JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
ADMINISTRADORA BOLIVIANA DE CARRETERAS (ABC)

No.

THE STUDY
ON
PREVENTIVE MEASURES
AGAINST ROAD DISASTERS ON MAIN NATIONAL ROADS
IN
THE REPUBLIC OF BOLIVIA

FINAL REPORT

ROAD DISASTER PREVENTION MANAGEMENT MANUAL

OCTOBER 2007

CENTRAL CONSULTANT INC.
in association with
EARTH SYSTEM SCIENCE CO., LTD.

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2007

ABC
JICA

GUIDE I DETERMINATION OF HIGH HAZARD CONTROL SECTIONS

GUIDE II DISASTER PREVENTION WORKS IN ROUTINE MAINTENANCE

GUIDE III MANAGEMENT FOR IMMINENT DANGER

GUIDE IV EMERGENCY RESPONCE

GUIDE V DISASTER PREVENTION WORKS

ROAD DISASTER PREVENTION MANAGEMENT MANUAL

PREFACE

ABC
JICA

PREFACE

Almost half of the national highway network in Bolivia is distributed in hilly and mountainous terrain with steep slopes and highly weathered rocks that are prone to slope disasters (landslides). Slope disasters are, therefore, frequently encountered in road maintenance as well as in road construction.
This manual indicates what should be executed and indicates the practical "soft and hard measures"* in current Bolivia (in 2006) in order to protect the national highways against slope disasters (landslides) and to guarantee the safety of vehicles and passengers passing-by.

* *page 0-6*

1. DISASTER MANAGEMENT

Disaster Management Cycle (DMC)

When we study how to cope with disasters, we have to consider Disaster Management Cycle (DMC). The DMC consists of three steps such as prevention / mitigation measures, emergency measures, restoration / reconstruction as shown Figure 0-1. Considering with DMC, disaster measures are not transitory.

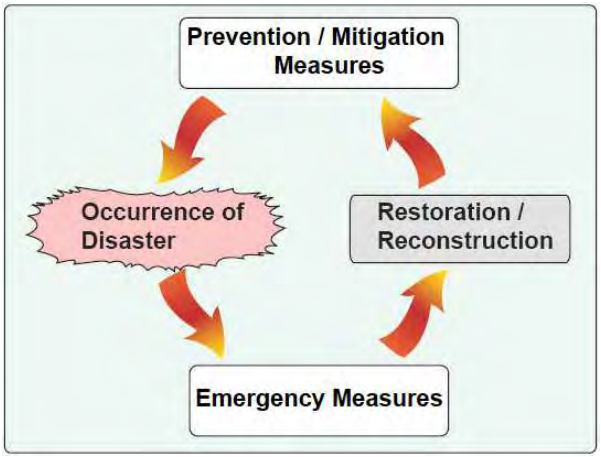


Figure 0-1 Disaster Management Cycle (DMC)

The main subject of this manual is prevention / mitigation of disasters, and does not mention restoration / reconstruction. Prevention / mitigation measures shall include measures at ordinary times.

Three types of prevention measures

The following three measures are taken as basic of disaster prevention measures generally.

EVACUATE from disasters
DEFEND against disasters
PREDICT and EVADE disasters

Above measures correspond with following road disaster prevention measures.

Table 0-1 Measures for Road Disasters

General Measures	Measures for Road Disasters
AVOID disasters	change road alignments
DEFEND against disasters	prevention works
PREDICT and **EVADE** disasters	traffic control (only protect vehicles and pedestrians against disasters, structure, not protect road structures)

Things to know for prevention measures

Generally, when disaster prevention measures are studied, the following queries shall be solved.

WHERE disasters will occur?
WHEN disasters will occur?
WHAT type of disasters will occur?
HOW disasters will occur?

PREFACE

Method of knowing WHERE disasters will occur

This manual proposes the following three methods to know where disaster will occur.

Slope inspection

Pick over dangerous points along the road

Daily maintenance

Watch road condition in ordinary, and perceive dangers

Disaster record

Disasters are repetitious. Once disasters occurred, the points and the surroundings may be dangerous scenes

Method of knowing WHEN disasters will occur

This manual proposes the following three methods to know when disaster will occur.

Always watch dangerous spots

Always watch the hazardous place when the signs of danger are found

As the case may be, monitor progress of danger by monitoring devises

Setting risk level based on precipitation

Install rain gauges along the highways and monitor the rain fall

Setting of threshold of dangerous status is important

Protection works based on disaster type

Design of protection works shall be changed based on the disaster types

But, for evasion, types of disasters are not important

2. STRUCTURE OF THE MANUAL

This manual is aimed at all of the national highways and ABC (Administradora Boliviana de Carreteras) which manages and operates the national highways.

The principle of this manual is ;

a. This is the guide for ABC action which puts emphasis on disaster prevention,
b. The disaster prevention means that keeping vehicles and passengers safe in the event of disaster, even if a road has been destroyed, and
c. The most of this manual except Guide IV prescribes the action before disaster.

The object of this manual is landslides include debris flow only, and not included flood, bridge and tunnel disasters.

The flow chart of this manual, which shows contents of the manual, is as shown in Figure 0-3. This manual relies on the existing national highway maintenance system of ABC in the nation, which consists of the Micro-empresas (micro companies), the Supervisors, ABC Regional Offices, ABC Head Office as shown below.

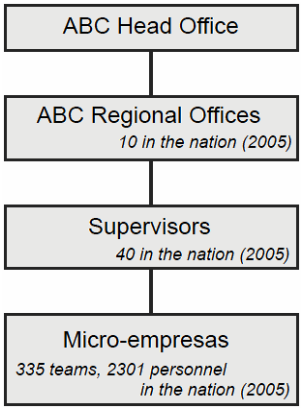


Figure 0-2 Organization in the National Highway Maintenance System in Bolivia

PREFACE

As measures of a disaster, one way is to set up protective facilities for a slope (hard countermeasure), and the other way is to defend a disaster indirectly there restricts an entrance and a utilization to a dangerous area through a disclosure of information (soft countermeasure). A goal of a road disaster prevention measure is to make a road safe condition by countermeasure construction along a road. However, for an enforcement of a countermeasure construction, a large amount of expenses and long time are required. We have to put emphasis on soft measures. Even the soft measure can not prevent the occurrence of disasters, the soft measures minimize the damage on humans and vehicles. This manual is based on this approach. This manual consists of the following five guides.

Guide I : Determination of High Hazard Control Sections
Guide II : Disaster Prevention Works in Routine Maintenance
Guide III : Management for Imminent Danger
Guide IV : Emergency Response
Guide V : Disaster Prevention Works

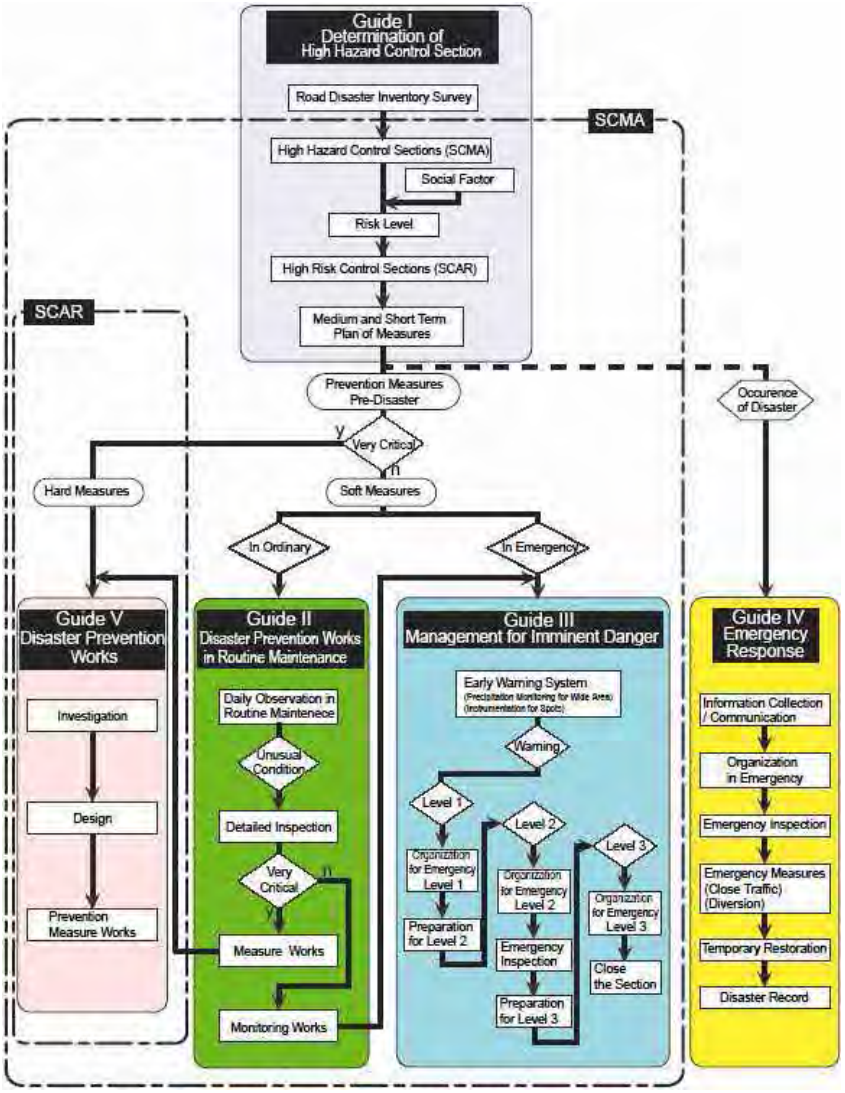


Figure 0-3 Flowchart of Road Disaster Prevention Management

PREFACE

Guide for Determination of High Hazard Control Sections

This is a guide to recognize critical spots (hazardous spots) on the national highways all over the country. To recognize critic spots means to make hazard maps for disaster prevention program. This inspection for all national highways is executed once or twice a year all over the country, and followed by five steps of program.

(1) Road Disaster Inventory Inspection

The Supervisors will recognize hazardous level of the highways with the object of finding the critic spots in all over the national highways. This inspection will be included in existing road inventory inspection on each 50m along the national highways in the course of road maintenance system. Hazard is classified into four levels from A to D and the results will be registered in tables of inventory inspection.

It is not expected specialized / high level inspections on all of the national highways at the beginning of the inspection work by the Supervisors since the Supervisors' capabilities would not be even at the beginning. This guide especially the part of hazard definition shall be modified by the ABC based on the Supervisors' capabilities after first one year inspections.

