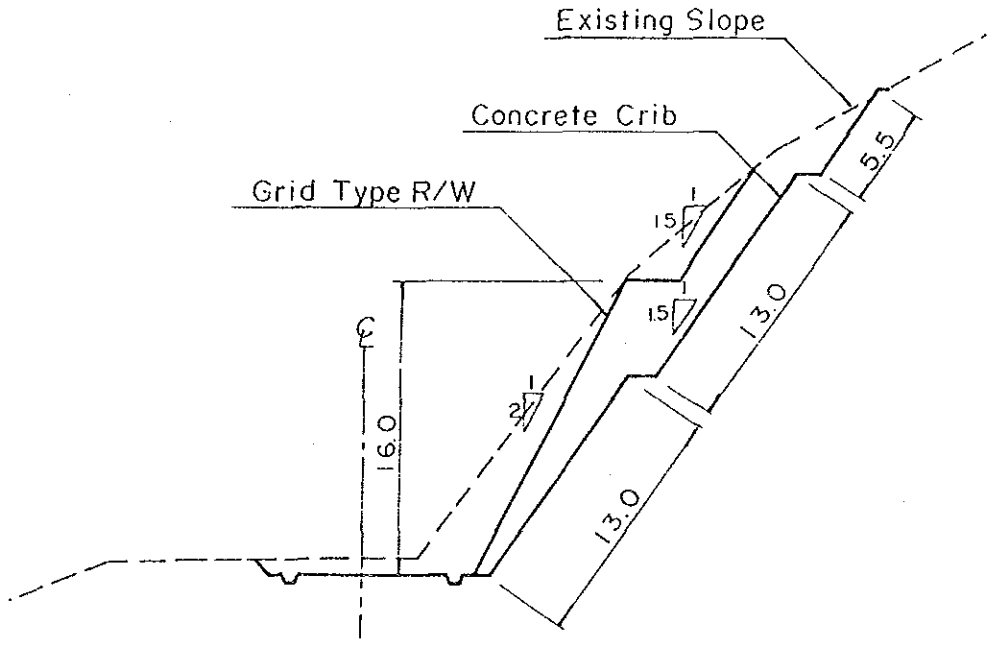
	Unit	Quantity	Unit Cost	Cost
Grid Type R/W	m^2	2,180	124.95 US	272,391 US
Supported Type R/W	m^2	2,515	216.42	544,296

(23) Selection for R + 0.3 / No.82 + 400

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As described below, Grid Type Concrete Retaining Wall is advantageous to the location in economical view point.

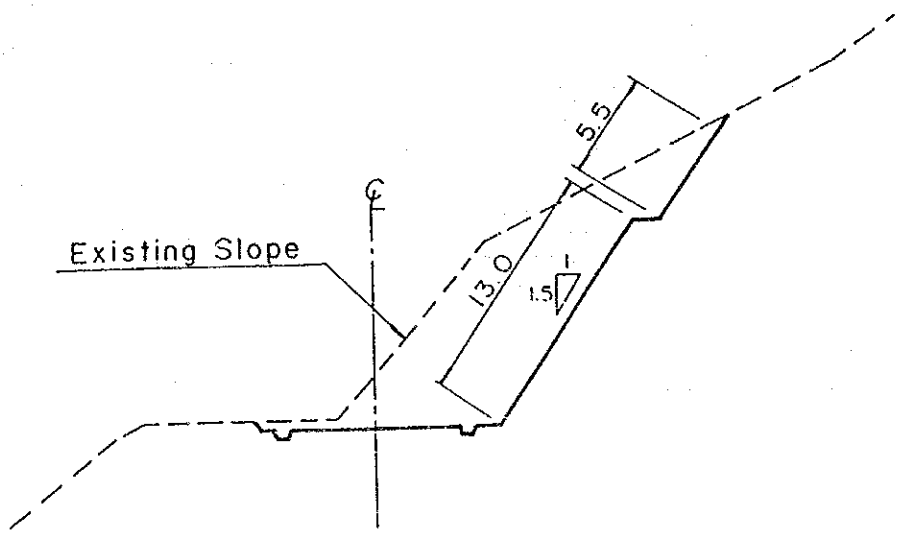
	Unit	Quantity	Unit Cost	Cost	Remarks
Concrete Crib	m^2	1,260	51.08 US	64,360 US	
Excavation	m^3	4,620	12.13	56,040	
Total				120,400	
Grid Type R/W	m^2	715	124.95	89,339	
Excavation	m^3	1,910	12.13	23,168	
Total				112,507	



(24) Selection for R + 1.8 / No.84 + 350

Applicable Countermeasures:
- Concrete Crib with concrete spraying and Anchoring
- Grid Type Concrete Retaining Wall

Optimum Countermeasure:
As illustrated below, Concrete Crib is adaptable to the location in topographical view point.



Apèndice 5-1 Diseño del Pavimento

Apèndice 5-1(1) Derivaciòn de los Factores ESAL

ESAL Factors were based on an assumed terminal serviceability of 2.5 and structural number (SN) of 5.0. In most cases, such an assumption provides information sufficiently accurate for design purposes.

Vehicle Type	Axle Load Distribution (front/rear)		ESAL Factor	
	(tons)	(Kips)	(front/rear)	(Total)
Passenger Car	S 0.6813	1.5	0.0002	0.0004
	S 0.6174	1.4	0.0002	
Bus	S 4.7248	10.4	0.088	1.598
	S 9.0752	20.0	1.51	
Light Truck	S 1.5916	3.5	0.002	0.004
	S 2.0084	4.4	0.002	
Medium Truck	S 2.5084	5.5	0.010	0.044
	S 3.6916	8.1	0.034	
Heavy Truck	S 5.073	11.2	0.189	0.553
	T 11.927	26.3	0.364	

Note : S = Single Axle, T = Tandem Axle

Table Axle load equivalency factors for flexible pavements, tandem axles and p_t of 2.5.

Axle Load (kips)	Pavement Structural Number (SN)					
	1	2	3	4	5	6
2	.0001	.0001	.0001	.0000	.0000	.0000
4	.0005	.0005	.0004	.0003	.0003	.0002
6	.002	.002	.002	.001	.001	.001
8	.004	.006	.005	.004	.003	.003
10	.008	.013	.011	.009	.007	.006
12	.015	.024	.023	.018	.014	.013
14	.026	.041	.042	.033	.027	.024
16	.044	.065	.070	.057	.047	.043
18	.070	.097	.109	.092	.077	.070
20	.107	.141	.162	.141	.121	.110
22	.160	.198	.229	.207	.180	.166
24	.231	.273	.315	.292	.260	.242
26	.327	.370	.420	.401	.364	.342
28	.451	.493	.548	.534	.495	.470
30	.611	.648	.703	.695	.658	.633
32	.813	.843	.889	.887	.857	.834
34	1.06	1.08	1.11	1.11	1.09	1.08
36	1.38	1.38	1.38	1.38	1.38	1.38
38	1.75	1.73	1.69	1.68	1.70	1.73
40	2.21	2.16	2.06	2.03	2.08	2.14
42	2.76	2.67	2.49	2.43	2.51	2.61
44	3.41	3.27	2.99	2.88	3.00	3.16
46	4.18	3.98	3.58	3.40	3.55	3.79
48	5.08	4.80	4.25	3.98	4.17	4.49
50	6.12	5.76	5.03	4.64	4.86	5.28
52	7.33	6.87	5.93	5.38	5.63	6.17
54	8.72	8.14	6.95	6.22	6.47	7.15
56	10.3	9.6	8.1	7.2	7.4	8.2
58	12.1	11.3	9.4	8.2	8.4	9.4
60	14.2	13.1	10.9	9.4	9.6	10.7
62	16.5	15.3	12.6	10.7	10.8	12.1
64	19.1	17.6	14.5	12.2	12.2	13.7
66	22.1	20.3	16.6	13.8	13.7	15.4
68	25.3	23.3	18.9	15.6	15.4	17.2
70	29.0	26.6	21.5	17.6	17.2	19.2
72	33.0	30.3	24.4	19.8	19.2	21.3
74	37.5	34.4	27.6	22.2	21.3	23.6
76	42.5	38.9	31.1	24.8	23.7	26.1
78	48.0	43.9	35.0	27.8	26.2	28.8
80	54.0	49.4	39.2	30.9	29.0	31.7
82	60.6	55.4	43.9	34.4	32.0	34.8
84	67.8	61.9	49.0	38.2	35.3	38.1
86	75.7	69.1	54.5	42.3	38.8	41.7
88	84.3	76.9	60.6	46.8	42.6	45.6
90	93.7	85.4	67.1	51.7	46.8	49.7

Table Axle load equivalency factors for flexible pavements, single axles and p_t 2.5.

Axle Load (kips)	Pavement Structural Number (SN)					
	1	2	3	4	5	6
2	.0004	.0004	.0003	.0002	.0002	.0002
4	.003	.004	.004	.003	.002	.002
6	.011	.017	.017	.013	.010	.009
8	.032	.047	.051	.041	.034	.031
10	.078	.102	.118	.102	.088	.080
12	.168	.198	.229	.213	.189	.176
14	.328	.358	.399	.388	.360	.342
16	.591	.613	.646	.645	.623	.606
18	1.00	1.00	1.00	1.00	1.00	1.00
20	1.61	1.57	1.49	1.47	1.51	1.55
22	2.48	2.38	2.17	2.09	2.18	2.30
24	3.69	3.49	3.09	2.89	3.03	3.27
26	5.33	4.99	4.31	3.91	4.09	4.48
28	7.49	6.98	5.90	5.21	5.39	5.98
30	10.3	9.5	7.9	6.8	7.0	7.8
32	13.9	12.8	10.5	8.8	8.9	10.0
34	18.4	16.9	13.7	11.3	11.2	12.5
36	24.0	22.0	17.7	14.4	13.9	15.5
38	30.9	28.3	22.6	18.1	17.2	19.0
40	39.3	35.9	28.5	22.5	21.1	23.0
42	49.3	45.0	35.6	27.8	25.6	27.7
44	61.3	55.9	44.0	34.0	31.0	33.1
46	75.5	68.8	54.0	41.4	37.2	39.3
48	92.2	83.9	65.7	50.1	44.5	46.5
50	112.	102.	79.	60.	53.	55.

Apèndice 5-1(2) Estimaciòn de los Nùmeros Estructurales de Diseño

The estimations of this design method used the recommend nomogram are presented by each layer on page AP-38 to AP-44.

On the other hand, a method of "AASHTO Interim Guide for Design of Pavement Structures 1972" is that the value is estimated by assuming the CBR value as presented on page AP-45 to AP-46. The results of this estimations are summarized below:

Section	No.0(Santa Barbara) -No.48	No.48 -No.60(Caranavi)	No.60(Caranavi) -End Point(Bella Vista)
Design CBR of Roadbed Soil	10.0	7.0	7.0
Roadbed	2.5 (2.9)	3.0 (3.0)	2.7 (2.7)
Sub-base Course	2.3	(2.3)	2.0 (2.0)
Base Course	1.7	(1.7)	1.5 (1.5)

Note: Parenthesized figures indicate the values estimated by AASHTO Interim Guide Method. Underlined figures indicate the adopted values.

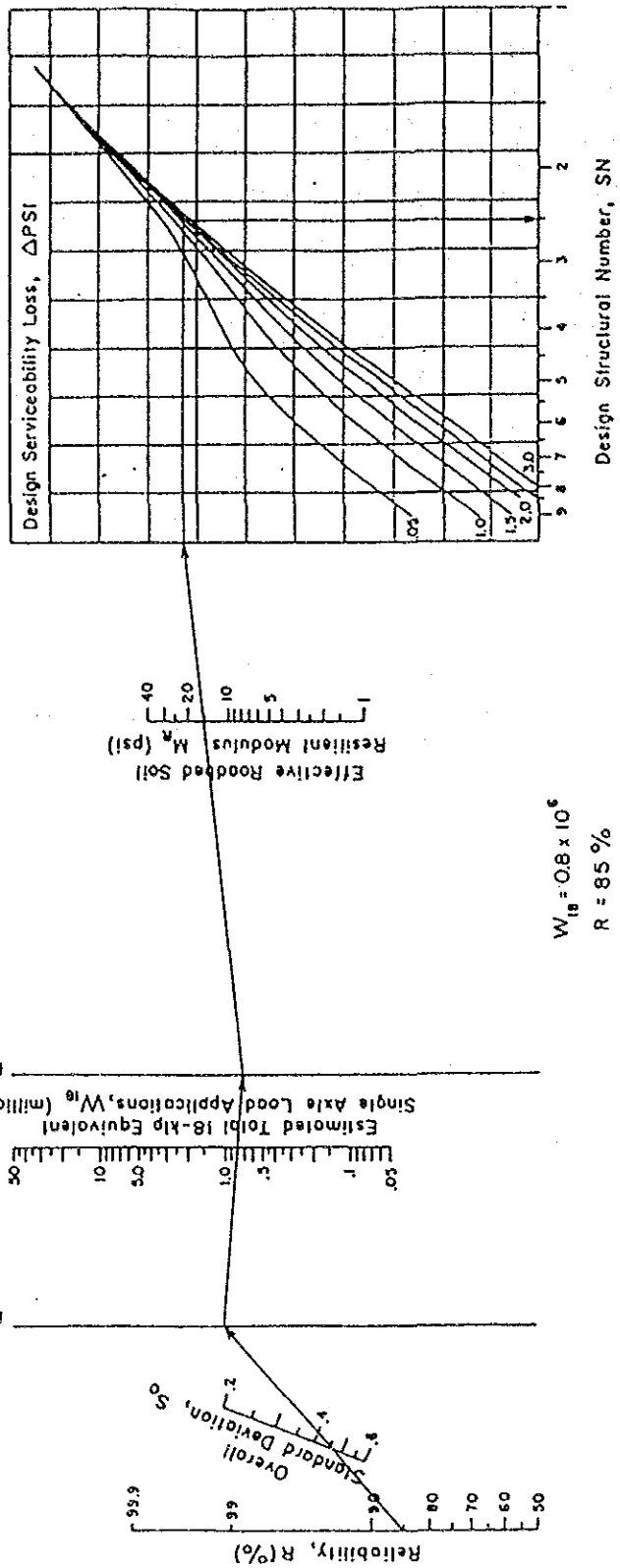
Reference: The adopted value (2.9) of roadbed in the section between No.0 (Santa Barbara) and No.48 corresponds to the elastic resilient modulus of 12,000psi.(AP-47)

