

Appendix 5
AHP Data

The analysis result table by the AHP

			Evaluation Criteria			Stability level	Traffic volume	Environmental evaluation	Natural condition	Benefit B/C	Restoration level	Development situation
			Weight of each Evaluation Criteria			0.3668	0.1673	0.0839	0.1800	0.0383	0.1430	0.0207
Routes No.	Type of Disaster	Serial Number of Disaster Critical Spots	Analysis result			Weight of each Alternative Spots						
			Weight	Rank	Judgment*	Stability level	Traffic volume	Environmental evaluation	Natural condition	Benefit B/C	Restoration level	Development situation
Nic1	R.F.	1	0.0211	15	D.P.S.	0.0110	0.0330	0.0449	0.0322	0.0168	0.0054	0.0246
	R.F.	2	0.0226	10	D.P.S.	0.0215	0.0324	0.0186	0.0322	0.0178	0.0054	0.0246
	Bridge	3	0.0209	16	D.P.S.	0.0276	0.0269	0.0071	0.0141	0.0517	0.0065	0.0114
	Bridge	4	0.0279	7	D.P.S.	0.0527	0.0269	0.0071	0.0028	0.0482	0.0065	0.0114
	Bridge	5	0.0220	12	D.P.S.	0.0276	0.0242	0.0186	0.0141	0.0276	0.0149	0.0237
	Bridge	6	0.0314	3	D.P.S.	0.0527	0.0242	0.0449	0.0028	0.0459	0.0105	0.0237
	R.F.	7	0.0189	23	D.P.S.	0.0215	0.0242	0.0186	0.0141	0.0070	0.0149	0.0237
	R.C.	8	0.0178	29	D.P.S.	0.0090	0.0242	0.0186	0.0299	0.0097	0.0171	0.0237
	R.C.	9	0.0125	44		0.0083	0.0242	0.0186	0.0028	0.0089	0.0171	0.0237
	R.C.	10	0.0131	42		0.0083	0.0242	0.0186	0.0068	0.0072	0.0171	0.0237
	R.C.	11	0.0175	30	D.P.S.	0.0162	0.0242	0.0186	0.0141	0.0109	0.0171	0.0237
	R.C.	12	0.0187	24	D.P.S.	0.0122	0.0242	0.0186	0.0322	0.0178	0.0116	0.0237
	R.C.	13	0.0183	26	D.P.S.	0.0094	0.0242	0.0186	0.0322	0.0129	0.0171	0.0237
	R.F.	14	0.0174	31		0.0094	0.0242	0.0186	0.0299	0.0088	0.0149	0.0237
	R.C.	15	0.0137	40		0.0089	0.0242	0.0186	0.0068	0.0168	0.0171	0.0237
	R.C.	16	0.0164	34		0.0094	0.0242	0.0071	0.0299	0.0206	0.0116	0.0237
	R.F.	17	0.0148	35		0.0070	0.0186	0.0186	0.0322	0.0083	0.0065	0.0246
	Bridge	18	0.0284	6	D.P.S.	0.0527	0.0052	0.0449	0.0068	0.0268	0.0116	0.0246
	Bridge	19	0.0285	5	D.P.S.	0.0527	0.0052	0.0449	0.0028	0.0278	0.0171	0.0246
	R.C.	20	0.0113	50		0.0090	0.0052	0.0186	0.0141	0.0091	0.0149	0.0246
	R.F.	21	0.0090	52		0.0089	0.0052	0.0186	0.0028	0.0160	0.0116	0.0246
R.F.	22	0.0089	53		0.0089	0.0052	0.0186	0.0068	0.0148	0.0065	0.0246	
Nic3	R.C.	23	0.0144	37		0.0090	0.0256	0.0071	0.0028	0.0341	0.0290	0.0090
	R.C.	24	0.0201	19	D.P.S.	0.0090	0.0256	0.0186	0.0299	0.0304	0.0290	0.0090
	R.C.	25	0.0214	14	D.P.S.	0.0147	0.0256	0.0186	0.0299	0.0428	0.0210	0.0090
	Bridge	26	0.0371	1	D.P.S.	0.0527	0.0256	0.0186	0.0322	0.0598	0.0253	0.0090
	R.C.	27	0.0186	25	D.P.S.	0.0094	0.0256	0.0036	0.0299	0.0223	0.0290	0.0090
	R.C.	28	0.0111	51		0.0083	0.0102	0.0071	0.0068	0.0068	0.0290	0.0043
	S.S.	29	0.0177	28	D.P.S.	0.0089	0.0102	0.0071	0.0322	0.0041	0.0423	0.0043
	D.F.	30	0.0217	13	D.P.S.	0.0198	0.0102	0.0071	0.0322	0.0051	0.0423	0.0043
	S.S.	31	0.0169	32		0.0074	0.0102	0.0036	0.0322	0.0061	0.0423	0.0043
	S.S.	32	0.0252	8	D.P.S.	0.0276	0.0102	0.0186	0.0299	0.0072	0.0423	0.0043
	S.S.	33	0.0229	9	D.P.S.	0.0276	0.0102	0.0071	0.0322	0.0111	0.0290	0.0043
	R.C.	34	0.0167	33		0.0198	0.0102	0.0071	0.0141	0.0079	0.0290	0.0043
Nic5	R.F.	35	0.0198	21	D.P.S.	0.0147	0.0101	0.0071	0.0322	0.0068	0.0423	0.0027
Nic15	D.F.	36	0.0117	47		0.0070	0.0053	0.0022	0.0322	0.0061	0.0105	0.0258
	D.F.	37	0.0117	48		0.0070	0.0053	0.0024	0.0322	0.0053	0.0105	0.0258
	D.F.	38	0.0076	55		0.0070	0.0053	0.0071	0.0068	0.0075	0.0105	0.0258
	D.F.	39	0.0082	54		0.0070	0.0053	0.0071	0.0068	0.0064	0.0149	0.0258
Nic26	R.F.	40	0.0138	39		0.0074	0.0207	0.0186	0.0141	0.0155	0.0171	0.0246
	R.F.	41	0.0147	36		0.0070	0.0207	0.0186	0.0141	0.0129	0.0253	0.0246
	R.F.	42	0.0115	49		0.0074	0.0207	0.0186	0.0028	0.0088	0.0171	0.0246
	R.F.	43	0.0120	45		0.0083	0.0207	0.0186	0.0028	0.0129	0.0171	0.0246
	R.F.	44	0.0183	27	D.P.S.	0.0110	0.0207	0.0186	0.0322	0.0118	0.0171	0.0246
	Bridge	45	0.0319	2	D.P.S.	0.0527	0.0207	0.0449	0.0028	0.0200	0.0253	0.0246
	R.F.	46	0.0142	38		0.0110	0.0183	0.0186	0.0141	0.0223	0.0116	0.0246
	R.C.	47	0.0127	43		0.0089	0.0183	0.0186	0.0028	0.0200	0.0210	0.0246
	R.F.	48	0.0134	41		0.0083	0.0183	0.0186	0.0141	0.0276	0.0116	0.0246
	R.C.	49	0.0199	20	D.P.S.	0.0147	0.0183	0.0071	0.0322	0.0111	0.0290	0.0246
	R.F.	50	0.0223	11	D.P.S.	0.0232	0.0183	0.0186	0.0322	0.0107	0.0171	0.0246
	R.C.	51	0.0194	22	D.P.S.	0.0228	0.0183	0.0071	0.0322	0.0155	0.0054	0.0090
	Bridge	52	0.0207	17	D.P.S.	0.0276	0.0199	0.0449	0.0068	0.0304	0.0065	0.0090
	R.C.	53	0.0119	46		0.0074	0.0199	0.0071	0.0141	0.0111	0.0149	0.0090
	Bridge	54	0.0204	18	D.P.S.	0.0276	0.0207	0.0449	0.0028	0.0373	0.0065	0.0090
	Bridge	55	0.0293	4	D.P.S.	0.0527	0.0207	0.0449	0.0028	0.0304	0.0065	0.0090

An Evaluation Points for Restoration level

Route No.	Name of city	Sireal Number of Disaster Critical spots	Type of disaster	Distance from Managua	Length of slope and Bridge(m)	Evaluation					Total	
						Distance from Managua	Space for diversion	Condition of detour road	Type of disaster	The scale of Disaster		
Nic1	Sebaco	1	R.F.	100	890	1	1	1	2	5	10	
		2	R.F.	100	350	1	1	1	2	5	10	
	Esteli	3	Bridge	150	29.3	2	1	1	4	3	11	
		4	Bridge	150	18.6	2	1	3	4	1	11	
	Yaraguina	5	Bridge	200	62	3	1	3	4	3	14	
		6	Bridge	200	15.5	3	1	3	4	1	12	
		7	R.F.	200	600	3	1	3	2	5	14	
		8	R.C.	200	280	3	1	3	3	5	15	
		9	R.C.	200	200	3	1	3	3	5	15	
		10	R.C.	200	440	3	1	3	3	5	15	
		11	R.C.	200	460	3	1	3	3	5	15	
		12	R.C.	200	130	3	1	3	3	3	13	
		13	R.C.	200	360	3	1	3	3	5	15	
		14	R.F.	200	240	3	1	3	2	5	14	
		15	R.C.	200	220	3	1	3	3	5	15	
		16	R.C.	200	120	3	1	3	3	3	13	
		El Espino	17	R.F.	250	110	4	1	1	2	3	11
			18	Bridge	250	64	4	1	1	4	3	13
	19		Bridge	250	109	4	1	1	4	5	15	
	20		R.C.	250	200	4	1	1	3	5	14	
	21		R.F.	250	230	4	1	1	2	5	13	
	22		R.F.	250	145	4	1	1	2	3	11	
Nic3	Sebaco	23	R.C.	150	130	2	5	5	3	3	18	
		24	R.C.	150	170	2	5	5	3	3	18	
	Matagalpa	25	R.C.	150	90	2	5	5	3	1	16	
		26	Bridge	150	17.5	2	5	5	4	1	17	
		27	R.C.	150	150	2	5	5	3	3	18	
		28	R.C.	150	110	2	5	5	3	3	18	
		29	S.S.	150	180	2	5	5	5	3	20	
		30	D.F.	150	150	2	5	5	5	3	20	
		31	S.S.	150	140	2	5	5	5	3	20	
		32	S.S.	150	192	2	5	5	5	3	20	
		33	S.S.	150	45	2	5	5	5	1	18	
Jinotega	34	R.C.	150	180	2	5	5	3	3	18		
Nic5		35	R.F.	200	200	3	5	5	2	5	20	
Nic15	Ocotal	36	D.F.	250	45	4	1	1	5	1	12	
		37	D.F.	250	65	4	1	1	5	1	12	
	38	D.F.	250	70	4	1	1	5	1	12		
LasManos	39	D.F.	250	100	4	1	1	5	3	14		
Nic26	San Isidor	40	R.F.	150	105	2	5	3	2	3	15	
		41	R.F.	150	235	2	5	3	2	5	17	
	El Jicalal	42	R.F.	150	160	2	5	3	2	3	15	
		43	R.F.	150	115	2	5	3	2	3	15	
		44	R.F.	150	160	2	5	3	2	3	15	
		45	Bridge	150	31	2	5	3	4	3	17	
		46	R.F.	150	77	2	5	3	2	1	13	
		47	R.C.	150	110	2	5	3	3	3	16	
		48	R.F.	150	60	2	5	3	2	1	13	
		49	R.C.	150	300	2	5	3	3	5	18	
		50	R.F.	150	150	2	5	3	2	3	15	
		51	R.C.	150	90	2	3	1	3	1	10	
		52	Bridge	150	17.9	2	3	1	4	1	11	
		53	R.C.	150	280	2	3	1	3	5	14	
		54	Bridge	150	7.2	2	3	1	4	1	11	
		Telica	55	Bridge	150	5.1	2	3	1	4	1	11