(2) Social Factors and Risk Level

To get the risk level from hazard level obtained in Inventory Inspections, the importance of the highways is defined. The importance of the highways is estimate by the traffic volume as the social factors at the moment, because no other factors of data can be found in Bolivia. The social factor is defined from the traffic volume of highways in this Guide.

The risk level is set for planning of measure works and emergency responses on all national highways in the nation. The risk level is defined with following formula;

Risk Level = Hazard Level x Social Factors

(3) Setting of High Hazard Control Sections (SCMA) / High Risk Control Sections (SCAR)

The ABC Regional Offices shall assign High Hazard Control Sections where high hazard locations are concentrated and High Risk Control Sections where high risk locations are concentrated. Both sections are for the plan of prevention measures and maintenance works (Guide II and Guide III). The ABC Regional Offices shall revise and check every year.

The disaster prevention program will be planned based on the risk level. The high risk control sections have generally priority of the disaster prevention program. It is recommendable that the simple prevention measures introduced in Guide V are applied to the high risk control sections with high priority.

PREFACE

Guide for Disaster Prevention Works in Routine Maintenance

This is a guide for ordinary maintenance in order to find the sign of disaster in so early stage as possible.

(1) Daily Observation

The daily observation is defined as the normal road patrol done by the Micro-empresas with attention to anomaly relating to slope stability. The Micro-empresas are appropriate organization to detect these anomalies in ordinary time, since they are always maintain their sections of the national highways. A simple and instructive manual (a. what is an anomaly, b. emergency methods in case of anomalies detection, c. formulary document) for the Micro-empresas is introduced in this guide.

The daily observation will be covered only on the High Hazard Control Sections (SCMA).

(2) Detailed Inspection

The Supervisor shall execute the detailed inspection to realize anomalies at the location reported by the Micro-empresa in the daily observation. The detailed inspection shall be recorded by the Supervisor. If an emergency is recognized at the location, the Supervisor shall communicate to ABC Regional Office.

Guide for Management for Imminent Danger

This is the guide of reactions and replies in emergency cases which is before disaster. The definition of emergency is important in this program and is discussed firstly related to precipitation and landslide monitoring. The emergency responses will be covered just on the High Hazard Control Sections (SCMA).

(1) Early Warning for Wide Area by Precipitation

Early warning system for wide area shall be established for imminences by the observation of precipitation along the national highways. As the practical method for Bolivia, the guide introduces a simple rain gauge as the warning device. The simple rain gauge can be made of cylindrical shape container with scale and installed at all the Micro-empresas stations, and shall be monitored by the Micro-empresas.

(2) Correspondence for Emergency (Pre-disaster)

Before disaster, when the monitoring shows that the road is in critical moment, emergency level is activated. Emergency level is classified into three levels based on the monitoring of precipitation or ground movement. The activation of emergency is based on the emergency levels. The road traffic on the section of the national highway shall be closed when an emergency is found in highest hazard levels.

PREFACE

Guide for Emergency Response

The guide shows the recovering activities of mid-disaster and post-disaster, and gives description of provisional preventive works and temporary works.

The guide introduces;-

- Information collection and communication,
- Organization in emergency,
- Emergency Inspection,
- Emergency measures,
- Temporary Restoration and,
- Disaster record,

When the disaster occurs, mostly first information could come to the police, and the police inform to ABC regional office.

The ABC regional office shall set up the emergency organization headed by the chief of the ABC regional office (Jefe Regional), and send the supervisor to collect the detailed information as soon as possible. If the supervisor could not reach the spot immediately, the supervisor shall solicit the micro-empresa for their observation and report to the Supervisor.

All the information shall be concentrated to the Jefe Regional, and the Jefe Regional shall take the responsibility of all the actions done by ABC, the supervisor and the micro-empresa.

The purpose of the emergency measure and the temporary restoration is to keep the safe traffic flow as soon as possible. However, if it is difficult to keep the safety of the road, the traffic shall be controlled.

Guide for Disaster Prevention Works

This is a guide for design of prevention measures as well as investigation for design of prevention measures.

(1) Design of Prevention Works

Principal methods for preventive works are described. There have been many road disasters related to water in Bolivia, therefore the drainage of surface water and groundwater are important and recommendable as effective and low cost prevention measures. The standard gradient of cut slopes and simple prevention measures are included in this guide. These simple prevention measures are recommendable for the High Risk Control Sections in preference to the other sections.

(2) Investigation

The geological / geotechnical investigation shall be executed prior to the measure works in order to design the prevention measures properly and to prevent unexpected matter in the construction period.

** soft measures : measures without large scale structures, such as traffic control, warning/evacuation etc.*

** hard measures : measures with large scale structures, such as dam, retaining wall etc.*

PREFACE

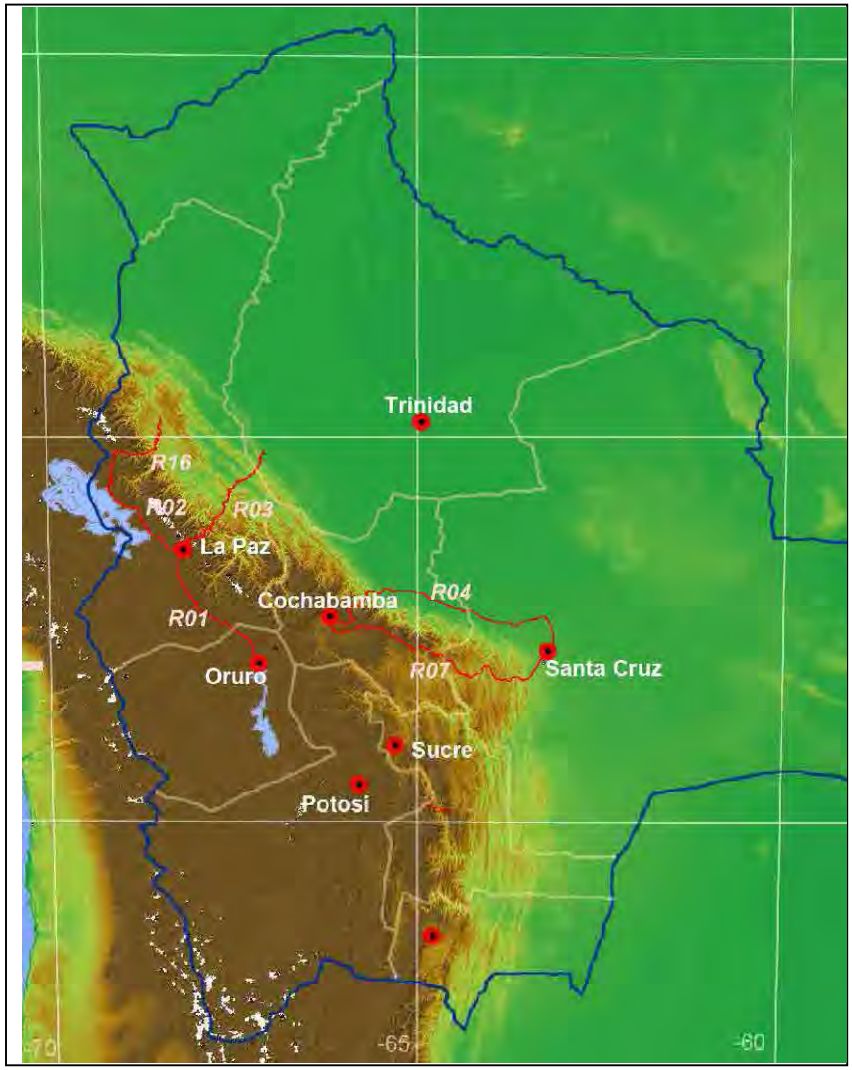


Figure 0-4 Map of Bolivia

Topography data source : Shuttle Radar Topography Mission 3 (SRTM-3)
Route map of major highways : GPS data by JICA mission

Photographs of the highways in Bolivia

Route 1

Route 2

PREFACE

Route 3

Route 4

Route 4

Route 7

PREFACE

Route 16

Route 16

Micro-empresas (Route 1)

PREFACE

This manual was created by Bolivia ABC with support by JICA Study Team.
The following people made efforts to create the manual.

SERVICIO NACIONAL DE CAMINOS (ABC), BOLIVIA

The persons in charge of the manual :

Ing. Maria Nadieazda Otero
Ing. Waldo A. Aliaga Aranda
Ing. Miguel Figueroa
Ing. Marcelo Cáceres

The persons in charge of trial of the manual :

Ing. Rene Berazain Carrasco
Ing. Andres Flores Montano

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM

The person in charge of the manual :

Ing. Fumihiko Yokoo

The persons in charge of Spanish / English :

Ing. Cinthya Prado Carpintero
Ing. Rodrigo Israel Ponce Ortuño
Lic. Midori Oishi

The JICA Study Team :

Team Leader: Ing. Akiomi Shimazu
Deputy Team Leader: Ing. Yukishi Tomida

June 2007, @ La Paz, Bolivia

ROAD DISASTER PREVENTION MANAGEMENT MANUAL

GUIDE I

DETERMINATION OF HIGH HAZARD CONTROL SECTION

ABC

JICA

CONTENTS

GUIDE I DETERMINATION OF HIGH HAZARD CONTROL SECTIONS

CONTENTS

OUT LINE

This is a guide to recognize critic spots (hazardous spots) on the national highways all over the country. It will be produce equivalent information as hazard / risk map of general disaster mitigation programs.