I. Estimations by This Vesign Method

SN for Roadbed

Highway Pavement Structural Design

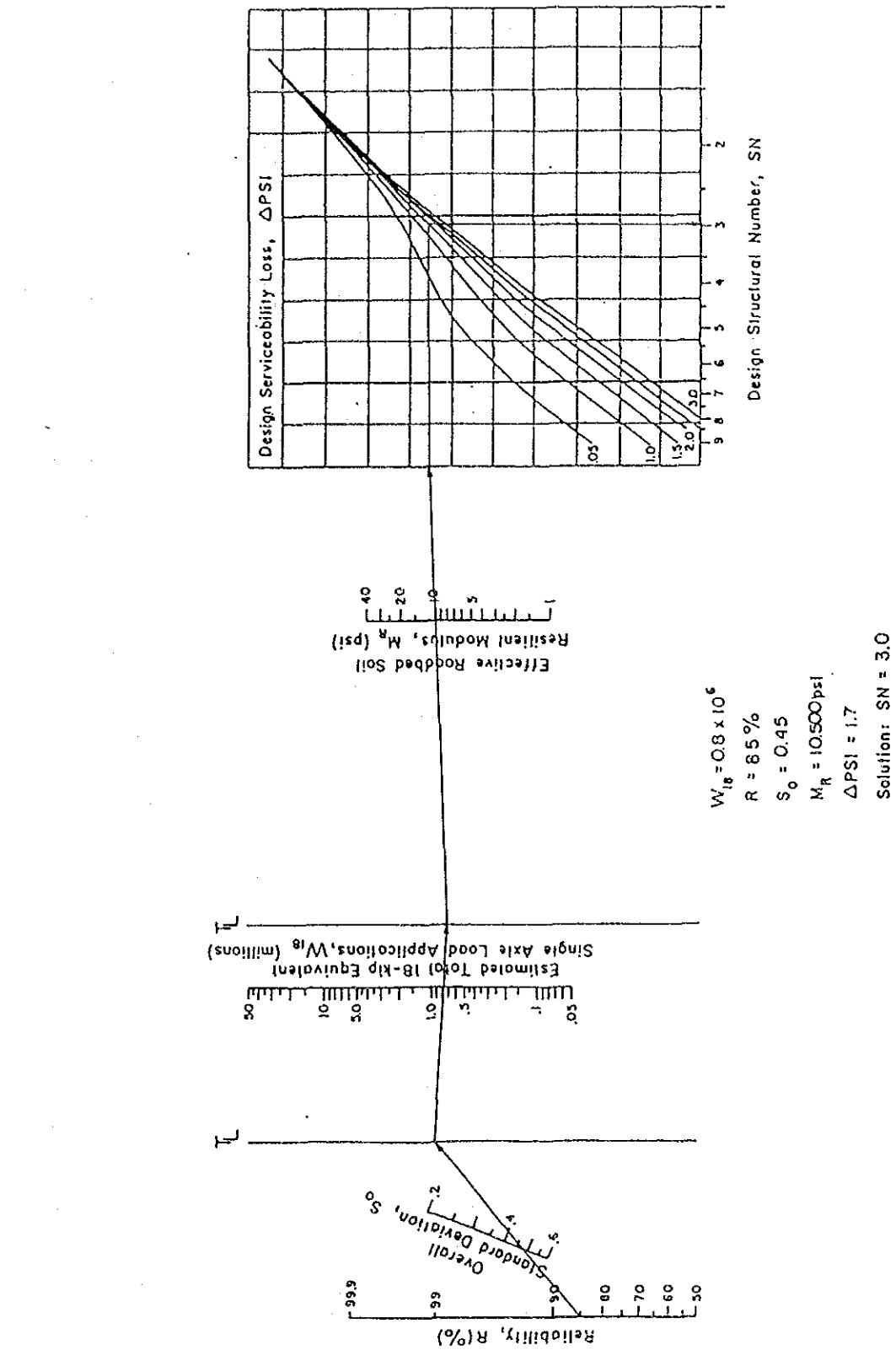
No. 0 (Sta. Barbara) – No. 48



SN for Roadbed

Highway Pavement Structural Design

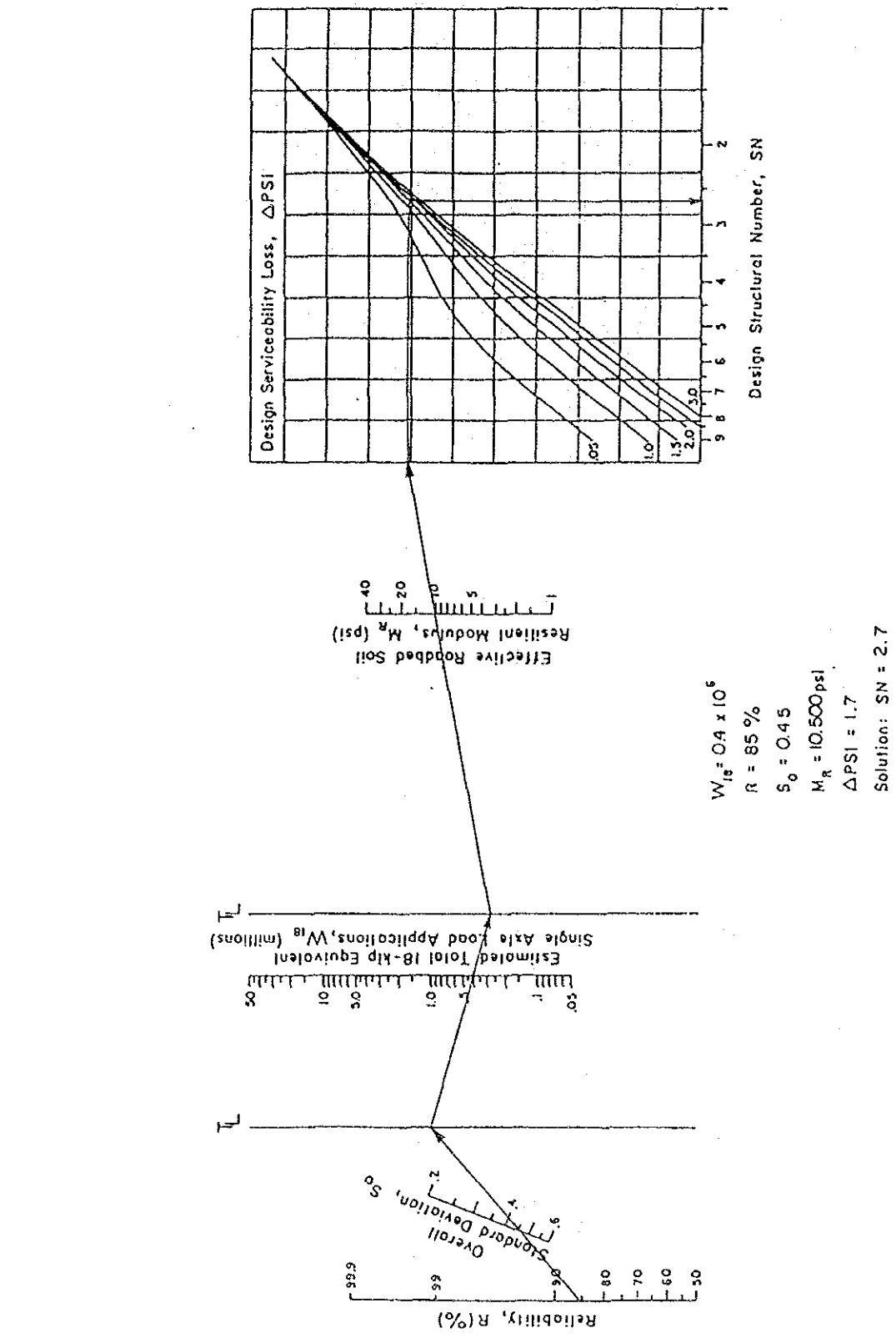
No. 48 – No. 60 (Caranavi)



SN for Roadbed

Highway Pavement Structural Design

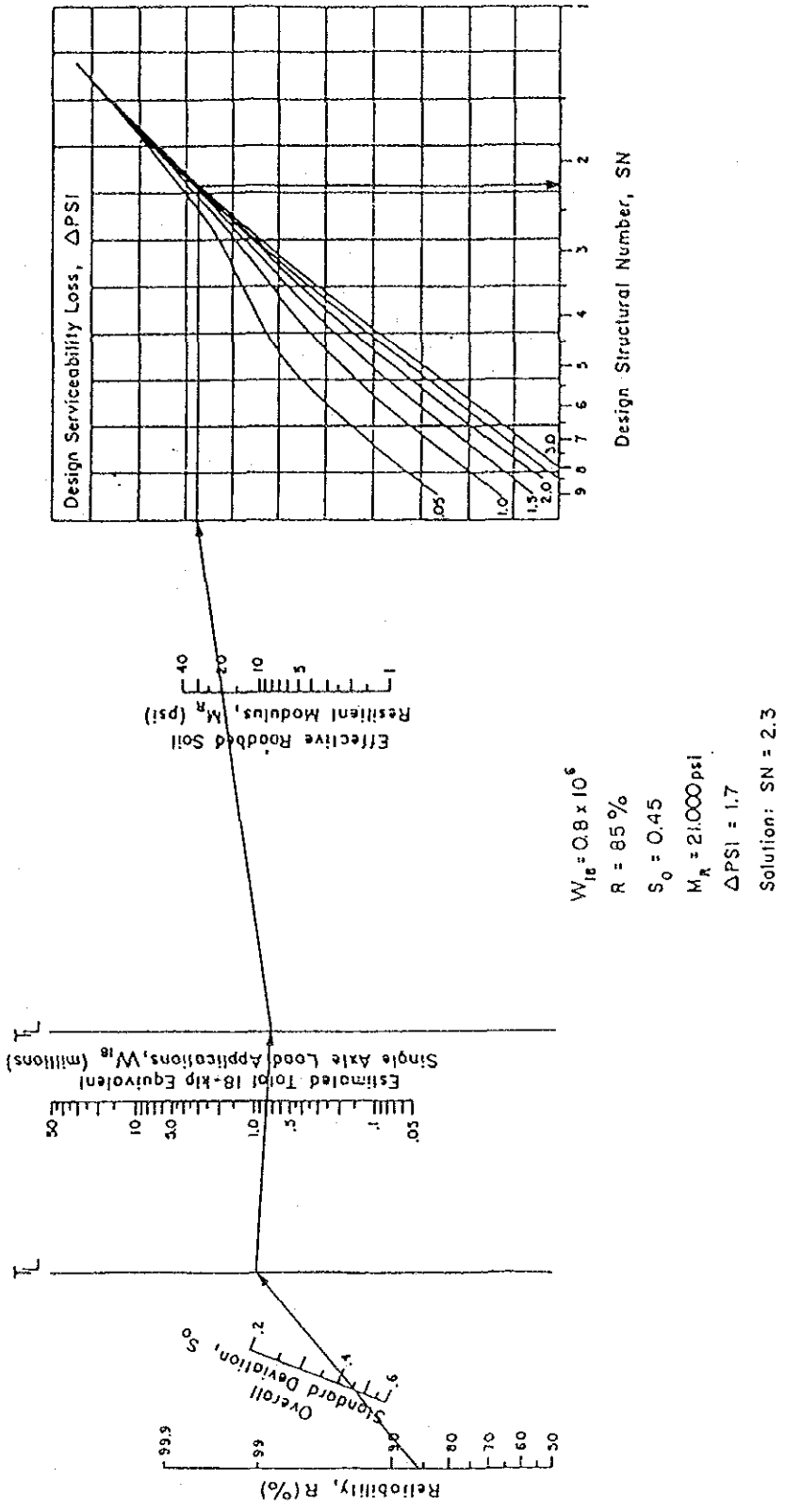
No. 60 (Caranavi) - End Point (Bella Vista)



SN for Subbase Course

Highway Pavement Structural Design

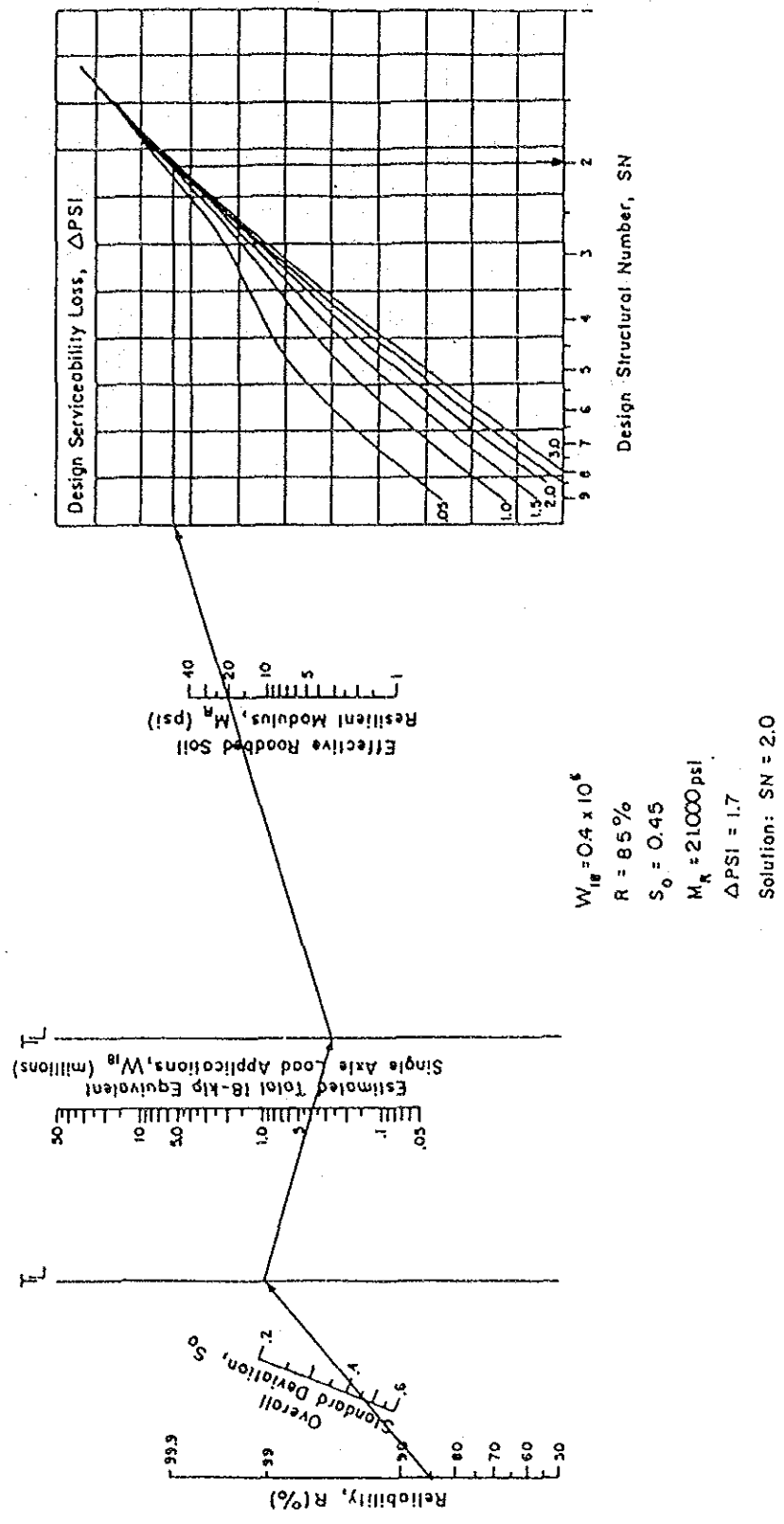
No.0 (Sta. Barbara) - No.60 (Caranavi)



SN for Subbase Course

Highway Pavement Structural Design

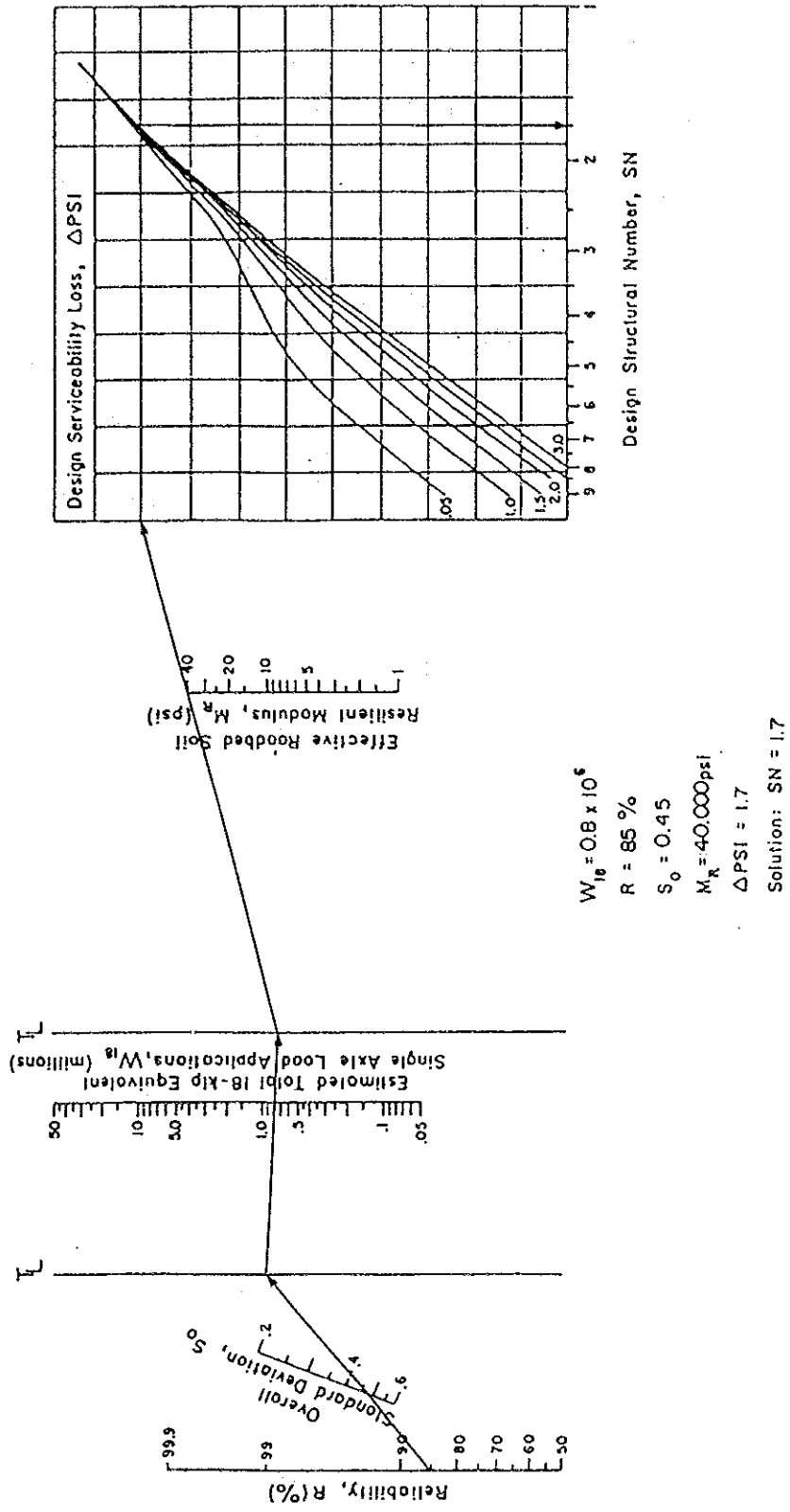
No. 60 (Caranavi) – End Point (Bella Vista)



SN for Base Course

Highway Pavement Structural Design

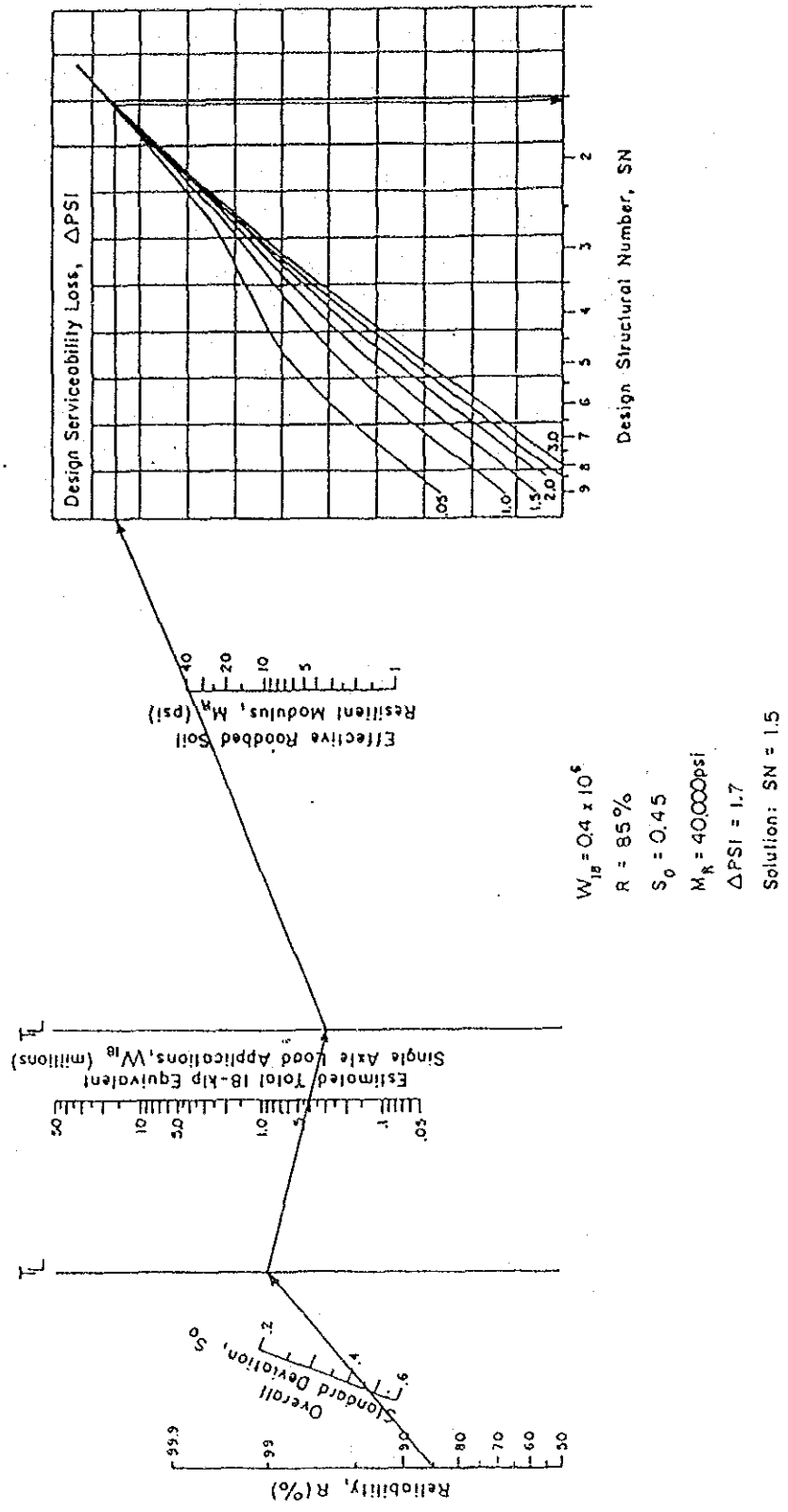
No. 0 (Sta. Barbara) - No. 60 (Caranavi)



SN for Base Course

Highway Pavement Structural Design

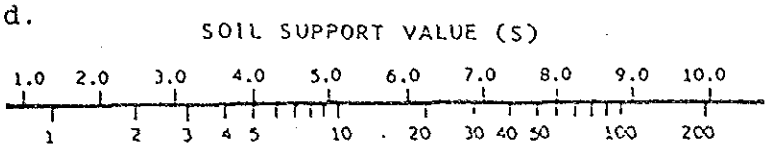
No. 60 (Caranavi) - End Point (Belle Vista)



II Estimation by AASHTO Interim Guide Method

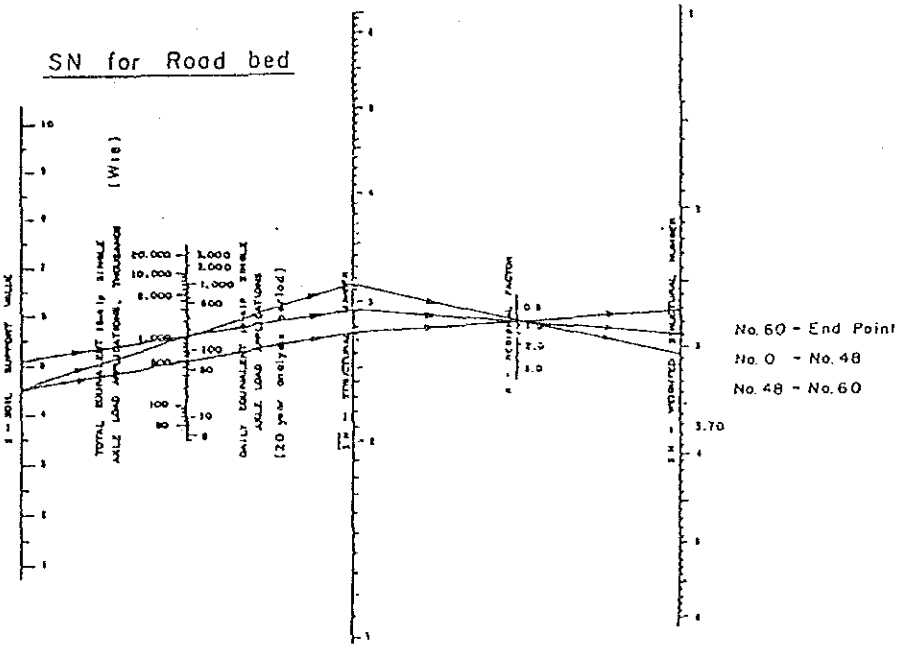
Step 1

The Soil support values for roadbed, base course and sub-base course were estimated using the following scale established.