Evaluation Criteria		Point	
Distance from Managua	≤100km	1	
	100 < L ≤ 150km	2	
	150 < L ≤ 200km	3	
	200km < L	4	
Space for management or calamity restoration	There is a enough space	1	
	There is not a enough space	5	
	The above-mentioned middle	3	
Condition of detour road	There is a detour.	1	
	There is no detour.	5	
	Much time is required for detour	5	
Type of disaster	Rock Falling (R.F.)	2	
	Rock Collapsing (R.C.)	3	
	Slop slide (S.S.)	5	
	Debris Flow (D.F.)	5	
	Scoring of fundation (Bridge)	4	
Length of slope and Bridge	Slope	≤100m	1
		100 < L ≤ 200m	3
	Bridge	200m < L	5
		≤20m	1
		20 < L ≤ 100m	3
	100m < L	5	

Development situation and an Evaluation Points

Route No.	Section		Serial Number of Disaster Critical Spots	The outline of a project	Evaluation	Total
Nic1	Sanbenito	Sebaco	1,2	Base point	1	10
				Road improvement construction will be completed in 2002.	5	
				Two bridges were reconstructed by the Japanese grantaide	4	
	Sebaco	Esteli	3,4	Base point	1	6
				Road improvement construction will be completed in 2002.	5	
	Esteli	Yaraguina	5~16	Base point	1	9
				Road improvement construction will be completed in 2002.	5	
				Two bridges were reconstructed by the IDBC	2	
				There is an urban development design in Esteli	1	
Yaraguina	El Espino	17~22	Base point	1	10	
			Road improvement construction will be completed in 2002.	5		
			Road improvement construction between Somot to San Lucas will be completed in 2002.	3		
			There is an urban development design in Somot	1		
Nic3	Sebaco	Matagalpa	23~27	Base point	1	5
				A bridge was reconstructed	2	
				Grants-in-aid (Denmark) of the shortcut road to Jinotega are determine	1	
				There is an urban development design in Mtagalpa	1	
Matagalpa	Jinotega	28~34	Base point	1	2	
			There is an urban development design in Jinotega	1		
Nic5	Matagalpa	El Tuna	35	Base point	1	1
Nic15	Yalaguina	Ocotal	36~39	Base point	1	12
				Road improvement construction will be completed in 2002.	5	
				One bridge was reconstructed	2	
				Improvement construction for the road connect to the object road and Ja	3	
				There is an urban development design in Ocotal	1	
Ocotal	LasManos	36~39	Base point	1	13	
			Road improvement construction will be completed in 2002.	5		
			Four bridges were reconstructed	8		
Nic26	El Jicalal	San Isidoro	40~50	Two bridges were reconstructed	4	10
				Some new School are built by Japanese grants-in-aide	2	
				There is the Plan for road improvement construction project	3	
					1	
Telica	El Jicalal	51~55	Base point	1	5	
			There is the Plan for road improvement construction project	3		
			There is the Plan for improvement construction project for the road b etween Lapas~Nic24	1		
			Some new School were built by Japanese grants-in-aide	1		

Evaluation Criteria	Pint
Base point	1 / Section
Road improvement construction will be completed in 2002.	5 / Project
Reconstruction of bridge on the object road was copleted	2 / Project
There is the Plan for road improvement construction project on the object road	3 / Project
There is the Brigde reconstruction of bridge on Object road was copleted	1 / Project
Improvement construction for the road that conect to the object road will be completed in 2002.	3 / Project
There is the Plan for improvement construction project for the road that conect to the object road	1 / Project
the Project for Education or Urbandvelopement will be completed over five years.	2 / Project
There is the Plan for Education or Urbandvelopement	1 / Project

Review of Score of Stability Survey

Route No.		Nic.1			
Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	Kilometer from Managua (km)	Type of disaster
1	70	78	N001A290	60.9	R.F.
2	78	84	N001A280	73.2	R.F.
3	90	90	Junquillal	113.19	Bridge
4	100	100	San Nicolas	135.64	Bridge
5	90	90	(R.Esteli)	150.33	Bridge
6	100	100	San Ram3n	151.85	Bridge
7	84	84	N001A240	168.4	R.F.
8	72	75	N001B230	168.6	R.C.
9	72	72	N001B200	169.8	R.C.
10	72	72	N001B190	170.7	R.C.
11	78	81	N001B170	171.3	R.C.
12	76	79	N001B150	175.0	R.C.
13	74	76	N001B120	176.2	R.C.
14	76	76	N001A110	178.7	R.F.
15	73	73	N001B100	187.3	R.C.
16	73	76	N001B070	204.7	R.C.
17	70	70	N001A050	214.7	R.F.
18	100	100	Rio Inali	226.89	Bridge
19	100	100	Rio Tapacali	233.245	Bridge
20	75	75	N001B030	232.5	R.C.
21	73	73	N001A020	233.7	R.F.
22	73	73	N001A010	235.6	R.F.
Sub-total				22spots	

Route No.		Nic..3			
Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	Distance from Sebaco(km) (*Bridge: from Managua)	Type of disaster
23	74	74	003B420	3.9	R.C.
24	72	75	003B400	6.9	R.C.
25	80	80	003B370	7.4	R.C.
26	100	100	El Guayacan	119.05	Bridge
27	74	76	N003B320	22.1	R.C.
28	70	72	N003B240	32.7	R.C.
29	73	73	N003C230	32.9	S.S
30	83	83	N003E170	35.2	D.F
31	71	71	N003C160	35.9	S.S
32	90	90	N003C150	38.9	S.S
33	90	90	N003C140	39.4	S.S
34	81	83	N003B120	40	R.C.
Sub-total				12spots	

Review of Score of Stability Survey

Route No.

NIC.5

Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	Distance from Matagalupa (km)	Type of disaster
35	76	80	N005A010	24.6	R.F.
Sub-total				1spots	

Route No.

Nic.15

Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	Distance from Las Manos (km)	Type of disaster
36	70	70	N015E010	9.9	D.F.
37	70	70	N015E020	11.1	D.F.
38	70	70	N015E050	11.7	D.F.
39	70	70	N015E060	13.6	D.F.
Sub-total				4spots	

Route No.

Nic.26

Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	between San Isidoro & Sebaco (km) (*Bridge:from	Type of disaster
40	71	71	N026A010	9.0	R.F.
41	70	70	N026A020	12.7	R.F.
42	71	71	N026A030	19.9	R.F.
43	72	72	N026A040	20.9	R.F.
44	70	78	N026A060	24.7	R.F.
45	100	100	La Banderita	170+952	Bridge
46	76	78	N026A100	29.3	R.F.
47	73	73	N026B110	29.8	R.C.
48	72	72	N026A130	33.6	R.F.
49	80	80	N026B140	34.0	R.C.
50	85	87	N026A150	34.2	R.F.
51	86	86	N026B160	37.0	R.C.
52	90	90	San Juan de Dios	156+785	Bridge
53	71	71	N026B210	45.5	R.C.
54	90	90	Papalon	108+154	Bridge
55	100	100	Solis	107+533	Bridge
Sub-total				16spots	
Total				Nic.1,3,5,15,26	

R.F.	:Rock Falling
R.C.	:Rock Collapsing
S.S.	:Slop slide
D.F.	:Debris Flow
Bridge	:Scoring of fundation

Appendix 6

Countermeasures Selection of Slope

Table A6-1 Selection of Prevention Countermeasure Method


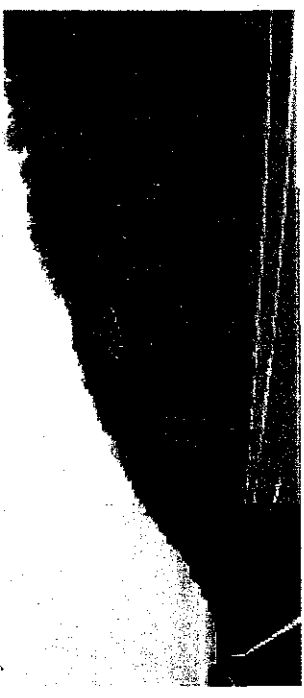
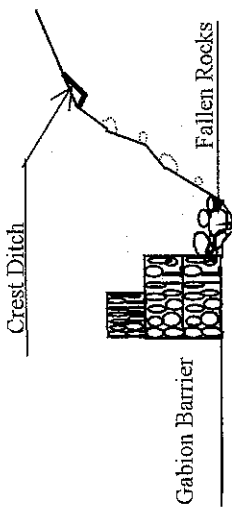
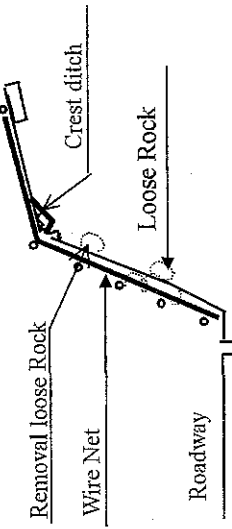
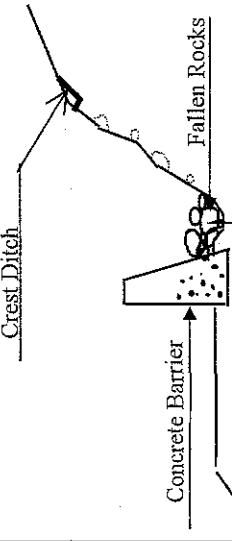
ID : N001A290	Topography	The Foot of The Ridge	Height and Incline	H =20 ~ 40 m , θ =45 ~ 52 deg.	The kind of The Rock	Alteration of Andesite and Tuff
Situation of Slope	Impact of Rain (Inflow water)	Leak out a little	Stability Analysis	Unnecessary	Purpose of Countermeasure	Rockfalls
	The Dry Season				The Rainy Season	
Comments	Because the crack interval of andesite is narrow, subdivided unstable stone is generated a lot. Therefore, many small stones fall. The talus remains thin on the slope, it becomes unstable in the rainy season. Inflow water is confirmed at whole slope.					
Alternative of Countermeasure	Removal + Barrier with gabion wall + Drainage		Removal + Prevention net + Drainage		Removal + Barrier with concrete wall + Drainage	
Workability	-Wire of gabion cannot resist against energy of the assumed falling rock. Δ	-The construction results are not in Nicaragua. -This type is almost permanent structure. ○	-The concrete barrier will be too big size for resistance against energy of the assumed falling rock. Δ			
Environment Impact	-Deterioration of environment will be forecast by damage of gabion. Δ	-It is necessary to cut trees. Δ	-Installing the concrete barrier lacks harmony with the surrounding. Δ			
Influence on Road	-It is difficult to stop completely jumping over rock by barrier. Width for construction of barrier is enough. Δ	-There is no problem. ⊙	-It is difficult to stop completely jumping over rock by barrier. Width for construction of barrier is enough. Δ			
Maintenance	-It is necessary to remove collected rock. Δ	-Durability depends on the life of the wire. Δ	-Because the structure is too large, the space for the removal of fallen rocks is necessary. Δ			
Economy	-This alternative is cheapest of all. Because maintenance cost is high, costs of three alternatives is almost even. ○	-Net materials are expensive, but maintenance cost isn't high. ○	-Maintenance cost is high. Δ			
Evaluation	-The gabion isn't steady by the collision of assumed falling rock. 3	-This type prevents completely dispersion of rock collapse. 1	-The concrete barrier isn't steady by the collision of assumed falling rock. 2			

