<u>Appendix 5</u> AHP Data

## The analysis result table by the AHP

			Eva	aluation Cri	iteria	Stability level	Traffic volume	Enviromental evaluation	Natural condition	Benefit B/C	Restoration	Development
			Weight	of each E	valuation	0.3668	0,1673	0.0839	0.1800	0.0383	0.1430	situation 0.0207
	Ì		A	Criteria malysis res	ult	V.0000	0.1070		each Alterna	<u> </u>	0.1430	0.0207
Route No.	Type of Dissaster	Serial Number of Disaster Critical Spots	Weight	Rank	*	Stability level	Traffic volume	Enviromental evaluation	Natural condition	Benefit B/C	Restoration level	Development situation
	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	5	0.0279	12	D.P.S.	0.0527	0,0269	0.0071	0.0028	0.0482	0.0065	0.0114
	Bridge Bridge	6	0.0220	3	D.P.S. D.P.S.	0.0527	0.0242 0.0242	0.0186	0.0141	0.0276 0.0459	0.0149 0.0105	0.0237
	R,F,	7	0.0314	23	D.P.S.	0.0215	0.0242	0.0186	0.0141	0.0070	0.0149	0,0237
	R.C.	8	0.0176	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
Nic1	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 15	0.0174	31 40		0.0094	0.0242 0.0242	0.0186	0.0299	0.0088	0.0149	0.0237
	R.C.	16	0.0137	34		0.0089	0.0242	0.0071	0.0068	0.0168	0.0171	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
	RF.	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
	R.C.	23	0.0144	37	D.P.S.	0.0090	0.0256	0.0071	0.0028	0.0341	0.0290	0.0090
	R.C. R.C.	24 25	0.0201	19 14	D.P.S.	0.0030	0.0256 0.0256	0.0186 0.0186	0.0299	0.0304	0.0290	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
Nic3	R.C.	28	0.0111	51		0.0083	0.0102	0.0071	0.0068	0.0068	0.0290	0.0043
MICO	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. R.C.	33	0.0229	9 33	D.P.S.	0,0276	0.0102 0.0102	0.0071	0.0322	0.0111	0.0290	0.0043
Nic5	R.F.	35	0.0101	21	D.P.S.	0.0147	0.0101	0.0071	0.0322	0.0068	0.0423	0.0027
	D.F.	36	0.0117	47		0,0070	0.0053	0.0022	0.0322	0.0061	0.0105	0.0258
N: 45	D.F.	37	0.0117	48		0,0070	0.0053	0.0024	0.0322	0.0053	0.0105	0.0258
Nic15	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
	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, R,F,	42 43	0.0115	49 45		0,0074	0.0207	0.0186	0.0028	0.0088	0.0171	0.0246
	R.F.	43	0.0183	45 27	D.P.S.	0.0083	0.0207	0.0186	0.0322	0.0129	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
Nic26	R.C.	47	0.0127	43		0.0089	0.0183	0.0186	0.0028	0.0200	0.0210	0.0246
I VADEFI	R.F.	48	0.0134	41		0.0083	0.0183	0.0186	0.0141	0.0276	0.0116	0.0246
į	R.C.	49	0.0199	20	D.P.S.	0.0147	0.0183	0.0071	0.0322	0.0111	0.0290	0.0246
ĺ	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. Bridge	53 54	0.0119	4 <del>6</del>	D.P.S.	0,0074	0,0199	0.0071	0.0141	0.0111	0.0149 0.0065	0.0090
	Bridge	55	0.0204	4	D.P.S.	0.0278	0.0207	0.0449	0.0028	0.0373	0.0065	0.0090
	211450		2,22,00			PAGE A5					2.000	

THE STUDY ON YULNERABILITY REDUCTION FOR MAJOR ROADS IN THE REPUBLIC OF NICARAGUA PAGE A5-1

Maximum peculiar value λ max= 56.857 The index of adjustment C. I. = 0.0344

	Weight	0.0110435	0.0214581	1/3 0.0278286	0.0526574	0.0276286	0.0214681	0.000044	0.0083495	0.0083455	0.0182234	0.0122035	0.0094126	O CORREST	0.0094126	0.0069848	0.0528574	0.0526674	0.008044	0.0088661	G.WIEREST	0.009044	0.0148614	0.0626574	0.0004128	0.0083485	0.0088881	0.0198103	0.0278266	0.0276286	0.0198103	0.0145814	0.0068849	0.0009849	0.0069849	0.0074163	0.0008848	0.0083485	0.0110435	0.0526574	0.0110435	0.0088851	0.0083495	0.0146614	0.0237833	0.0278266	0.0074163	0.0278286	
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Maximum peculiar value  $\lambda$  max= 56.425 The index of adjustment C. I. = 0.0264

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An Evaluation Points for Restoration level

						s for Res	SCOLACION		uation		
Route No.	Name of city	Sireal Number of Disaster Critical spots	Type of disaster	Distance from Managua	Length of slope and Bridge(m)	Distannce from Managua	Space for diversion	Condition of detour road	Type of disaster	The scale of Disaster	Total
		1	R.F.	100	890	1	11	1	2	5	10
		2	R.F.	100	350	1	1	1	2	5	10
	Sebaco	3	Bridge	150	29.3	2	1	1	4	3	11
		4	Bridge	150	18.6	2	1	3	4	11	11
	Esteli	5	Bridge	200	62	3	!	3	4	3	14
		6	Bridge	200	15.5	3	11	3	4	1	12
	ļi	7	R.F.	200	600	3	1	3	2	5	14
		<u>8</u> 9	R.C. R.C.	200 200	280 200	3	1 1	3	3	5	15
		10	R.C.	200	440	3	1	3	3	5 5	15 15
		11	R.C.	200	460	3	1	3	3	5	15
Nic1		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
	Yaraguina	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
	El Espino	22	R.F.	250	145	4	1	1	2	3	11
	Sebaco	23	R.C.	150	130	2	5	5	3	3	18
•		24	R.C.	150 150	170 90	2	5	5 5	3	3 1	18
		25 26	Bridge	150	17.5	2	5	5	4	1	16 17
		27	R.C.	150	150	2	5	5	3	3	18
	Matagalpa	. 28	R.C.	150	110	2	5	5	3	3	18
Nic3	Maragarpa	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_
	Ocotal	36	D.F.	250	45	4	1	1	5	1	12
Nic15		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.	250 150	100	4	1 5	<u>1</u>	<u>5</u> 2	3	1 <u>4</u> 15
- 1	an Isidor	40 41	R.F.	150	105 235	2 2	5 5	3	2	3 5	15 17
-		42	R.F.	150	160	2	5	3	2	3	15
		43	R.F.	150	115	2	5	3	2	3	15
İ		44	R.F.	150	160	2	5	3	2	3	15
		45	Bridge	150	31	2	5	3	4	3	17
l	_	46	R.F.	150	77	2	5	3	2	1	13
Nic26		47	R.C.	150	110	2	5	3_	3	3	16
MICEG		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
	El Jicalal	51	R.C.	150	90	2	3	11	3	11	10
1		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