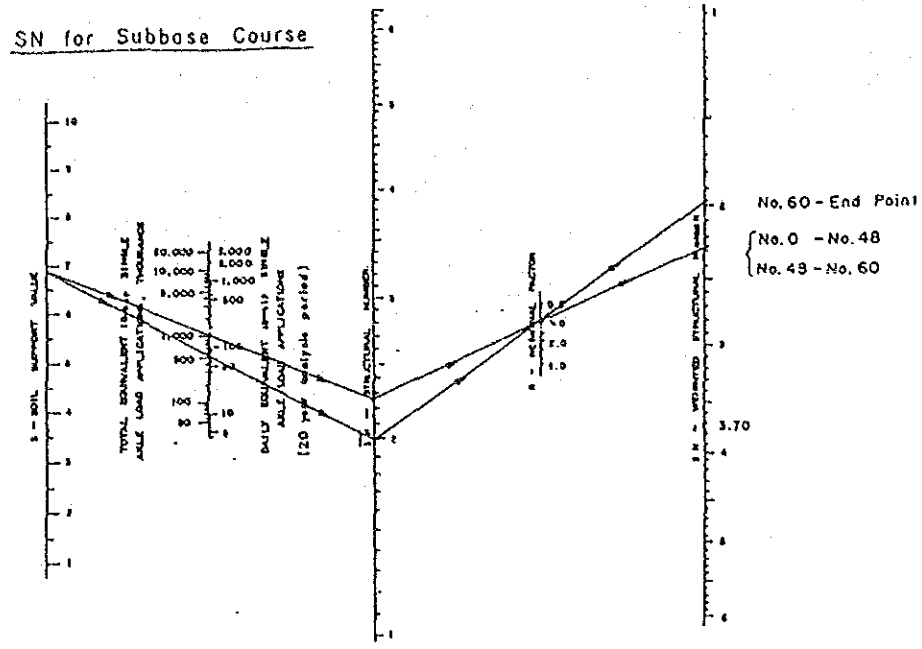
	Design CBR(%)	Soil Support Value	Remarks
Roadbed	10.0	5.1	No.0 - No.48
	7.0	4.5	No.48 - End Point
Sub-base Course	30.0	6.8	The CBR value was determined by the availability on site.
Base Course	80.0	8.5	- ditto -

Step 2



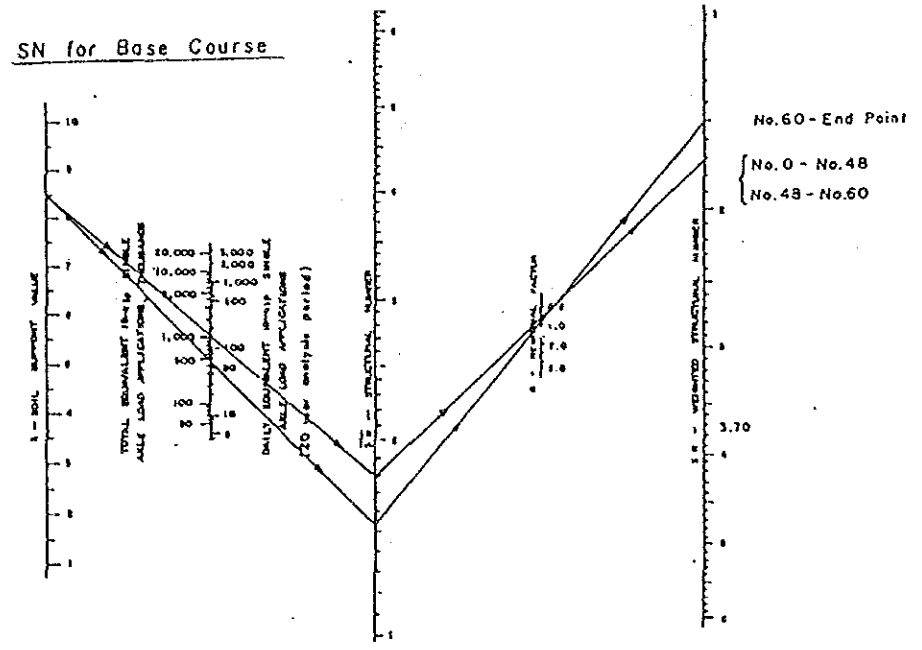
	S	W_{18}	R	SN
No. 0 - No.48	5.1	861.066	0.9	2.9
No.48 - No.60	4.5	861.066	0.9	3.0
No.60 - End Point	4.5	409.645	0.9	2.7

SN for Subbase Course

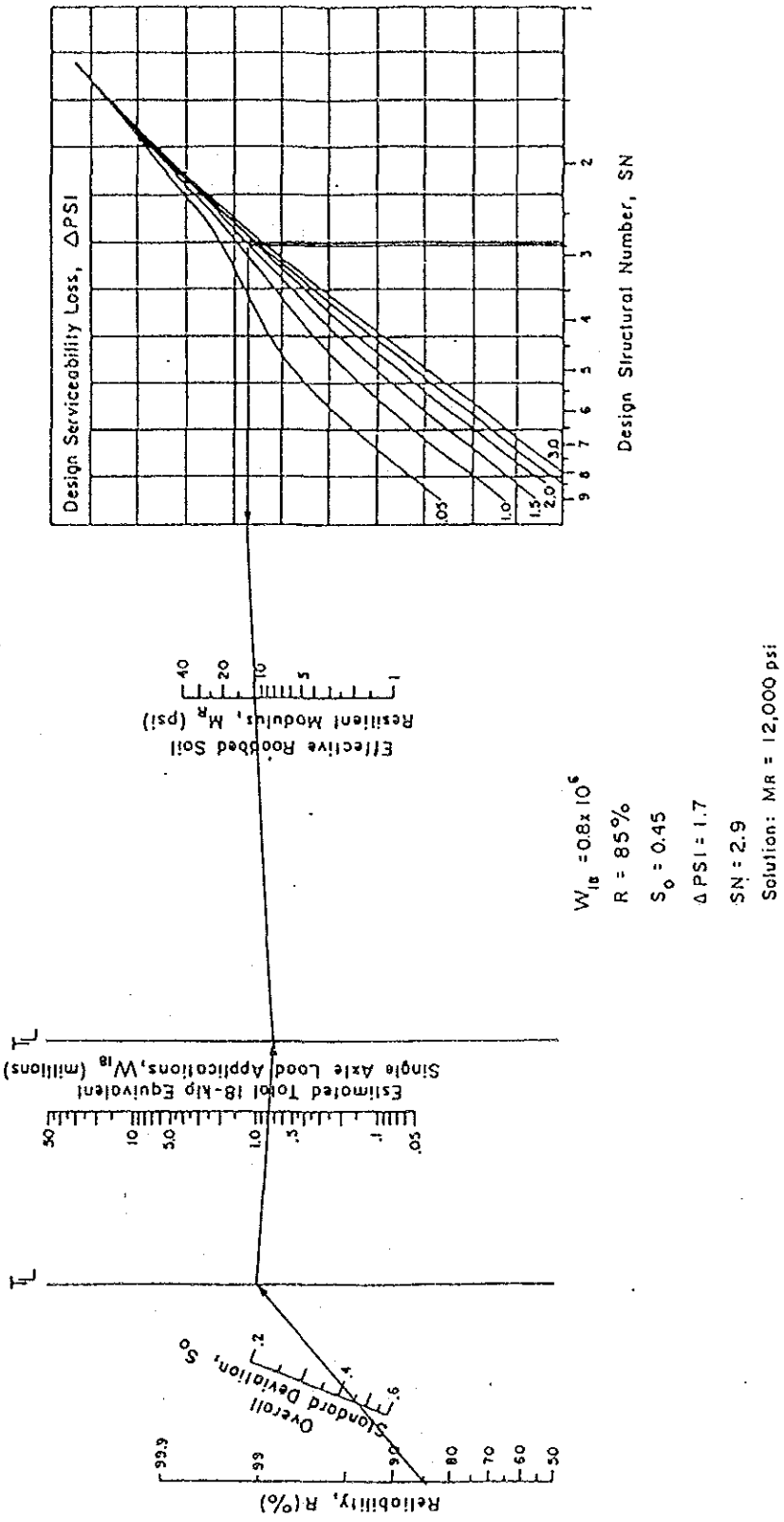


	S	W_{18}	R	SN
No. 0 - No.48	6.8	861.066	0.9	2.3
No.48 - No.60	6.8	861.066	0.9	2.3
No.60 - End Point	6.8	409.645	0.9	2.0

SN for Base Course



	S	W_{18}	R	SN
No. 0 - No.48	8.5	861.066	0.9	1.7
No.48 - No.60	8.5	861.066	0.9	1.7
No.60 End Point	8.5	409.645	0.9	1.5



Design chart for flexible pavements based on using mean values for each input.

Apèndice 5-1(3) Determinaciòn de los Espesores de la Capa

No. 0 (Santa Barbara) - No.48

$SN_1 / a_1 = 1.7 / 0.44 = 3.86 < \underline{D_1^* = 4}$

$SN_1^* = a_1 D_1^* = 0.44 \times 4 = 1.76 > SN_1 = 1.7$

$(SN_2 - SN_1^*) / a_2 m_2 = (2.3 - 1.76 / 0.14 \times 1.0 = 3.86 < \underline{D_2^* = 6}$

$SN_2^* = a_2 D_2^* m_2 = 0.14 \times 6 \times 1.0 = 0.84$.

$SN_1^* + SN_2^* = 1.76 + 0.84 = 2.6 > SN_2 = 2.3$

$(SN_3 - (SN_1^* + SN_2^*)) / a_3 m_3 = (2.9-2.6) / 0.11 \times 1.0 = 2.73 < \underline{D_3^* = 6}$

No.48 - No.60 (Caranavi)

$SN_1 / a_1 = 1.7 / 0.44 = 3.86 < \underline{D_1^* = 4}$

$SN_1^* = a_1 D_1^* = 0.44 \times 4 = 1.76 > SN_1 = 1.7$

$(SN_2 - SN_1^*) / a_2 m_2 = (2.3-1.76) / 0.14 \times 1.0 = 3.86 < \underline{D_2^* = 6}$

$SN_2^* = a_2 D_2^* m_2 = 0.14 \times 6 \times 1.0 = 0.84$

$SN_1^* + SN_2^* = 1.76 + 0.84 = 2.6 > SN_2 = 2.3$

$(SN_3 - (SN_1^* + SN_2^*)) / a_3 m_3 = (3.0 - 2.6) / 0.11 \times 1.0 = 3.64 < \underline{D_3^* = 6}$

No.60 (Caranavi) - End Point (Bella Vista)

$SN_1 / a_1 = 1.5 / 0.44 = 3.41 < \underline{D_1^* = 4}$

$SN_1^* = a_1 D_1^* = 0.44 \times 4 = 1.76 > SN_1 = 1.5$

$(SN_2 - SN_1^*) / a_2 m_2 = (2.0 - 1.76) / 0.14 \times 1.0 = 1.71 < \underline{D_2^* = 6}$

$SN_2^* = a_2 D_2^* m_2 = 0.14 \times 6 \times 1.0 = 0.84$

$SN_1^* + SN_2^* = 1.76 + 0.84 = 2.6 > SN_2 = 2.0$

$(SN_3 - (SN_1^* + SN_2^*)) / a_3 m_3 = (2.7-2.6) / 0.11 \times 1.0 = 0.91 < \underline{D_3^* = 6}$

Note: In the AASHTO Guide (1986), a minimum thickness of 6 inches is recommended to aggregate base. Furthermore, a minimum thickness of base and subbase should be 2.5 to 3.0 times of maximum aggregate diameter from previous experience. Assuming that the maximum aggregate diameter is 2 inches, the minimum thicknesses should be 6 inches. As described above, all of the estimated thickness of base and subbase were less than the minimum thickness. Thus, the design layer thickness of base and subbase adopted 6 inches of minimum thickness.

Apèndice 6-1 Cantidades de Movimiento de Tierras y Construcciòn de Puentes

QUANTITY ESTIMATES

Section of Project				1	2	3	4	5	6	Total
Station No			Unit	0+000 - 25+300	25+300 - 46+760	46+760 - 60+000	60+000 - 79+550	79+550 - 101 +300	101+300 - 108 +630	0+000 - 108 +630
Proposed Road Length			m	25,042	20,543	13,059	19,416	21,725	7,330	107,115
Total Tunnel Length			m	0	745	0	0	0	0	745
Total Bridge Length			m	258	172	181	134	25	0	770
Total Section Length			m	25,300	21,460	13,240	19,550	21,750	7,330	108,630
Earth Work	Clearing and Grubbing		ha	48.13	38.38	20.85	30.30	36.85	7.98	182.49
	Excavation A		m^3	120,786	143,289	319,367	203,723	643,364	167,421	1,597,950
	Excavation B		m^3	2,757,124	2,492,559	516,378	1,081,222	1,659,798	199,986	8,707,067
	Finished Rolling of Subgrade		m^2	253,756	208,162	132,327	196,742	220,139	74,275	1,085,401
	Slope	Seed Spraying	m^2	20,527	15,104	41,430	55,703	75,375	25,107	233,246
		Concrete Spraying	m^2	18,184	37,113	6,660	24,475	8,229	794	95,455
		Cribworks	m^2	2,627	3,773	890	2,500	1,790		11,544
		Concrete Pitching	m^2			400	1,810			2,210
	Retaining Wall	Gravity(4m)	m	50						50
		Stone Masonry	m^2	2,947	1,230	14,373	2,623	2,869	712	24,754
		Grid Type	m^2	6,206	5,222	2,343	3,573	26,304	1,612	45,260
	Culvert	Box 3.0X3.0	m	50	50	75	40	160		375
		Box 4.0X4.0	m	35	10					45
		Pipe Φ1.0	m	1,997	1,643	1,045	1,553	1,738	584	8,560
	Disaster	Catch Netting	m^2		800		2,000	1,040		3,840
		Gabion	m		42		102			144
		Catch Fence	m	51	42			54		147
		Gabion Dam	m^3			3,764	5,211		2,179	11,154
		Shed	m		62					62
		French Drain	m						1,010	1,010
	Drainage		Km	25.0	20.5	13.1	19.5	21.7	7.3	107.1
Pavement	Subbase Course		m^2	249,048	204,300	129,872	193,092	216,055	72,897	1,065,264
	Base Course		m^2	239,657	196,596	124,975	185,811	207,908	70,148	1,025,095
	Binder Course		m^2	232,917	191,071	121,463	180,589	202,065	68,176	996,281
	Surface Course		m^2	229,010	187,867	119,426	177,550	198,675	67,033	979,571
Bridge	ℓ ≥ 50m		Set	2	2		2			6
	ℓ < 50m		Set	2	2		1	1		7
Tunnel	Lining		m		120					120
	Unsupported		m		625					625
	Portal		Pcs		4					4
Others	Traffic Sign and Guard Rail		Km	25.0	20.5	13.1	19.5	21.7	7.3	107.1
	Marking		Km	25.0	20.5	13.1	19.5	21.7	7.3	107.1
Pavement	Asphalt Macadam Surface		m^2	228,082	187,106	118,941	176,841	197,871	66,762	975,603

Note : Excavation A = Excavation, used for embankment material including compaction
Excavation B = Excavation, waste soil transport

A. Quantities of Earthwork

A.1 Quantity of Clearing and Grubbing

Section	1	2	3	4	5	6	Total
Quantity(ha)	48.13	38.38	20.85	30.30	36.85	7.98	182.49

Section 1 (No.0+000 - No.25+300): 6.00(1)+4.92(2)+7.18(3)+5.60(4)+5.59(6)+6.05(7)+5.60(8)+2.14(9)=48.13ha

Section 2 (No.25+300 - No.46+760): 2.83(9)+5.12(10)+6.7(11)+4.63(12)+5.30(13)+6.00(14)+2.50(16)=38.38ha

Section 3 (No.46+760 - No.60+000): 1.80(16)+6.55(17)+5.20(18)+5.65(19)+1.65(20)=20.85ha

Section 4 (No.60+000 - No.79+550): 4.65(21)+4.28(22)+5.05(23)+5.40(24)+5.40(25)+3.80(26)+1.72(27)=30.30ha

Section 5 (No.79+550 - No.101+300): 1.82(27)+4.25(28)+4.90(29)+3.80(30)+6.38(31)+5.50(32)+6.20(33)+4.00(34)=36.85ha

Section 6 (No.101+300 - No.108+630): 0.78(34)+4.00(35)+3.20(36)=7.98ha

Note: ( ) : Drawing No.
Refer: Drawing of plan (36 sheets)
Calculation by planimeter