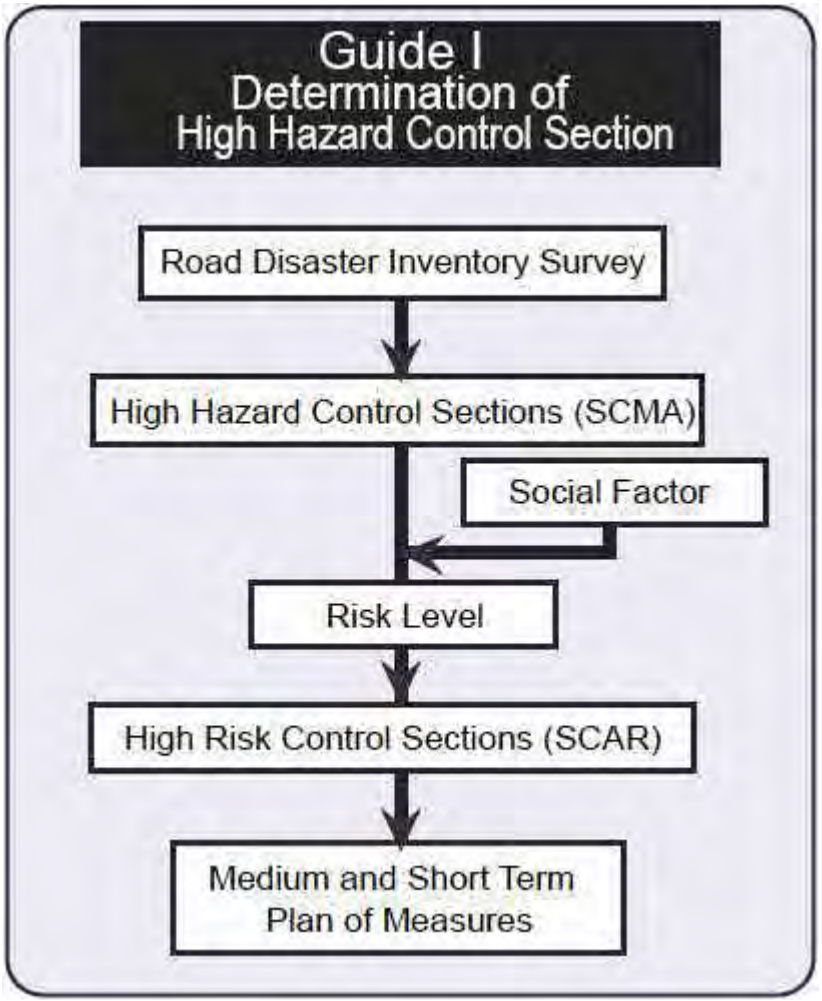


Figure 0.1 Contents of Inspection and Plan

1. ROAD DISASTER INVENTORY INSPECTION

1.1 PURPOSE

Disaster inventory inspection is to pick up critical spots where there are signs of the road disasters along the highways. The inventory inspection is not record of disasters, but is expectation of disasters.

This inspection of critical spots is the most basic activity to collect information for the disaster prevention plan. The inspection is for recognition of the high hazard locations on all of the national highways, so as to know the high risk locations of the national highways and to establish the disaster prevention works in routine maintenance (Guide II) plan and the management of imminent danger (Guide III).

1.2 PERSONNEL AND RECORDING FORM

Personnel

The disaster inventory inspection is involved in existing road maintenance inventory inspection executed by the Supervisors two times a year.

The Supervisors shall carry out the disaster inventory inspection.

The follow up engineers shall examine the inventory inspection result done by the supervisors.

Recording Form

The survey result shall be recorded on the recording form shown on page I-4. The details of inventories which shall be recorded on the recording form are explained in next section 1.3 Inventory.

1.3 INVENTORY

Road Disaster Classification

The inventory which shall be recorded on the form is the disaster type and hazard level. The type of disasters will be following six types.

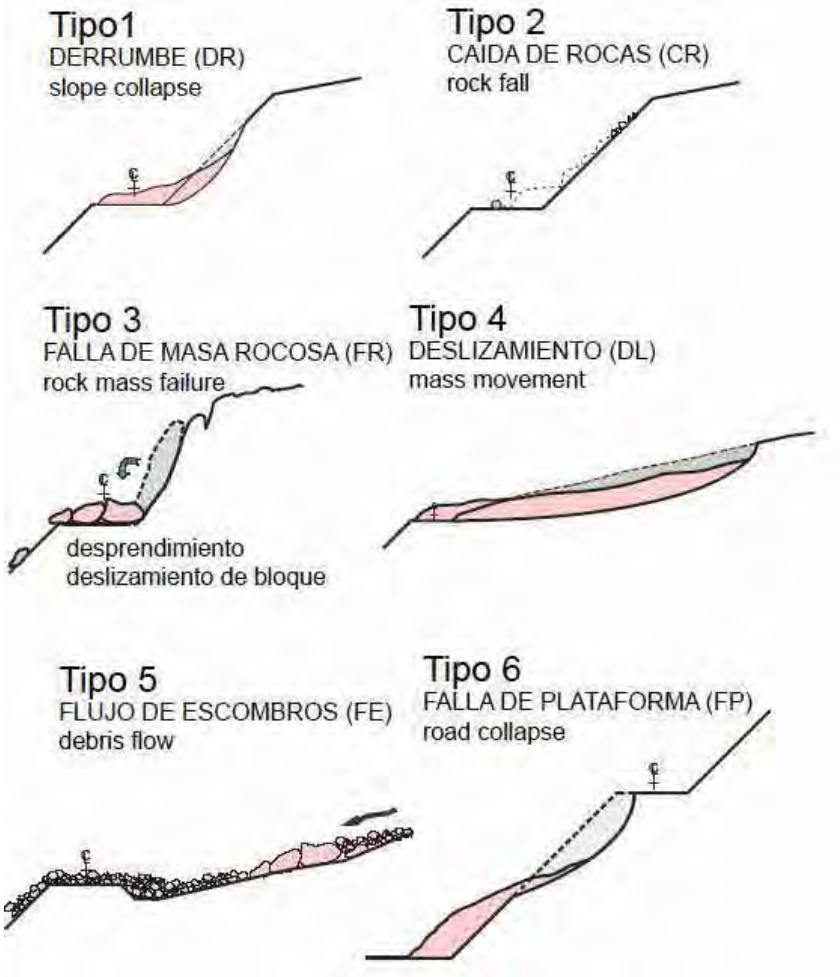


Figure 1.1 Road Disaster Classification

1. ROAD DISASTER INVENTORY INSPECTION

Hazard Level

The hazard level is classified into four levels, A, B, C and D as shown in Table 1.1.

Table 1.1 Hazard Level

Hazard Level	Description	Hazard Score
Level A : (Active)	Material is currently moving, and landslide features are fresh and well defined. or slopes with evidence of landslide or debris flow activity within the past year. (=measures are urgently required)	**3**
Level B : (Dormant)	Unstable factors* are discernible, or locations where measure works have been completed partially (= regular monitoring is required)	**2**
Level C : (Stable)	Stable locations in mountainous area, or locations where has unstable factors but recovery will be simple in the event of a disaster	**1**
Level D: (Flat land)	Stable locations in flat land	**0**

1.4 TIMING

The disaster inventory inspection shall be carried out two times a year. It is recommendable to carry out before rainy season (October) and after rainy season (April).

1.5 IMPROVEMENT OF INVENTORY INSPECTION

Generally, the scoring system which scores extent of road hazardousness based on geomorphic, geological, hydrological, meteorological, vegetable and road conditions is employed for the disaster inventory inspection. Geological or geomorphic specialists for scoring system and it may take long time to complete the disaster inventory inspection with scoring system on the whole highways in Bolivia. In order to shorten the inventory inspection in whole country, this guide recommends using existing road maintenance system which consists of the Follow-up engineer and Supervisors without scoring system. It depends on the Supervisors capability, experience and sensitivity. The level of the inventory inspection could not be uniform since the Supervisors' capabilities are not even. The guide anticipates that the Supervisors improved their capabilities of the inspection with training and experience. In order to improve the Supervisors capability, an expert of disaster inventory inspection (road disaster prevention manager) shall be arranged in ABC headquarter, and he shall guide all the Follow-up engineers and the Supervisors in the country. The expert shall held inventory inspection training course regularly. This guide also shall be improved in order to adjust the Supervisors' capabilities by the ABC.

The scoring system is recommended after the disaster inventory inspection will come to stay in the country in future. For the future reference, the scoring sheet of road disaster management being used in Japan is attached in this Guide, Appendix I-3.

1. ROAD DISASTER INVENTORY INSPECTION

Table 1.2 Inventory Inspection Sheet
(example of the trial on Route 3)

REGISTRO DE PUNTOS CRITICOS POR SECCION

CODIGO DE RUTA:	F-0003 (LA PAZ - TRINIDAD)	PROG. INICIO SECCION SNC:	181+060	OFICINA REGIONAL:	LA PAZ
TRAMO REGIONAL:	10 (COTAPATA - QUIQUIBEY)	LECTURA SNC (KM):	29,76	SUPERVISOR:	ING. RENE BERAZAIN CARRASCO
CODIGO DE SECCION:	0100	LECTURA ODOMETRO (KM):	30,45	ENCARGADO DE REGISTRO:	ING. ANDRES FLORES MONTAÑO
REFERENCIA DE LA SECCION:	CARRASCO - ENTRE RIOS	FACTOR DE CORRECCION:	0,977		

LEC ODOMETRO		PROGRESIVA CALCULADA		LONGITUD DE EL PUNTO CRITICO	ANCHO PLATAFOR (M)	DATOS DEL PUNTO CRITICO									
Recorrido	Corregido	DE	HASTA			TIPO DE FALLA	SECCION TIPICA				NIVEL DE RIESGO	NIVEL DE AMENAZA	POSIBLE CAUSA	POSIBLE SOLUCION	REFERENCIA	DATOS RELEVANTES DEL PUNTO CRITICO (GEOMETRIA, TIPO DE TERRENO, ETC.)
3+000	2+532	183+992	184+092	100		1, 2			X		3	B	LLUVIA	BANQUINA, ENSANCHE		
4+000	3+509	184+969	185+019	50		1, 4			X		3	B	LLUVIA	BANQUINA		
8+700	8+503	189+563	189+613	50		4			X		3	B	LLUVIA	BANQUINA		
10+700	10+456	191+518	191+568	50		3			X		3	B	LLUVIA	BANQUINA		
12+500	12+217	193+277	193+327	50		4			X		3	B	LLUVIA	LIMPIEZA PERIODICA		
12+700	12+412	193+472	193+522	50		4			X		3	B	LLUVIA	RELLENO		
18+300	17+885	198+945	198+995	50		4			X		3	B	LLUVIA	LIMPIEZA PERIODICA		
19+800	19+351	200+411	200+461	50		1			X		3	B	LLUVIA	BANQUINA		
20+500	20+035	201+095	201+115	20		4			X		3	B	LLUVIA	LIMPIEZA PERIODICA		
21+150	20+671	201+731	201+931	200		1, 2, 4			X		3	B	LLUVIA	LIMPIEZA PERIODICA		
23+300	22+772	203+932	203+882	50		1, 4			X		3	B	LLUVIA	LIMPIEZA PERIODICA		

Disaster classification is not same as the classification in this Guide

2. SOCIAL FACTORS AND RISK LEVEL

2.1 SOCIAL FACTORS

Risk will be given added weight by the importance of the highways.
Risk Value can be estimated with following formula.