Table A6-2 Selection of Prevention Countermeasure Method

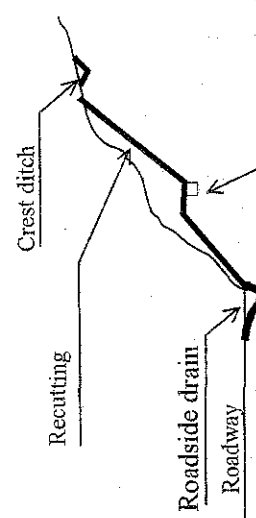
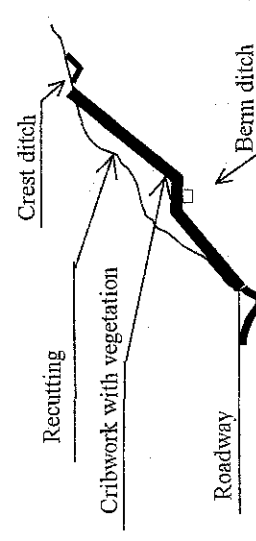
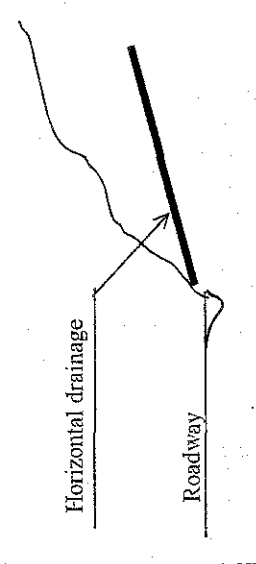
ID: N001A280	Topography	The Foot of The Ridge	Height and Incline	H = 7 ~ 11 m , θ = 45 ~ 75 deg.	The kind of The Rock	Tuff
Situation of Slope	Impact of Rain (Inflow water)	Inflow water	Stability Analysis	Necessary	Purpose of Countermeasure	Rockfalls
Situation of Slope	The Dry Season				The Rainy Season	
Comments	<p>Red mark is clear slide scarp, blue mark is colluvium. The change was not especially seen through the dry season and rainy season. The stability of the slope is necessary, because the slide scarp approaches to the vicinity of the electric tower (yellow mark). The inflow water from the talus and the installed french drain were confirmed.</p>					
Alternative of Countermeasure	<p>Recutting + Drainage</p>  <p>Recutting + Cribwork with vegetation + Drainage</p>  <p>Horizontal drainage</p> 					
Workability	<p>-The slope become unstable by raise of underground water, but this alternative cannot suppress the rise of underground water level. Δ</p>					
Environment Impact	<p>-Slope is expected of natural vegetation. Δ</p>					
Influence on Road	<p>-Traffic control is necessary during construction, but here is no influence after construction. ○</p>					
Maintenance	<p>-The maintenance is necessary until the vegetation takes root. Δ</p>					
Economy	<p>-It is the most economical in three alternatives ○</p>					
Evaluation	<p>-This alternative is beneath in maintenance and environmental. 2</p>					
Workability	<p>-The slope become unstable by raise of underground water, but this alternative cannot suppress the rise of underground water level. Δ</p>					
Environment Impact	<p>-The environment is prevented from deteriorating by vegetation among the cribwork. ○</p>					
Influence on Road	<p>-Traffic control is necessary during construction, but here is no influence after construction. ○</p>					
Maintenance	<p>-The maintenance is necessary until the vegetation takes root. Δ</p>					
Economy	<p>-The cost of cribwork is expensive. Δ</p>					
Evaluation	<p>The purpose of cribwork is for the vegetation and it does not take part in stability. 3</p>					
Workability	<p>-Underground water level is suppressed by horizontal drainage, therefore the slope become stable. ○</p>					
Environment Impact	<p>-The present condition of slope surface will be maintained because it will be not touched. ◎</p>					
Influence on Road	<p>-One lane is restricted by the boring. Δ</p>					
Maintenance	<p>-The inspection is necessary water volume from the horizontal drainage. ○</p>					
Economy	<p>-The horizontal drainage is expensive, but other costs are unnecessary ○</p>					
Evaluation	<p>-This alternative is economical and effective. 1</p>					

Table A6-3 Selection of Prevention Countermeasure Method



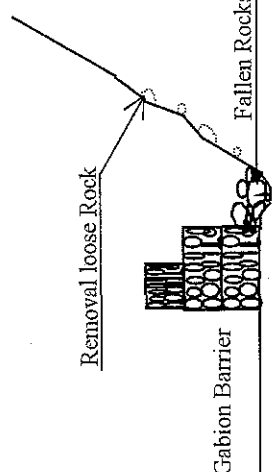
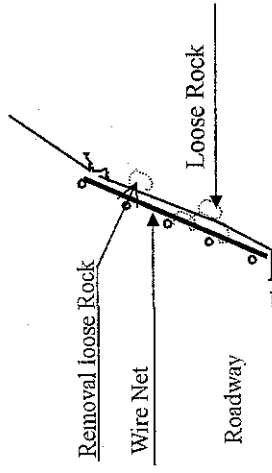
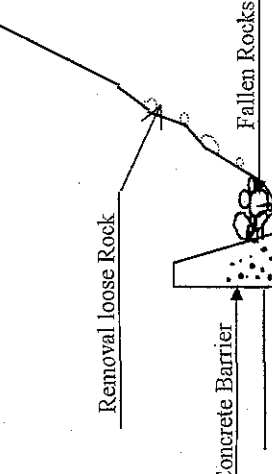
ID : N001A240	Topography	The Foot of The Ridge	Height and Incline	H _i =12 ~ 18 m, θ =45~57 deg.	The kind of The Rock	Almost Tuff and Andesite is a part.
Situation of Slope	Impact of Rain (Inflow water)	No exist	Stability Analysis	Unnecessary	Purpose of Countermeasure	Rockfalls
Situation of Slope					The Rainy Season	
Comments	Inflow water was not seen in the rainy season. Loosening advanced and the small rock collapse was confirmed at ten places. There are falling rocks at part marked in red.					
Alternative of Countermeasure	<p>Removal + Barrier with gabion wall</p> 	<p>Removal + Prevention net</p> 	<p>Removal + Barrier with concrete wall</p> 			
Workability	-Wire of gabion cannot resist against energy of the assumed falling rock. Δ	-The construction results are not in Nicaragua. -This type is almost permanent structure. ○	-The concrete barrier will be too big size for resistance against energy of the assumed falling rock. Δ			
Environment Impact	-Deterioration of environment will be forecast by damage of gabion. Δ	-It is necessary to cut trees. Δ	-Installing the concrete barrier lacks harmony with the surrounding. Δ			
Influence on Road	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. Δ	-There is no problem. ◎	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. Δ			
Maintenance	-It is necessary to remove collected rock. Δ	-The environment deterioration is eased by partially constructing the net. Δ	-It is necessary to remove fallen rocks. ○			
Economy	-Durability depends on the life of the wire. Δ	-Net materials are expensive, but maintenance cost isn't high. ○	-The maintenance of the structure is unnecessary. ○			
Evaluation	-Because maintenance cost is high, costs of three alternatives are almost even. ○	-This type prevents completely dispersion of rock collapse. 3	-The cost is middle of all. But the costs of three alternatives are almost even. ○			
	-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough. 3	-This type prevents completely dispersion of rock collapse. 1	-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough. 2			

Table A6-4 Selection of Prevention Countermeasure Method



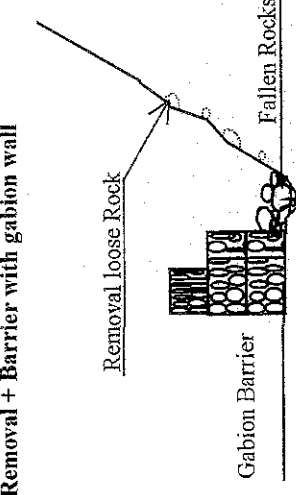
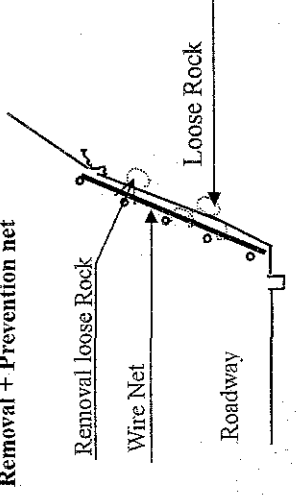
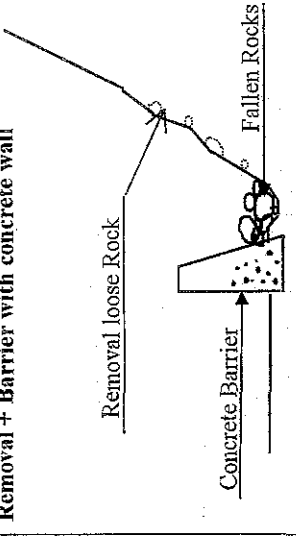
ID : N001B230	Topography	The Foot of The Ridge	Height and Incline	H =13 ~ 33 m , θ =40~65 deg.	The kind of The Rock	Almost Tuff and Andesite is a part.
Situation of Slope	Impact of Rain (Inflow water)	After rain	Stability Analysis	Unnecessary	Purpose of Countermeasure	Rock Collapse
Situation of Slope	The Dry Season			The Rainy Season		
Comments	Left side photograph, The part marked in red is andesite, it is distributed in the upper part of slope. Tuff that weathering is early is distributed in the lower part of slope. The andesite becomes on the overhang and falls. Right side photograph; Upper red mark is loose andesite and lower red mark is tuff. Seepage is oozing from the boundary of the andesite and the tuff					
Alternative of Countermeasure	Removal + Barrier with gabion wall		Removal + Prevention net		Removal + Barrier with concrete wall	
Workability Structural feature	-Wire of gabion cannot resist against energy of the assumed falling rock. △	-The construction results are not in Nicaragua. -This type is almost permanent structure. ○	-The concrete barrier will be too big size for resistance against energy of the assumed falling rock. △			
Environment Impact	-Deterioration of environment will be forecast by damage of gabion. △	-It is necessary to cut trees. △	-Installing the concrete barrier lacks harmony with the surrounding. △			
Influence on Road	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. △	-There is no problem. ◎	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. △			
Maintenance	-It is necessary to remove collected rock. △	-The environment deterioration is eased by partially constructing the net. △	-It is necessary to remove fallen rocks. △			
Economy	-Because maintenance cost is high, costs of three alternatives are almost even. ○	-Net materials are expensive, but maintenance cost isn't high. ○	-The maintenance of the structure is unnecessary. ○			
Evaluation	-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough. 3	-This type prevents completely dispersion of rock collapse. 1	-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough. 2			