A.2 Quantity of Excavation Soil

Section	1	2	3	4	5	6	Total
Item							
Cutting	2,865,515	2,627,084	785,667	1,283,024	2,304,623	330,366	10,196,279
Embankment	120,489	143,289	271,514	204,155	642,126	130,381	1,511,954
Replacement			48,000			37,040	85,040
Excavation A	120,489	143,289	319,514	204,155	642,126	167,421	1,596,994
Excavation B	2,745,026	2,483,795	514,153	1,078,869	1,662,497	199,985	8,684,325

Quantity of Replacement (Improvement of Subgrade)

No. 48 ~ No.54 6,000m(L) X 8m(W) X 1m(t) = 48,000m3
No.104 ~ E.P. 4,630m(L) X 8m(W) X 1m(t) = 37,040m3

L : Road Length W : Road Wide t : Thickness

Refer: Earth Volume Calculation sheets (70 sheets)

A.3 Quantity of Rolling of Sub-grade

Unit: m^2

Section	1	2	3	4	5	6	Total
Rolling of Sub-grade	253,756	208,162	132,327	196,742	220,139	74,275	1,085,401

$A(m^2)$ = W(m) X L(m) W : Road Wide L : Road Length

Section 1 A = 10.133 X 25,042.5 = 253,756m^2
Section 2 A = 13.133 X 20,543 = 208,162m^2
Section 3 A = 10.133 X 13,059 = 132,327m^2
Section 4 A = 10.133 X 19,416 = 196,742m^2
Section 5 A = 10.133 X 21,725 = 220,139m^2
Section 6 A = 10.133 X 7,330 = 74,275m^2

A.4 Quantity of Slope Protection

Unit:m^2

Section	1	2	3	4	5	6	Total
Item							
Seed Spraying	20,527	15,104	41,430	55,703	75,375	25,107	233,246
Concrete Spraying	18,184	37,113	6,660	24,475	8,229	794	95,455
Cribworks	2,627	3,773	890	2,500	1,790		11,544
Concrete Pitching			400	1,810			2,210

Seed Spraying All of Embankment Slope
* Refer Calculation Sheets (70 sheets)

Concrete Spraying

Section 1

No. 3+645	-	No. 3+750	1,700m^2
4+375	-		1,305
7+050	-	7+150	2,140
12+600	-	12+700	2,520
14+160	-	14+300	2,520
16+160	-	16+255	792
21+160			2,987
23+ 50	-	23+150	4,220

Section 2

No.25+950	-	No.26+ 50	4,755m^2
26+780	-	26+850	930
28+845	-	29+120	13,588
29+575	-	29+905	10,377
31+850	-	31+950	6,550
45+230	-		913

Section 3

No.47+520	-		510m^2
49+230	-	No.49+230	3,570
49+710	-	49+860	1,260
57+750	-		1,320

Section 4

No.63+ 50	-	No.63+375	8,284m^2
63+850	-	63+950	1,950
66+000			184
69+110	-	69+340	6,120
69+625	-	69+700	1,267
70+250	-	70+350	3,400
70+600	-	70+750	3,270

Section 5

No.90+690	-	No.90+850	4,084m^2
99+ 10	-	99+100	2,570
99+200	-	99+270	1,575

Section 6

No.101+475	794m^2

Crib Works

Section 1

No. 0+700	240m^2
2+200	400
8+100	520
10+900	685
12+780	782

Section 2

No.29+500	1,260m^2
38+740	1,040
44+400	1,437

Section 3

No.55+500	890m^2

Section 4

No.66+500	420m^2
75+570	780
78+600	1,300

Section 5

No.84+350	1,790m^2

Concrete Pitching

Section 3

No.58+200	400m^2

Section 4

No.70+100	900m^2
77+800	910

A.5 Quantity of Retaining Wall

Item	1	2	3	4	5	6	Total
Gravity(m)	50						50
Stone Masonry(m2)	2,947	1,230	14,373	2,623	2,869	712	24,754
Grid Type(m2)	6,206	5,222	2,343	3,573	26,304	1,612	45,260

Gravity (H=4m)

Section 1 No.1+ - No.1+530 50m

Stone Masonry				Grid Type			
Section 1 No.	1+930 - No.	1+960	30m2	Section 1 No.	0+700		3,354
	2+575 -	2+640	240		1+580 - No.	1+649	578
	6+700		520		16+100 -	16+120	667
	13+890 -	14+ 50	1,050		17+380 -	17+420	250
	15+850 -	15+870	50		19+75	19+110	136
	17+250 -	17+320	150		19+130 -	19+150	88
	20+ 75 -	20+120	125		20+500 -	20+540	250
	21+540 -	21+680	467		21+950 -	21+990	388
	23+740 -	23+770	50		24+300 -	24+390	495
	24+460 -	24+540	175				
Section 2 No.	33+ 70 -	33+120	355	Section 2 No.	25+350 -	25+365	70
	33+200 -	33+250	300		33+700		1,252
	34+780 -	34+850	175		35+510 -	35+580	578
	42+710 -	42+735	50		37+240 -	37+260	829
	46+350 -	46+450	300		39+ 30		2,493
	46+700 -	46+730	50				

Section 3 No.	46+790	-	46+800	50	Section 3 No.	47+270	448
	50+220	-	50+900	7,280		49+700	1,895
	50+900	-	51+ 50	2,280			
	51+850	-	52+300	3,375	Section 4 No.	66+780 - No.66+840	490
	52+870	-	52+960	338		68+440 -	872
	54+170	-	54+270	375		74+750 - 74+790	308
	54+320	-	54+350	150		75+630 - 76+ 50	1,150
	55+510	-	55+650	525		78+380 - 78+460	640
Section 4 No.	61+270	-	61+340	263	Section 5 No.	79+855 - No. 79+900	670
	63+300	-	63+445	315		80+240 - 80+300	244
	66+ 50	-	66+155	263		80+350	2,012
	66+670	-	66+780	360		82+400	715
	76+680	-	76+730	63		83+650 - 83+690	290
	76+820	-	76+860	100		85+770 - 85+870	625
	77+470	-	77+520	188		89+345 - 89+470	630
	78+100			411		89+620 - 89+800	878
	79+470	-	79+51	630		89+980 - 90+ 50	640
	79+510	-	79+520	30		90+660 - 90+680	105
						91+250 - 91+260	93
Section 5 No.	79+580	- No.	79+600	50		91+320 - 91+430	760
	83+145	-	83+230	300		91+960 - 92+ 70	1,460
	83+300	-	83+455	465		92+340 - 92+550	3,235
	83+525	-	83+630	202		92+710 - 92+760	173
	84+930	-	85+000	158		94+300 - 94+375	700
	86+530	-	86+670	525		94+470 - 94+520	740
	86+720	-	86+870	225		94+550 - 94+630	135
	87+790	-	87+850	184		97+420 - 97+490	790
	89+ 60	-	89+100	120		97+670 - 97+680	288
	89+200	-	89+235	120		97+730 - 97+790	908
	89+540	-	89+600	145		98+ 25 - 98+210	8,170
	92+180	-	92+285	375		98+960 - 99+ 00	433
						99+130 - 99+190	525
Section 6 No.	102+475	- No.	102+520	85		99+700 - 99+745	641
	103+ 20	-	103+150	368		100+320 - 100+400	444
	104+400	-	104+440	79			
	105+325	-	105+390	180	Section 6 No.	101+400 - No.101+455	438
						101+840 - 101+855	240
						102+670 - 102+720	244
						103+150 - 103+210	282
						103+385 - 103+450	408

A.6 Quantity of Culvert

Section	1	2	3	4	5	6	Total
Item							
Box - 3.0 X 3.0	50	50	75	40	160		375
Box - 4.0 X 4.0	35	10					45
Pipe 600	3,339	2,739	1,741	2,589	2,897	977	14,282

Box Culvert

	3.0m(B) X 3.0m(H)		4.0m(B) X 4.0m(H)	
Section1	No. 20+540	L=50m	No. 14+160	L=35m
Section2	No. 28+145	L=15m	No. 30+180	L=10m
	43+700	L=35m		
Section3	No. 49+210	L=35m		
	49+685	L=40m		
Section4	No. 64+630	L=40m		
Section5	No. 96+490	L=70m		
	97+225	L=40m		
	98+420	L=50m		

Pipe Culvert

Average Interval 150^{m} Average Length 20^{m}

Section1 26,963^{m} X 1/250^{m} X 20^{m} = 1,997^{m}
Section2 20,543^{m} X 1/250^{m} X 20^{m} = 1,643^{m}
Section3 13,059^{m} X 1/250^{m} X 20^{m} = 1,045^{m}
Section4 19,416^{m} X 1/250^{m} X 20^{m} = 1,553^{m}
Section5 21,725^{m} X 1/250^{m} X 20^{m} = 1,738^{m}
Section6 7,300^{m} X 1/250^{m} X 20^{m} = 584^{m}

A.7 Quantity of Disaster

Section	1	2	3	4	5	6	Total
Item							
Catch Netting(m2)		800		2,000	1,040		3,840
Gabion (m)		42		102		144	
Catch Fence (m)	51	42			54	147	
Gabion Dam (m3)			3,764	5,211		2,179	11,154
Shed (m)		62					62
French Drain (m)						1,010	1,010

Catch Netting	Section 2	No. 35+560	800m2
	Section 4	No. 76+320	2,000m2
Gabion	Section 2	No. 33+700	42m
	Section 4	No. 76+320	102m
Catch Fence	Section 1	No. 12+780	51m
	Section 2	No. 76+320	42m
	Section 5	No. 92+900	54m
Gabion Dam	Section 3	No. 49+210	3,764m3
	Section 4	No. 68+820	1,274m3
		No. 73+890	1,098m3
	Section 6	No.103+190	2,179m3
Shed	Section 2	No. 40+300	62m
French Drain	Section 6	No.104+ 20	290m
		No.104+670	270m
		No.105+840	120m
		No.107+500	330m

A.8 Quantity of Drainage

Section 1	25 Km	Type 1+Type 2
Section 2	20.5Km	Type 1+Type 2
Section 3	13.1Km	Type 1+Type 2
Section 4	19.5Km	Type 1+Type 2
Section 5	21.7Km	Type 1+Type 2
Section 6	7.3Km	Type 1+Type 2

Type 1 : Road side drain and Top of Slope
Type 2 : Drain ditch on berm

A.9 Quantity of Pavement

Unit:m^2

Section	1	2	3	4	5	6	Total
Item							
Sub-base Course	249,048	204,300	129,872	193,092	216,055	72,897	1,065,264
Base Course	239,657	196,596	124,975	185,811	207,908	70,148	1,025,095
Binder Course	232,917	191,071	121,463	180,589	202,065	68,176	996,281
Surface Course	229,010	187,867	119,426	177,550	198,675	67,033	979,571
Asphalt Macadam	228,082	187,106	118,941	176,841	197,871	66,762	975,603

Typical cross-section

9.0m

t=5cm Surface Course
t=5cm Binder Course
t=15cm Base Course
t=15cm Sub-base Course

A = W1.L + W2.L.
A : Area W1 : Standard side W2 : Greatest widening(1.4m)
L : Road Length : Widening Portion for Road Length(5%)

Surface Course	A=(9+0.075)L+(1.4X0.05)L=9.075L+0.07L=9.145L				
Binder Course	A=(9+0.231)L+0.07L=9.231L+0.07L=9.301L				
Base Course	A=(9+0.500)L+0.07L=9.500L+0.07L=0.57L				
Sub-base Course	A=(9+0.875)L+0.07L=9.875L+0.07=9.945L				
Sub-base Course	Section 1	9.945	X	25,042.5	= 249,048m^2
	Section 2	9.945	X	20,543	= 204,300m^2
	Section 3	9.945	X	13,059	= 129,872m^2
	Section 4	9.945	X	19,416	= 193,092m^2
	Section 5	9.945	X	21,725	= 216,055m^2
	Section 6	9.945	X	7,330	= 72,897m^2
Base Course	Section 1	9.57	X	25,042.5	= 239,657m^2
	Section 2	9.57	X	20,543	= 196.596m^2
	Section 3	9.57	X	13,059	= 124,975m^2
	Section 4	9.57	X	19,416	= 185,811m^2
	Section 5	9.57	X	21,725	= 207,908m^2
	Section 6	9.57	X	7,330	= 70,148m^2
Binder Course	Section 1	9.301	X	25,042	= 232,917m^2
	Section 2	9.301	X	20,543	= 191,071m^2
	Section 3	9.301	X	13,059	= 121,463m^2
	Section 4	9.301	X	19,416	= 180,589m^2
	Section 5	9.301	X	21,725	= 202,065m^2
	Section 6	9.301	X	7,330	= 68,176m^2
Surface Course	Section 1	9.145	X	25,042	= 229,010m^2
	Section 2	9.145	X	20,543	= 187,867m^2
	Section 3	9.145	X	13,059	= 119,426m^2
	Section 4	9.145	X	19,416	= 177,550m^2
	Section 5	9.145	X	21,725	= 198,675m^2
	Section 6	9.145	X	7,330	= 67,033m^2
Asphalt Macadam	Section 1	9.108	X	25,042	= 228,082m^2
	Section 2	9.108	X	20,543	= 187,106m^2
	Section 3	9.108	X	13,059	= 118,941m^2
	Section 4	9.108	X	19,416	= 176,841m^2
	Section 5	9.108	X	21,725	= 197,871m^2
	Section 6	9.108	X	7,330	= 66,762m^2

A.10 Quantity of Tunnel

Two Nos Tunnels were designed between No.35+610 and No.36+430 in this project. (See Drawing (12) and (13))

Tunnel(1)	Lining	30m + 30m =	60m
	Unsupported		300m
	Total		360m
	Portal		2 pieces
Tunnel(2)	Lining	30m + 30m =	60m
	Unsupported		325m
	Total		385m
	Portal		2 pieces
Total	Lining		120m
	Unsupported		625m
	Portal		4 pieces

A.11 Quantity of Others

Traffic Sign and Guard Rail

Traffic Sign	Type R-19	11 pieces
	Type P	22 pieces
	Identif.	11 pieces
	Destino.	11 pieces
	B.M.	21 pieces

Guard Rail All of River or Valley Side

Section 1	25.0Km
Section 2	20.5Km
Section 3	13.1Km
Section 4	19.5Km
Section 5	21.7Km
Section 6	7.3Km

Marking(W=10cm) Two straight lines for both road side one line for Road Center

Section 1	25.0Km
Section 2	20.5Km
Section 3	13.1Km
Section 4	19.5Km
Section 5	21.7Km
Section 6	7.3Km

Bridges Quantity

1. Quantity of Superstructure

		Unit	Point A	Patuni	Challa	Cascada	Alto Choro	Pto.Leon	Cajones	Chojna	San Silverio	San Lorenzo	Espiritu	Carrasco	Avaroa
Concrete	P	m^3	1207.40	70.80	35.4	26.912	280.218	138.00	46.00	30.028	280.180	294.490	294.490	80.385	147.25
	A	m^3	—	111.838	55.649	45.995	—	203.301	70.544	49.96	—	—	—	106.423	—
Form		m^2	4193.06	(61.719) 544.218	(61.719) 272.109	(57.082) 222.597	1171.282	(97.535) 884.754	(97.535) 317.548	(65.742) 241.173	1171.282	1236.450	1236.450	(133.303) 454.848	585.640
Rainforcement Bar		ton	205.26	(0.779) 19.906	(0.779) 9.953	(0.740) 8.163	47.637	(1.265) 36.161	(1.265) 12.563	(0.826) 8.861	47.637	50.063	50.063	(1.768) 18.870	25.033
PC-Cable		kg	48296.0	4602.0	2301.0	1749.3	9807.6	8970.0	2990.0	1951.8	9807.6	10307.2	10307.2	5225.0	5153.7
Shoe		Set	4	20	10	8	8	24	8	8	8	8	8	10	4
Handrail		m	265.00	79.76	39.88	36.88	96.076	96.076	49.88	43.88	96.076	101.556	101.556	59.88	47.338
Expantion		m	22.0	24.8	24.8	22.0	23.0	23.0	22.0	22.0	23.0	23.0	23.0	27.0	23.0
Drainage		Pce	28.0	10	6	6	12	12	6	6	12	12	12	6	6
Newel Post		Set	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Erection		m^3	1207.40	—	—	—	—	—	—	—	—	—	—	—	—
		ton	—	177.0	88.5	67.28	701.0	701.0	115.0	75.07	701.0	737.0	737.0	200.96	350.0

※ Quantity of I-Girder is shown in ( )

2. Quantity of Substructure

(Abutment)

	Excavation (m^3)	Concrete (m^3)	Form (m^2)	Reinforcement Bar (ton)	Leveling concrete (m^2)	Staging (Spc.m^3)
Point A	247.4	122.10	236.86	6.72	6.60	181.06
Patuni	851.0	147.71	236.76	8.12	12.83	195.28
Challa	279.7	159.14	262.07	8.75	8.07	265.52
Cascada	506.7	102.36	202.38	5.63	8.06	161.40
Alto Choro	534.7	167.71	283.90	9.22	7.70	217.28
Pto Leon	712.4	228.73	370.54	12.58	9.68	497.56
Cajous	161.6	154.88	266.80	8.52	7.36	295.27
Chojna	142.6	142.88	229.65	7.86	8.40	108.66
San Silverio	748.3	284.48	414.46	15.65	11.00	361.84
San Lorenzo	912.1	204.58	340.60	11.25	9.35	281.52
Espiritu	878.2	159.52	259.88	8.77	9.35	190.78
Carrasco	1962.7	370.14	545.21	20.36	15.67	540.13
Avaroa	219.2	62.86	155.30	3.46	6.26	161.40

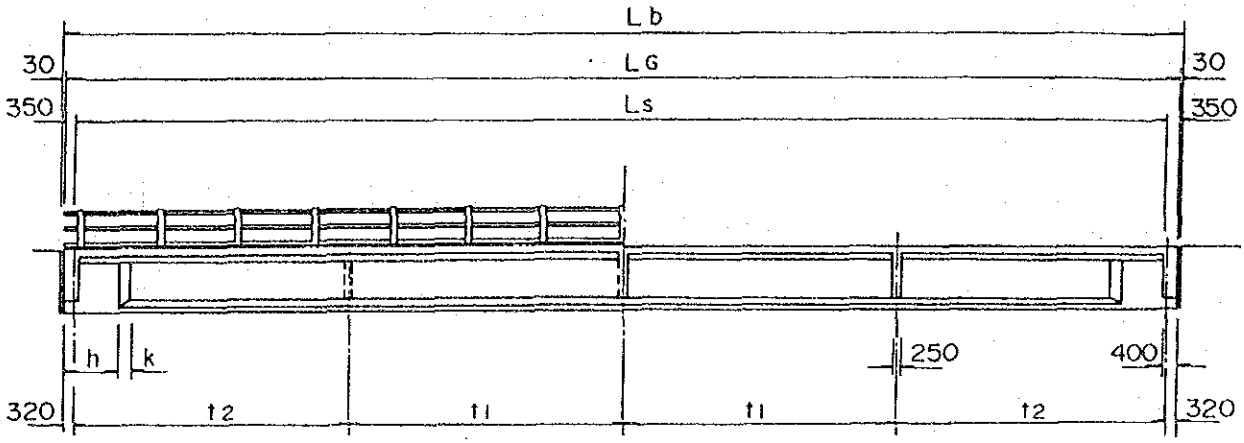
(Pire)