Risk Value = Social Factors x Hazard Level
(Social Score) (Hazard Score)

Usually, social factors of roads consist of traffic volume, existence of important facilities, key industry area or existence of detour. However, only the traffic volume can be the social factor in this Guide since it is difficult to obtain other factors in Bolivia. The traffic volumes of the national highways in Bolivia are shown in Table 2.2 and Figure 2.1, and the social factor is shown in Table 2.1.
The Hazard Score has been stated in accordance with Hazard Level as follows;

Hazard Level A = 3
Hazard Level B = 2
Hazard Level C = 1
Hazard Level D = 0

For example, assuming the slope in between Sacaba and Colomi on route 4 (Social Factor 6) has the hazard level A, the risk value should be;

Risk Value = 3 (Hazard Level A) x 6 = 18

Another example, assuming the slope in between Achacachi and Escoma on route 16 (Social Factor 3) has the hazard level A, the risk value should be;

Risk Value = 3 (Hazard Level A) x 3 = 9

Table 2.1 Traffic Volume and Social Factor

Social Factor	Traffic Volume (AADT*)
8	> 10.000
7	5000 - 1000
6	2000 - 5000
5	1000 - 2000
4	500 - 1000
3	150 - 500
2	80 - 150
1	<80

**AADT : Annual Average*

Improvement of Social Factor

As the social factors of the highways, other than traffic volumes, important public facilities such as hospitals, schools, police stations and fire stations shall be considered. And also, industrial condition along the highways can be important social factors. However, there is not objective social information which can be used as numerical analysis other than the traffic volumes in the country. At the moment, the traffic volume is the best indicator of industrial importance of the highways, because the traffic volume of highways in the area where local economy has been invigorated has been increased.
In future, the social factor shall be improved based on importance of the highways based on public facilities and industrial conditions along the highways.

2. SOCIAL FACTORS AND RISK LEVEL

Table 2.2 Traffic Volume of National Highways

COMPOSICIÓN DE TRÁFICO PROMEDIO DIARIO ANNUAL GESTIÓN 2006

8	> 10.000
7	5000 - 10.000
6	2.000 - 5.000
5	1.000 - 2.000
4	500 - 1.000
3	150 - 500
2	80 - 150
1	<80

TPDA : Tráfico Proyectado de acuerdo a un análisis estadístico.

Ruta No.	TRAMO	NOMBRE ESTACIÓN	No. EST.	T.P.D.A.	
1	Desaguadero - Tiwanacu	Guaqui	110	1287	5
	Tiahuanaco - Rio Seco	Laja	112	1720	5
	Senkata - Patacamaya	Achica Arriba	114	2038	6
	Patacamaya - Cr. a Luribay	Sica Sica	115	1623	5
	Cr. a Luribay - Panduro	Konani	118	1537	5
	Panduro - Caracollo	Quemalla	210	1508	5
	Caracollo - Oruro	San Pedro	210	1108	5
	Vinto - Machacamarca	Machacamarquita	210	1509	5
	Machacamarca - Challapata	Pazña	212	983	4
	Challapata - Yocalla	Ventilla	214	281	3
	Yocalla - Tarapaya	Yocalla	710	408	3
	Tarapaya - Potosí	Caseta Peaje	712	1022	5
	[illegible] - Cucho Ingenio	Alto Tambo	714	783	4
	Cucho Ingenio - Cr. Otavi	Cucho Ingenio	716	221	3
	Cr. Otavi - Camargo	Padcoyo	717		
	Camargo - El Puente	Camargo	718		
	El Puente - Iscayachi	Iscayachi	304		
	Iscayachi - Tomatas	Santa Bárbara	312	343	3
	Tomatas - Tarija	El Rancho	300	2181	6
	Cr. Panamericano - Padcaya	Calamuchita	316	1080	5
	Padcaya - Bermejo	La Mamora	318	484	3
2	La Paz - El Alto [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Rio Seco - Huarina	Patamanta	122	3629	6
	Huarina - Tiquina	Huarina	123	888	4
	Tiquina - Copacabana	Tocopa	124	234	3
3	La Paz - Cotapata	Pongo	133	824	4
	Cotapata - Santa Bárbara	Santa Bárbara	132	289	3
	Santa Bárbara - Caranavi	San Rafael	134	485	3
	Caranavi - Sapecho	Caranavi	153	389	3
	Sapecho - Quiquibey	Km. 53	135	121	2
	Quiquibey - Yucumo	Yucumo	836	211	3
	Yucumo - San Borja	Yucumo	838	211	3
	San Borja - San Ignacio	Pte. Maniqui	830	44	1
	San Ignacio - Puerto Ganadero	San Ignacio	832	78	1
	Puerto Almacén - Trinidad	Pto. Ibare	834	408	3
4	Tambo Quemado - Cr. Cosapa	Tambo Quemado	142	288	3
	Cr. Cosapa - Rio Desaguadero	Cr. Caracollo	144	337	3
	Rio Desaguadero - [illegible]	[illegible]	140	839	4
	Caracollo - Colhuasi	Vilapata	840	888	4
	Colhuasi - Huayllamarca	Colhuasi	842	1108	5
	Huayllamarca - Confital	Anaquao	844	1199	5
	Confital - Parotani	Confital	441	1582	5
	Parotani - Puente Paratani	Paratani	442	2750	6
	Puente Paratani - Vinto	Suticollo	444	2834	6
	Quillacollo - Cochabamba	[illegible]	[illegible]	[illegible]	[illegible]
	Cochabamba - Sacaba	[illegible]	[illegible]	[illegible]	[illegible]
	Sacaba - Colomi	Tutimayu	445	2694	6
	Colomi - Villa Tunari	Paracti	446	2108	6
	Villa Tunari - Cr.Rt.F15 (Ivirgarzama)	Pte. Chimoré	447	2398	6
	Cr.Rt.F015 (Ivirgarzama) - Rio Ichilo	Ivirgarzama	448	2597	6
	Rio Ichilo - Yapacaní	Yapacaní	440	2818	6
	Yapacaní - Portachuelo	Portachuelo	540	114	2
	Portachuelo - Montero	Puerto Mendez	542	345	3
	Montero - Warnes	Warnes	[illegible]	[illegible]	[illegible]
	Warnes - Santa Cruz	Km. 17	545	140	2
	Santa Cruz - Cotoca	Caseta Peaje	500	4589	6
	Cotoca - Paraíso	Cotoca	602	3025	6
	Paraíso - El Tinto	[illegible]	[illegible]	[illegible]	[illegible]
	El Tinto - San José de Chiquitos	Chiquitos	546	1200	5
	San José Chiquitos - Roboré	Chiquitos	547		
	Roboré - El Carmen	Candelaria	541	5336	7
	El Carmen - Puerto Suárez	Galeo	550	449	2
	Pto. Suárez - A. Concepción	Rotonda	548	147	2
5	Hito 60 - Uyuni	Uyuni	756	128	2
	Uyuni - Potosí	Cebadillas	754	225	3
	Potosí - Betanzos	Don Diego	750	1872	5
	Betanzos - Puente Méndez	Retiro	752	880	4
	Puente Méndez - Cr. Rt. 2402 (Yotala)	Totacoa	250	944	4
	Cr.Rt.2402 (Yotala) - Sucre	Pte. Villazón	252	833	4
	Sucre - La Palma	Zapatera	253	274	3
	La Palma - [illegible]	La Palma	254	383	3
	[illegible] - Pte. Arce	Sucre	256	180	3
	Puente Arce - Aiquile	Aiquile	458	383	3
	Aiquile - Peña Colorada	Aiquile	452	152	3
	Peña Colorada - La Palizada	Peña Colorada	454	188	3
	Aiquile - Epizana	Aiquile	456	147	2
6	Machacamarquita - Huanuni	Machacamarquita	608	835	4
	Huanuni - Llallagua	Huanuni	602	321	3
	Llallagua - Uncía	Llallagua	604	2188	6
	Uncía - Pocoata	Pocoata	283	112	2
	Pocoata - Ravelo	Cr. Macha	262	31	1
	Ravelo - Sucre	Chucho Tambo	260	94	2
	Sucre - Yamparáez	Caseta peaje	264	828	4
	Yamparáez - Tarabuco	Yamparáez	266	383	3
	Tarabuco - Padilla	Zudañez	268	175	3
	Padilla - Monteagudo	Padilla	270	90	2
	Monteagudo - Muyupampa	Monteagudo	272	122	2
	Muyupampa - Ipati	Muyupampa	274	78	1
	Cr.Rt. F09 (Ipati) - Camiri	Camiri	566	1553	5
	Boyuibe - Hito Villazón	Boyuibe	360	46	1
7	Cochabamba - Paracaya	Km. 10	470	6082	
	Paracaya - Epizana	Paracaya	472	1432	5
	Epizana - Comarapa	Epizana	474	738	4
	Comarapa - La Palizada	La Palizada	576	2158	6
	La Palizada - Mataral	Mataral	574	427	3
	Mataral - Angostura	Samaipata	572	483	3
	Angostura - La Guardia (Km. 17)	La Guardia	570	932	4
8	Yucumo - Rurrenabaque	Yucumo	860	194	3
	Rurrenabaque - Puerto Yata	Rurrenabaque	866	259	3
	Puerto Yata - El Choro	Las Américas	866	108	2
	El Choro - Rio Ivon	Puerto Ivon	864	143	2
	Rio Ivon - Riberalta	Caseta Peaje	862	181	3
	Riberalta - Rio Yata	El Prado	861	283	3
	Rio Yata - Guayaramerín	Cr. T. Esperanza	380	285	3
9	San Pedro - Trinidad	[illegible]	384	185	3
	Trinidad - Villa Bánzer	[illegible]	390	185	3
	Villa Bánzer - Pto. San Pablo	Villa Bánzer	392	346	3
	Pto. San Pablo - Asc. Guarayos	Asc. Guarayos	592	252	3
	Asc. Guarayos - San Ramón	Camp.SMC	590	374	3
	San Ramón - Los Troncos	Pte. San Julián	550	582	4
	Los Troncos - Cr. Rt. F04 (Pailón)	Los Troncos	554	582	4
	Cr. Rt. F07 (Km. 13) - Abapó	Hg. Mora	380	580	4
	Abapó - Cr. Rt. F06 (Ipati)	Abapó	389	2871	6
	Camiri - Boyuibe	Boyuibe	386	707	4
	Boyuibe - Villamontes	Cruce a Machareti	384	485	3
	Villamontes - Campo Pajoso	Sachapera	380	846	4
	Campo Pajoso - Yacuiba	Campo Pajoso	382	2534	6
10	Guabirá - Okinawa	Guabirá	510	1739	5
	Okinawa - Los Troncos	Okinawa	515	1581	5
	San Ramón - San Javier	San Ramón	512	335	3
	San Javier - Concepción	San Javier	514	278	3
	Concepción - San Ignacio de Velasco	Concepción	516	232	3
	San Ignacio de Velasco - San Vicente	San Ignacio	518	173	3
	San Vicente - San Matías	San Vicente	518	165	3
	Guabirá - Chané	Saavedra	511	3838	6
	Chané - Colonia Piraí	Chané	513	2539	6
10	Guabirá - Okinawa	Guabirá	510	1739	5
	Okinawa - Los Troncos	Okinawa	515	1581	5
	San Ramón - San Javier	San Ramón	512	335	3
	San Javier - Concepción	San Javier	514	278	3
	Concepción - San Ignacio de Velasco	Concepción	516	232	3
	San Ignacio de Velasco - San Vicente	San Ignacio	518	173	3
	San Vicente - San Matías	San Vicente	518	165	3
	Guabirá - Chané	Saavedra	511	3838	6
	Chané - Colonia Piraí	Chané	513	2539	6
11	Cr. Panamericano - Entre Ríos	Narvaez	380	238	3
	Entre Ríos - Villamontes	Palos Blancos	382	187	3
	Villamontes - Ibibobo	San Antonio Nuevo	384	888	4
12	Pisiga - Sabaya	Sabaya	828		
	Sabaya - Toledo	Toledo	824	333	3
	Toledo - Oruro	Puente España	422	488	3
	Oruro - Capachos	Capachos	820	1370	5
	Capachos - Caihuasi	Paria	822		
13	Cobija - Porvenir	Km. 18	830	1815	5
	Porvenir - Santa Elena	Porvenir	832	134	2
	Santa Elena - Puerto Rico	Santa Elena	834	197	3
	Puerto Rico - Peña Amarilla	Puerto Rico	836	33	1
	Peña Amarilla - El Choro	El Choro	838	32	1
14	Cucho Ingenio - Cotagaita	Cucho Ingenio	740	198	3
	Cotagaita - Tupiza	Remedios	742	149	2
	Tupiza - Villazón	Cuartos	744	227	3
15	Cr. Rt. F04 (Ivirgarzama) - Puerto Villarroel	Cr.Ruta 4	445	1085	5
16	Huarina - Achacachi	Huarina	160	1287	5
	Achacachi - Escoma	Achacachi	162	333	3
	Escoma - Charazani	Charazani	[illegible]		
	Chive - Planchon	Filadelfia	880	84	2
	Planchon - Porvenir	Porvenir	882	258	3
17	San Ignacio - San Rafael	San Ignacio	517	281	3
	San Rafael - San José de Chiquitos	La Trancas	535	119	2
18	Cr.Rt. F13 (Km.19) - Nareuda	Mangapari	918	78	1
	Nareuda - Extrema	Nareuda	919	31	1
19	Cr. Rt. 01 - Viacha	Caseta Peaje	[illegible]		
	Viacha - Botijlaca	Botijlaca	190	118	2
	Botijlaca - Vichaya	Caquiaviri	192	88	2
20	Las Carreras - Mochara	Hornillos	[illegible]		
21	Tupiza - Atocha	Salo	720	79	1
	Atocha - Uyuni	Atocha	721	48	1
22	Mataral - Vallegrande	Trigal	320	288	3
	Vallegrande - Ipita	Guadalupe	325	336	3
23	Paracaya - Arani	Paracaya	420	988	4
	Arani - Mizque	Mizque	424	233	3
	Mizque - Aiquile	Aiquile	426	332	3
24	Villa Tunari - Cr. Castillo	Cr. Castillo	480	1889	5
	Cr. Castillo - Isiboro	Samuzabety	482	777	4
25	Cr.Rt F03 (Unduavi) - Puente Villa	Unduavi	150		
	Puente Villa - Chulumani	Villa	152		
	Chulumani - La Plazuela	La Plazuela	154		
	La Plazuela - Circuata	La Plazuela	155		
	Independencia - Monteagudo	[illegible]	160		
	[illegible] - Vinto	Vinto	460		
26	[illegible] - Quime	[illegible]	180		
	Quime - Mapo	Quime	182		
27	Aiquile - Turco	Aiquile	872		
	Turco - Cr.Rt. F04 (Crucero)	Turco	874		
28	Cr.Rt.F01 [illegible] - Villazón	[illegible]	380		
29	Palos Blancos - Campo Pajoso	Palos Blancos	388		
30	Challapata - Huari	Challapata	830		
	Huari - Sevaruyo	Huari	832		
	Sevaruyo - Uyuni	Uyuni	834		