Table A6-5 Selection of Prevention Countermeasure Method

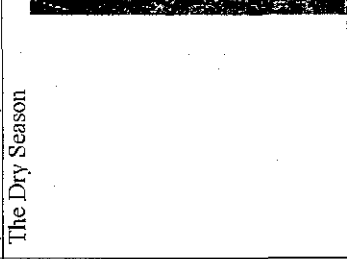


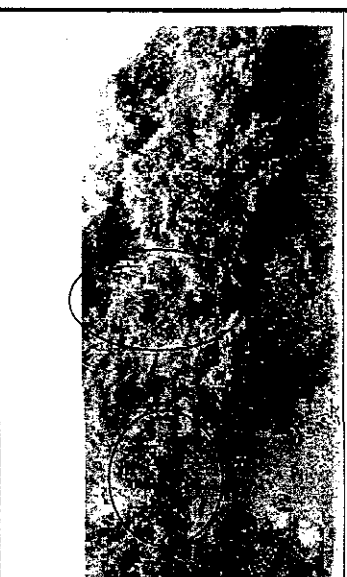
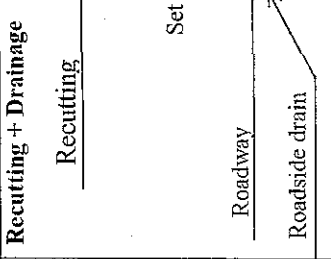
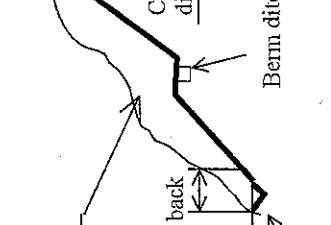
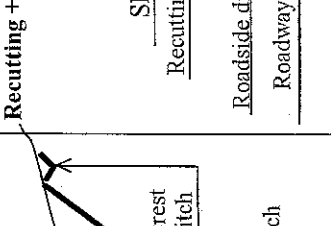
ID : N001B170	Topography	The Foot of The Ridge	Height and Incline	H =13 ~ 41 m , θ =42 ~ 70 deg.	The kind of The Rock	Almost Andesite but under part is Tuff.	
Situation of Slope	Impact of Rain (Inflow water)	After rain	Stability Analysis	Unnecessary	Purpose of Countermeasure	Rock Collapse	
Situation of Slope				The Rainy Season			
Comments	Left side photograph; Red mark is andesite, its lower side is tuff that weathering is early. Right side photograph; Seepage is oozing from red mark portion in rainy season. There are a lot of skin dropping because weathering is early, therefore andesite becomes unstable and collapses.						
Alternative of Countermeasure	<p>Recutting + Drainage</p> 	<p>Recutting + Shotcrete + Drainage</p> 	<p>Recutting + Cribwork with vegetation + Drainage</p> 				
Workability Structural feature	-Slope will be cut for the purposes of removal of weathering and to keep sight distance. ○	-Slope will be cut from the toe for removal of unstable materials in the upper part, and then shotcrete will be constructed. ○	-The slope will be cut for the purposes of removal of weathering and to keep sight distance. ○	-Slope will be cut for the purposes of removal of weathering and to keep sight distance. ○	-The environment is prevented from deteriorating by vegetation among the cribwork. ○	-Slope will be cut for the purposes of removal of weathering and to keep sight distance. ○	
Environment Impact	-Slope is expected of natural vegetation. △	-It is difficult to harmonize with surroundings. △	-It is difficult to harmonize with surroundings. △	-It is difficult to harmonize with surroundings. △	-The environment is prevented from deteriorating by vegetation among the cribwork. ○	-The environment is prevented from deteriorating by vegetation among the cribwork. ○	
Influence on Road	-Traffic control is necessary during construction, but here is no influence after construction. ○	-The is no problem. ○	-The is no problem. ○	-The is no problem. ○	-Traffic control is necessary during construction, but here is no influence after construction. ○	-Traffic control is necessary during construction, but here is no influence after construction. ○	
Maintenance	-The maintenance is necessary until the vegetation takes root. △	-It is necessary to confirm volume of oozing. ○	-It is necessary to confirm volume of oozing. ○	-It is necessary to confirm volume of oozing. ○	-The maintenance is necessary until the vegetation takes root. It is important to maintain anchor of cribwork. △	-The maintenance is necessary until the vegetation takes root. It is important to maintain anchor of cribwork. △	
Economy	-It is the most economical in three alternatives. ◎	-The cost is middle of all. ○	-The cost is middle of all. ○	-The cost is middle of all. ○	-The cost of cribwork is expensive. △	-The cost of cribwork is expensive. △	
Evaluation	-This alternative is economical and effective. 1	-The environmental and the measures oozing are inferior. 2	-The environmental and the measures oozing are inferior. 2	-The environmental and the measures oozing are inferior. 2	-The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. 3	-The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. 3	

Table A6-6 Selection of Prevention Countermeasure Method



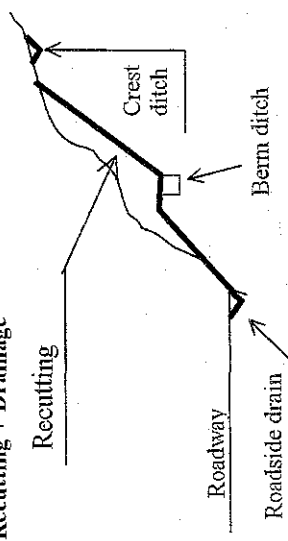
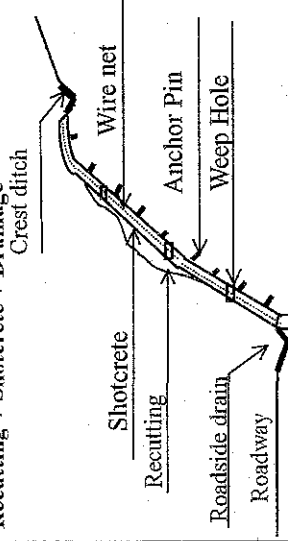
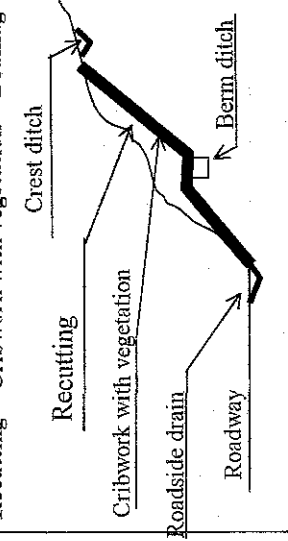
ID : N001B150	Topography	The Point of The Ridge	Height and Incline	H = 7 ~ 13 m , θ = 50 ~ 70 deg.	The kind of The Rock	Almost Tuff but Upper part are Andsite.
	Impact of Rain (Inflow water) The Dry Season	After rain	Stability Analysis	Unnecessary	Purpose of Countermeasure The Rainy Season	Rock Collapse
Situation of Slope						
Comments	There are vertical cooling joint. Cracks are open by weathering advance. There are comparatively large falling rocks. Prevention of weathering is necessary after cutting tuff. As a result, the andsite can be prevented from collapse.					
Alternative of Countermeasure						
Workability	- The weathering is measured by installation of drainage facilities. ○	- It is necessary special equipment. - It is excels for countermeasure of weathering. ◎	- The purpose of cribwork are for the vegetation and increase stability. ○			
Environment Impact	- Slope is expected of natural vegetation. △	- It is difficult to harmonize with surroundings. △	- The environment is prevented from deteriorating by vegetation among the cribwork. ○			
Influence on Road	- Traffic control is necessary during construction, but here is no influence after construction. ○	- The is no problem. ○	- Traffic control is necessary during construction, but here is no influence after construction. ○			
Maintenance	- The maintenance is necessary until the vegetation takes root. △	- It is necessary to confirm volume of oozing. ○	- The maintenance is necessary until the vegetation takes root. It is important to maintain anchor of cribwork. △			
Economy	- It is the most economical in three alternatives. ○	- The cost is middle of all. ○	- The cost of cribwork is expensive. △			
Evaluation	- This alternative is beneath in maintenance and environmental. 2	- It is the most effective in the weathering measures. Infiltration of water can be prevented by crest ditch. 1	- The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. 3			

Table A6-7 Selection of Prevention Countermeasure Method

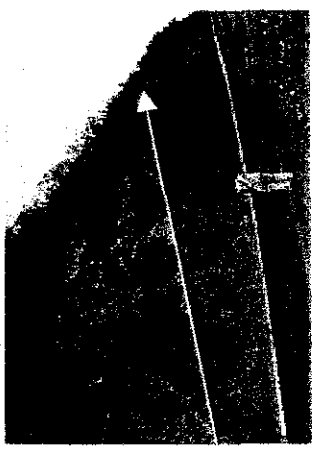


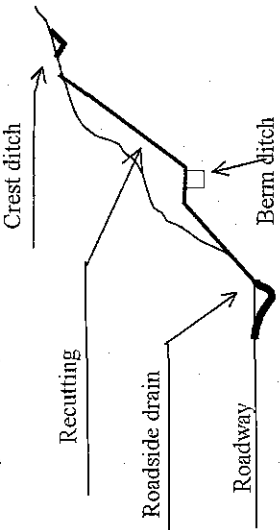
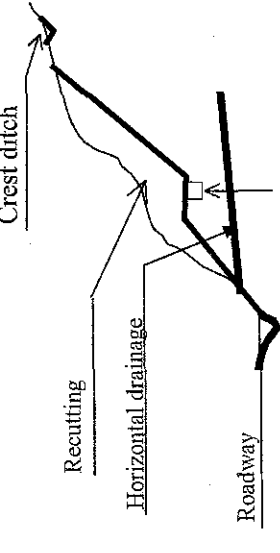
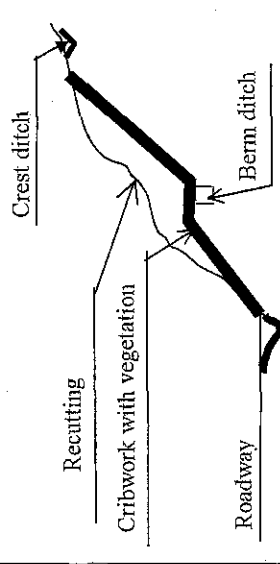
ID : N001B120	Topography	Height and Incline	H = 17 ~ 50 m, θ = 50~75 deg.	The kind of The Rock	Tuff and Andesite. Middle part of slope are Dyke.
Situation of Slope	Impact of Rain (Inflow water) The Dry Season	After rain	Stability Analysis	Purpose of Countermeasure	Rock Collapse
			Unnecessary	The Rainy Season	
Comments	There is a collapse history. The part where the slope height is large is an intrusive rock and a hard rock. It is intrusive along the fault (white mark), therefore the rock is extremely weak at its both sides. The condition of a peripheral rock by influence of the fault is bad, and there is a possibility to be going to repeat a big collapse in the future. Drastic counter measurements are necessary				
Alternative of Countermeasure	<p>Recutting + Drainage</p> 	<p>Recutting + Horizontal drainage + Drainage</p> 	<p>Recutting + Cribwork with vegetation + Drainage</p> 		
Workability Structural feature	-Large-scale collapse is prevented by cut of 55° Stability will increase by drainage facilities. ○	-Horizontal drainage is added to left side alternative as the increase stability. △	-The purpose of cribwork are for the vegetation and increase stability ○		
Environment Impact	-Slope is expected of natural vegetation. △	-Slope is expected of natural vegetation. △	-The environment is prevented from deteriorating by vegetation among the cribwork. ○		
Influence on Road	-Traffic control is necessary during construction, but here is no influence after construction. ○	-Traffic control is necessary during construction, but here is no influence after construction. ○	-Traffic control is necessary during construction, but here is no influence after construction. ○		
Maintenance	-It is necessary to maintain slope surface. △	-The inspection is necessary water volume from the horizontal drainage. △	-The maintenance is necessary until the vegetation takes root. It is important to maintain anchor of cribwork. △		
Economy	-It is the most economical in three alternatives. ◎	-The cost is middle of all. ○	-The cost of cribwork is expensive. △		
Evaluation	-Drainage facilities are effective to prevent weathering. This alternative is the most effective economically. 1	-Inflow water after rain is much, but horizontal drainage is not necessary. 2	-The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. 3		