	Excavation (m^3)	Concrete (m^3)	Form (m^2)	Reinforcement Bar (ton)	Leveling concrete (m^2)	Staging (Spc.m^3)
Point A	334.0	1117.10	742.60	78.20	28.62	1287.0
Patuni	205.2	89.98	139.58	6.30	3.00	147.12
Alto Choro	113.9	83.18	129.03	5.82	3.20	136.00
Pto Leon	318.0	162.21	192.04	11.35	6.00	401.28
San Silverio	209.7	115.83	183.02	8.11	4.00	206.00
San Lorenzo	370.4	205.50	295.57	14.39	4.80	336.60
Espiritu	307.4	243.24	327.72	17.03	5.60	381.10

Quantity

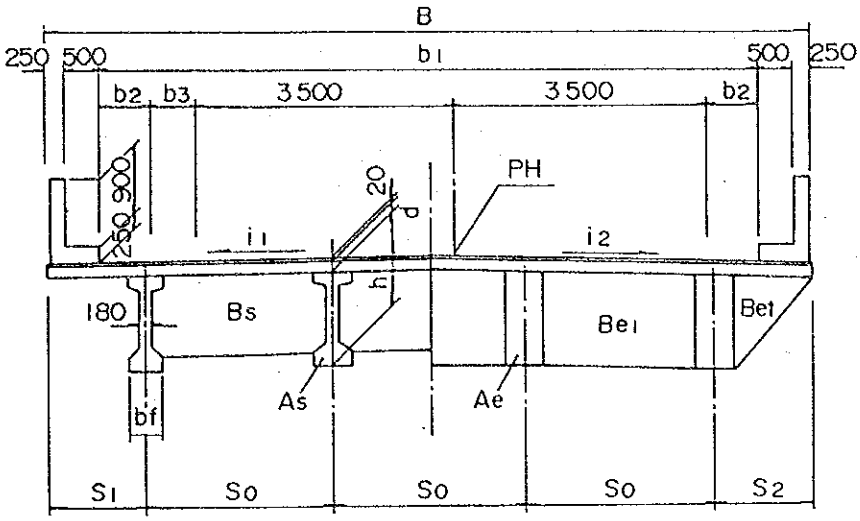
1.Superstructure

1.1 I-Girder



(Unit : m)

Name of Bridges	Total Bridge Length (L_B)	Girder Length (L_G)	Span (L_S)	Cross Beam				K
				T_1	T_2	h_t	個	
Patuni	40.000	19.94×2	19.65×2	6.400	6.450	0.770	2	0.40
Challa	20.000	19.94	19.3	6.400	6.450	0.770	2	0.40
Cascada	18.500	18.44	17.8	6.140	6.150	0.770	2	0.40
Pto.Leon	75.000	24.94×3	24.65×3	6.000	6.150	0.975	3	0.40
Cajones	25.000	24.94	24.3	6.000	6.150	0.975	3	0.40
Chojña	22.000	21.94	21.3	7.100	7.100	0.870	2	0.40
Carrasco	30.000	29.94	29.3	7.350	7.300	1.115	3	0.50



Name of Bridges	Width				Spaceing of Girder			Slab	Girder		
	B	b_1	b_2	b_3	S_o	S_1	S_2	d	h	b_f	n
Patuni	11.90	10.40	0.60	2.00	2.40	0.800 ~ 1.700	1.700 ~ 0.800	0.19	1.10	0.51	5
Challa	11.90	10.40	0.60	2.00	2.40	0.64~ 1.804	1.660 ~ 0.753	0.19	1.10	0.51	5
Cascada	10.50	9.00	1.00	—	2.60	1.35	1.35	0.19	1.10	0.51	4
Pto.Leon	8.80	7.30	0.15	—	2.20	1.10	1.10	0.18	1.50	0.51	4
Cajones	10.50	9.00	1.00	—	2.60	1.35	1.35	0.19	1.50	0.51	4
Chojña	10.50	9.00	1.00	—	2.60	1.35	1.35	0.19	1.20	0.51	4
Carrasco	13.00	12.00	2.50	—	2.60	1.30	1.30	0.19	1.70	0.56	5

Cross Section Area (Unit : m^2)

	Patuni	Challa	Cascada	Pto.Leon	Cajones	Chojña	Carrasco
End of Girder (A_e)	0.561	0.561	0.561	0.772	0.772	0.612	0.962
Center of Girder (A_s)	0.317	0.317	0.317	0.412	0.412	0.337	0.472
End Cross Beam (Be_1)	2.079	2.079	2.229	2.528	3.128	2.508	3.458
End Cross Beam (Be_2)	0.602	0.602	0.602	0.821	0.821	0.657	0.862
Inner Cross Beam (B_s)	1.665	1.665	1.882	2.302	2.770	2.064	3.218

(1) Concrete Volume

1) Girder (Type P)

$V_G = A_S \times (L_G - 2 \cdot h - 2 \cdot K) + 2 \times A_e \times h + \frac{1}{2}(A_S + A_e) \times K \times 2$

2) Cross Beam (Type A)

$V_C = 3 \times B_S \times 0.25 + 3 \times Be_1 \times 0.400 + 2 \times Be_2 \times 0.400$

(4) (4)

3) Slab (Type A)

$V_S = B \times d \times L_G$

4) Pavement (Type A)

$V_P = 0.02 \times b_1 \times L_G$

Concrete Volume (Unit : m^3)

	Patuni	Challa	Cascada	Pto.Leon	Cajones	Chojna	Carrasco	Sub Total
V_G	(7.080) 70.800	(7.080) 35.400	(6.728) 26.912	(11.500) 138.000	(11.500) 46.000	(7.507) 30.028	(16.077) 80.385	(67.472) 472.525
V_C	11.162	11.162	9.761	13.523	16.300	10.785	25.585	98.278
V_S	40.339	40.339	32.915	49.755	49.755	35.593	73.952	322.648
V_P	4.148	4.148	3.319	4.489	4.489	3.582	6.886	31.061
Total	111.298	55.919	45.995	203.301	70.544	49.960	106.423	648.440

(2) Volume of Form Area

1) Girder (Per 1 Girder)

$A_G = a_1 \times (L_G - 2h - 2k) + a_2 \times (h - 0.40) + \frac{1}{2}(a_1 + a_2) \times K + 2 \times Ae$

2) Cross Beam

$Ac_1 = (n-1) \times 2 \times B_S \times m + (n-1) \times (S_o - b_f) \times 0.25 \times m$

$Ac_2 = (n-1) \times 2 \times Be_1 \times 2 + (n-1) \times (S_o - b_f) \times 0.40 \times 2$

$Ac_3 = 2 \times Be_2 \times 2 \times 2 + \sqrt{(S_1 - b_f/2)^2 + h^2} + 2 \times \sqrt{(S_2 - b_f/2)^2 + h^2}$

$Ac = Ac_1 + Ac_2 + Ac_3$

3) Slab

$As_1 = (n-1) \times (S_o - b_f/2) \times (L_G - 2 \times 0.40 - 0.25m)$

$As_2 = S_1 \times (L_G - 0.40 \times 2) + S_2 \times (L_G - 0.40 \times 2)$

$As_3 = (d + 0.02) \times (L_G + B) \times 2$

$As = As_1 + As_2 + As_3$

(Per 1 Span)

	Unit	Patuni	Challa	Cascada	Pto.Leon	Cajones	Chojña	Carrasco
a_1	m^2/m	3.092	3.092	3.092	3.918	3.918	3.291	4.451
a_2	m^2/m	2.710	2.710	2.710	3.510	3.510	2.910	4.018
A_G	m^2	61.719	61.719	57.082	97.535	97.535	65.742	133.303
A_C	m^2	193.458	193.458	156.470	195.039	208.983	169.080	295.571
A_S	m^2	78.651	78.651	66.127	99.715	108.565	72.093	159.277
Total	m^2	272.109	272.109	222.597	294.754	317.548	241.173	454.848

Reinforcement Bar

1) Girder (110 kg/m^3)

$W_G = V_G \times 110$ / Girder

2) Cross Beam (145 kg/m^3)

$W_C = V_C \times 145$

3) Slab (205 kg/ m^3)

$W_S = V_S \times 205$

(Per 1 Span)

	Unit	Patuni	Challa	Cascada	Pto.Leon	Cajones	Chojña	Carrasco
W_G	t	0.779	0.779	0.740	1.265	1.265	0.826	1.768
W_C	t	1.684	1.684	1.415	1.961	2.363	1.564	3.710
W_S	t	8.269	8.269	6.748	10.200	10.200	7.297	15.160
Total	t	9.953	9.953	8.163	12.161	12.563	8.861	18.870

4) PC-Cable (65kg/m^3)

$W_P = V_G \times 65$

5) Handrail

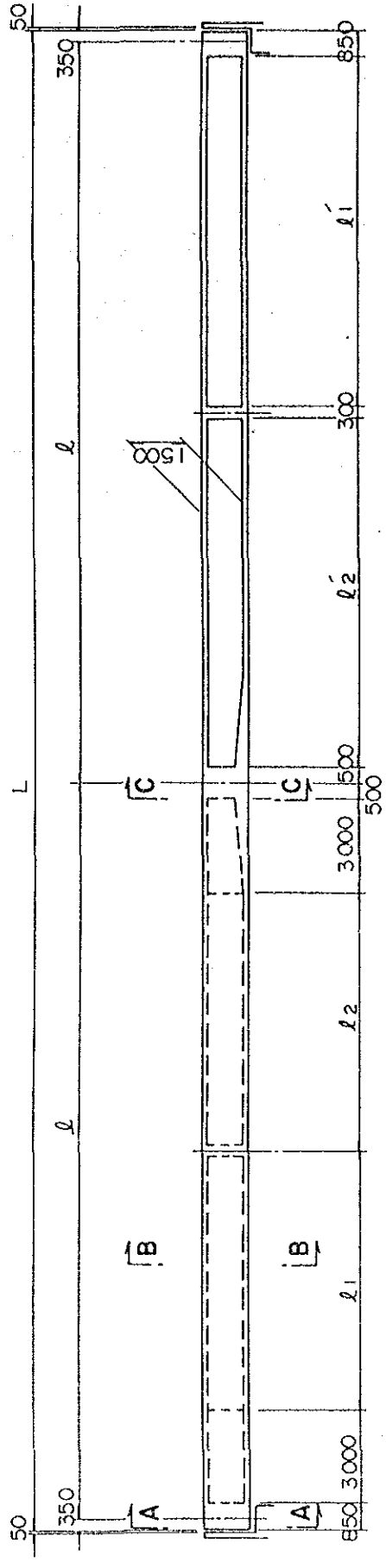
$L = L_B \times 2$

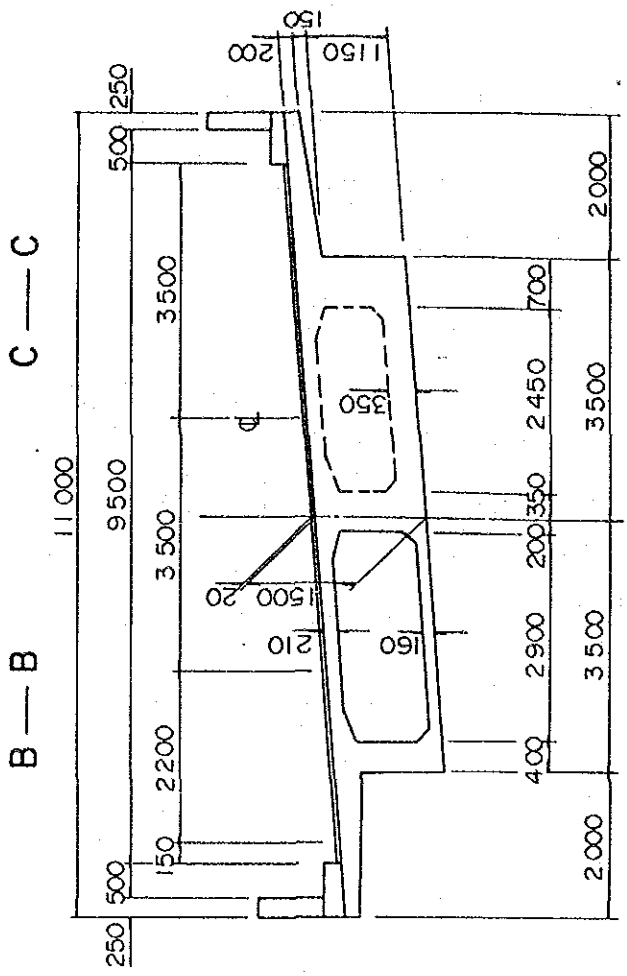
6) Expantion

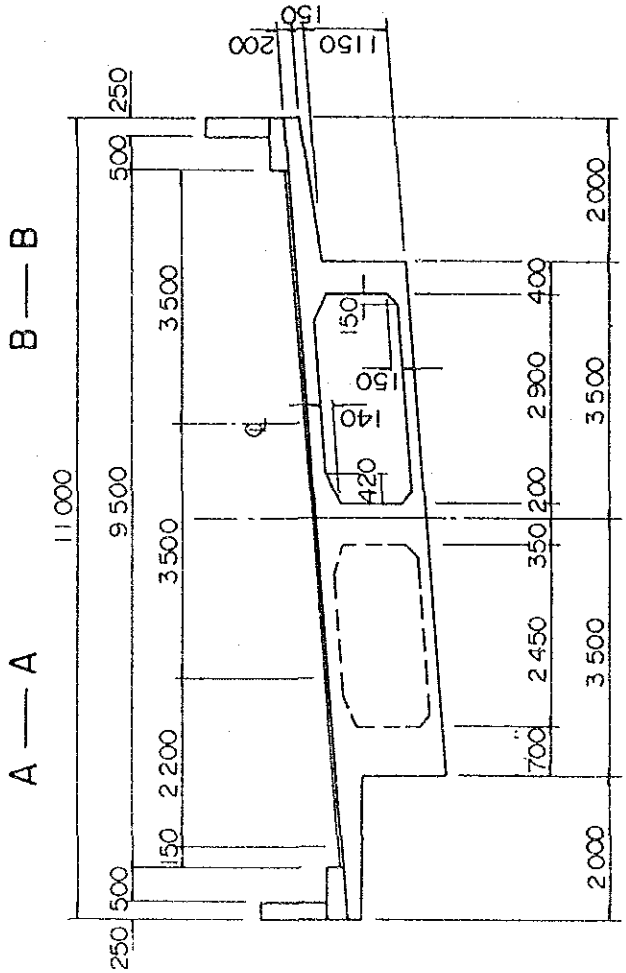
$L = B \times 2$

7) Drainage (1Pce/10m)

$n = LB/10 + 1$


50
350
850
ℓ
ℓ1
ℓ2
300
150
C
C
500
500
3000
L
B
B
A
A
350
50
850


B — B
C — C
150
200
1150
250
500
3500
11000
9500
3500
2200
150
500
250
700
2450
350
200
2900
400
2000
3500
d
1350
1500
20
210
160


A — A
B — B
150
200
1150
250
500
3500
11000
9500
3500
2200
150
500
250
400
2900
200
350
2450
700
2000
3500
d
150
150
140
420

Name of Bridge	Bridge Length	Center of Girder (m²)				Areas (m²)		
		L	ℓ	ℓ_1	ℓ_2	A_1 (A-A)	A_2 (B-B)	A_3 (C-C)
Alto Choro	50.000	48.038	23.669	8.400	8.269	6.226	5.209	7.157
San Silverio	50.000	48.038	23.669	8.400	8.269	6.226	5.209	7.157
San Lorenzo	52.000	50.778	25.039	9.100	8.939	6.226	5.209	7.157
Espiritu	52.000	50.778	25.039	9.100	8.939	6.226	5.209	7.157
Avaroa	25.00	24.019	23.319	8.160	8.160	6.226	5.209	———

1. Concrete Volumes

1) Girder (V_A)

$V_1 = A_1 \times 0.85$

$V_2 = 1/2 \times (A_1 + A_2) \times 3.00$

$V_3 = A_1 \times (\ell_1 + \ell_2)$

$V_4 = 1/2 \times (A_2 + A_3) \times 3.00$

$V_5 = A_3 \times 0.50$

$$V_A = V_1 + V_2 + V_3 + V_4 + V_5$$

2) Cross Beam (V_B)

$V_1 = \{1.13 \times 2.45 \times 2 - (a+b)\} \times 0.85$

$V_2 = \{1.13 \times 2.90 \times 2 - (a+b)\} \times 0.30$

$V_3 = \{0.94 \times 2.45 \times 2 - (a+b)\} \times 0.50$

$a = 1/2 \times 0.14 \times 0.42 \times 4 = 0.118 \ (m^2)$

$b = 1/2 \times 0.15 \times 0.15 \times 4 = 0.045 \ (m^2)$

$$V_B = V_1 + V_2 + V_3$$

$$\Sigma V = V_A + V_B$$

Name of Bridge	Per 1 Span		Per Bridge		
	V_A	V_B	V_A	V_B	ΣV
Alto Choro	131.402	8.707	262.804	17.414	280.218
San Silverio	131.402	8.707	262.804	17.414	280.218
San Lorenzo	138.538	8.707	277.076	17.414	294.490
Espiritu	138.538	8.707	277.076	17.414	294.490
Avaroa	138.538	8.707	138.538	8.707	147.245

2. Form Areas

Upper Slab(A_a)

$$a_1 = (0.20+\sqrt{0.15^2+2.00^2})\times L/2 \times 2$$
$$a_2 = 1/2\times\{(2.45-2\times0.42)+(2.90-2\times0.42)\times 3.00\times4$$
$$a_3 = (2.90-2\times0.42)\times(\ell_1+\ell_2-0.3)\times2$$
$$a_4 = \sqrt{0.14^2+0.42^2}\times(2\times3.0+\ell_1+\ell_2-0.3)\times4$$
$$A_a = a_1+a_2+a_3+a_4$$

Web(A_b)

$$a_1 = 1.15\times L/2\times2$$
$$a_2 = 0.84\times(3.00+\ell_1+\ell_2-0.3)\times4$$
$$a_3 = 1/2\times(0.84+0.65)\times3.00\times4$$
$$a_4 = \sqrt{0.15^2+0.15^2}\times(2\times3.00+\ell_1+\ell_2-0.3)\times4$$
$$A_b = a_1+a_2+a_3+a_4$$

Lower Slab(A_c)

$$A_c = 7.00\times L/2$$

Cross Beam(A_d)

$$a_1 = (1.13\times2.45-1/2\times0.14\times0.42\times2-1/2\times0.15^2\times2)\times2$$
$$a_2 = (1.13\times2.90-1/2\times0.14\times0.42\times2-1/2\times0.15^2\times2)\times4$$
$$a_3 = (0.94\times2.45-1/2\times0.14\times0.42\times2-1/2\times0.15^2\times2)\times2$$
$$A_d = a_1+a_2+a_3$$