2. SOCIAL FACTORS AND RISK LEVEL

2.2 RISK LEVEL

(1) Risk Level

Risk Level is basic information for establishment of short/medium plan of road disaster prevention.

Risk Level is classified into 4 levels in this guide.

The basic policy of prevention measure of each Risk Level is shown in Table 2.3.

Table 2.3 Risk Level

Risk Level	Value of Risk Rating	Range of Risk Value (Rv)	Basic Policy of the Slope management
Level I	Very High	Rv $\geq$ 18	Implementation of prevention measure
Level II	High	12 $\leq$ Rv < 18	Regular patrol and monitoring
Level III	Moderate	3 $\leq$ Rv < 12	Periodical inspection
Level IV	Low	Rv < 3	Screening out of slope follow- up list

(2) Setting of High Hazard Control Sections (SCMA) / High Risk Control Sections (SCAR)

High Hazard Control Sections (SCMA) shall be assigned the sections where high hazard locations (Level A) are concentrated. High Risk Control Section shall be assigned the sections where high risk locations (Level I to III) are concentrated. Both sections are for the plan of prevention measures and maintenance works (Guide II, III & V).

High Hazard / High Risk Control Sections will be assigned by ABC Regional Offices based on the inventory inspection results. For the decision of High Risk Control Sections, list of risk level shall be prepared by ABC Regional Offices.

(3) Mapping of High Hazard Locations and High Risk Locations

ABC Regional Offices shall prepare the map on which hazard levels and risk levels are entered in order to understanding of locations for the managers and engineers.

However, the location on roads can be explained by only distance from the starting points since roads are linear structures. It is recommendable to explain the location of critical spots, hazardous locations with only the distance for the moment until advanced GIS system for the national highway network is introduced. Examples of explanation of the locations along roads with the distance are shown on page I-9 and I-10.

3. SHORT AND MEDIUM TERM WORK PLAN

The following actions shall be taken on High Hazard Control Sections (SCMA) / High Risk Control Sections (SCAR).

High Hazard Control Sections (SCMA)
a. Daily inspection by the Micro-empresas (Guide II)
b. Emergency inspection (Guide II & III)
c. Traffic Control in imminent danger (Guide III)

High Risk Control Sections (SCAR)
a. Same things as in High Hazard Section
b. Given priority of prevention measures (Guide V) as, improve road and slope drainage system in the high risk sections, improve other prevention measures as mentioned in Guide V
c. Plan of Prevention Measures / Countermeasures

For the item c. of SCAR above, ABC Regional Offices shall make a plan of road disaster prevention based on Risk Level and cost of prevention measure works estimated.
Risk Level and cost of the prevention measure works of each regional office shall be tabled as shown in Table 3.1.

Table 3.1 Example of Estimated Total Cost of Prevention Works

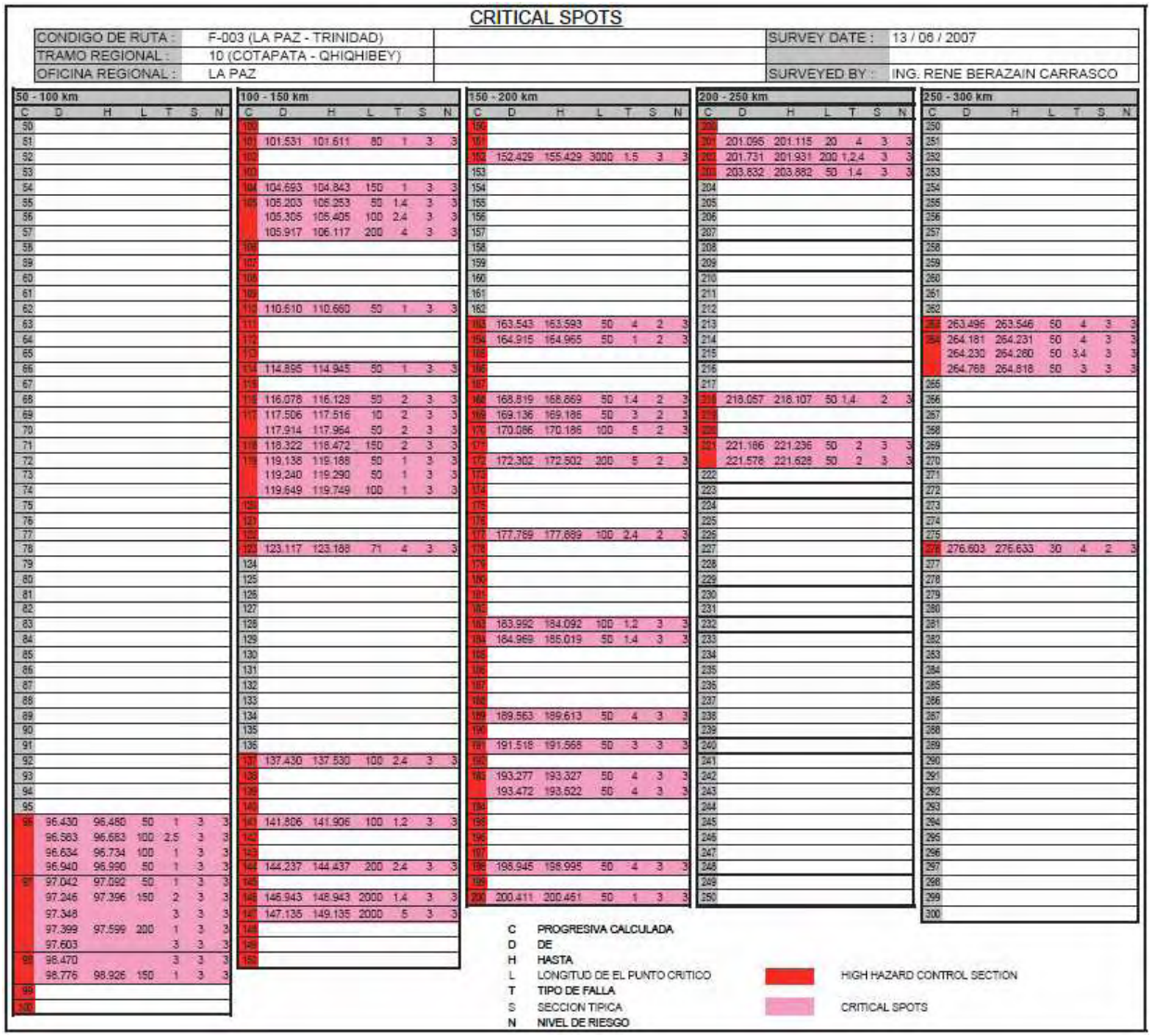
Risk Level	Estimated Total Cost of Prevention Works (US$ million)			
	Route A	Route B	Route C	Route D
Level I	80	15	8	26
Level II	15	0	2	13
Level III	0	0	0	0
Level IV	0	0	0	0

(Example)

This information shall be open for all the interested people from road administration office so as to be easy to find the risk.