Table A6-8 Selection of Prevention Countermeasure Method




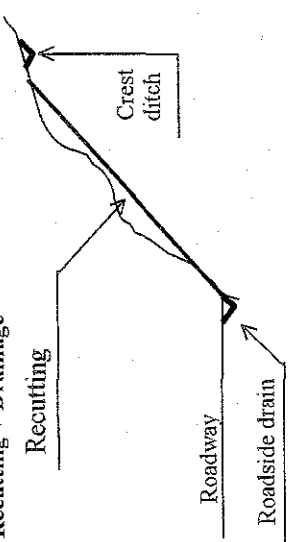
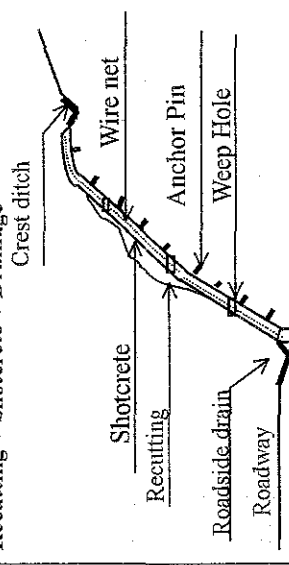
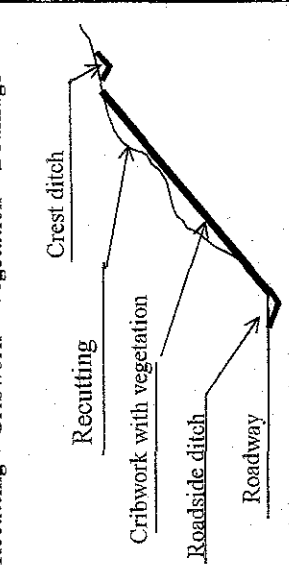
ID : N003B400	Topography	The Point of The Small Ridge	Height and Incline	HI = 8 ~ 18 m , θ = 33 ~ 48 deg.	The kind of The Rock	Tuff and a part of Agglomerate
	Impact of Rain (Inflow water) The Dry Season	After rain	Stability Analysis	Unnecessary	Purpose of Countermeasure The Rainy Season	Rock Collapse and Topping
Situation of Slope						
Comments	The surface water flow along the crack, and it ooze from the vicinity of the toe of the slope (red mark). The width of crack of tuff increases, the toppling phenomenon is caused.					
Alternative of Countermeasure	<p>Recutting + Drainage</p> 	<p>Recutting + Shotcrete + Drainage</p> 	<p>Recutting + Cribwork + Vegetation + Drainage</p> 			
Workability	- The weathering is measured by installation of drainage facilities. ○	- Cutting is no need for stability. - It is excels for countermeasure of weathering. ◎	- The purpose of cribwork are for the vegetation and increase stability ○			
Environment Impact	- Slope is expected of natural vegetation. △	- It is difficult to harmonize with surroundings. △	- The environment is prevented from deteriorating by vegetation among the cribwork. ○			
Influence on Road	- Traffic control is necessary during construction, but here is no influence after construction. ○	- Traffic control is necessary during construction, but here is no influence after construction. ○	- Traffic control is necessary during construction, but here is no influence after construction. ○			
Maintenance	- The maintenance is necessary until the vegetation takes root. △	- It is necessary to confirm volume of oozing. △	- The maintenance is necessary until the vegetation takes root. It is effective for weathering ○			
Economy	- It is the most economical in three alternatives. ◎	- The cost is middle of all. ○	- The cost of cribwork is expensive. △			
Evaluation	- Drainage facilities are effective to prevent weathering. This alternative is the most effective economically. J	- There is a problem in durability when there is a lot of inflow water after drain. 2	- The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. 3			

Table A6-9 Selection of Prevention Countermeasure Method

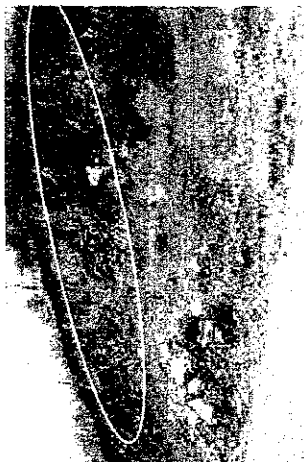

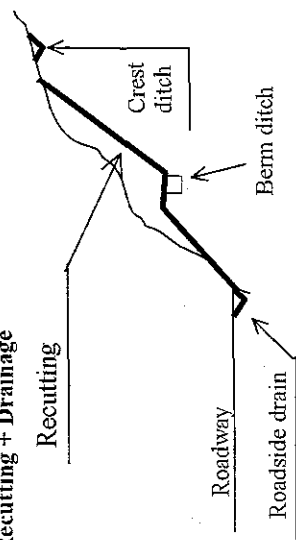
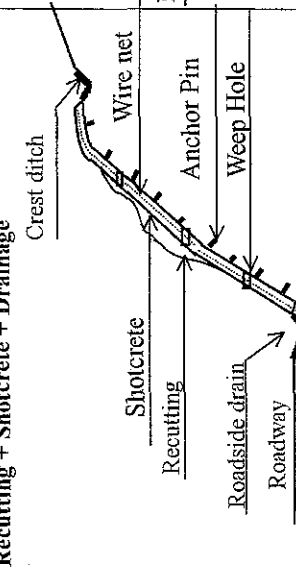
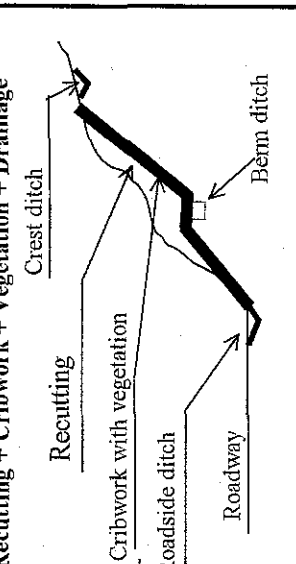
ID : N003B370	Topography	The Point of The Small Ridge	Height and Incline	H = 8 ~ 18 m , θ = 45 ~ 53 deg.	The kind of The Rock	Tuff
Situation of Slope	Impact of Rain (Inflow water) The Dry Season	No exist	Stability Analysis	Unnecessary	Purpose of Countermeasure The Rainy Season	Rock Collapse
Situation of Slope						
Comments	There are two types tuff. Tuff marked in white has vertical cooling joint(hard rock; IIB type) Lower side tuff that weathering is early(II A type) . Inflow water was not able to be confirmed in the rainy season.					
Alternative of Countermeasure	Recutting + Drainage 	Recutting + Shotcrete + Drainage 	Recutting + Vegetation + Drainage 			
Workability Structural feature	-There is not problem of construction. - The weathering is measured by installation of drainage facilities	-Special equipment is necessary. -It is excels for countermeasure of weathering.	-The purpose of cribwork are for the vegetation and increase stability	○		
Environment Impact	-Slope is expected of natural vegetation.	-It is difficult to harmonize with surroundings.	-The environment is prevented from deteriorating by vegetation among the cribwork.	△		
Influence on Road	-Traffic control is necessary during construction, but here is no influence after construction.	-Traffic control is necessary during construction, but here is no influence after construction.	-Traffic control is necessary during construction, but here is no influence after construction.	○		
Maintenance	-The maintenance is necessary until the vegetation takes root.	-It is necessary to confirm volume of oozing.	-The maintenance is necessary until the vegetation takes root. It is effective for weathering	△		
Economy	-It is the most economical in three alternatives.	-The cost is middle of all.	-The cost of cribwork is expensive.	○		△
Evaluation	-The purpose of prevention can be economically achieved.	-There is a problem in durability when there is a lot of inflow water.	-The purpose of cribwork is for the vegetation, and it does not contribute almost in stability.	1	2	3



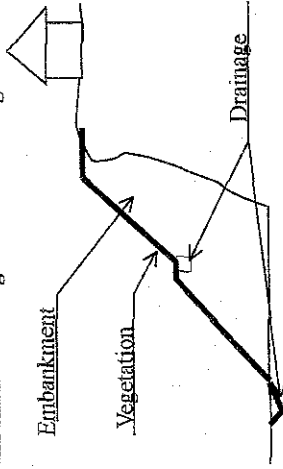
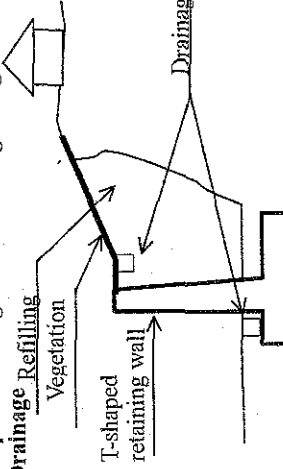
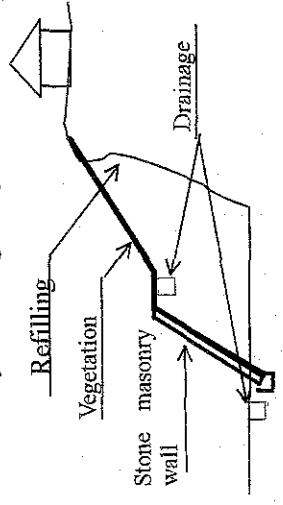
Table A6-10 Selection of Prevention Countermeasure Method			
ID : N003B320	Topography	The Point of The Small Ridge	Height and Incline
	Impact of Rain (Inflow water) The Dry Season	After rain	Stability Analysis
			Unnecessary
			Purpose of Countermeasure
			The Rainy Season
Situation of Slope			Rock Collapse
Comments	The weathering of tuff is advancing, the distributed layer of scoria at leg of slope is weak to rain, and collapse is early. The inflow water was confirmed from the part marked in red in rainy season.		
Alternative of Countermeasure	 <p>Embankment + Vegetation + Drainage</p>	 <p>T-shaped retaining wall + Refilling + Vegetation + Drainage</p>	 <p>Stone masonry + Refilling + Vegetation + Drainage</p>
Workability Structural feature	-Behavior of existing slope and constructed embankment is problem. Δ	-There is no problem of loosening of the backfill by the retaining wall. Construction is no problem. \odot	-There is no problem of loosening of the backfill by the retaining wall. Construction is no problem. \circ
Environment Impact	-Embankment harmonizes with surroundings by the vegetation. \odot	-Retaining wall has feeling of stability and somewhat overpowering. It harmonize with surrounding by vegetation. \circ	-Retaining wall has feeling of stability and somewhat overpowering. It harmonize with surrounding by vegetation. \circ
Influence on Road	-The width of the road is insufficient. Δ	-There is no problem of the width of the road. \odot	-Stone masonry height is up to 5m, therefore the width of the road is insufficient. Δ
Maintenance	-It is necessary to maintain behavior of existing slope and constructed embankment. Δ	-Maintenance is not necessary. \odot	-Maintenance is not necessary. \odot
Economy	-It is the most economical in three alternatives. But it has problem of width of the road. \odot	-Retaining wall is expensive. Δ	-Stone masonry is expensive. \circ
Evaluation	-It is difficult to select for lack of width of the road. 3	-This alternative excels in the structure and maintenance. 1	-It is difficult to select for lack of width of the road. 2

Table A6-11 Selection of Prevention Countermeasure Method


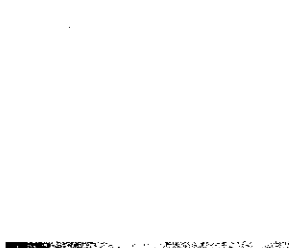

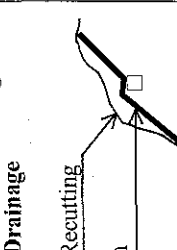
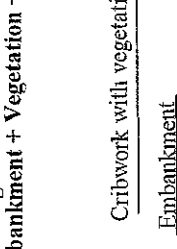
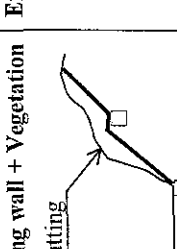
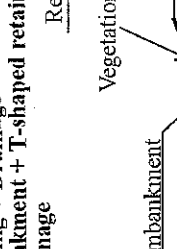
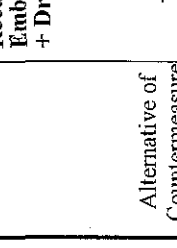
ID : N003C230	Topography	The Point of The Small Ridge	Height and Incline	The kind of The Rock	Tuff
Situation of Slope	Impact of Rain (Inflow water) The Dry Season	Leak out a little	Unnecessary	Purpose of Countermeasure	Rock Collapse, Slope Sliding
Situation of Slope			Stability Analysis	The Rainy Season	
Comments	The weathering of tuff is advancing, its geological features collapse easily and are weak to rain. The transformation was not seen at fill. Water collected in leg of slide scarp(white mark). The seepage and small collapsing was confirmed.				
Alternative of Countermeasure	<p>Retcutting + Drainage Embankment + T-shaped retaining wall + Vegetation + Drainage</p> 	<p>Retcutting + Crib work + Vegetation + Drainage Embankment + Vegetation + Drainage</p> 	<p>Retcutting + Crib work + Vegetation + Drainage Embankment + Retaining wall + Vegetation + Drainage</p> 	<p>Retcutting + Crib work + Vegetation + Drainage Embankment + Retaining wall + Vegetation + Drainage</p> 	<p>Retcutting + Crib work + Vegetation + Drainage Embankment + Retaining wall + Vegetation + Drainage</p> 
Workability	-Cut slope is stability by cutting of 45°. -Embankment increase stability by installation of retaining wall ○				
Structural feature	-Cut slope is stability by cutting of 45°. -Embankment increase stability by bench cutting of existing slope ○				
Environment Impact	-Cut slope is expected of natural vegetation. ○				
Influence on Road	-One lane is operated while constructing ○				
Maintenance	-The maintenance is necessary until the vegetation takes root. ○				
Economy	-Retaining wall is expensive. ○				
Evaluation	-Retaining wall is unnecessary for stability. 3				
	-One lane is operated while constructing ○				
	-The maintenance is necessary until the vegetation takes root. ○				
	-Cribwork, stone masonry, and horizontal drain is expensive ○				
	-Stone masonry and horizontal drainage are unnecessary for stability. 2				