End of Girder(A_e)

$$a_1 = 1/2(0.20+0.35)\times2.0\times2$$
$$a_2 = 1.50\times7.00$$
$$A_e = a_1+a_2$$

$$\Sigma A = A_a+A_b+A_c+A_d+A_e$$

Name of Bridge	For 1 Span						For Bridge
	A_a	A_b	A_c	A_d	A_e	ΣA	ΣA
Alto Choro	235.063	148.245	168.133	22.600	11.600	585.641	585.641 × 2 = 1171.282
San Silverio	235.063	148.245	168.133	22.600	11.600	585.641	585.641 × 2 = 1171.282
San Lorenzo	249.141	157.161	177.723	22.600	11.600	618.225	618.225 × 2 = 1236.450
Espiritu	249.141	157.161	177.723	22.600	11.600	618.225	618.225 × 2 = 1236.450
Avaroa	235.063	148.245	168.133	22.600	11.600	585.641	585.641 × 1 = 585.641

3) Reinforcement Bar (170kg/m³)
W = ΣV × 0.170 (ton)

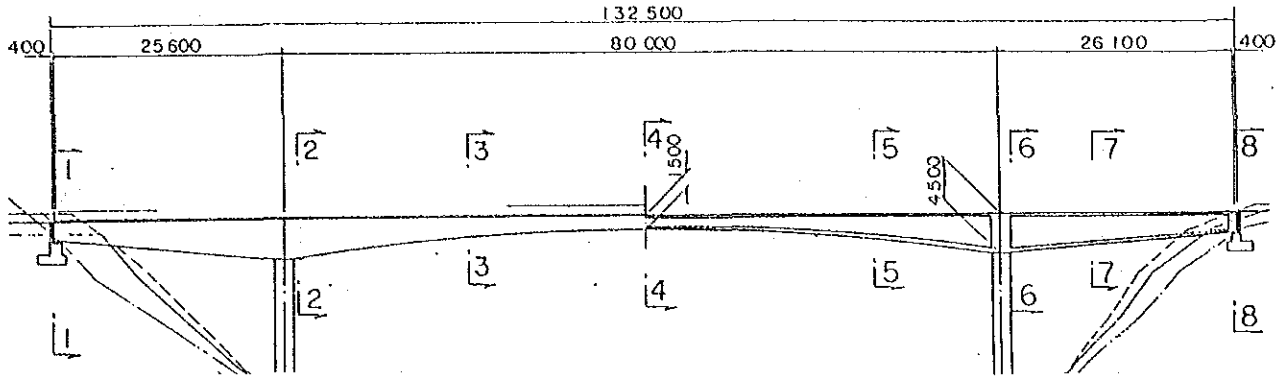
4) PC-Cable (35kg/m³)
W = ΣV × 35 (kg)

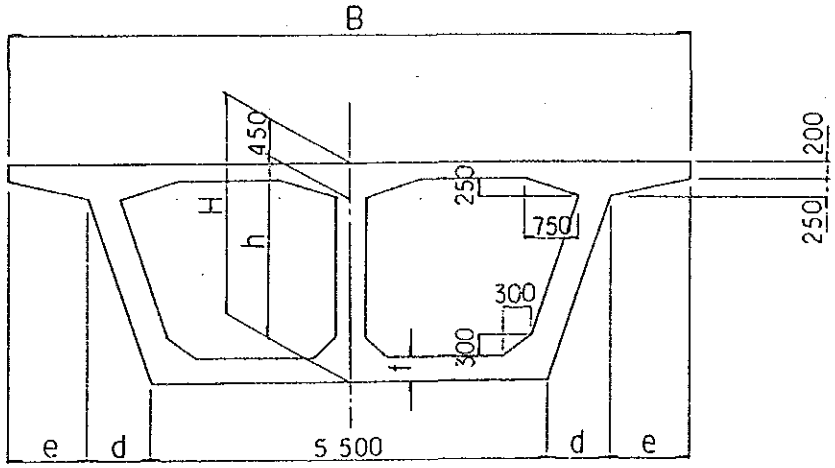
5) Handrail
L = L × 2 (m)

6) EXpantion
L = 11.0×2 = 22.0m

7) Drainage (1Pce/10m)
n = L/10 + 1

1.3 Point A Bridge





Cross Section	B	H	h	d	e	f	l
1 – 1	11.000	2.500	2.05	0.683	2.067	0.300	25.60
2 – 2	11.000	4.500	4.05	1.350	1.400	0.500	20.00
3 – 3	8.800	3.038	2.588	0.863	0.787	——	20.00
4 – 4	8.800	1.500	1.05	0.350	1.300	0.350	27.10
5 – 5	8.800	3.585	3.135	1.045	0.605	——	12.90
6 – 6	10.219	4.500	4.05	1.350	1.400	0.500	7.10
7 – 7	11.000	3.934	3.483	1.161	1.589	——	19.00
8 – 8	11.000	2.500	2.05	0.683	2.067	0.300	

(1)Concrete

1) Upper Slab

V_1 = 11.00×25.60 ×0.20+½(11.00+8.80) ×20×0.20+8.80×20.0×0.20
+8.80×27.10 ×0.20+½(8.80 +10.219) ×12.90 ×0.2 +(10.219 + 11.00) ×7.10×0.20
+11.00 ×19.00 ×0.20 = 257.664

V_2 =½×0.250 ×0.750 ×131.70×4 = 49.388

V_3 =½(2.067+1.400)×25.60 ×0.25+½(1.400+0.787)×20.00 ×0.25
+½(0.787+1.300)×20.0×0.25+½(1.300+0.605)×27.10 ×0.25
+½(0.605+1.400)×12.90 ×0.25+½(1.400+1.589)×7.10×0.25
+½(1.589+2.067)×19.00 ×0.25 = 44.551 ×2 = 89.102

V_U = 396.154m³

2) Lawer Slab

V_1 = 5.50 ×80.0×(0.35 +0.50) ×½ = 187.0

V_2 = 5.50 ×25.6×(0.30 +0.50) ×½ = 56.32

V_3 = 5.50 ×26.1×(0.30 +0.50) ×½ = 57.42

V_4 = 0.30²×½×131.7 ×4 = 23.706

V_L = 324.446m³

3) Web

V_1 = (0.95+3.80) ×0.40×40×½×2 +½(3.80 +2.0)×25.60 × 0.40
+½(3.80 +2.0)×26.10 × 0.40 = 97.972

V_2 =½(0.95 +3.80) ×½(0.422+0.738)×40×½×2 ×2
+½(3.80 +2.0)×0.738 ×25.60 ×2 +½(3.80 +2.0)×26.10 ×0.738 ×2 = 223.818

V_W = 321.790m³

4) Cross Beam

V_1 =½(1.812+2.495)×2.0 ×1.5 ×4 = 25.842

V_2 =½(1.812+3.162)×3.8 ×3.0 ×4 = 113.407

V_C = 139.249m³

5) Pavement

V_P = 257.664×1/10 V_P = 25.766m³

Total V = 1207.4 m³

(2) Form

1) Upper Slab

$A_1 = \frac{1}{2}(2.60 + 1.60) \times 40.0 \times 4 = 336.0$

$A_2 = \frac{1}{2}(2.60 + 1.933) \times (25.6 + 26.1) \times 2 = 234.356$

$A_3 = \frac{1}{2}(2.067 + 1.400) \times 25.60 + \frac{1}{2}(1.40 + 0.787) \times 20.0 + \frac{1}{2}(0.787 + 1.30) \times 20.0$
$+ \frac{1}{2}(1.30 + 0.605) \times 27.10 + \frac{1}{2}(0.605 + 1.40) \times 12.90 + \frac{1}{2}(1.40 + 1.589) \times 7.10$
$+ \frac{1}{2}(1.589 + 2.067) \times 19.0 = 171.206 \times 2 = 342.411$

$A_4 = \sqrt{0.25^2 + 0.75^2} \times 131.70 \times 4 = 416.472$

$A_S = 1329.239 m^2$

2) Web

$A_1 = \frac{1}{2}(3.25 + 0.40) \times 40 \times 2 \times 2 = 292.0$

$A_2 = \frac{1}{2}(3.25 + 1.45) \times (26.1 + 25.6) \times 2 = 242.99$

$A_3 = \frac{1}{2}(\sqrt{1.35^2 + 4.05^2} + \sqrt{1.05^2 + 0.35^2}) \times 40 \times 2 \times 2 = 430.070$

$A_4 = \frac{1}{2}(\sqrt{1.35^2 + 4.05^2} + \sqrt{2.05^2 + 0.683^2}) \times (26.1 + 25.6) \times 2 = 332.434$

$A_5 = \frac{1}{2}(\sqrt{1.35^2 + 3.25^2} + \sqrt{0.40^2 + 0.35^2}) \times 40 \times 2 \times 2 = 324.059$

$A_6 = \frac{1}{2}(\sqrt{1.35^2 + 3.25^2} + \sqrt{1.45^2 + 0.35^2}) \times (26.1 + 25.6) \times 2 = 259.062$

$A_7 = \sqrt{0.30^2 + 0.30^2} \times 131.70 \times 4 = 223.502$

$A_W = 2114.117 m^2$

3) Lower Slab

$A_1 = 5.50 \times 131.70 = 724.35 m^2$

$A_2 = \frac{1}{2} \times (5.50 + 6.866) \times 2.05 \times 2 = 25.350 m^2$

$A_L = 749.70 m^2$

Total A = $4193.056 m^2$

(3) Reinforcement Bar (170kg/m³)

W = 1207.4 × 0.170 = 205.26 t

(4) PC-Cable (40kg/m³)

W = 1207.4 × 40 = 48296 kg

(5) Handrail

L = 132.5 × 2 = 265 m

(6) Expantion

L = 11.0 × 2 = 22 m

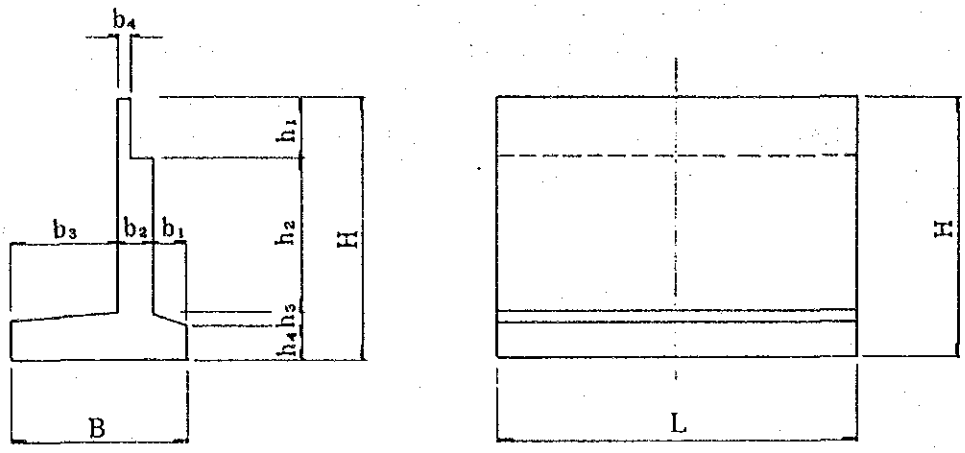
(7) Drainage (1pce/10m)

n = 14pce × 2 = 28 pce

2. Substructure

2-1 Abutment

(1) Type 1



unit : m

A1-Abut.											
	H	h1	h2	h3	h4	B	b1	b2	b3	b4	L
Point A	5.00	2.86	1.14	—	1.00	3.00	0.5	1.00	1.50	0.50	11.00
Patuni	6.00	1.20	3.80	—	1.00	4.00	1.00	1.00	2.00	0.30	12.29
Challa	6.00	1.50	3.50	—	1.00	4.00	1.00	1.00	2.00	0.30	12.29
Casdaca	5.00	1.35	2.45	0.20	1.00	3.00	0.50	1.00	1.50	0.30	11.56
Alto Choro	6.00	1.61	3.19	0.20	1.00	3.50	0.80	1.00	1.70	0.30	11.00
Pto.Leon	8.50	1.72	5.58	0.20	1.00	5.00	1.20	1.20	2.60	0.40	8.80
Cajones	5.40	1.75	2.45	0.20	1.00	3.50	0.80	1.00	1.70	0.40	10.50
San Silverio	8.50	1.81	5.69	0.20	1.00	5.00	1.20	1.20	2.60	0.40	11.00
San Lorenzo	8.00	1.61	5.19	0.20	1.00	5.00	1.20	1.00	2.80	0.30	11.00
Espiritu	6.70	1.61	4.09	—	1.00	3.50	0.80	1.00	1.50	0.30	11.00
Carrasco	8.00	1.95	4.85	0.20	1.00	4.50	1.00	1.00	2.50	0.40	13.98
A2-Abut.											
	H	h1	h2	h3	h4	B	b1	b2	b3	b4	L
Point A	5.00	2.86	1.14	—	1.00	3.00	0.50	1.00	1.50	0.50	11.00
Patuni	5.00	1.20	2.80	—	1.00	3.00	0.50	1.00	1.50	0.30	12.92
Challa	5.50	1.50	3.00	—	1.00	3.30	0.80	1.00	1.50	0.30	12.92
Alto Choro	6.00	1.61	3.19	0.20	1.00	3.50	0.80	1.00	1.70	0.30	11.00
Pto.Leon	10.00	1.72	7.08	0.20	1.00	6.00	1.50	1.20	3.30	0.40	8.80
Cajones	6.30	1.75	3.35	0.20	1.00	3.50	0.80	1.00	1.70	0.40	10.50
San Silverio	8.50	1.81	5.69	0.20	1.00	5.00	1.20	1.20	2.60	0.40	11.00
San Lorenzo	6.56	1.61	3.95	—	1.00	3.50	0.80	1.00	1.50	0.30	11.00
Espiritu	8.00	1.61	5.19	0.20	1.00	5.00	1.20	1.00	2.80	0.30	11.00
Carrasco	10.00	1.95	6.85	0.20	1.00	5.00	1.20	1.20	2.50	0.40	13.98

1) Concrete (210Kg/cm²)

$V=(B \times h_4+1/2 \times b_3 \times h_3+1/2 \times b_1 \times h_3+b_2 \times (h_2+h_3)+b_4 \times h_1) \times L \quad (m^3)$

2) Form

$A_1=(2 \times h_1+2h_2+2h_4) \times L$

$A_2=(1/2(b_2+B) \times h_3+B \times h_4+b_2 \times h_2+b_4 \times h_1) \times 2$

$\Sigma A=A_1+A_2 \quad (m^2)$

3) Reinforcement Bar (55Kg/m³)

$W=V \times 0.055$ (ton)

4) Leveling Concrete (t=10cm)

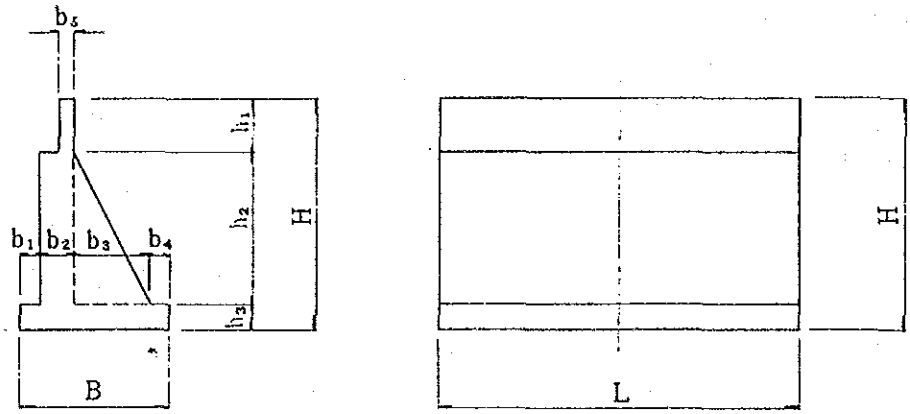
$Ve=B \times L \times 0.10 \quad (m^3)$

5) Staging (Spc. m³)

6) Quantity (Abutment;Type1) unit : m

	Concrete (m^3)	Form (m^2)	Reinforcement Bar (ton)	Leveling Concrete (m^3)	Staging (spc.m^3)
A_1-Abut.					
Point A	61.050	118.432	3.358	3.30	90.53
Patuni	79.23	120.45	4.358	6.08	107.17
Challa	86.426	139.02	4.753	4.11	136.11
Casdaca	70.93	124.73	3.901	4.05	90.53
Alto Choro	83.853	141.95	4.612	3.85	108.64
Pto.Leon	102.925	169.472	5.661	4.40	222.82
Cajones	82.163	143.75	4.519	3.68	165.86
San Silverio	142.241	207.23	7.823	5.50	180.92
San Lorenzo	135.641	195.03	7.460	5.50	166.72
Espiritu	71.403	152.69	3.927	3.85	126.30
Carrasco	172.34	242.69	9.479	7.28	211.83
A_2-Abut.					
Point A	61.050	118.432	3.358	3.30	90.53
Patuni	68.48	116.31	3.766	6.75	88.11
Challa	72.713	123.05	3.999	3.96	129.41
Alto Choro	83.853	141.95	4.612	3.85	108.64
Pto.Leon	125.805	201.072	6.919	5.28	274.74
Cajones	72.713	123.05	3.999	3.68	129.41
San Silverio	142.241	207.23	7.823	5.50	180.92
San Lorenzo	68.935	145.57	3.791	3.85	114.80
Espiritu	88.121	107.19	4.847	5.50	64.48
Carrasco	199.80	302.52	10.989	8.39	328.30

(2) Type 2



unit : m

A1-Abut.											
	H	h1	h2	h3	B	b1	b2	b3	b4	b5	L
Chojna	3.80	1.45	1.35	1.00	2.50	0.30	0.90	0.80	0.50	0.30	12.12
Avaroa	3.50	1.70	1.30	0.50	2.50	0.30	1.00	0.70	0.50	0.40	13.65
A2-Abut.											
Cascada	3.00	1.35	1.15	0.50	2.00	0.30	0.90	0.50	0.30	0.30	11.59
Chojna	4.00	1.45	1.55	1.00	2.50	0.30	0.90	0.80	0.50	0.30	12.12
Avaroa	3.50	1.70	1.30	0.50	2.50	0.30	1.00	0.70	0.50	0.40	12.29

1) Conctete (210Kg/cm²)

$V=(B \times h_3+b_2\times h_2+b_5\times h_1+1/2 \times b_3\times h_2) \times L \quad (m^3)$

2) Form

$A_1=(2\cdot h_1 +h_2+h_3+\sqrt{b_3^2 +h_2^2})\times L$

$A_2=(B\times h_3+b_2\times h_2+b_5\times h_1+1/2 \times b_3\times h_2) \times 2$

$\Sigma A=A_1+A_2 \quad (m^2)$

3) Reinforcement Bar (55Kg/m³)