	Évaluatio	on Criteria	Point
	<del> </del>	≦100km	1
Di_t f	. M	100< L ≦150km	2
Distance from	i wanagua	150< L ≦200km	3
		200km< L	4
Space for mana		There is a enough space	1
calamity res	_	There is not a enough space	5
calamity res	LOTATION	The above-mentioned middle	3
******		There is a detour.	1
Condition of d	etour road	There is no detour.	5
		Much time is required for detour	5
		Rock Falling (R.F.)	2
		Rock Collapsing (R.C.)	3
Type of di	saster	Slop slide (S.S.)	5
		Debris Flow (D.F.)	5
		Scoring of fundation (Bridge)	4
		≦100m	1
	Slope	100 < L ≦200m	3
Length of slope		200m< L	5
and Bridge		≦20m	1
	Bridge	20 < L ≦100m	3
		100m< L	5

THE STUDY ON VULNERABILITY REDUCTION FOR MAJOR ROADS IN THE REPUBLIC OF NICARAGUA PAGE A5-9

Development situation and an Evaluation Points

		Develor		ation and an Evaluation Points		
Route No.	Sec	tion	Serial Number of Disaster Critical Spots	The outline of a project	Evaluation	Total
		Γ	Circlear Obocs	Base point	T-	
		İ		Road improvement construction will be completed in 2002.	5	
	Sanbenito	Sebaco	1,2	Two bridges were reconstructed by the Japanese grantaide	4	10
;	Carlocano	000000	',-	The shages trate resonant december of the superiors granted		
				Base point	1	
		1		Road improvement construction will be completed in 2002.	5	
	Sebaco	Esteli	3,4			_
						6
Níc1				Base point	1	_
				Road improvement construction will be completed in 2002.	5	
	Esteli	Yaraguina	5~16	Two bridges were reconstructed by the IDBC	2	
				There is an urban development design in Esteli	1	9
}			 	Base point		
ſ		}	/	Road improvement construction will be completed in 2002,	5	
1	Yaraguina	El Espino	17~22	Road improvement construction between Somot toSan Lucas will be		
		<b>,</b>		completed in 2002.	3	10
i		ł		There is an urban development design in Somot	1	
				Base point	1	
				A bridge was reconstructed	2	
[	Sebaco	Matagalpa	23~27	Grants-in-aid (Denmark) of the shortcut road to Jinotega are determine	1	
		<del>-</del> -		There is an urban development design in Mtagalpa	1	5
Nic3						
				Base point	1	
				There is an urban development design in Jinotega	1	
1	Matagalpa	Jinotega	28~34			2
			L			2
\r =	10 1	F1 T	0.5			
Nic5	Matagalpa	El Tuna	35			
1				Base point		1
				Base point	1	
				Road improvement construction will be completed in 2002.	5 2	
1	Yalaguina	Ocotal		One bridge was reconstructed	2	
				Improvement construction for the road conect to the object road and Ja	3	12
Nic15				There is an urban development design in Ocotal	1	· · · · · · · · · · · · · · · · · · ·
-				Base point	1	
	0	1 1. 2	06-00	Road improvement construction will be completed in 2002.	5	
	Ocotal	LasManos	36~39	Four bridges were reconstructed	8	13
						13
				Two bridges were reconstructed	4	
1				Some new School are built by Japanese grants-in-aide	2	
	El Jicalal	San Isidoro	40~50	There is the Plan for road improvement construction project	3	
					1	10
Nic26				Base point	1	-
-			]	There is the Plan for road improvement construction project	3	
- }		, res   12	51~55	There is the Plan for improvement construction project for the road b	1	
	Telica	El Jicalal		etween Lapas~Nic24		5
1		i		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 Urbandivelopement will be completed over five years.	2 /Project
There is the Plan for Education or Urbandivelopement	1 /Project

THE STUDY
ON VULNERABILITY REDUCTION
FOR MAJOR ROADS
IN THE REPUBLIC OF NICARAGUA

PAGE A5-10

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JAPAN ENGINEERING CONSULTANTS CO., LTD.

## Review of Score of Stability Survey

Route No.			Nic.1		
Serial Number					+ .
of Disaster	Score of	Scare of		Kilometer from	Type of
Critical Spots	Phase1	Phase2	ID.No	Managua (km)	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.Estelî)	150.33	Bridge
6	100	100	San Ramon	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	RioTapacali	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.			Nic3		
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.	18 T 32 T 3 T 3	M AN003C230F	32.9	S:S:
30	83	83	N003E170	35.2	D.F.
31	<b>经工作</b> 证证 70	*6.65 ## T. # \$2.71	N003G160	35.9	\$ S.S.+10
32	90	90	⇒ *5 N003C150	38.9	S:S:5:
33	90	90	N003C140	394	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	

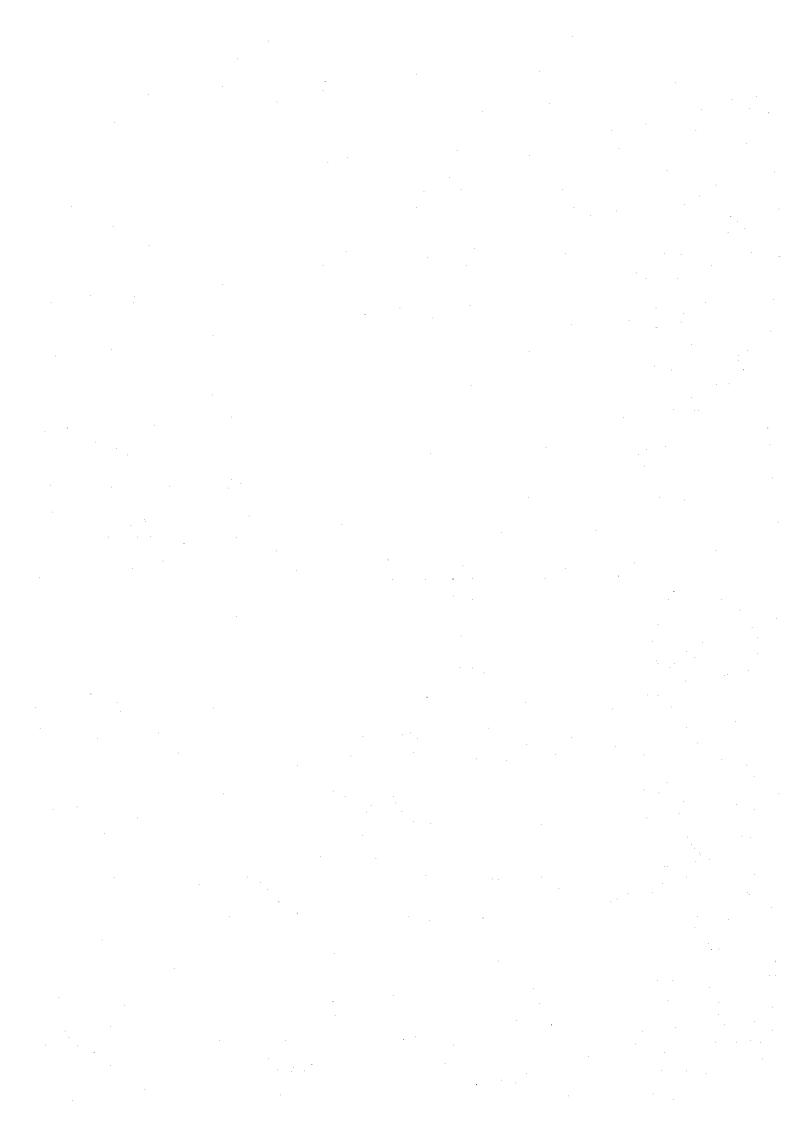
Route No.			Nic.15		
Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	Distance from Las Manos (km)	Type of disaster
36	70	70	N015E010	9.9	D.F
37	70	70	N015E020	11.1 × 1	O D.F:
38	70	70	N015E050	11.7	D.F.
39	70	70	N015E060	13.6	D.F.
Sub-total				4spots	