3. SHORT AND MEDIUM TERM WORK PLAN

Table 3.2 Critical Spots and SCMA along Route 3



CRITICAL SPOTS

CONDIGO DE RUTA :	F-003 (LA PAZ - TRINIDAD)
TRAMO REGIONAL :	10 (COTAPATA - QHIQHIBEY)
OFICINA REGIONAL :	LA PAZ
SURVEY DATE :	13 / 06 / 2007
SURVEYED BY :	ING. RENE BERAZAIN CARRASCO

50 - 100 km

C	D	H	L	T	S	N
50						
51						
52						
53						
54						
55						
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58						
59						
60						
61						
62						
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81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91						
92						
93						
94						
95						
96	96.430	96.480	50	1	3	3
	96.563	96.663	100	2.5	3	3
	96.634	96.734	100	1	3	3
	96.940	96.990	50	1	3	3
97	97.042	97.092	50	1	3	3
	97.246	97.396	150	2	3	3
	97.348			3	3	3
	97.399	97.599	200	1	3	3
	97.603			3	3	3
98	98.470			3	3	3
	98.776	98.926	150	1	3	3
99						
100						

100 - 150 km

C	D	H	L	T	S	N
100						
101	101.531	101.611	80	1	3	3
102						
103						
104	104.693	104.843	150	1	3	3
105	105.203	105.253	50	1.4	3	3
	105.305	105.405	100	2.4	3	3
	105.917	106.117	200	4	3	3
106						
107						
108						
109						
110	110.610	110.660	50	1	3	3
111						
112						
113						
114	114.895	114.945	50	1	3	3
115						
116	116.078	116.128	50	2	3	3
117	117.506	117.516	10	2	3	3
	117.914	117.964	50	2	3	3
118	118.322	118.472	150	2	3	3
119	119.138	119.188	50	1	3	3
	119.240	119.290	50	1	3	3
	119.649	119.749	100	1	3	3
120						
121						
122						
123	123.117	123.188	71	4	3	3
124						
125						
126						
127						
128						
129						
130						
131						
132						
133						
134						
135						
136						
137	137.430	137.530	100	2.4	3	3
138						
139						
140						
141	141.806	141.906	100	1.2	3	3
142						
143						
144	144.237	144.437	200	2.4	3	3
145						
146	146.943	148.943	2000	1.4	3	3
147	147.135	149.135	2000	5	3	3
148						
149						
150						

150 - 200 km

C	D	H	L	T	S	N
150						
151						
152	152.429	155.429	3000	1.5	3	3
153						
154						
155						
156						
157						
158						
159						
160						
161						
162						
163	163.543	163.593	50	4	2	3
164	164.915	164.965	50	1	2	3
165						
166						
167						
168	168.819	168.869	50	1.4	2	3
169	169.136	169.186	50	3	2	3
170	170.086	170.186	100	5	2	3
171						
172	172.302	172.502	200	5	2	3
173						
174						
175						
176						
177	177.789	177.889	100	2.4	2	3
178						
179						
180						
181						
182						
183	183.992	184.092	100	1.2	3	3
184	184.969	185.019	50	1.4	3	3
185						
186						
187						
188						
189	189.563	189.613	50	4	3	3
190						
191	191.518	191.568	50	3	3	3
192						
193	193.277	193.327	50	4	3	3
	193.472	193.522	50	4	3	3
194						
195						
196						
197						
198	198.945	198.995	50	4	3	3
199						
200	200.411	200.461	50	1	3	3

200 - 250 km

C	D	H	L	T	S	N
200						
201	201.095	201.115	20	4	3	3
202	201.731	201.931	200	1,2,4	3	3
203	203.832	203.882	50	1.4	3	3
204						
205						
206						
207						
208						
209						
210						
211						
212						
213						
214						
215						
216						
217						
218	218.057	218.107	50	1.4	2	3
219						
220						
221	221.186	221.236	50	2	3	3
	221.578	221.628	50	2	3	3
222						
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248						
249						
250						

250 - 300 km

C	D	H	L	T	S	N
250						
251						
252						
253						
254						
255						
256						
257						
258						
259						
260						
261						
262						
263	263.496	263.546	50	4	3	3
264	264.181	264.231	50	4	3	3
	264.230	264.280	50	3,4	3	3
	264.768	264.818	50	3	3	3
265						
266						
267						
268						
269						
270						
271						
272						
273						
274						
275						
276	276.603	276.633	30	4	2	3
277						
278						
279						
280						
281						
282						
283						
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286						
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298						
299						
300						

C	PROGRESIVA CALCULADA
D	DE
H	HASTA
L	LONGITUD DE EL PUNTO CRITICO
T	TIPO DE FALLA
S	SECCION TIPICA
N	NIVEL DE RIESGO

HIGH HAZARD CONTROL SECTION

CRITICAL SPOTS

This is the result of the trial of the manual carried out in 2007 along route 3. Total 58 critical spots were recognized. Various types of disasters continue in some sections on the highway. The sections where disasters continue are called High Hazard Control Sections (SCMA). Total numbers of SCMA shown in the table are six sections as bellow.

1. 96 km – 124 km
2. 137 km – 153 km
3. 163 km – 204 km
4. 218 km – 222 km
5. 263 km – 265 km
6. 276 km – 277 km

The critical spots and SCMA can be managed with simple tables in this way.

Disaster classification is not same as the classification in this Guide

3. SHORT AND MEDIUM TERM WORK PLAN

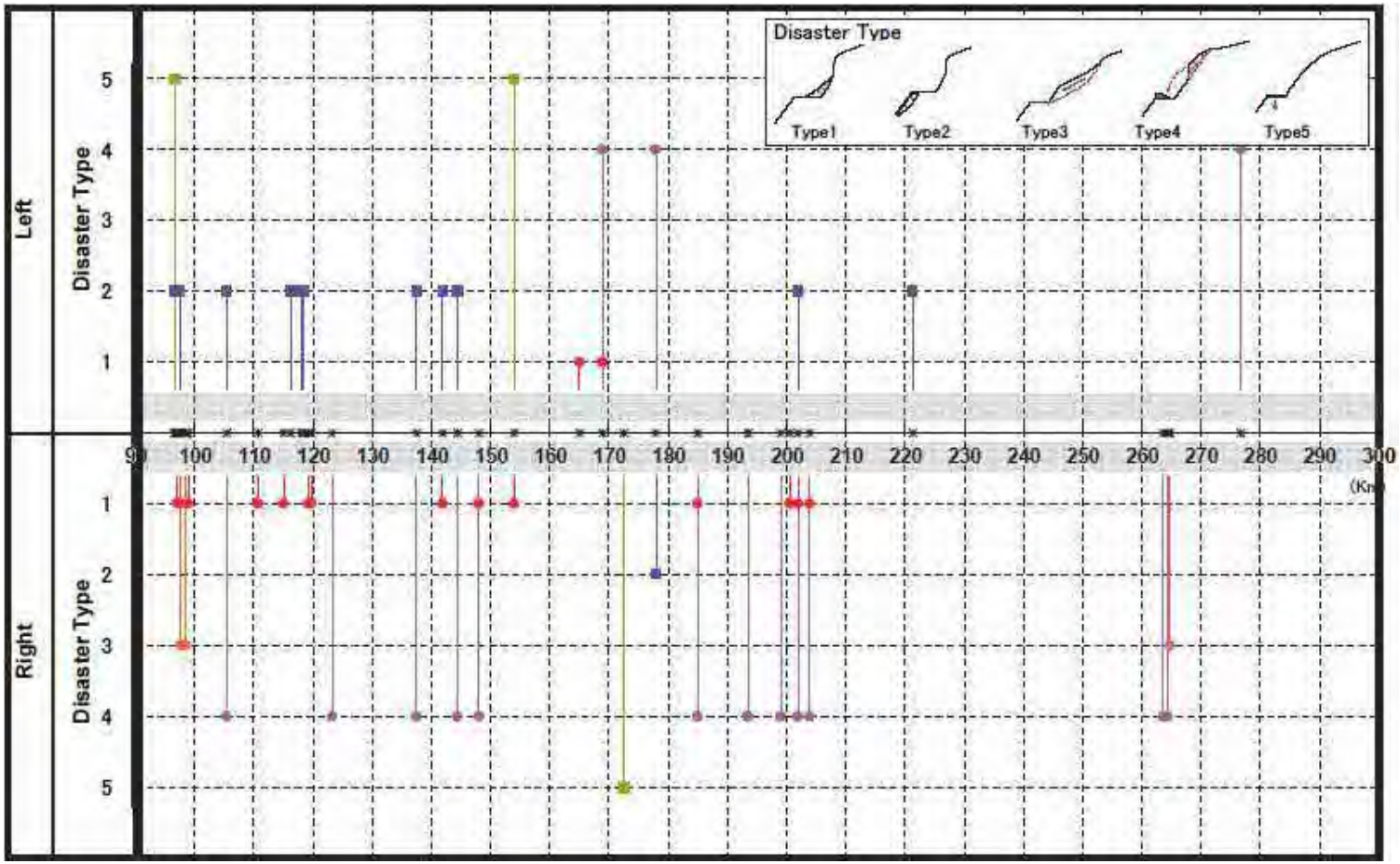


Figure 3.1 Locations and Types of Disasters along Route 3 *(Disaster classification is not same as the classification in this Guide)*

This figure shows location and type of disasters visually is the result of the trial of the manual carried out in 2007 along route 3. The figure shows that type 2 disasters on left side and type 1 and type4 disasters on right side of the highway. This is because the highway runs the place where mountains locate on right side and ravines locate on left side of the highway. In this way, characteristics of disasters can be clarified with simple figures like this.

APPENDIX I-1

CLASSIFICATION OF ROAD DISASTERS

APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

A1-1 SCIENTIFIC LANDSLIDE CLASSIFICATION

The most common classification of landslide in the world may be the Vern's Classification (1978) shown below

Table A1-1.1 Classification of Landslide (Vern's)

Material	Types of Movement		
	Fall / Topple	Slide / Spread	Flow
Rock	**Rock Fall / Toppling**	**Rock Slide**	Rock Avalanche
Earth	**Earth Fall (Slope Collapse)**	**Earth Slide**	Earth Flow (Mudflow)
Debris	**Debris Fall**	Debris Slide	**Debris Flow**

Rock : *A hard or firm mass that was intact and in its natural place before the initiation of movement*

Earth : *describes material in which 80% or more of the particles are smaller than 2mm, the upper limit of sand sized particles*

Debris : *Contains a significant proportion of coarse material; 20% to 80% of the particles are larger than 2mm, and the remainder are less than 2mm*

The term landslide denotes "the movement of a mass of rock, debris or earth down a slope". The phenomena described as landslides are not limited to either the "land" or "sliding", and usage of the word has implied a much more extensive meaning than its component parts suggest. Ground subsidence and collapse are excluded.