Table A6-12 Selection of Prevention Countermeasure Method



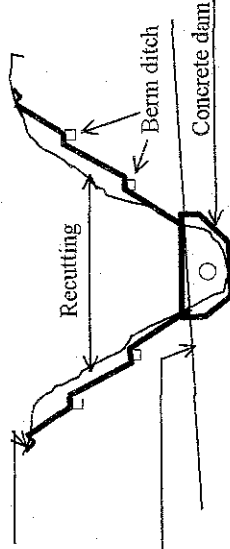
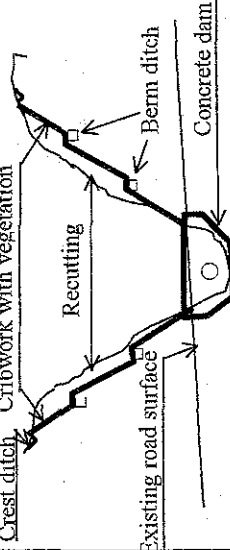
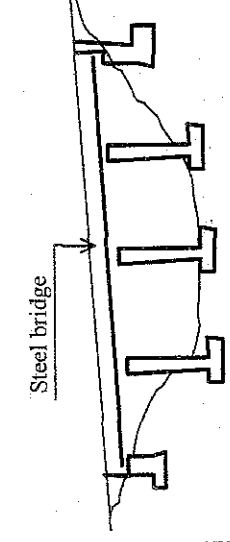
ID : N003E170	Topography	The Mountainside	Height and Incline	H = 10 ~ 22 m, θ = 45 ~ 62 deg.	The kind of The Rock	Alteration of Tuff and Andesite (Alteration zone)
	Impact of Rain (Inflow water)	Debris Flow Inflow water	Stability Analysis	Unnecessary	Purpose of Countermeasure	Debris Flow and Rockfalls
Situation of Slope						
Comments	The quality of rock is changed. The difference of hard and soft is violent because of the place. The weathering belt in the hillside has surface collapse due to shallow seepage. The main disaster is flash flood than debris flow. The main disaster is flash flood than debris flow.					
Alternative of Countermeasure	 <p>Recutting + Drainage Concrete dam + Box culvert</p>	 <p>Recutting + Cribwork with vegetation Concrete dam + Box culvert</p>	 <p>Recutting + Cribwork with vegetation+ Drainage Steel bridge</p>	The Rainy Season		
Workability Structural feature	Construction is not so difficult. ○	Construction is not so difficult. ○	Construction is not so difficult. The purpose of cribwork are for the vegetation and increase stability ○	-The bridge of the length of about 100m is necessary. -Countermeasure of the approach road slope is necessary. △		
Environment Impact	Slope is expected of natural vegetation. -It is difficult to harmonize with surroundings until taking root. △	The environment is prevented from deteriorating by vegetation among the cribwork. ○	The environment is prevented from deteriorating by vegetation among the cribwork. ○	-The environment is prevented from deteriorating by vegetation among the cribwork. ○		
Influence on Road	Detour of traffic is necessary during construction. △	Detour of traffic is necessary during construction. △	Detour of traffic is necessary during construction. △	-Detour of traffic is necessary during construction. △		
Maintenance	Maintenance is not for stability. ○	Maintenance is necessary until the vegetation takes root. ○	Maintenance is necessary until the vegetation takes root. ○	-The maintenance is necessary until the vegetation takes root. Maintenance of bridge is unnecessary. ○		
Economy	This alternative is cheapest of all. Maintenance cost is higher than other alternatives ◎	The cost is middle of all. ○	The cost is middle of all. ○	-Cost of new bridge construction is very expensive. △		
Evaluation	Weathering can be considerably prevented by installation of drainage facilities. 1	Cut slope excels in stability and maintenance. -The necessity of cribwork is vague. 2	Cut slope excels in stability and maintenance. -The necessity of cribwork is vague. 2	-The purpose of shift of road alignment is avoidance of debris flow. The bridge is unnecessary for stability. 3		

Table A6-13 Selection of Prevention Countermeasure Method


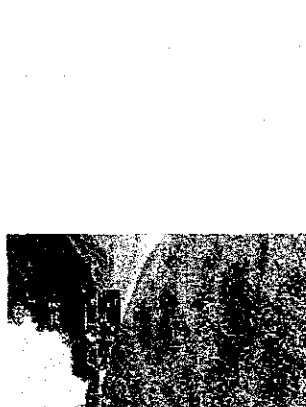



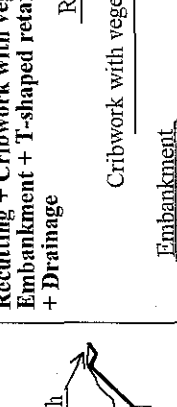
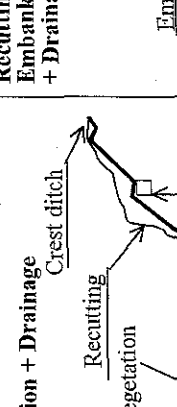
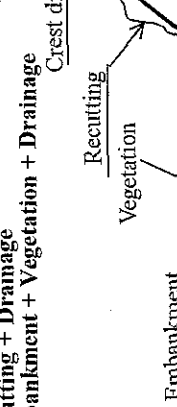
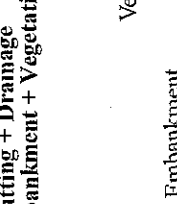
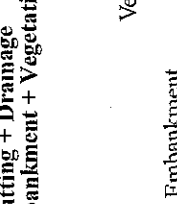
ID : N003C150	Topography	The Mountainside	Height and Incline	The kind of The Rock	Tuff
Situation of Slope	Impact of Rain (Inflow water) The Dry Season	After rain	Stability Analysis	Necessary	Slope Sliding, Rock Collapse
				The Rainy Season	
Comments	Weathering of tuff is advancing. The inflow water from part marked in red was confirmed. A part marked in white is collapse topography. There is a slide scarp at inner part. The vicinity of the toe of slope is a steady tuff.				
Alternative of Countermeasure	<p>Recutting + Drainage Embankment + Vegetation + Drainage</p> 	<p>Recutting + Cribwork with vegetation + Drainage Embankment + T-shaped retaining wall + Vegetation + Drainage</p> 	<p>Recutting + Cribwork with vegetation + Drainage Embankment + Retaining wall + Vegetation + Drainage</p> 	<p>Recutting + Cribwork with vegetation + Drainage Embankment + Retaining wall + Vegetation + Drainage</p> 	<p>Recutting + Cribwork with vegetation + Drainage Embankment + Retaining wall + Vegetation + Drainage</p> 
Workability Structural feature	-Cut slope become stable by cutting of collapse soil. -Embankment increase stability by bench cutting of existing slope.	-The purpose of cribwork is for the vegetation and increase stability.	-The purpose of cribwork is for the vegetation and increase stability.	-The purpose of cribwork is for the vegetation and increase stability.	-The purpose of cribwork is for the vegetation and increase stability.
Environment Impact	-It harmonizes with surrounding by vegetation on embankment. Slope is expected of natural vegetation.	-It harmonizes with surrounding by vegetation	-It harmonizes with surrounding by vegetation	-It harmonizes with surrounding by vegetation.	-It harmonizes with surrounding by vegetation.
Influence on Road	-One lane is operated while constructing	-One lane is operated while constructing.	-One lane is operated while constructing.	-One lane is operated while constructing.	-One lane is operated while constructing.
Maintenance	-The maintenance is necessary until the vegetation takes root. Embankment side is private land.	-The maintenance is necessary until the vegetation takes root. The width of land use is minimum.	-The maintenance is necessary until the vegetation takes root. The width of land use is minimum.	-The maintenance is necessary until the vegetation takes root. The width of land use is middle.	-The maintenance is necessary until the vegetation takes root. The width of land use is middle.
Economy	-This alternative is cheapest of all.	-Cribwork and retaining wall are expensive.	-Cribwork and retaining wall are expensive.	-Cribwork, stone masonry and horizontal drainage are expensive.	-Cribwork, stone masonry and horizontal drainage are expensive.
Evaluation	-The purpose of prevention can be economically achieved.	-Cribwork and retaining wall are unnecessary for stability.	-Cribwork and retaining wall are unnecessary for stability.	-Stone masonry and horizontal drainage are unnecessary for stability.	-Stone masonry and horizontal drainage are unnecessary for stability.

Table A6-14 Selection of Prevention Countermeasure Method



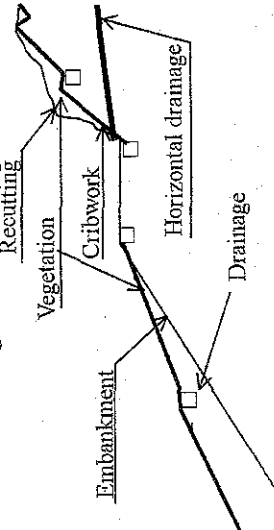
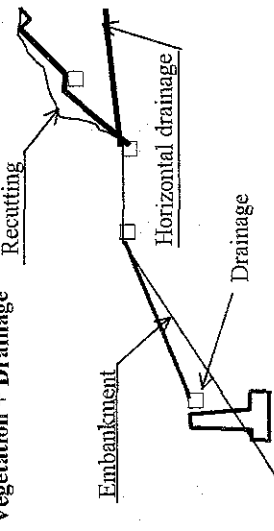
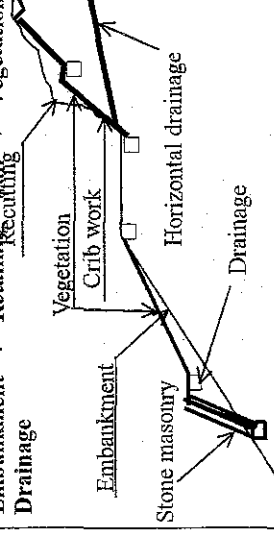
ID : N003C140	Topography	The Mountainside	Height and Incline	H = 6 ~ 9 m , θ = 45 ~ 60 deg.	The kind of The Rock	Tuff
	Impact of Rain (Inflow water) The Dry Season	Inflow water	Stability Analysis	Necessary	Purpose of Countermeasure	Slope Sliding, Rock Collapse
					The Rainy Season	
Situation of Slope						
Comments	Weathering of tuff is advancing. There is a watercourse in the rock and it was confirmed by the oozing from embankment. It is necessary to examine the installation of the horizontal drainage to control the water level. The cut gradient will be determined according to the boring result and the position of the church. T-shaped retaining wall will be necessary because it minimizes width of land use of coffee plantation.					
Alternative of Countermeasure				Recutting + Horizontal Drain + Drainage Embankment + T-shaped retaining wall + Vegetation + Drainage	Recutting + Cribwork with vegetation + Drainage + Horizontal drainage Embankment + Retaining Wall + Vegetation + Drainage	Recutting + Cribwork with vegetation + Drainage + Horizontal drainage Embankment + Retaining Wall + Vegetation + Drainage
Workability	-The purpose of cribwork is for the vegetation and increase stability. But it does not contribute almost in stability	-Some technologies are necessary. -Embankment increase stability by installation of retaining wall.	-Construction is not difficult. -Some technologies are necessary.	○	◎	◎
Environment Impact	-It harmonizes with surrounding by vegetation. The vegetation on the cut side is done with cribwork.	-Cut slope is expected of natural vegetation.	-It harmonizes with surrounding by vegetation. The vegetation on the cut side is done with cribwork.	○	△	○
Influence on Road	-One lane is operated while constructing	-One lane is operated while constructing	-One lane is operated while constructing	○	○	○
Maintenance	-The maintenance is necessary until the vegetation takes root. The width of land use is maximum.	-The maintenance is necessary until the vegetation takes root. The width of land use is minimum.	-The maintenance is necessary until the vegetation takes root. The width of land use is middle.	△	◎	○
Economy	-Cribwork is expensive.	-Retaining wall is expensive.	-Cribwork and stone masonry are expensive.	○	○	△
Evaluation	-The width of land use is maximum, therefore it has an impacts on coffee plantation.	-The width of land use is minimum, therefore It decrease an impacts on coffee plantation.	-The width of land use is necessary more wide than T-shaped retaining wall.	3	1	2