Route No.			Nic.26		
Serial Number of Disaster Critical Spots	Score of Phase1	Score of Phase2	ID.No	between San Ishidoro & 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	Papalón	108+154	Bridge
55	100	100	Solis	107+533	Bridge
Sub-total				16spots	
Total			· N	lic.1,3,5,15,26	

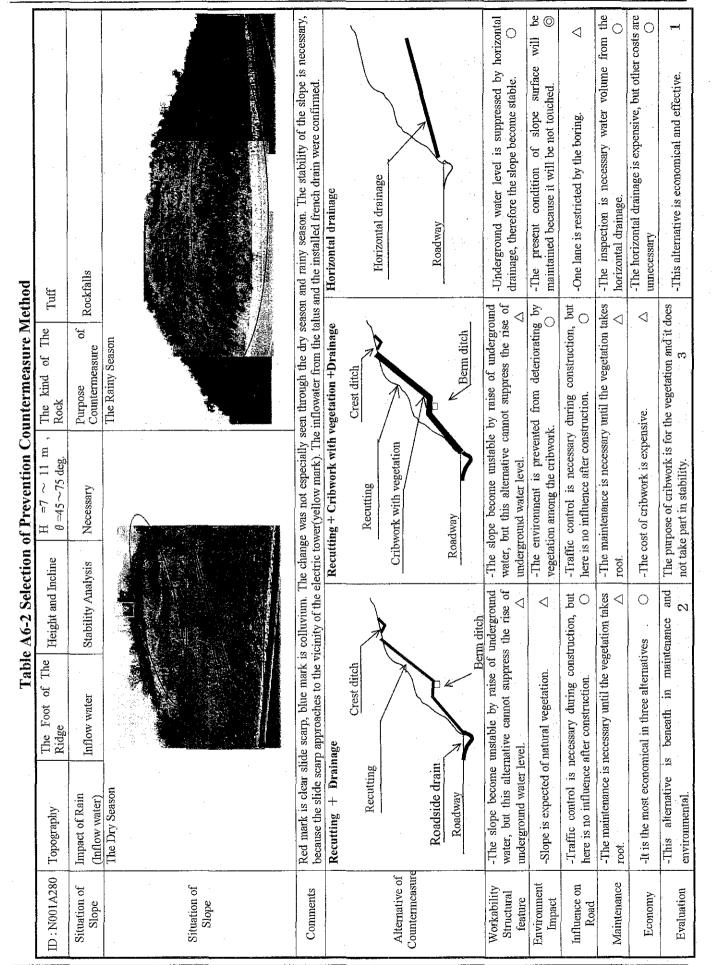
R.F.		:Rock Falling	
R.C.		:Rock Collapsing	
SS-	constant and security	:Slop slide:	In addition a
D.F.		:Debris Flow	
Bridge		:Scoring of fundation	