Vern's Landslide classification has two terms: the first term describes the material type and the second term describes the type of movement as shown in Table A1-1.1. The material types are Rock, Earth and Debris, and the types of movement describe how the landslide movement is distributed through the displaced mass. The five cinematically distinct types of movement are described in the sequence fall, topple, slide, spread and flow.

Sometimes in engineering sector employs simply classification which is basically combination of the two terms in Vern's classification such as Rock fall, Rock topple, Debris slide, Debris flow Earth slide etc.

APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

A1-2 ROAD DISASTER ENGINEERING CLASSIFICATION

Scientific classification is sometimes complicated and takes longer time, since it requires knowledge and experience of geological study and natural science.

In order to work out the measures against road disasters and to design the prevention measures, this guide recommends the road disaster engineering classification as shown in Figure A1-2.1 and Table A1-2.2. The engineering classification which consists of six types of road disasters is based on configuration of landslides, and relation to roads. It is common classification in Bolivia.

The following sections describe regional characteristics and occurrence mechanisms of slope disasters, and gives a general description and classification of road disasters involving roads based on experiences and knowledge in Japan.

Table A1-2.2 Characteristics of Road Disasters Type (common characteristics in Bolivia)

Type	Disaster Type	Movement	Topography	Material	Moisture	Size	Speed
1	**Slope Collapse (DR)**	Fall, Slide	Steep / High Slope	Weathered Rock - Earth	Moist	Small - Medium (<5,000m^3)	Rapid
2	**Rock Fall (CR)**	Fall	Steep / High Slope	Rock	Dry	Very Small (< 5 m^3)	Extremely Rapid
3	**Rock Mass Failure (FR)**	Topple, Slide	Steep / High Slope	Rock	Dry	Medium (> 1,000m^3)	Rapid
4	**Mass Movement (DL)**	Slide	Gentle Slope with Characteristic Landform	Earth – Debris - Rock	Moist	Large (> 5,000m^3)	Slow
5	**Debris Flow (FE)**	Flow	Stream	Debris - Mud	Very Wet	Small (< 1,000m^3)	Rapid
6	**Road Collapse (FP)**	Slide, Fall	Embankment Slope Road Shoulder	Fill Material - Earth	Moist - Wet	Small (< 1,000m^3)	Rapid

APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

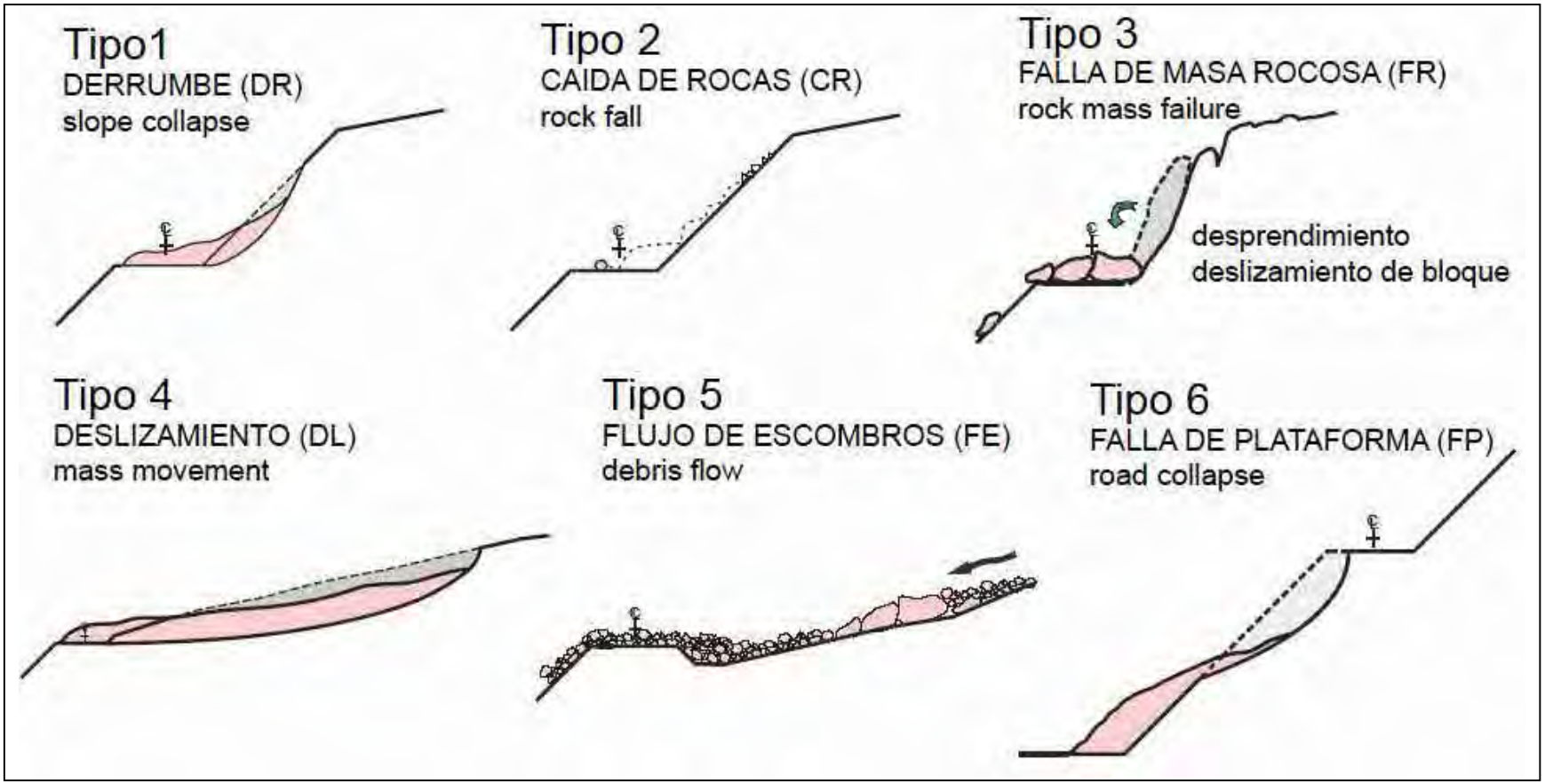


Figure A1-2.1 Road Disaster Classification

APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

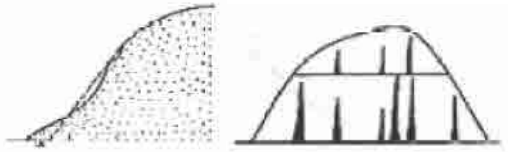
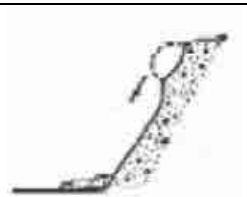
TYPE 1 SLOPE COLLAPSE (DR)

Material : weathered rock / earth, Speed : rapid, Scale : shallow

This refers to failure of loose and porous soil and rocks from slope when the loose materials are filled by water during heavy rainfall or are shaken loose by earthquake. This failure type is marked as sudden with rapid movement without prior indication, generally as a result of damage, structural weakness, or lack of support.

Mechanism of collapse is breakdown of loose and porous part of the slope itself. Generally, the size of failure is less than 1,000 m^3 because only the loose part of the slope surface collapses. Material is mostly highly weathered rock or colluviums. Depth of collapses are relatively shallow.

<example>

	Exfoliation of the surface or formation of a gully due to dry wet repetition, freezing and rain water erosion, etc; may develop into a deep failure if not arrested
	Collapse of an overhang section at a slope
	Slipping of the surface rock layer due to weathering, etc.
	Photo of collapse (in Japan)

APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

TYPE 2 ROCK FALL (CR)

Material : rock, Speed : very rapid, Scale : very small

Free fall or rolling down of a rock or few rocks individually from a steep slope or cliff. This failure type is also marked as sudden with rapid failure that is prone to occur during heavy rainfall. But this type of failure could occur sometimes with no relation to weather conditions. Generally, the size of a rock fallen is small and is less than 5 m^3, and total volume of fallen rocks together with is less than 100 m^3. Collapse and Rock Fall occur in similar topography/geological conditions. A fall starts with the detachment of rock from a steep slope along a surface on which little or no shear displacement takes place. The material then descends mainly through the air by falling, bouncing, or rolling. Movement is very rapid to extremely rapid.

Rock fall is a phenomenon where foliated rocks and gravel due to enlarged cracks (caused by joints, foliation and stratification developed in the bedrock) in the bedrock or outcropped rocks, boulders and gravel originally contained in talus material, pyroclastic material or a gravel bed with low degree of compaction start to fall down a slope.

<example>

	Dropping of gravel located on a sandy slope containing gravel
	Sliding down of gravel contained in the sediment above the bedrock
	Slipping of rocks along cracks of the rock base (joints, samaal faults or thin layer); often a wedge-shaped failure
	Photo of rock fall (Japan)

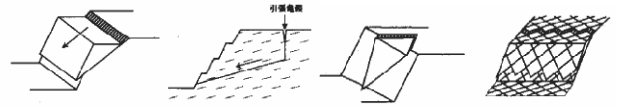
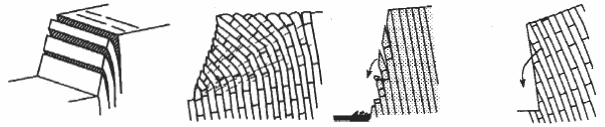
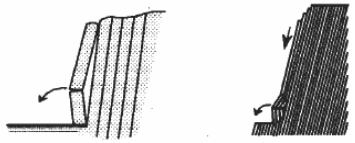
APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

TYPE 3 ROCK MASS FAILURE (FR)

Material : rock, Speed : rapid, Scale : medium

Mass failure in a rock slope such as planar slide, wedge slide, and toppling. The mechanism is closely related to geological discontinuity. Deformation of rock mass often implies a signal of final failure. Generally, size is more than 100 m^3.
The term applies to masses of loose rock which move under the force of gravity along an inclined surface of competent bedrock. Rock mass failure can be classified into one of four categories depending on the type and degree of structural control.
Planar failure in rock in which a discontinuity "daylights" the slope face.