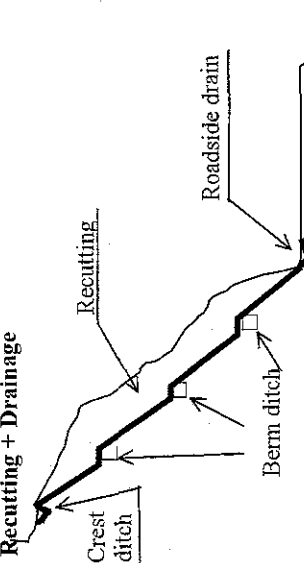
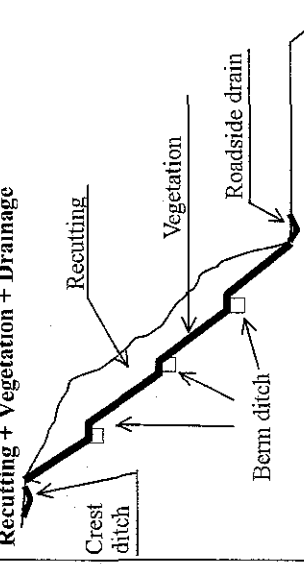
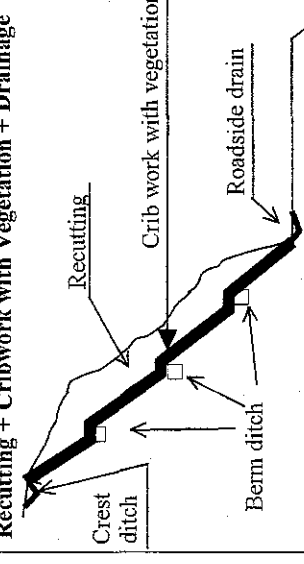
Table A6-15 Selection of Prevention Countermeasure Method					
ID : N005A010	Topography	The Mountainside	Height and Incline	The kind of The Rock	Talus and Tuff
	Impact of Rain (Inflow water)	Inflow water Surface Water	Stability Analysis	Purpose of Countermeasure	Rockfalls
Situation of Slope	The Dry Season		Necessary	The Rainy Season	
Comments	The slope consists mainly of talus of diluvial age over tuff. The existing road became unstable by the leg of talus was cut. The crest ditches were installed after collapse, but the infiltrating water is oozing. Falling rock continues because the gradient of cut is too steep.				
Alternative of Countermeasure	 <p>Recutting + Drainage</p>	 <p>Recutting + Vegetation + Drainage</p>	 <p>Recutting + Cribwork with Vegetation + Drainage</p>		
Workability	-Large-scale collapse is prevented by cut of 35°. Stability will increase by drainage facilities. ○	-Vegetation is added to left side alternative as the increase stability. ○	-The purpose of cribwork is for the vegetation and increase stability. But it does not contribute almost in stability. ○		
Environment Impact	-Slope is expected of natural vegetation. △	-Slope is expected of natural vegetation. △	-The environment is prevented from deteriorating by vegetation among the cribwork. ○		
Influence on Road	-One lane is operated while constructing ○	-One lane is operated while constructing ○	-One lane is operated while constructing ○		
Maintenance	-It is necessary to maintain slope surface. △	-The maintenance is necessary until the vegetation takes root △	-The maintenance is necessary until the vegetation takes root △		
Economy	-It is the most economical in three alternatives. ◎	-It costs the maintenance expense of the vegetation. ○	-Cribwork is expensive. △		
Evaluation	-The purpose of prevention can be economically achieved. I	The effect of the vegetation cannot be expected. 3	-The effect that corresponds to expense of cribwork cannot be expected. 2		

Table A6-16 Selection of Prevention Countermeasure Method


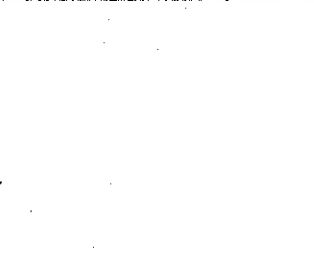

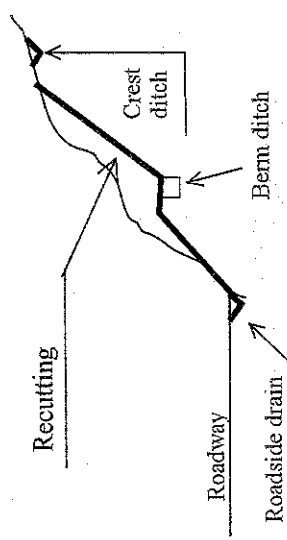
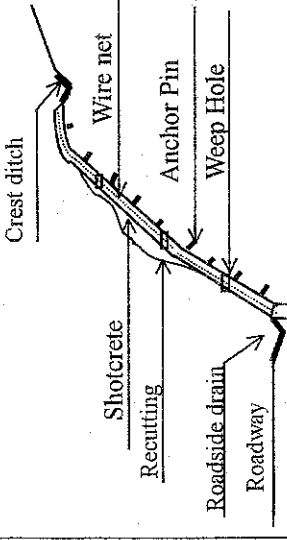
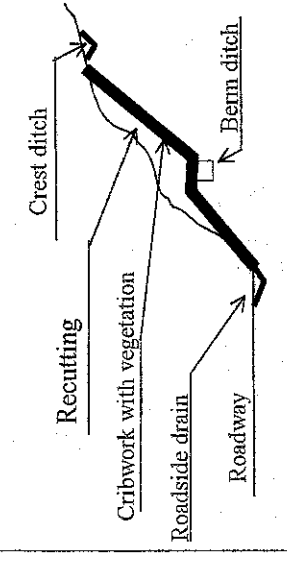
ID : N0026A060	Topography	The Mountain side	Height and Incline	H = 9 ~ 14 m , θ = 53 ~ 63 deg.	The kind of The Rock	Tuff
	Impact of Rain (Inflow water) The Dry Season	After water	Stability Analysis	Unnecessary	Purpose of Countermeasure The Rainy Season	Rockfalls
Situation of Slope						
Comments	The surface dropping and falling rock stand out in rainy season. The layer of weathering tuff collapses, therefore andesite near shoulder become overhanging and collapses. Tuff becomes collapse along the cracks because it is subdivided by repeating dry and wet.					
Alternative of Countermeasure	<p>Recutting + Vegetation + Drainage</p> 	<p>Recutting + Shotcrete + Drainage</p> 	<p>Recutting + Crib work with vegetation + Drainage</p> 			
Workability	-Construction is not difficult. Cutting is inferior in respect of the weathering measures	△	-It is necessary special equipment. -It is excels for countermeasure of weathering.	◎		-Construction is not difficult. -Some technologies are necessary.
Environment Impact	-Slope is expected of natural vegetation.	△	-It is difficult to harmonize with surroundings.	△		-The environment is prevented from deteriorating by vegetation among the cribwork.
Influence on Road	-Traffic control is necessary during construction, but here is no influence after construction.	○	-Traffic control is necessary during construction, but here is no influence after construction.	○		Traffic control is necessary during construction, but here is no influence after construction.
Maintenance	-The maintenance is necessary until the vegetation takes root.	△	-It is necessary to confirm volume of coozing.	○		-The maintenance is necessary until the vegetation takes root. It is effective to the weathering measures.
Economy	-It is the most economical in three alternatives.	◎	-The cost is middle of all.	○		-Cribwork is expensive. It is the most expensive of all.△
Evaluation	-Maintenance, environmental, and weathering are inferior.	2	-It is the most effective in the weathering measures. Infiltration of water can be prevented by crest ditch.	1		Stability and the environmental are excels after measures. But it is expensive.

Table A6-17 Selection of Prevention Countermeasure Method



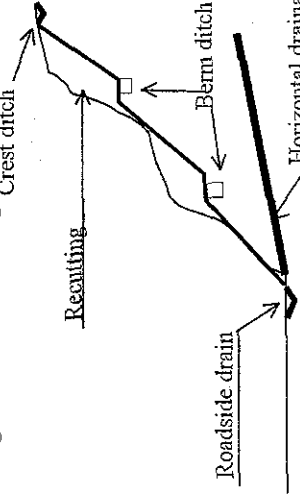
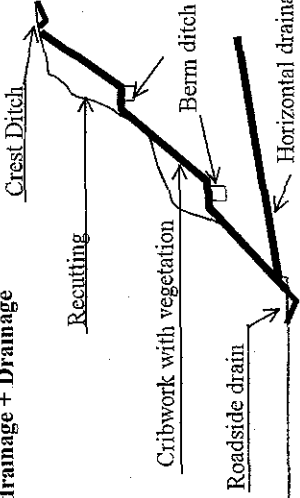
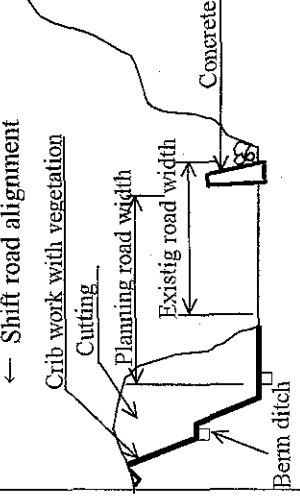
ID : N0026B140	Topography	The Mountainside	Height and Incline	$H = 11 \sim 33 \text{ m}$, $\theta = 50 \sim 60 \text{ deg.}$	The kind of The Rock	Tuff and Andesite, The Portion is Fracture Zone.
Situation of Slope	Impact of Rain (Inflow water) The Dry Season	Inflow water	Stability Analysis	Necessary	Purpose of Countermeasure	Rock Collapse
				The Rainy Season		
Comments	The width of crashed zone of tuff is about 50m. The angle of slide scarp is 60°, and it is instability. Falling rock was confirmed in dry season, it enters the rainy season and has increased further. 40° is recommended as the angle of cutting. The slope has the small collapsing in the vicinity of the crashed zone. The inflow water was confirmed from the cracks.					
Alternative of Countermeasure	 <p>Recutting + Horizontal drainage + Drainage Crest ditch</p>	 <p>Recutting + Cribwork with vegetation + drainage Crest Ditch</p>	 <p>Shift road alignment ← Shift road alignment Crib work with vegetation Cutting Planning road width Existing road width Concrete barrier Berm ditch</p>			
Workability	-Large-scale collapse is prevented by cut of 40° at fracture zone, 55° at the other zone. Stability will increase by horizontal drainage facilities. ○	-Cribwork is added to left side alternative as the increase stability and vegetation. ○	-The road alignment is shifted, and then concrete barrier is installed. Cribwork is installed after slope is cut at the opposite side. △			
Environment Impact	-Slope is expected of natural vegetation. △	-The environment is prevented from deteriorating by vegetation among the cribwork. ○	-Vegetation is done among the cribwork, but opposite side remain slope of existing condition. △			
Influence on Road	-One lane is operated while constructing ○	-One lane is operated while constructing ○	-One lane is operated while constructing ○			
Maintenance	-The maintenance is necessary until the vegetation takes root. Inspection of slope surface is necessary. △	-The maintenance is necessary until the vegetation takes root. ○	-Maintenance of cribwork side is unnecessary, but maintenance of existing slope side is necessary. ○			
Economy	-It is the most economical in three alternatives. ◎	-Cribwork is expensive. △	-Cutting and concrete barrier are expensive. △			
Evaluation	-Slope increases stability; because slope is cut to gentle gradient, and horizontal drainage is installed. 1	-The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. 2	-The barrier is too big size. An economical effect cannot be demonstrated by shifting. 3			