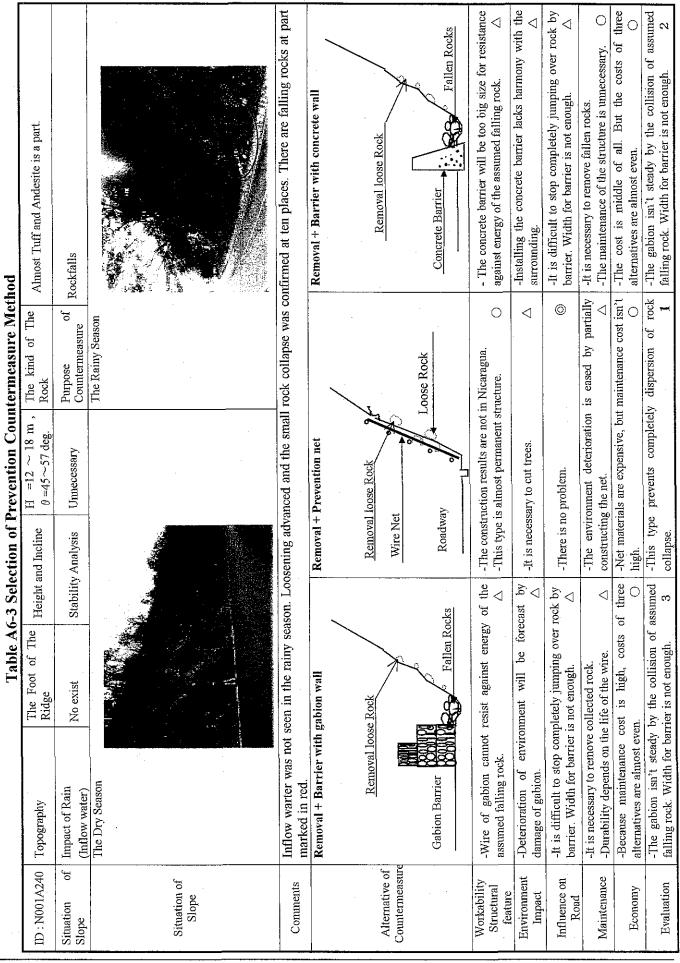
## Appendix 6

Countermeasures Selection of Slope

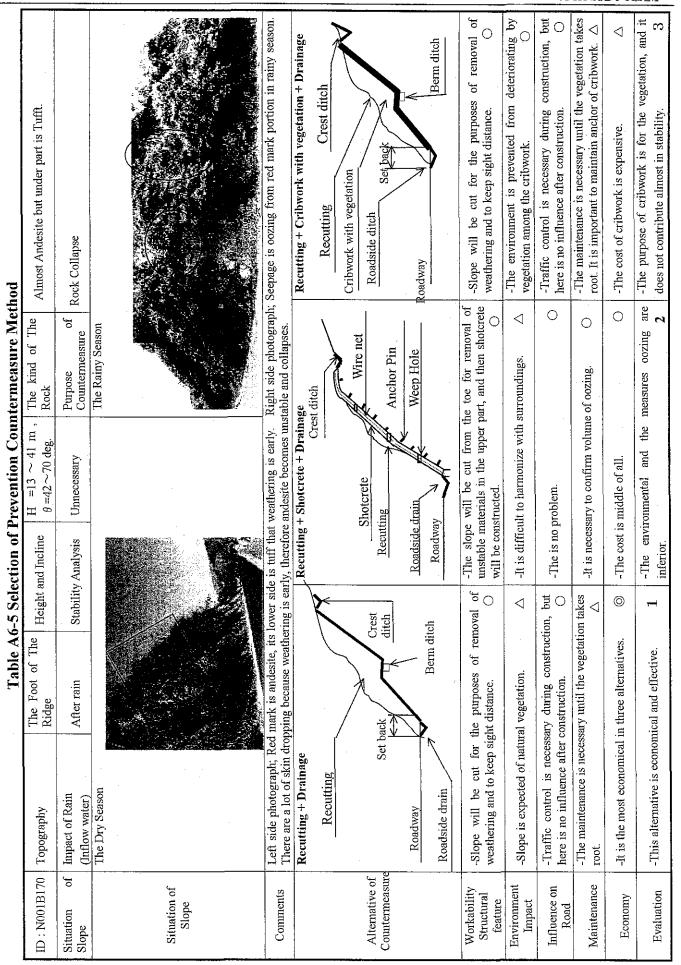


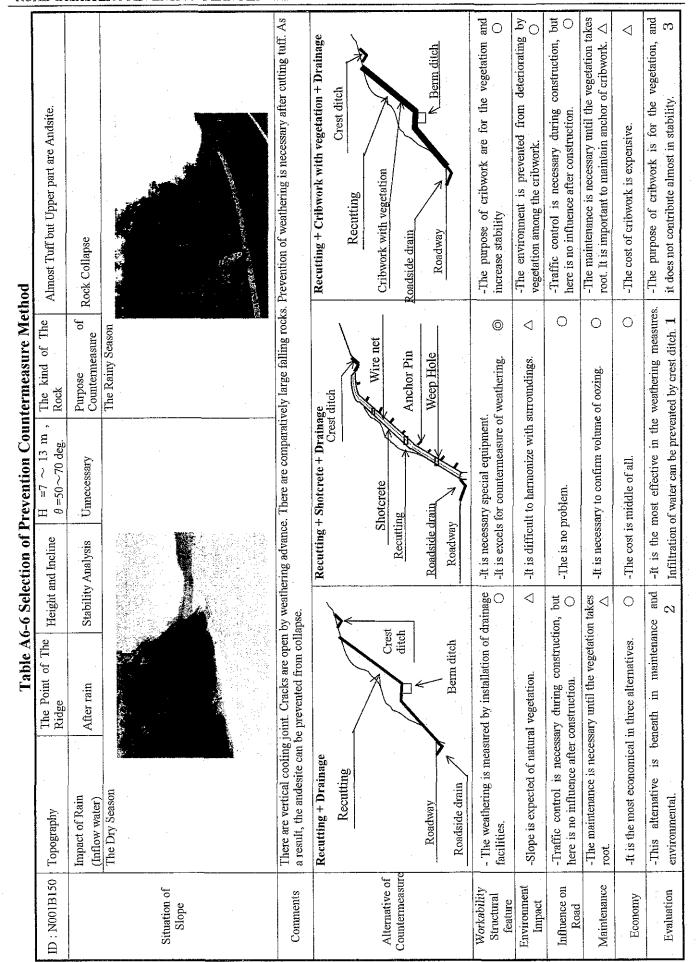
	1									- 1	Ţ			. 1		
por	Alternation of Andesite and Tuff	fails				Because the crack interval of andesite is narrow, subdivided unstable stone is generated a lot. Therefore, many small stones fall. The talus remains thin on the slope, it becomes unstable in the rainy season. Inflow warter is confirmed at whole slope.	Removal + Barrier with concrete wall + Drainage	Crest Ditch	Concrete Barrier	T differ NOCKS	- The concrete barrier will be too big size for resistance against energy of the assumed falling rock. △	-Installing the concrete barrier lacks harmony with the surrounding.	-It is difficult to stop completely jumping over rock by barrier. Width for construction of barrier is enough. $\triangle$	-Because the structure is too large, the space for the removal of fallen rocks is necessary. $\hfill \triangle$	-Maintenance cost is high.	The concrete barrier isn't steady by the collision of assumed falling rock. $2$
e Meth		of Rockfalls	u u			any small		2 ditch	ı		0		· (©	et.	cost isn't	of rock 1
Table A6-1 Selection of Prevention Countermeasure Method	The kind of The Rock	Purpose Countermeasure	The Rainy Season			a lot. Therefore, m	Removal + Prevention net + Drainage	Crest ditch	Loose Rock		-The construction results are not in Nicaragua. -This type is almost permanent structure.			-Durability depends on the life of the wire of net.	-Net materials are expensive, but maintenance cost isn't high.	completely dispersion
ntion C	$=20 \sim 40 \text{ m}$ , $45 \sim 52 \text{ deg}$ .	ary				generated	ntion net	Rock	000	<b>%</b>	results are	cut trees.	lem.	ds on the li	expensive	prevents comp
of Preve	H = $20 \sim 40$ 1 $\theta = 45 \sim 52$ deg.	Unnecessary				ble stone is slope.	/al + Preve	Removal loose Rock Wire Net	a dayaya	Noauway	onstruction ype is almo	-It is necessary to cut trees.	There is no problem.	ility depen	iaterials are	.jbe
lection (	i Incline	analysis				rided unstal d at whole	Remov	Ren	<u></u>	4						d -This type collapse.
A6-1 Se	Height and Incline	Stability Analysis			A Section	row, subdiv	ainage		-	Fallen Rocks	ergy of the $\triangle$	forecast by △	ver rock by enough.		maintenanc nost even.(	of assume
Table	of The	little				esite is nan ow warter i	wall +Dr	7NC		Faller	against en	will be	jumping o f barrier is	ed rock. I the wire.	l. Because itives is alr	collision
	The Foot Ridge	Leak out a little				rval of and eason. Infl	rith gabion	Crest Ditch			gabion cannot resist against energy alling rock.	environment	completely struction o	ove collect n the life of	sapest of al	ady by the
			ason			crack inte	Barrier w	Ö	arrier		abion can ling rock.	)	alt to stop dth for con	ary to remdepends or	ative is che,	n isn't ste
	Topography	Impact of Rain (Inflow water)	The Dry Season			Because the crack interval of andesite is narrow, subdivided unstable ste unstable in the rainy season. Inflow warter is confirmed at whole slope.	Removal + Barrier with gabion wall +Drainage		Gabion Barrier		-Wire of gabion can assumed falling rock.	-Deterioration of damage of gabion.	-It is difficult to stop completely jumping over rock by barrier. Width for construction of barrier is enough. $\triangle$	It is necessary to remove collected rock. Durability depends on the life of the wire.	-This alternative is cheapest of all. Because maintenance cost is high, costs of three alternatives is almost even.	The gabion isn't steady by the collision of assumed falling rock.
	ID: N001A290			Situation of Slope		Comments		Alternative of	Countermeasure		Workability Structural feature	ti.	Influence on Road	nce	Economy	Evaluation
								7	U							