$W=V\times 0.055 \quad (ton)$

4) Leveling Concrete

$Ve=B \times L \times 0.10 \quad (m^3)$

5) Staging (Spc. m²)

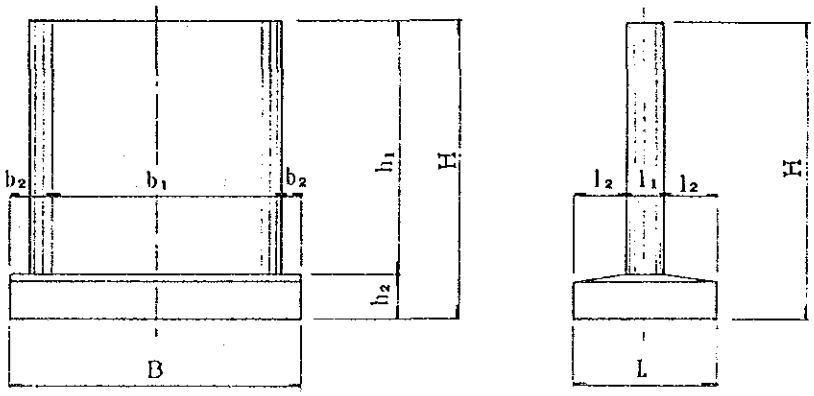
(See Type 1)

6) Quantity (Abutment:Type2)

A_1-Abut.					
	Concrete (m^3)	Form (m^2)	Reinforcement Bar (ton)	Leveling Concrete (m^3)	Staging (Spc.m^3)
Chojna	73.108	111.14	4.021	4.20	98.89
Avaroa	31.43	77.65	1.729	3.13	90.53
A_2-Abut.					
Cascada	31.43	77.65	1.729	4.01	70.87
Chojna	69.773	118.51	3.838	4.20	89.77
Avaroa	31.43	77.65	1.729	3.13	70.87

2-2 Pier

(1) Type 1



P1-Pier									
	B	b_1	b_2	L	l_1	l_2	H	h_1	h_2
Point A	9.50	5.50	2.00	10.70	2.00	4.35	21.00	15.00	6.00
Alto Choro	8.00	6.80	0.50	4.00	1.00	1.50	8.00	6.80	1.20
San Silverio	8.00	6.80	0.50	5.00	1.00	2.00	15.00	10.30	1.20
San Lorenzo	8.00	7.00	0.50	6.00	1.20	2.40	18.00	16.50	1.50
Espiritu	8.00	7.00	0.50	7.00	1.30	2.85	20.00	18.50	1.50
P2-Pier									
Point A	9.50	5.50	2.00	10.70	2.00	4.35	26.00	18.00	8.00

1) Concrete (210kg/cm²)

$V = (b_1-1_1)\times h_1\times 1_1 + 1/4 \times\pi\times 1_1^2 \times h_1 + B\times L \times h_2 (m^3)$

2) Form

$A = (b_1-1_1)\times h_1 + 2\times\pi\times 1_1\times h_1 + 2\cdot(B+L)\times h_2 \ (m^2)$

3) Reinforcement Bar (70kg/m³)

$W = V\times 0.070$ (ton)

4) Leveling Concrete

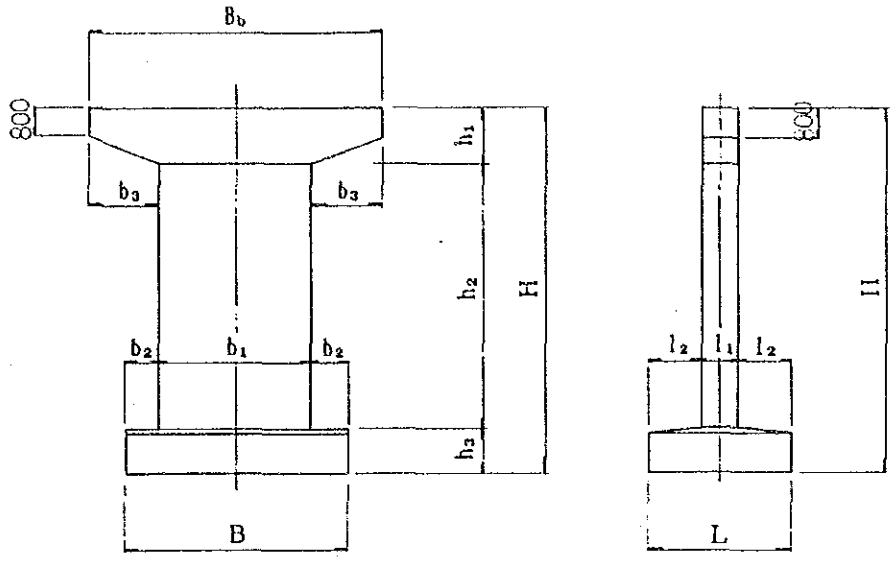
$V_e = B \times L \times 0.10 \ (m^3)$

5) Staging(Spc.m³)

6) Quantity (Pier : Type 1)

P_1 - Pier					
	Concrete (m³)	Form (m³)	Reinforcement Bar (ton)	Leveling Control (m³)	Staging (Spc·m³)
Point A	483.50	338.90	33.85	13.50	562.5
Alto Choro	83.18	129.03	5.81	3.20	136.0
San Sliverio	115.83	183.02	8.11	4.00	206.0
San Lorenzo	205.50	295.57	14.39	4.80	336.0
Espiritu	243.24	327.72	17.03	5.60	381.10
P_2 - Pier					
Point A	633.60	403.70	44.35	15.12	724.5

(2) Type 2



	B	b_1	b_2	b_3	L	l_1	l_2	H	h_1	h_2	h_3	B_b
Patuni	6.00	5.00	0.50	2.75	5.00	1.20	1.90	14.00	1.50	10.91	1.20	10.50
Pto.Leon	6.00	4.00	1.00	2.00	5.00	1.20	1.90	10.00	1.50	7.30	1.20	8.00

1) Concrete (210kg/m³)

$V = \frac{1}{2}(0.80 + h_1) \times b_3 \times h_1 + b_1 \times (h_1 + h_2) \times b_3 + B \times L \times h_3$ (m³)

2) Form

$A_1 = 2 \times (0.80 + h_1) + b_1 \times (h_1 + h_2) \times 2 + 0.80 \times \ell_1 \times 2 + \sqrt{(h_1 - 0.8)^2 + b_3^2} \times \ell_1 \times 2$

$+ b_2 \times h_2 \times 2 + 2 \times (B + L) \times h_3$ (m²)

3) Reinforcement Bar (70kg/m³)

$W = V \times 0.070$ (ton)

4) Leveling Concrete

$V = B \times L \times 0.10$

5) Staging (Spc·m³)

See : Type-1

6) Quantity (Pire : Type 2)

		Concrete (m³)	Form (m²)	Reinforcement Bar (ton)	Leveling Concrete (m³)	Staging (Spc·m³)
Patuni		89.98	139.58	6.299	3.00	147.12
Pto:Leon	P_1	81.104	96.02	5.677	3.00	200.64
	P_2	81.104	96.02	5.677	3.00	200.64

Apêndice 6-2 Precios Principales; Materiales y Equipo

LABOUR COST

US$

Item	Unit	L.C.		F.C.	Total	Remark
		Duties	Other			
Foreman	PRS	1.91	1.75		19.06	
Mechanic of Heavy Equipmemt	PRS	2.73	24.53		27.26	
Operator of Heavy Equipment	PRS	1.88	16.91		18.79	
Operator of Light Equipment	PRS	1.63	14.67		16.30	
Operator Assistant	PRS	1.63	14.67		16.30	
Operator of Crusher Plant Operator of Asphalt Plant	PRS	1.88	16.91		18.79	
Measurer	PRS	1.63	14.67		16.30	
Driver	PRS	1.44	12.94		14.38	
Technician of Explosive	PRS	1.70	15.30		17.00	
Perfortor	PRS	1.63	14.67		16.30	
Carpenter Formworker	PRS	1.64	14.75		16.39	
Reinforcement Worker	PRS	1.37	12.31		13.68	
Masonry Worker	PRS	1.37	12.31		13.68	
Plasterer	PRS	1.38	12.45		13.83	
Electrician, Welder	PRS	1.37	12.31		13.68	
Surveyor	PRS	1.32	11.90		13.22	
Skilled Worker	PRS	1.88	16.91		18.79	
Administrator	PRS	1.32	11.90		13.22	
Normal Worker	PRS	0.92	8.32		9.24	
Cook	PRS	1.22	10.94		12.16	
Cook Assistant	PRS	1.08	9.76		10.84	
Guard Man	PRS	1.25	11.27		12.52	

MATERIAL COST

US$

Item	Size & Type	Unit	L.C.		F.C.	Total	Remark
			Duties	Other			
Cement	Portland	50Kg	0.48	5.70	-	6.18	
Reinforcement	Detemed	Kg	0.21	0.04	0.65	0.90	
Reinforcement	Mild	Kg	0.21	0.04	0.62	0.87	
Timber	For Bridge	m^3	31.39	269.10	-	300.49	
Timber	For Bridge	m^2	0.38	3.02	-	3.40	
Timber	Normal	m^3	8.97	103.15	-	112.12	
Timber	Normal	m^2	0.29	2.34	-	2.65	
Steel Plate	t=2mm	m^2	20.42	0.58	61.32	81.32	
Steel Plate		Kg	0.43	0.04	1.30	1.77	
Separating Agent		ℓ	0.25	0.04	-	0.29	
Vinyl Chloride Pipe	PVC φ4"	m	0.59	4.70	-	5.29	
Nail		Kg	0.31	0.04	0.94	1.29	
Binding Wire		Kg	0.30	0.04	0.90	1.24	
Wire Mesh	1.3Kg/m^2	m^2	0.39	0.05	1.17	1.61	
Admixture		Kg	0.61	-	1.83	2.44	
Anchor Bolt	φ16 ℓ=400mm	Pcs	0.13	0.03	0.39	0.55	
Extra Anchor Bort	φ9 ℓ=200mm	Pcs	0.02	0.01	0.06	0.09	
Detonator		No	0.09	0.01	0.30	0.40	
Dynamite		Kg	0.40	0.04	1.20	1.64	
Bit+Rod		No	22.37	1.47	40.92	64.76	
Seed		Kg	0.70	6.30	-	7.00	
Soil Improving Grass		m^3	9.40	84.60		94.00	
Filler		ton	0.73	0.96	2.73	3.00	
Prestressing Bar		Kg	0.63	0.06	1.91	2.60	

MATERIAL COST

US$

Item	Size & Type	Unit	L.C.		F.C.	Total	Remark
			Duties	Other			
Gasoline		ℓ	0.03	0.28	-	0.31	
Disel	10w40	ℓ	0.03	0.23	-	0.26	
Engine Oil	SEA 30	ℓ	0.09	0.79	-	0.88	
		ℓ	0.08	0.73	-	0.81	
Hydraulic Oil	ϕ60cm	ℓ	0.12	1.05	-	1.17	
Conrete Pipe Culver		m	6.00	54.00	-	60.00	
Cut-back Asphalt		ton	84.94	31.13	255.06	371.13	
Seal Carpet		ton	74.94	31.13	225.06	331.13	
Guard Rail	20.1Kg/m	m	.95	0.75	14.87	20.57	
Traffic Marking	w=10cm	m	0.02	0.18	-	0.20	
Bolt, Nut		Kg	0.19	0.15	0.66	1.00	
Propan Gas		Kg	0.02	0.19		0.21	
Concrete Pipe	ϕ=0.6m	m	6.00	54.00		60.00	
Concrete Pipe	ϕ1.0m	m	11.65	104.86		116.50	

OPERATION COST

US$

Item	Size & Type	Unit	L.C.		F.C.	Total	Remark
			Duties	Other			
Bulldozer	D6		12.61	13.35	42.52	68.48	A -13
Bulldozer	D7		15.26	11.89	52.00	79.15	-15
Bulldozer (Attach Ripper)	D8		28.84	14.28	102.64	145.76	-14
Track Crane	10~11Ton		9.28	5.99	32.72	47.99	-16
Track Crane	4Ton		3.74	4.49	12.25	120.48	-17
Excavator (Back hoe)	0.6m³		9.87	7.77	34.19	51.83	-18
Macadam Roller	10~12Ton		6.15	9.83	19.14	35.12	-21
Tire Roller	20Ton		7.93	9.69	25.93	43.55	-22
Vibrator Roller	10Ton		10.74	10.79	36.13	57.66	-23
Road Sprinkler	6,000 ℓ		3.81	4.41	12.60	20.82	-24
Crusher Plant	60m³/h		35.27	10.56	129.76	175.59	-25
Asphalt Finisher	W=3.6m		13.75	5.19	50.13	69.07	-26
Asphalt Plant	60Ton/h		14.97	10.61	53.04	78.62	-27
Motor Grader	W=3.7m		8.62	8.37	29.16	46.15	-28
Tire Roller	10Ton		6.25	9.32	19.72	35.29	-29
Tractor Shovel	1.6m³		2.37	3.33	0.76	6.46	-11
Dump Track	6m³		4.83	3.57	16.81	25.21	-12
Small Track	3.5Ton		1.61	3.40	4.59	9.60	-19
Distributer	4,000 ℓ		5.21	5.09	17.64	27.94	-20

Construction Equipment			Unit	Bulldozer	Bulldozer	Bulldozer	Motor Scraper	Motor Grader	Motor Grader	Vibrator Roller
Type				D6	D8	D-7	10.7m³	3.7m	4.0m	9.7ton
Engine Power			PS	141	319	250	330	125	180	127
Weight			Ton	15.0	32.0	18.5	30.2	11.5	15.1	11
Life Time			Years	6	6	6	6	6	6	6
Working Time per Year			Hours	1100	1200	1200	1200	1100	1000	750
Working Day per Year			Days	170	180	170	170	155	150	150
Depreciation Rate per Hour			10^{-6}	352	352	325	268	324	353	471
CIF of La Paz			$	120800	291600	160000	190000	90000	122000	62600
Customs Duties			$	31770	76690	42080	49970	23670	32086	16464
Transportation (Construction Site) and Other Cost			$	767	1548	895	825	431	635	532
Purchase Price			$	153337	369838	202975	240795	114101	154721	79596
F.C. Depreciation			$/hr	42.52	102.64	52.00	50.92	29.16	43.07	33.30
L.C.	Duties	Income Tax	$/hr	11.18	26.99	13.68	13.39	7.67	11.33	8.76
		Fuel	$/hr	0.46	1.03	0.81	1.05	0.25	0.36	0.42
		Lube. Cost	$/hr	0.09	0.21	0.16	0.21	0.05	0.07	0.08
		Sub Total	$/hr	11.73	28.23	14.65	14.65	7.97	11.76	9.26
	Others	Transportation	$/hr	0.27	0.54	0.29	0.22	0.14	0.22	0.28
		Fuel	$/hr	3.65	8.27	6.48	8.40	2.01	2.89	3.32
		Lube. Cost	$/hr	0.73	1.65	1.30	1.68	0.40	0.58	0.66
		Sub Total	$/hr	4.65	10.46	8.07	10.30	2.55	3.69	4.26
Total (per hour)			$/hr	58.90	141.33	74.72	75.87	39.68	58.52	46.82

NOTE: F.C. = Foreign Currency, L.C. = Local Currency

Construction Equipment			Unit	Vibrator Roller	Tire Roller	Macadam Roller	Tractor Shovel	Tractor Shovel	Tractor Shovel	Tractor Shovel
Type				11t	10ton	20ton	10 ~12ton	0.6m³	0.8m³	1.6m³
Engine Power			PS	118	145	165	158	46	65	100
Weight			Ton	11.0	8.5	11	10	3.9	7.0ton	9.5ton
Life Time			Yers	6	7	7	7	6	6	6
Working Time per Year			Hours	800	900	900	900	800	900	1000
Working Day per Year			Days	160	150	150	150	120	135	150
Depreciation Rate per Hour			10^{-6}	446	348	348	348	370	411	370
CIF of La Paz			$	81000	56670	74500	55000	52800	57000	41000
Customs Duties			$	21303	14904	19594	14465	13886	14991	10783
Transportation (Construction Site) and Other Cost			$	532	411	532	484	189	339	459
Purchase Price			$	102835	71985	94626	49949	66875	72330	52242
F.C. Depreciation			$/hr	36.13	19.72	25.93	19.14	19.54	23.43	15.17
L.C.	Duties	Income Tax	$/hr	9.50	5.19	6.82	5.03	5.14	6.16	3.99
		Fuel	$/hr	0.39	0.24	0.28	0.29	0.11	0.23	0.24
		Lube. Cost	$/hr	0.08	0.05	0.06	0.06	0.02	0.05	0.05
		Sub Total	$/hr	9.97	5.48	7.16	5.38	5.27	6.44	4.28
	Others	Transportation	$/hr	0.24	0.14	0.19	0.17	0.07	0.14	0.17
		Fuel	$/hr	3.09	1.95	2.22	2.35	0.88	1.86	1.92
		Lube. Cost	$/hr	0.62	0.39	0.44	0.47	0.18	0.37	0.38
		Sub Total	$/hr	3.95	2.48	2.85	2.99	1.13	2.37	2.47
Total (per hour)			$/hr	50.05	27.68	35.94	27.51	25.94	32.24	21.92

NOTE: F.C. = Foreign Currency, L.C. = Local Currency

Construction Equipment			Unit	Wheel Loader	Tractor Shovel	Excavator	Excavator	Small Truck	Truck	Large Truck
Type				1.4m³	2.1m³	0.6m³	1.0m³	3.5t	6.0m³	8.0m³
Engine Power			PS	107	125	105	175	140	160	244
Weight			Ton	12.7	12.2	18.0	30	1.9	5.2	7.1
Life Time			Years	6	6	5	5	5	5	5
Working Time per Year			Hours	1100	1200	1300	1300	1700	1500	1600
Working Day per Year			Days	165	170	185	195	220	200	215
Depreciation Rate per Hour			10^{-6}	359	325	304	308	255	367	328
CIF of La Paz			$	95800	195000	111000	206000	17660	45800	53550
Customs Duties			$	25195	51285	29193	54178	4734	12045	14084
Transportation (Construction Site) and Other Cost			$	614	908	870	1451	42	156	163
Purchase Price			$	121609	247193	104436	261629	22776	58096	67977
F.C. Depreciation			$/hr	34.39	63.38	34.19	63.45	4.59	16.81	17.56
L.C.	Duties	Income Tax	$/hr	9.05	16.67	8.99	16.69	1.21	4.42	4.62
		Fuel	$/hr	0.38	0.30	0.35	0.58	0.15	0.16	0.16
		Lube. Cost	$/hr	0.08	0.06	0.07	0.12	0.03	0.03	0.03
		Sub Total	$/hr	9.51	17.03	9.41	17.39	1.39	4.61	4.81
	Others	Transportation	$/hr	0.22	0.30	0.26	0.45	0.01	0.06	0.05
		Fuel	$/hr	3.06	2.40	2.80	4.66	1.21	1.31	1.31
		Lube. Cost	$/hr	0.61	0.48	0.56	0.93	0.24	0.26	0.26
		Sub Total	$/hr	3.89	3.18	3.62	6.04	1.46	1.63	1.62
Total (per hour)			$/hr	47.79	83.59	47.22	86.88	7.44	23.05	23.99