Table A6-18 Selection of Prevention Countermeasure Method


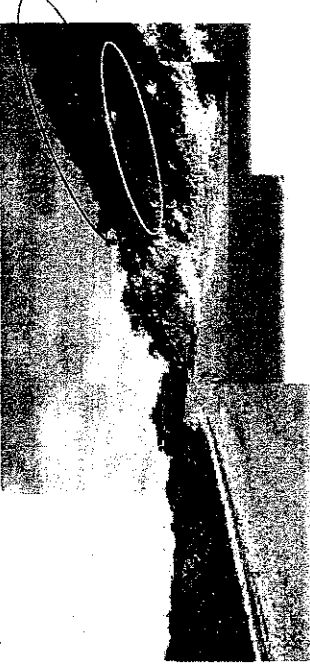
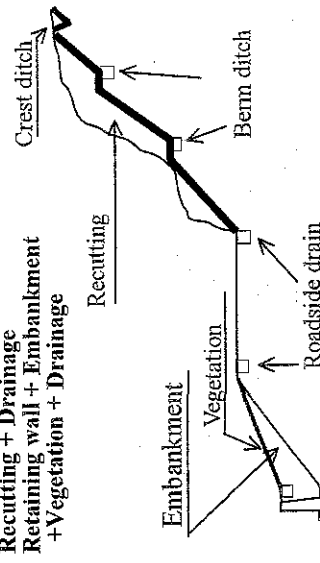
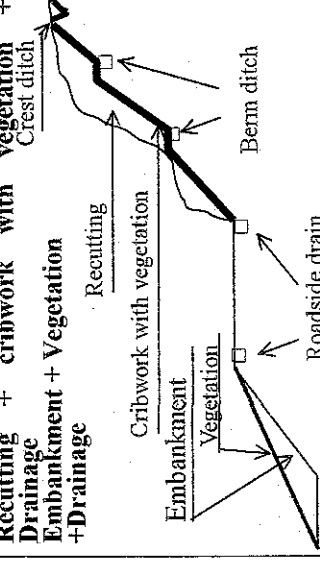
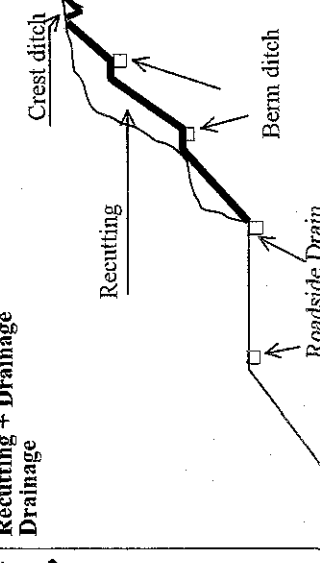
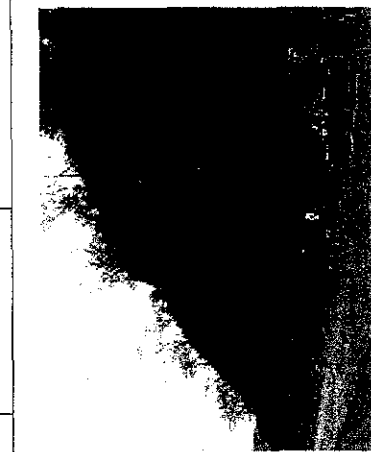
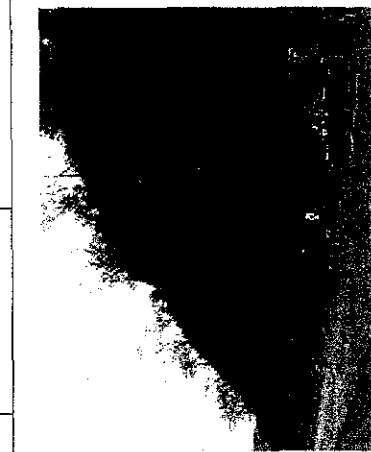
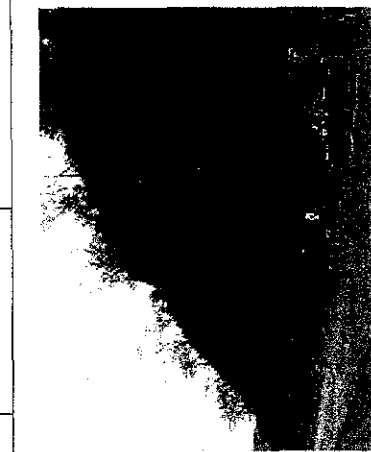
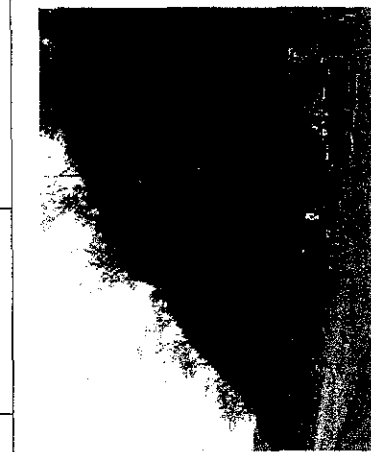
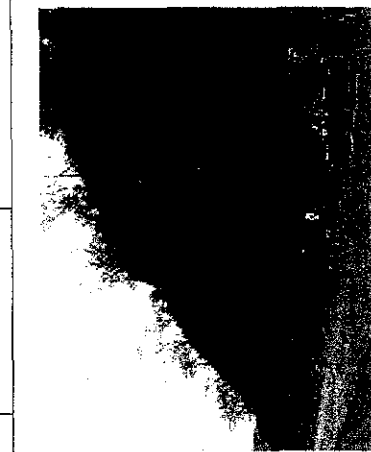
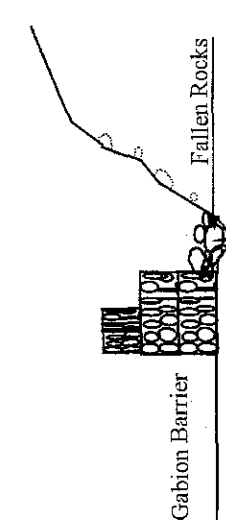
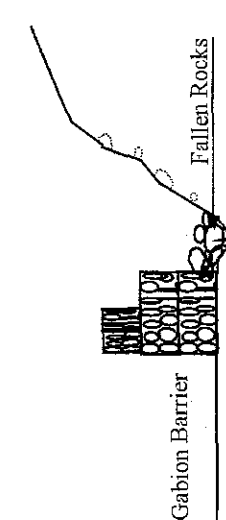
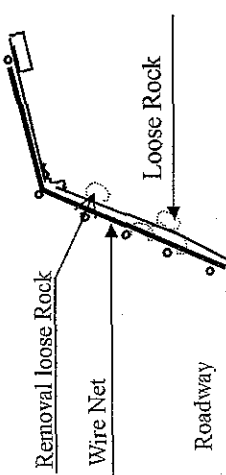
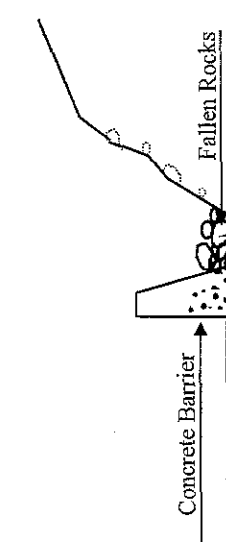
ID	Topography	The Mountainside	Height and Incline	H = 18 ~ 56 m, θ = 48 ~ 56 deg.	The kind of The Rock	Agglomerate, Tuff and Andesite, (Alteration zone)
Situation of Slope	Impact of Rain (Inflow water)	After rain	Stability Analysis	Necessary	Purpose of Countermeasure	Rockfalls
Situation of Slope	The Dry Season				The Rainy Season	
Comments	The whole of slope is a changing in quality action and a fragile rock. Marked in red is slide scarp, it is a supply source of the falling rock and the collapse, and it piles up in the place which slope was marked in white. The slope on the road side collapses easily, too and minute gravel diffuse to the road. The inflow water was confirmed at four positions in rainy season.					
Alternative of Countermeasure	Retcutting + Drainage Retaining wall + Embankment +Vegetation + Drainage		Retcutting + cribwork with vegetation + Drainage +Embankment +Vegetation		Retcutting + Drainage	
Workability	-Large-scale collapse is prevented and stability increase by cut of 55°. Retaining wall is installed at embankment side.		-Cribwork and vegetation are added to left side alternative as the increase stability. Embankment increase stability by bench cutting of existing slope.		-Large-scale collapse is prevented and stability increase by cut of 55°. Roadside ditch is installed at shoulder of slope at embankment side.	
Environment Impact	-Slope is expected of natural vegetation at cut slope side		-The environment is prevented from deteriorating by vegetation among the cribwork.		-Slope is expected of natural vegetation at cut slope side.	
Influence on Road	-One lane is operated while constructing		-One lane is operated while constructing		-One lane is operated while constructing	
Maintenance	-The maintenance is necessary until the vegetation takes root.		-The maintenance is necessary until the vegetation takes root.		-Inspection of slope surface is necessary.	
Economy	-Retaining wall of embankment side is expensive.		-Cribwork is expensive		-It is the most economical in three alternatives.	
Evaluation	-Slope increases stability, because slope is cut to gentle gradient, and economical drainage system is installed. Retaining wall is unnecessary for stability.	3	-The purpose of cribwork is for the vegetation, and it does not contribute almost in stability. Embankment is unnecessary for stability.	2	-Slope increases stability, because slope is cut to gentle gradient, and economical drainage system is installed	1

Table A6-19 Selection of Prevention Countermeasure Method

ID: N0026B160	Topography	The Mountainside	Height and Incline	H = 11 ~ 22 m, θ = 53 ~ 70 deg.	The kind of The Rock	Tuff and Andesite,
	Impact of Rain (Inflow water) The Dry Season	After rain	Stability Analysis	Necessary	Purpose of Countermeasure	Rock Collapse
Situation of Slope					The Rainy Season	
Comments	Cracks of andesite are open. The toppling phenomenon has been caused. The removals of unstable rocks are necessary.					
Alternative of Countermeasure						
Workability	-Wire of gabion cannot resist against energy of the assumed falling rock. Δ	-The construction results are not in Nicaragua. -This type is almost permanent structure. ○	-The concrete barrier will be too big size for resistance against energy of the assumed falling rock. Δ			
Environment Impact	-Deterioration of environment will be forecast by damage of gabion. Δ	-It is necessary to cut trees. Δ	-Installing the concrete barrier lacks harmony with the surrounding. Δ			
Influence on Road	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. Δ	-There is no problem. ◎	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. Δ			
Maintenance	-It is necessary to remove collected rock. Δ	-The environment deterioration is eased by partially constructing the net. Δ	-It is necessary to remove fallen rocks. ○			
Economy	-Durability depends on the life of the wire. Δ	-Net materials are expensive, but maintenance cost isn't high. ○	-The maintenance of the structure is unnecessary. ○			
Evaluation	-Because maintenance cost is high, costs of three alternatives are almost even. ○	-This type prevents completely dispersion of rock collapse. 1	-The cost is middle of all. But the costs of three alternatives are almost even. ○			
	-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough. 3		-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough. 2			