poq	Almost Tuff and Andesite is a part.	Rock Collapse		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	Removal + Barrier with concrete wall	Removal loose Rock	Concrete Barrier Fallen Rocks	- The concrete barrier will be too big size for resistance against energy of the assumed falling rock. $\hfill \triangle$	-Installing the concrete barrier lacks harmony with the surrounding. $\triangle$		It is necessary to remove fallen rocks.  The maintenance of the structure is unnecessary.	-The cost is middle of all. But the con alternatives are almost even.	The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough.
ntermeasure Meth	The kind of The Rock	Purpose of Countermeasure	The Rainy Season	of slope. Tuff that weath	\		Loose Rock	in Nicaragua.		0	is eased by partially	tt maintenance cost isn't	ly dispersion of rock
Selection of Prevention Countermeasure Method	H = $13 \sim 33 \text{ m}$ , $\theta = 40 \sim 65 \text{ deg}$ .	S Unnecessary		ributed in the upper part tph; Upper red mark is lo	Removal + Prevention net	Removal loose Rock Wire Net	Roadway	-The construction results are not in NicaraguaThis type is almost permanent structure.	It is necessary to cut trees.	-There is no problem.	-The environment deterioration is constructing the net.	-Net materials are expensive, but maintenance cost isn't high.	type prevents completely sc.
	Height and Incline	Stability Analysis		is andesite, it is dist Right side photogra	Remov	Ren		of the	forecast by It is no	Þá.		of three	-This
Table A6-4	The Foot of The Ridge	After rain		Left side photograph; The part marked in red andesite becomes on the overhang and falls. andesite and the tuff	Removal + Barrier with gabion wall	Removal loose Rock	POUR Fallen Rocks	-Wire of gabion cannot resist against energy assumed falling rock.	environment will be fo	It is difficult to stop completely jumping over rock barrier. Width for barrier is not enough.	It is necessary to remove collected rock.  -Durability depends on the life of the wire.	-Because maintenance cost is high, costs alternatives are almost even.	-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough.
	Topography	Impact of Rain (Inflow water)	The Dry Season	Left side photograph andesite becomes on andesite and the tuff	Removal + Barrie	·	Gabion Barrier	-Wire of gabion can assumed falling rock.	-Deterioration of damage of gabion.	-It is difficult to st barrier. Width for	It is necessary to r Durability depend	-Because maintenance cost alternatives are almost even.	-The gabion isn't falling rock Width
	ID: N001B230	Situation of Slope	Situation of Slope	Comments		Alternative of Countermeasure		Workability Structural feature	Environment Impact	Influence on Road	Maintenance	Economy	Evaluation