Construction Equipmet			Unit	Road Sprinkler	Dump Truck	Truck Crane	Truck Crane	Truck Crane	Truck Crane	Truck Crane
Type				6000 l	11t(8.0m³)	Cap.carga 4t grua 2.9t	10 - 11t	15 - 16t	25t	35t
Engine Power			PS	160	281	140	225	236	255	302
Weight			Ton	11.0	9.2	6.1	13.5	18	29.0	39.0
Life Time			Years	5	5	5	6	6	5	6
Working Time per Year			Hours	1100	1700	1300	1100	1100	1100	1100
Working Day per Year			Days	180	225	175	160	160	160	160
Depreciation Rate per Hour			$\times 10^{-6}$	336	509	308	271	271	271	271
CIF of La Paz			$	37500	62000	39000	115000	145000	212000	244400
Customs Duties			$	9863	16306	10257	30245	38135	55756	64277
Transportation (Construction Site) and Other Cost			$	121	156	114	453	540	818	965
Purchase Price			$	47484	78462	49257	145698	183135	268574	309642
F.C. Depreciation			$/hr	12.60	19.56	12.01	31.16	39.30	57.45	66.23
L.C.	Duties	Income Tax	$/hr	3.31	5.04	3.16	8.28	10.33	15.11	17.42
		Fuel	$/hr	0.17	0.16	0.15	0.20	0.21	0.23	0.37
		Lube. Cost	$/hr	0.03	0.03	0.03	0.04	0.04	0.05	0.07
		Sub Total	$/hr	3.51	5.23	3.34	8.44	10.58	15.39	17.86
	Others	Transportation	$/hr	0.04	0.05	0.04	0.12	0.15	0.22	0.26
		Fuel	$/hr	1.38	1.31	1.21	1.62	1.70	1.84	3.67
		Lube. Costs	$/hr	0.28	0.26	0.24	0.32	0.34	0.37	0.73
		Sub Total	$/hr	1.70	1.62	1.49	2.06	2.19	2.43	4.66
Total (per hour)			$/hr	17.81	26.41	16.84	41.66	52.07	75.27	88.75

NOTE: F.C. = Foreign Currency, L.C. = Local Currency, (**) = Gasoline, (*) = Per day

Construction Equipmet			Unit	Selection Plant	Concrete Pump	Concrete Pump	Concrete Cutter	Concrete Mixer Car	Asphalt Plant
Type				50t/hr	18m³/hr	45m³/h	tcc- 3	3.5m³	60 t/h
Engine Power			PS	60	25	145	8	195	227
Weight			Ton	3.0	3.0	7.3	0.13	7.5	79
LifeT Time			Years	5	4	4	3	5	6
Working Time per Year			Hours	2000	900	1300	—	1000	900
Working Day per Year			Days		110	190	100	165	170
Depreciation Rate per Hour			$\times 10^{-6}$	255	531	419	1333	360	365
CIF of La Paz			$	60000	28500	96580	2570	55440	145325
Customs Duties			$	15780	7496	25400	676	14581	38220
Transportation Construction Site) and Other Cost			$	145	145	353	6	161	3820
Purchase Price			$	75925	36141	122333	3252	70384	187365
F.C. Depreciation			$/hr	15.30	15.13	40.47	3.43	19.96	53.04
L.C.	Duties	Income Tax	$/hr	4.02	3.98	10.64	0.90	5.25	13.95
		Fuel	$/hr	0.14	0.05	0.30	0.23 (**)	0.23	—
		Lube. Cost	$/hr	0.03	0.01	0.06	0.05	0.05	—
		Sub Total	$/hr	4.19	4.04	11.00	1.18	5.35	13.95
	Others	Transportation	$/hr	0.04	0.08	0.15	0.01	0.06	1.39
		Fuel	$/hr	1.15	0.43	2.47	1.86 (**)	1.83	—
		Lube. Cost	$/hr	0.23	0.09	0.49	0.37	0.37	—
		Sub Total	$/hr	1.42	0.60	3.11	2.24	2.26	1.39
Total (per hour)			$/hr	20.91	19.77	54.58	6.85	27.57	68.38

NOTE: F.C. = Foreign Currency, L.C. = Local Currency, (*)= Per day

Construction Equipmet			Unit	Crusher Plant	Asphalt Finisher	Engine Sprayer	Pile Driver	Concrete Mixer	Compaction Roller(*)	Drill Jambo
Type				60m³/hr	3.6	200 l	3.5t	600Lts	60 - 100kg	7t
Engine Power			PS	172	34	3.5	106	30	4	49
Weight			Ton	46.5	8.0	0.17	49	2.6	0.078	7.0
Life Time			Years	6	7	3	5	4	3	6
Working Time per Year			Hours	4500	600	600	1200			550
Working Day per Year			Days	500	100	150	170	120	140	140
Depreciation Rate per Hour			10^{-6}	2333	474	525	354	3750	4167	258
CIF of La Paz			$	556200	105760	1840	807000	11000	2200	120800
Customs Duties			$	146281	27815	484	212241	2893	579	31770
Transportation (Construction Site) and Oather Cost			$	2249	387	8	2370	126	4	767
Purchase Parice			$	704730	133962	2332	1021611	14019	2783	153337
F.C. Depreciation			$/hr	129.76	50.13	0.97	285.68	41.25	9.17	42.52
L.C.	Duties	Income Tax	$/hr	34.08	13.18	0.25	75.13	10.85	2.41	11.18
		Fuel	$/hr	0.54	0.08	0.009	0.14	0.22	0.14 **	0.46
		Lube. Cost	$/hr	0.11	0.02	0.002	0.03	0.04	0.03	0.09
		Sub Total	$/hr	34.73	13.28	0.26	75.30	11.11	2.58	11.73
	Others	Transportation	$/hr	0.52	0.18	0.01	0.84	0.47	0.02	0.27
		Fuel	$/hr	4.29	0.68	0.07	1.09	1.80	1.11 **	3.65
		Lube. Cost	$/hr	0.86	0.14	0.01	0.22	0.36	0.22	0.73
		Sub Total	$/hr	5.67	1.00	0.09	2.15	2.63	1.35	4.65
Total (per hour)			$/hr	170.16	64.41	1.32	363.13	54.99	13.10	58.90

NOTE: F.C. = Foreign Currency, L.C. = Local Currency

Construction Equipment			Unit	Tamper	Stressing (*) Equipment	(*) Compressor	(*) Compressor	Electri (*) Ventilator	(*) Generator	(*) Generator
Type				60 - 100kg	Freyssinett	20m³/min	10m³/min	40m³/min	75kw	110KW
Engine Power			PS	4	—	252	140	60	100	120
Weight			Ton	0.078	0.15	5.5	2.7	0.46	2.3	2.6
Life Time			Year	3	8	6	6	6	6	6
Working Time per Year			Hours		—	-	-	-	—	-
Working Day per Year			Days	140	—	140	140	200	140	140
Depreciation Rate per Hour			$\times 10^{-6}$	4167	2500	2500	2500	1500	1893	1905
CIF of La Paz			$	2200	31000	64500	50500	4400	15000	25000
Customs Duties			$	579	8153	16964	13282	1157	3945	6575
Transportation (Construction Site) and Other Cost			$	4	7	266	131	22	111	126
Purchase Price			$	2783	39160	81730	63913	5579	19056	31701
F.C. Depreciation			$/hr	9.17	77.50	161.25	126.25	6.60	28.39	47.63
L.C.	Duties	Income Tax	$/hr	2.41	20.38	42.41	33.21	1.74	7.47	12.53
		Fuel	$/hr	0.14 **	—	0.91	0.50	0.18	0.35	0.42
		Lube. Cost	$/hr	0.03	—	0.18	0.10	0.04	0.07	0.08
		Sub Total	$/hr	2.58	20.38	43.5	33.81	1.96	7.89	13.03
	Others	Transportation	$/hr	0.02	0.02	0.67	0.33	0.03	0.21	0.24
		Fuel	$/hr	1.11 **	—	7.26	4.03	1.47	2.81	3.37
		Lube. Cost	$/hr	0.22	—	1.45	0.81	0.29	0.56	0.67
		Sub Total	$/hr	1.35	0.02	9.38	5.17	1.79	3.58	4.28
Total (per hour)			$/hr	13.10	97.90	214.13	165.23	10.35	39.86	64.94

Construction Equipment			Unit	Generator	Earth (*) Drill	Small (*) Breaker	Drop (*) Hammer	Drill	Water (*) Pump	Welder (*)
Type				256KW	-	40Kg	600 ~800Kg	-	φ8	—
Engine Power			PS	350	5.5KW	-	-	-	35	—
Weight			Ton	4.8	0.54	0.039	0.78	0.008	0.92	0.23
Life Time			Years	7	6	2	2	2	5	7
Working Time per Year			Hours	-	-	-	-	-		—
Working Day per Year			Days	140	140	150	150	150	135	200
Depreciation Rate per Hour			10^{-6}	1905	2464	4500	4500	4500	3630	1378
CIF of La Paz			$	39587	83000	3900	3520	1370	9142	5860
Customs Duties			$	10411	21829	1026	926	360	2404	1541
Transportation (Construction Site) and Other Cost			$	232	26	2	38	1	44	11
Purchase Price			$	50230	104855	4928	4484	1731	11590	7412
F.C. Depreciation			$/hr	75.41	204.51	17.55	15.84	6.17	33.19	8.08
F.C.	Duties	Income Tax	$/hr	19.83	53.79	2.53	4.17	1.62	8.73	2.12
		Fuel	$/hr	1.23	-	-	-	-	1.41	—
		Lube. Cost	$/hr	0.25	-	-	-	-	0.28	—
		Sub Total	$/hr	21.31	53.79	2.53	4.17	1.62	10.42	2.12
	Others	Transportation	$/hr	0.44	0.06	0.06	0.17	0.01	0.16	0.02
		Fuel	$/hr	9.83	-	-	-	-	11.29	—
		Lube. Cost	$/hr	1.97	-	-	-	-	2.26	—
		Sub Total	$/hr	12.24	0.06	0.06	0.17	0.01	13.71	0.02
Total (per hour)			$/hr	108.96	258.36	20.14	20.18	7.80	57.32	10.22

Construction Equipment			Unit	Water (*) Pump	(*) Vibrator	Weighing Machine	Oil (*) Jacky	Hydraulic (*) Pump	(*) Winch	Belt (*) Conveyer	Leg (*) Hammer
Type				ϕ = 4"	1.2"	Cap. 1000kg	Freyssinett	Freyssinett	1 t	7 m	600 - 800Kg
Engine Power			PS	3.7	4.5		—	-	7.5km	3.0	-
Weight			Ton	0.10	0.045		0.10	0.15	0.50	0.23	0.78
Life Time			Years	3	4	0.20	8	8	7	3	2
Working Time per Year			Hours	—	—		—	-	—	—	—
Working Day per Year			Days	180	130		—	-	140	130	150
Depreciation Rate per Hour			$\times 10^{-6}$	1850	3462	2153	1929	2500	2990	4487	4500
CIF of La Paz			$	1600	1320	3260	31000	31000	28900	2300	31000
Customs Duties			$	421	347	857	8153	8153	7601	605	8153
Transportation (Construction Site) and Other Cost			$	5	2	8	5	7	24	11	38
Purchase Price			$	2026	1669	4125	39158	39160	36525	2916	39191
F.C. Depreciation			$/hr	2.96	4.57	7.02	59.80	77.50	86.41	10.32	139.5
L.C.	Duties	Income Tax	$/hr	0.78	1.20	1.85	15.73	20.38	22.73	2.71	36.69
		Fuel	$/hr	0.15	0.26	—	—	-	—	0.02	-
		Lube. Cost	$/hr	0.03	0.05	—	—	-	—	0.00	-
		Sub Total	$/hr	0.96	1.51	1.85	15.73	20.38	22.73	2.74	36.69
	Others	Transportation	$/hr	0.01	0.01	0.02	0.01	0.02	0.07	0.05	0.17
		Fuel	$/hr	1.19	2.11	—	—	-	—	0.14	-
		Lube. Cost	$/hr	0.23	0.42	—	—	-	—	0.03	-
		Sub Total	$/hr	1.43	2.54	0.02	0.01	0.02	0.07	0.22	0.17
Total (per Hour)			$/hr	5.35	8.62	8.89	75.54	97.90	109.21	13.28	176.36

Apèndice 6-3 Costo Unitario de Construcciòn

UNIT COST FOR CONSTRUCTION

US$

Item	Cost		Unit	L.C.		F.C.	Total	Remarks
				Duties	Others			
Earth Work	Clearing and Grubbing		ha	2,789	2,599	9,460	14,845	A-31
	Excavation A		m^3	1.40	1.30	2.07	4.50	38
	Excavation B		m^3	1.42	1.38	4.72	7.52	39
	Finished Rolling of Subgrade		m^2	0.01	0.02	0.04	0.07	37
	Slope	Seed Spraying	m^2	0.13	1.13		1.23	73
		Concrete Spraying	m^2	3.29	11.97	7.59	22.85	65
		Cribworks	m^2	6.95	4.58	15.71	47.24	111
		Concrete Pitching	m^2	5.15	13.68	13.12	31.95	112
	Retaining Wall	Gravity(4m)	m	35.12	224.54	50.02	309.77	69
		Stone Masonry	m^2	4.12	27.66	4.69	36.47	63
		Grid Type	m^2	17.07	67.07	30.87	115.01	61
	Culvert	Box 3.0X3.0	m	202	488	523	1,213	71
		Box 4.0X4.0	m	282	696	730	1,708	72
		Pipe Φ1.0m	m	17.58	131.21	12.43	161.22	70
	Disaster	Catch Netting	m^2	2.00	1.59	5.95	9.54	113
		Gabion	m	11.56	25.22	29.94	66.72	114
		Catch Fence	m	20.48	39.02	53.30	112.80	115
		Gabion Dam	m^3	12.78	28.54	35.45	76.77	116
		Shed	m	1,565.36	2,904.05	4,444.72	8,914.13	117
		French Drain	m	3.54	7.63	10.44	21.61	118
	Drainage		Km	4,530	29,637	5,826	39,993	74
Pavement	Subbase Course		m^2	0.36	0.30	1.28	1.94	87
	Base Course		m^2	0.74	1.17	2.40	4.31	88
	Binder Course		m^2	1.08	0.93	3.67	5.68	82
	Surface Course		m^2	1.28	0.88	4.04	6.20	83
Bridge	$\ell \geq 50^m$		Set					
	$\ell < 50^m$		Set					
Tunnel	Lining		m	1,022	3,180	2,713	6,915	92
	Unsupported		m	751	2,076	2,038	4,865	91
	Portal		Pcs	2,827	9,317	7,176	19,320	93
Others	Traffic Sign and Guard Rail		Km	5,910	1,740	14,050	21,700	104
	Marking		Km	47.50	427.50		475	105
Pavement	Macadam Asphalt		m^2	0.70	0.97	1.97	3.64	89

CONSTRUCTION COST

US$

Item	Size & Type	Unit	L.C.		F.C.	Total	Remark
			Duties	Other			
Concrete Class.B	210Kg/cm²	m³	13.49	49.85	34.71	98.05	A -41
Concrete Class.C	160Kg/cm²	m³	5.51	37.33	8.10	50.94	-42
Concrete Class.D	-	m³	5.27	34.35	8.14	47.76	-43
Concrete Mixing		m³	0.84	5.71	0.78	7.33	-48
Concrete Placing (A)	by Man Power	m³	0.43	3.91	-	4.34	-49
Concrete Placing (B)	by Piping	m³	0.75	3.15	1.51	5.41	-49
Concrete Placing (C)	by Crane	m³	1.48	1.65	4.58	7.71	-49
Form Work		m²	0.67	6.23	0.04	6.94	-51
Reinforcement Work		Ton	228.62	105.46	689.13	1,023.21	-52
Scaffolding Work		m³	0.61	4.50	0.45	5.56	-54
Loading Cost		m³	0.24	0.33	0.76	1.33	-11
Transportation Cost		m³	0.09	0.07	0.33	0.49	-12
Transportation Cost		Ton	0.04	0.03	0.13	0.20	-12
Sand	From Swapi	m³	8.04	6.75	29.07	43.86	-45
Sand	From Site	m³	1.20	1.43	3.99	6.62	-45
Gravel	From Alt. Ben:	m³	7.28	6.53	26.02	39.83	-45
Gravel	From Site	m³	1.79	2.26	5.89	9.94	-45
Drainage	Type 1	m	1.36	8.41	1.95	11.72	-75
Drainage	Type 2	m	1.82	12.82	19.19	16.55	-76
Excavation for Tunnel		m³	5.36	12.41	15.63	33.40	-94
Mortar Spray for Tunnel	t=15cm	m²	3.36	15.92	7.93	27.48	-97
Anchor Works for Tunnel		Pcs	14.06	54.88	43.04	111.98	-98
Lining Concrete for Tunnel	t=45cm	m	240.30	929.69	550.49	1,720.48	-101

Unit Cost for Bridge Constructiion							
Name of Work	Size and Type	Unit	L.C.		F.C.	Total	Remarks
			Duties	Others			
Excavation	For Structure	m^3	1.65	6.98	3.31	11.94	B-32
Concrete	Type -P	m^3	16.22	67.28	38.51	122.01	B-29
Concrete	Type -A	m^3	15.08	58.71	37.00	110.79	B-30
Concrete	Type -D	m^3	5.27	34.35	8.14	47.76	A-43
Concrete Mixing		m^3	0.84	5.71	0.78	7.33	A-48
Concrete Placing		m^3	0.75	3.15	1.51	5.41	A-49
Form(hard)		m^2	0.98	7.87	0.24	9.09	B-12
Form(simple)		m^2	0.67	6.23	0.04	6.94	A-51
Reinforcement Bar		Ton	233.81	127.98	694.18	1055.97	B-26
PC-Assembiling		Kg	1.41	0.42	4.61	6.44	B-3
Slab		m^3	69.02	145.12	176.22	390.36	B-4
Cross Beam		m^3	48.71	122.24	120.49	291.44	B-5
Shoe	neopren	Pce	42.66	15.36	126.77	184.79	B-6
Shoe(Box)	neopren	Pce	79.91	15.72	240.26	335.89	B-6
Expansion Joint		m	9.12	3.60	25.00	37.72	B-8
Drenage		Pce	0.58	5.02	-	5.60	B-9
Handrail		m	16.66	35.43	42.38	94.47	B-10
Newel Post		Br.	107.17	63.08	788.83	959.08	B-11
I-Girder		m^3	142.55	177.84	416.83	737.22	B-1
Main Girder (Box)		m^3	109.73	137.75	319.08	566.56	B-2
Staging		Sec·m^3	0.61	4.50	0.45	5.56	B-31
Erection	Girder	ton	4.40	1.26	18.04	23.70	
Erection		m^3	19.7	2.09	55.3	77.09	C-