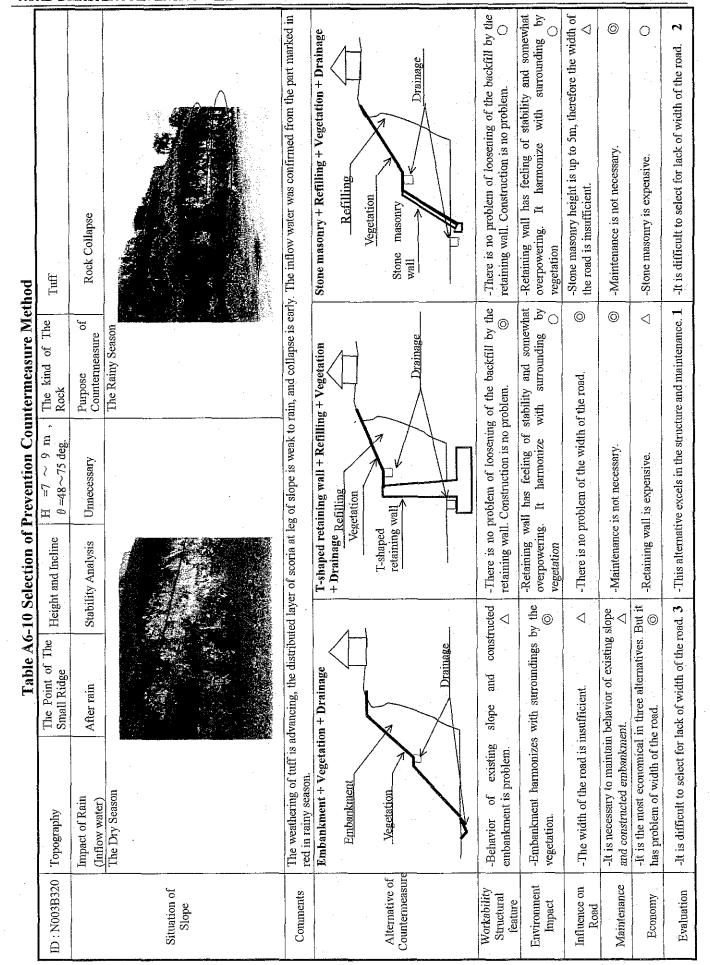


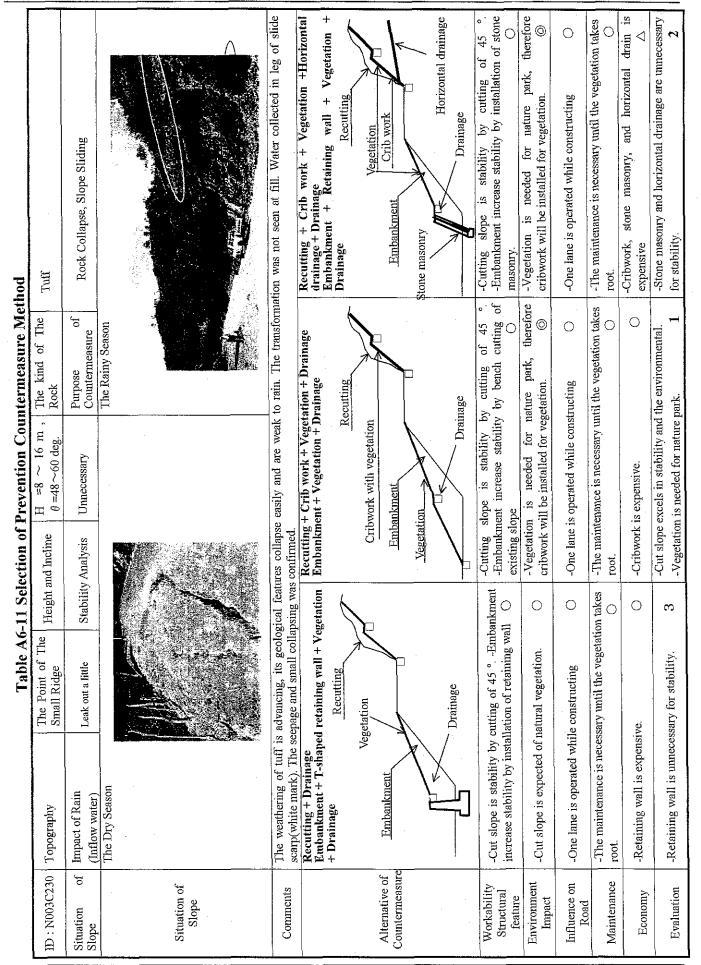


ıntermeasur	Topography Teight and Incline $\frac{H}{\theta} = 17 \sim 50 \text{ m}$ , The kind of The $\frac{1}{\theta} = 17 \approx 10 \text{ m}$ Tuff and Andesite. Middle part of slope are Dyke.	Impact of Rain After rain Stability Analysis Unnecessary Countermeasure (Inflow water)			Crest ditch  Crest ditch	Recutting Recutting Recutting Analysis and Recutting Recutting Recutting Analysis and Analysis a	Roadway Roadway Berm ditch Berm ditch	-Large-scale collapse is prevented by cut of 55 °. Horizontal drainage is added to left side alternative as -The purpose of cribwork are for the vegetation stability will increase by drainage facilities.	-Slope is expected of natural vegetation.	Traffic control is necessary during construction, but here is no influence after construction.	-It is necessary to maintain slope surface.	-It is the most economical in three alternatives.	-Drainage facilities are effective to prevent weathering. Inflow water after rain is much, but horizontal drainage. The purpose of cribwork is for the vegetation, and This alternative is the most effective economically. 1 is not necessary.
		Impact of (Inflow w			Recutting	ı	Ro					,	
	ID: N001B120		Situation of Slope	Comments		Alternative of Countermeasure		Workability Structural feature	Environment Impact	Influence on Road	Maintenance	Economy	Evaluation

		Table A6-9 S	-9 Selection of	election of Prevention Countermeasure Method	termeasure Me	thod
ID: N003B370	Topography	The Point of The Small Ridge	Height and Incline	H = 8 $\sim$ 18 m, $\theta$ = 45 $\sim$ 53 deg.	The kind of The Rock	Tuff
Situation of Slope	Impact of Rain (Inflow water)	No exist	Stability Analysis	Umecessary	Purpose of Countermeasure	Rock Collapse
	The Dry Season				The Rainy Season	
Situation of Slope						
Comments	There are two types tuff. Tuff mare to be confirmed in the rainy season.	Tuff marked in white v season.	has vertical cooling	Tuff marked in white has vertical cooling joint(hard rock; II B type) y season.		Lower side tuff that we athering is $\mbox{early}( II A  \mbox{type})$ . Inflow water was not able
	Recutting + Drainage Recutting		Recutting	Recutting + Shotcrete + Drainage Cr	ge Crest ditch	Recutting + Cribwork + Vegetation + Drainage  Crest ditch
		toril 1	-	Chotorata	Wire net	Cribwork
Alternative of Countermeasure		ditch		Recutting	Anchor Pin	Roadside ditch
	Roadside drain	Berm ditch	, [ 	Roadside drain Roadway	Weep Hole	Roadway Bern ditch
Workability Structural feature	-There is not problem of construction The weathering is measured by installation of drainage facilities	onstruction The wea	<del> </del>	-Special equipment is necessary. -It is excels for counterneasure of weathering	weathering.	-The purpose of cribwork are for the vegetation and increase stability
Environment Impact	-Slope is expected of natural vegetation.	al vegetation.	△.It is diffi	It is difficult to harmonize with surroundings	urroundings.	-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.	ny during constructic onstruction.		-Traffic control is necessary during construction, here is no influence after construction.	ring construction, but	-Traffic control is necessary during construction, but here is no influence after construction.
Maintenance	-The maintenance is necessary until the vegetation takes root. $\hfill \triangle$	ary until the vegetation		-It is necessary to confirm volume of oozing	of oozing.	-The maintenance is necessary until the vegetation takes root. It is effective for weathering
Есопоту	-It is the most economical in three afternatives.	n three alternatives.	© -The cost	The cost is middle of all.	0	-The cost of cribwork is expensive. △
Evaluation	-The purpose of prevention achieved.	can be	economically -There is a p	There is a problem in durability when there is a lot of inflow water. $2$	when there is a lot o	f -The purpose of cribwork is for the vegetation, and it does not contribute almost in stability.

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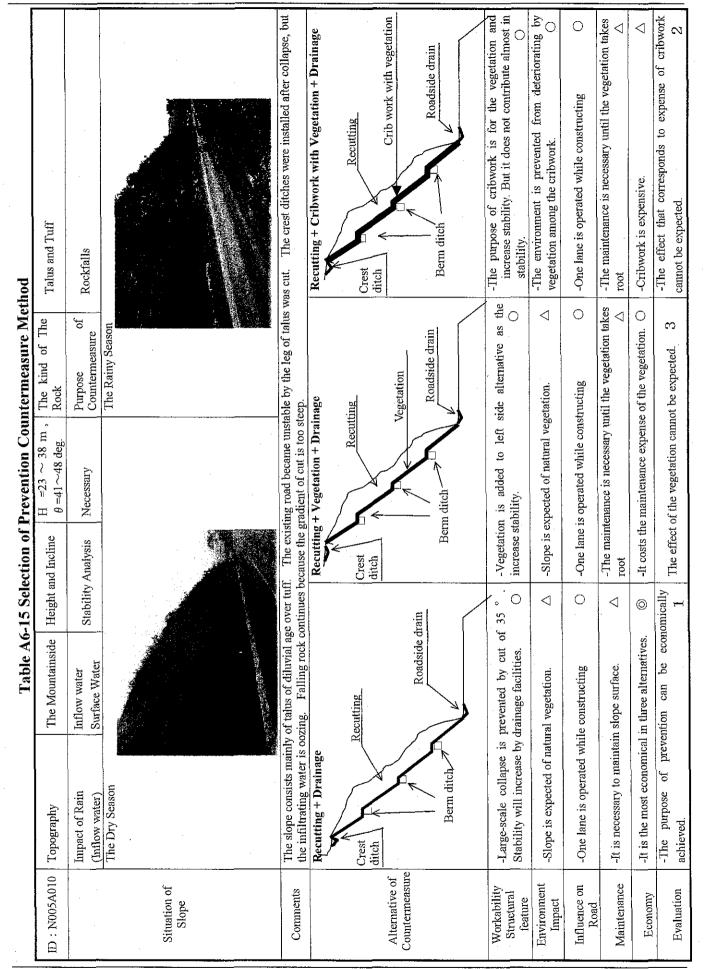


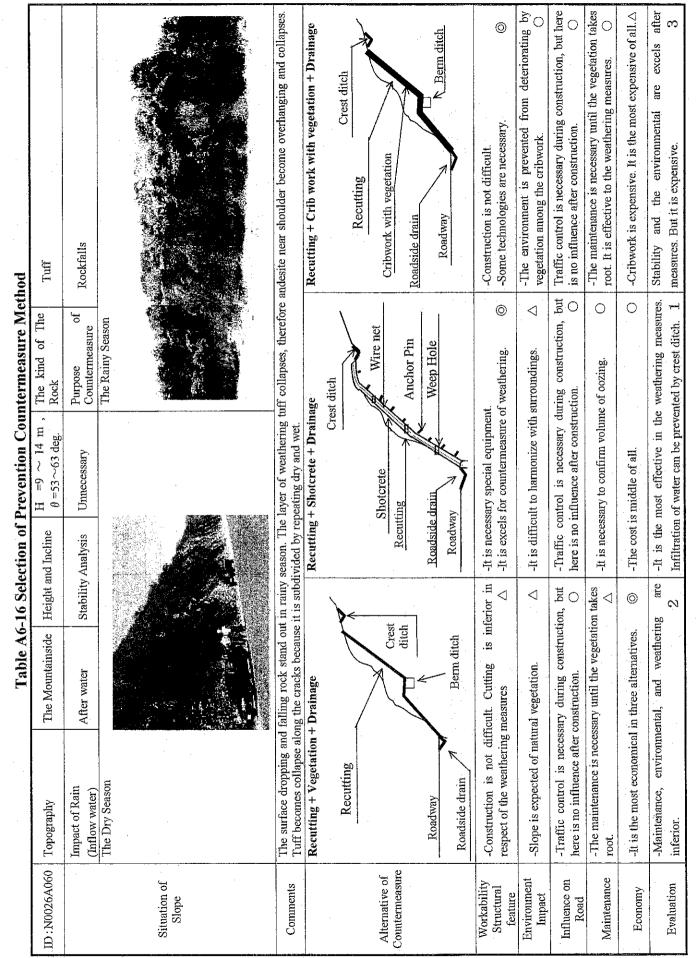
poq	Alternation of Tuff and Andesite (Alteration zone)	Debris Flow and Rockfalls			and soft is violent because of the place. The weathering belt in the hillside has surface collapse due to shallow seepage. main disaster is flash flood than debris flow.	Recutting + Cribwork with vegetable+ Drainag Steel bridge	Steel bridge			-The bridge of the length of about 100m is necessary.  -Countermeasure of the approach road slope is necessary	-The environment is prevented from deteriorating by vegetation among the cribwork.	- Detour of traffic is necessary during construction. $\triangle$	-The maintenance is necessary until the vegetation takes root. Maintenance of bridge is unnecessary.	-Cost of new bridge construction is very expensive. $\triangle$	-The purpose of shift of road alignment is avoidance of debris flow. The bridge is unnecessary for stability. 3
untermeasure Met	, The kmd of the Rock	Purpose of Countermeasure	The Rainy Season		ace. The weathering belt oris flow.	egetable+ Drainage	Bi	Berm ditch	Concrete dam	difficult. The purpose of ion and increase stability O	prevented from deteriorating by cribwork.	during construction.	until the vegetation takes	0	stability and maintenance. is vague.
eventio	scline $\theta = 45 \sim 62 \text{ deg.}$	lysis Unnecessary			and soft is violent because of the place. The main disaster is flash flood than debris flow.	Recutting + Cribwork with vegetable+ Drainage Concrete dam + Box culvert	A)	Existing road surface	*	-Construction is not so difficult. The purpose cribwork are for the vegetation and increase stability	-The environment is prevente vegetation among the cribwork	- Detour of traffic is necessary during construction.	-The maintenance is necessary until the vegetation takes root.	-The cost is middle of all.	slope excels in necessity of cribwork
	Height and Incline	Stability Analysis					j 	. (	Concrete dam	) Ÿ ;;;	to	۵	O Toot.	is (	ابر ور
Table A6-12	The Mountainside	Debris Flow Inflow water			The quality of rock is changed. The difference of hard The main disaster is flash flood than debris flow. The	nage x culvert	Recutting	Berm ditch	Conte	so difficult.	-Slope is expected of natural vegetationIt is difficult harmonize with surroundings until taking root.	- Deiour of traffic is necessary during construction.	for stability.	-This alternative is cheapest of all. Maintenance cost higher than other alternatives	be considerably prevented tge facilities.
	Topography	Impact of Rain (Inflow water)	The Dry Season		The quality of rock i	Recutting + Drainage Concrete dam + Box culvert				-Construction is not so difficult.	-Slope is expected o harmonize with surr	- Detour of traffic is	-Maintenance is not for stability.	-This alternative is cheapest higher than other alternatives	-Weathering can be considinstallation of drainage facilities.
	ID: N003E170			Situation of Slope	Comments		Alternative of	Countermeasure		Workability Structural feature	Environment Impact	Influence on Road	Maintenance	Economy	Evaluation

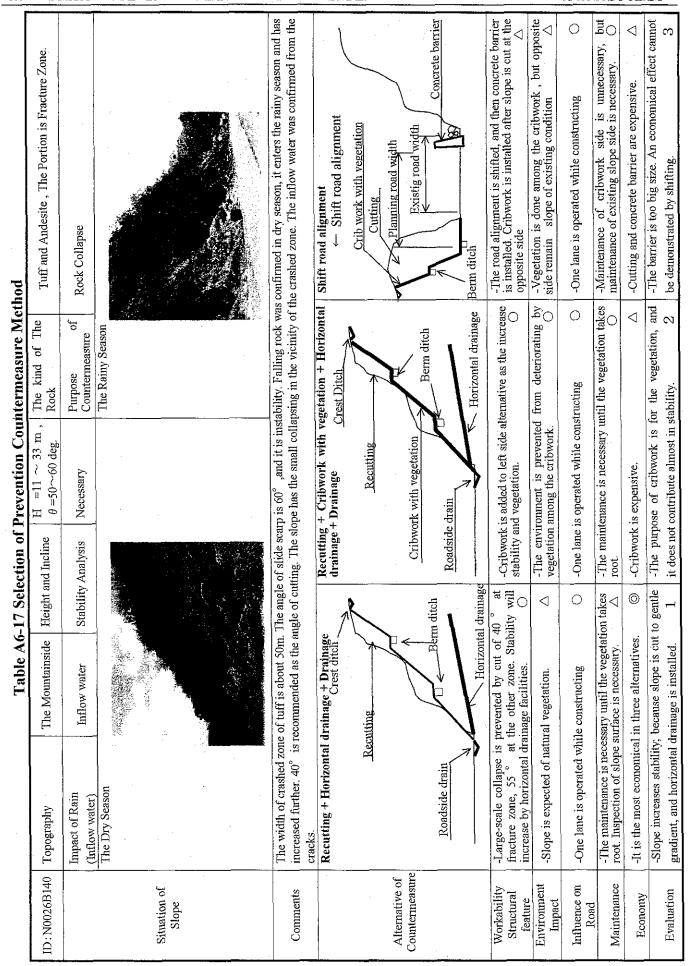
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ORIENTAL CONSULTANTS CO., LTD. in association with JAPAN ENGINEERING CONSULTANTS CO.,LTD.

<b>bo</b> Tuff	Slope Sliding, Rock Collapse			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.	Recutting + Cribwork with vegetation + Drainage +  Horizontal drainage  Embankment + Retaining wall + Vegetation +  Drainage  Vegetation  Crib work	Stone masonry Horizontal drainage Drainage	-Construction is not difficultSome technologies are necessary.	-It harmonizes with surrounding by vegetation. The vegetation on the cut side is done with cribwork.	One lane is operated while constructing	-The maintenance is necessary until the vegetation takes root. The width of land use is middle.	-Cribwork and stone masoury are expensive.	-The width of land use is necessary more wide than T-shaped retaining wall. $2$
Intermeasure Metho The kind of The	Purpose of Countermeasure	The Rainy Season		by the oozing from embankr g to the boring result and the	+ Drainage retaining wall +-	ontal drainage/	by installation of		0		0	therefore It
Table A6-14 Selection of Prevention Countermeasure MethodJuntainside Height and Incline $\theta = 45 \sim 60 \text{ deg}$ . Rock	ž			Weathering of tuff is advancing. There is a watercourse in the rock and it was confirmed by the oozing from embankment. horizontal drainage to control the water level. The cut gradient will be determined according to the boring result and the posinecessary because it minimizes width of land use of coffee plantation.	Recutting + Horizontal Drain Embankment + T-shaped Vegetation + Drainage Recut	Dra	-Some technologies are necessaryEmbankment increase stability retaining wall.	Cut slope is expected of natural vegetation.	One lane is operated while constructing	-The maintenance is necessary until the vegetation takes root. The width of land use is minimum.	-Retaining wall is expensive.	-The width of land use is minimum, decrease an impacts on coffee plantation
ble A6-14 Selection o	x Stability Analysis			is a watercourse in the level. The cut gradies of land use of coffee pl		Horizontal drainage	ļ	rk O	0			
Table AC	Inflow water			Weathering of tuff is advancing. There is a watercourse in the rock a horizontal drainage to control the water level. The cut gradient will be necessary because it minimizes width of land use of coffee plantation.	Recutting + Cribwork with vegetation + Horizontal drain + Drainage Embankment + Vegetation+ Drainage Recutting Vegetation  Vegetation	Drai	The purpose of cribwork is for the vegetation and increase stability. But it does not contribute almost in stability	-It harmonizes with surrounding by vegetation. vegetation on the cut side is done with cribwork.	One lane is operated while constructing	-The maintenance is necessary until the vegetation takes root. The width of land use is maximum. $\triangle$	pensive.	-The width of land use is maximum, therefore $\mbox{\ It}$ has an impacts on coffee plantation.
Topography	Impact of Rain (Inflow water)	The Dry Season		Weathering of t horizontal drain: necessary becau:		<b>\</b>	-The purpose c increase stability stability	-It harmonizes v	-One lane is ope	-The maintenan root. The width	-Cribwork is expensive.	-The width of land use is man impacts on coffee plantation.
ID: N003C140			Situation of Slope	Comments	Alternative of	Counterneasure	Workability Structural feature	Environment Impact	Influence on Road	Maintenance	Economy	Evaluation







Situation of Signation of Slope Slope Slope T	The Mountainside Heigl After rain Stabi nging in quality action and ced in white. The slope on t ment Crest ditch	Ility Analysis Necessary Rock (Alteration Zone)  Necessary Rock (Alteration Zone)  The Rainy Season  T
+ + A LEAT LAT LAT LAT LAT LAT LAT LAT LAT LAT L	Embankment + Vegetation  +Drainage  Recutting  Cribwork with vegetation  Berm ditch  d and stability increase wall is installed at alternative as the increase stability. Embankmen  critical cut slope side  A section at cut slope side  Cribwork and vegetation are added to left so increase stability by bench cutting of existing slope.  The environment is prevented from deteriorating of existing slope.  Cribwork is operated while constructing of existing slope.  Cribwork is expensive.  Cribwork is expensive of cribwork is for the vegetation takes a slope is cut to gentle of ocean contribute almost in stability. Embankmen stability.  Cribwork is expensive of cribwork is for the vegetation, and does not contribute almost in stability. Embankmen stability.  Stability.  S unnecessary for stability.	Recutting Roadside Drain Large-scale collapse is prevented and stal by cut of \$5°. Roadside ditch is installe of slope at embankment sideSlope is expected of natural vegetation at -One lane is operated while constructing large-time most economical in three alternativities the most economical in three alternativities increases stability; because slope is gradient, and economical drainage system

hod	Tuff and Andesite,	Rock Collapse				ary.	Removal + Barrier with concrete wall + Drainage		arisonal Distriction	Concrete Barrier Fallen Rocks	- The concrete barrier will be too big size for resistance against energy of the assumed falling rock. $\hfill \triangle$	-Installing the concrete barrier lacks harmony with the surrounding. $\hfill \triangle$	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. $\triangle$			-The gabion isn't steady by the collision of assumed falling rock. Width for barrier is not enough.
intermeasure Met	The kind of The Rock	Purpose of Countermeasure	The Rainy Season			ınstable rocks are necess	rainage		Loose Rock		t in Nicaragua.	abla	© 1	n is eased by partially $\triangle$	at maintenance cost isn't	ely dispersion of rock
election of Prevention Countermeasure Method	ine H =11 $\sim$ 22 m, $\theta$ =53 $\sim$ 70 deg.	sis Necessary				Cracks of andesite are open. The toppling phenomenon has been caused. The removals of unstable rocks are necessary	Removal + Prevention net + Drainage	Removal loose Rock Wire Net		Roadway	-The construction results are not in Nicaragua. -This type is almost permanent structure.	It is necessary to cut trees.	-There is no problem.	-The environment deterioration is eased by partially constructing the net. $\hfill \triangle$	-Net materials are expensive, but maintenance cost isn't high.	type prevents completely pse.
19 Selection	Height and Incline	Stability Analysis				nenon has beer					<del>                                     </del>	v. d		-The		ssumed -This ty
Table A6-19 S	The Mountainside	After rain			2	open. The toppling phenor	Removal + Barrier with gabion wall +Drainage			Mage Fallen Rocks	-Wire of gabion cannot resist against energy of the assumed falling rock. $\hfill \triangle$	environment will be forecast	-It is difficult to stop completely jumping over rock by barrier. Width for barrier is not enough. $\hfill \triangle$	we collected rock.	-Because maintenance cost is high, 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.
	Topography	Impact of Rain (Inflow water)	The Dry Season			Cracks of andesite are	Removal + Barrier w		Gabion Barrier		-Wire of gabion cam assumed falling rock.	-Deterioration of env damage of gabion.	-It is difficult to stop completely jumpi barrier. Width for barrier is not enough.	-It is necessary to remove collected rock. -Durability depends on the life of the wire.	-Because maintenance cost alternatives are almost even.	-The gabion isn't steady by the collision falling rock. Width for barrier is not enough
 	ID:N0026B160		0.00	Slope		Comments		41 A	Countermeasure		Workability Structural feature	Environment Impact	Influence on Road	Maintenance	Economy	Evaluation