<example>

Wedge Failure	 Wedge failure on two intersecting discontinuities with a line of intersection which "daylights" the slope.
Toppling Failure	 Toppling failure in hard rock with slabs or columns defined by discontinuities that dip steeply into the slope
Buckling Failure	 Buckling failure in hard rock with steep "daylights" the slope.
combination of Rock Mass Failure & Collapse	

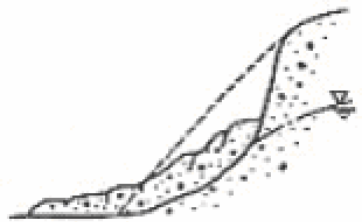
APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

TYPE 4 MASS MOVEMENT (DL)

Material : earth / debris / rock, Speed : slow, Scale : large

Mass movement is a phenomenon where the soil mass above a boundary deep in the ground gradually shifts downward. Mass movement sites tend to be concentrated in areas with specific geology or geological structure. Compared to collapses of cut slope or a natural slope, the gentler slope moves on a large-scale, forming specific topography (landslide topography).
Mass movement of highly weathered rocks, debris and soil across a slip surface. It is characterized by its deformed slope landscape. Size is large, generally more than 5,000 m^3 and ranges to several hundred thousands of cubic meters.

<example>



Large-scale slipping of a slope formed by soft and not well consolidated soil or slope with an unstable factor in terms of the geological structure due to a rise of teh groundwater level.

Lower layers with different permeability

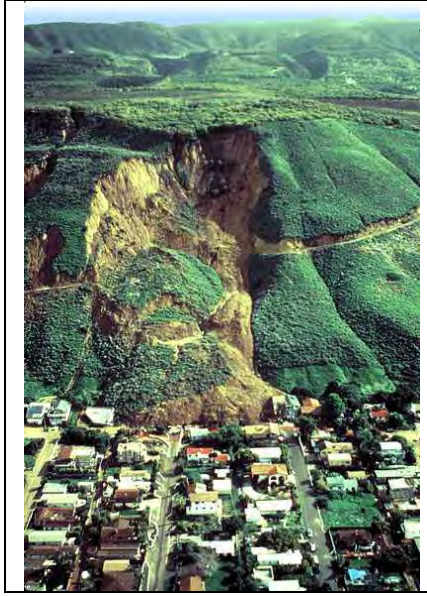


Photo of slow-move landslide (USA)

APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

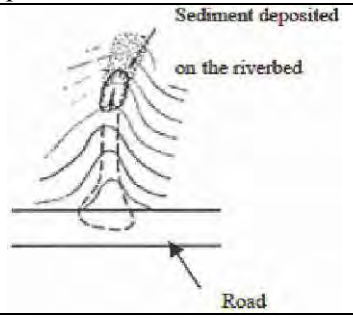
TYPE 5 DEBRIS FLOW (FE)

Material : debris / mud, Speed : rapid (flow), Scale : small

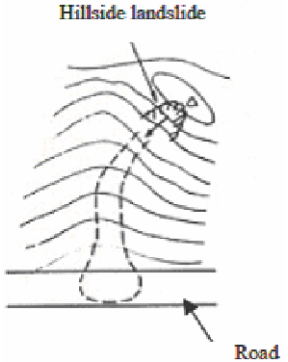
Debris flows, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are common types of fast-moving landslides. These flows generally occur during periods of intense rain-fall or rapid snowmelt. they usually start on steep hillsides as shallow landslides that liquefy and accelerate to speeds that are typically about 15km/h, but can exceed 55km/h.

Source area is upstream of road slope. Rapid flow of boulder, gravel, sand, silt clay mixed with a large quantity of water that is mainly generated by slope collapse and heavy rainfall. It flows down riverbed with gradient of over 20-degree gradient and stops to deposit in the riverbed with gradient of under 10 degrees.

<example>



Fluidisation of sediment and gravel deposited on the bed of a steep stream due to the supply of a large quantity of water, a downpour or rapid thawing



Fuidisation of sediment produced by a hillside failure as the structure is broken up while sliding down the slope and mixed with water

Photo of debris flow (Japan)

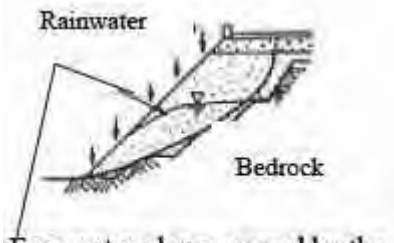
APPENDIX I-1 CLASSIFICATION OF ROAD DISASTERS

TYPE 6 ROAD COLLAPSE (FP)

Material : earth / fill material, Speed : rapid, Scale : small

All types of slope failure such as slump or collapse of slope, settlement of road surfaces due to various causes, scouring of toe part of slope and so on.
Collapse or slide occur on the part of a banking section where the soil from the existing ground level to the subgrade level is banked is called an embankment.
Embankment failure occurs below the road level and mostly the part of road surface taken away by the failure.

<example>



Free water planes caused by the permeation of rainwater

Failure along the boundary between the bedrock and an embankment due to the permeation of rainwater when an embankment is constructed above ground which is steeply inclined in the cross-sectional direction


photo in Japan

APPENDIX I-2

HAZARD LEVEL
AND
UNSTABLE FACTORS

APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

A2-1 HAZARD LEVEL

The hazard level is classified into four levels, A, B, C and D as shown in Table A2-1.1.

Table A2-1.1 Slope Hazard Level

Hazard Level	Description	Hazard Score
Level A : (Active)	Material is currently moving, and landslide features are fresh and well defined. or slopes with evidence of landslide or debris flow activity within the past year. (=measures are urgently required)	**3**
Level B : (Dormant)	Unstable factors* are discernible, or locations where measure works have been completed partially (= regular monitoring is required)	**2**
Level C : (Stable)	Stable locations in mountainous area, or locations where has unstable factors but recovery will be simple in the event of a disaster	**1**
Level D: (Flat land)	Stable locations in flat land	**0**

***Unstable Factors**

Unstable Factors or Sign of Disaster is described each disaster types as follows.

APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

A2-2 UNSTABLE FACTORS –

TYPE 1 SLOPE COLLAPSE (DR)

The surface conditions of slopes can be yardsticks of judgment of stability of the slopes. Abnormal on cut slopes generally can be found easily, however, abnormal on natural slopes can be missed even an inspector inspects on the slopes carefully. When the abnormal conditions shown on Figure A2-3.1 are found on a slope, the slope may be in the state of low stability.

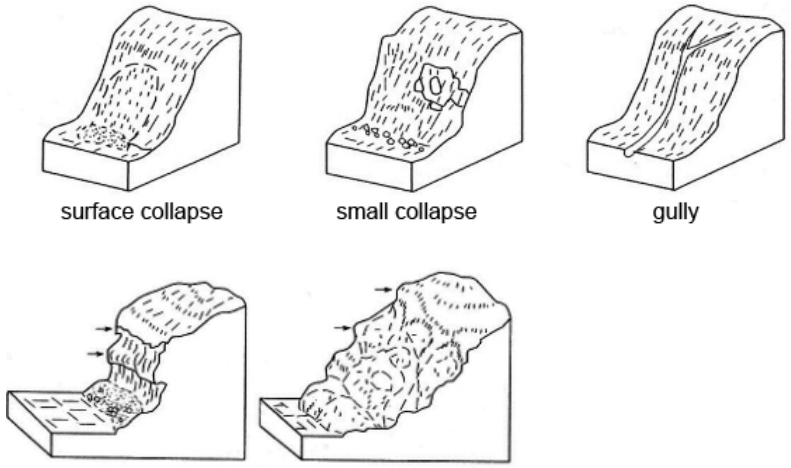


Figure A2-3.1 Sign of collapse

vegetation

The slopes consist of soil or highly weathered rock without vegetation can be eroded easily, and trigger collapses. Gullies can be formed on the slopes. They will accelerate instability of the slopes, and cause of bigger collapses.

The slopes covered with weeds suffer less surface erosion than the slopes without vegetation. However, small collapses can occur frequently.

The slopes covered with trees shows having been stable for long time. However, deep collapses occurred on the slopes covered with trees with heavy rain since the slopes had not experience disasters on it for long time, depth of weathered layer have been thicker and thicker,

APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

A2-3 UNSTABLE FACTORS –

TYPE 2 ROCK FALL (CR)

The stability of rocks on slopes may be judged with following manners.

Unstable (critical):	there are rocks which expose 2/3 of their diameter from the surface of the slope. or, there are rocks which totally come out from the ground and can be moved by hand.
Unstable (middle):	there are less unstable rocks than above (critical). or, there are rocks which expose less than 2/3 of their diameter. or, there are rocks which totally come out form the ground but can not be moved by hand.
Stable :	no unfixed rocks are found, or only stable unfixed rocks on the slope.

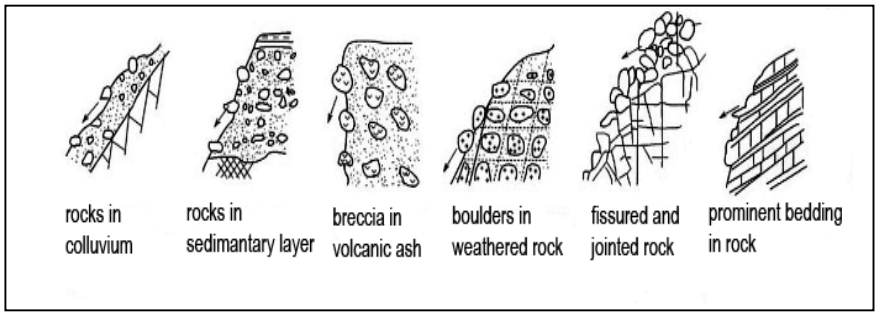


Figure A2-2.1 Examples of unstable rocks on slopes

A2-4 UNSTABLE FACTORS –

TYPE 3 ROCK MASS FAILURE (FR)

Rock Mass Failure usually occurs suddenly after small movement of the rock masses for long time. Generally it is difficult to find the sign of rock mass failure, however, the sign of rock mass failure may be found with careful observation on the slope with the following points.

a. open crack
   - usually it occurs on the top of unstable rock mass
   - by movement of rock mass, width and length of open crack could be expand

b. horizontal crack
   - usually it occurs at the bottom of rock mass
   - gap between upper and lower of the crack becomes bigger

c. compression crack
   - usually it occurs at the bottom of rock mass
   - usually it occurs by the concentration of stress
   - usually it is vertical

d. looseness
   - by the movement, looseness of cracks and joints can be progress

e. small collapse and rock fall
   - new rock fall and new colluvium at the toe of the slope can be seen
   - exfoliation on slope surface occur

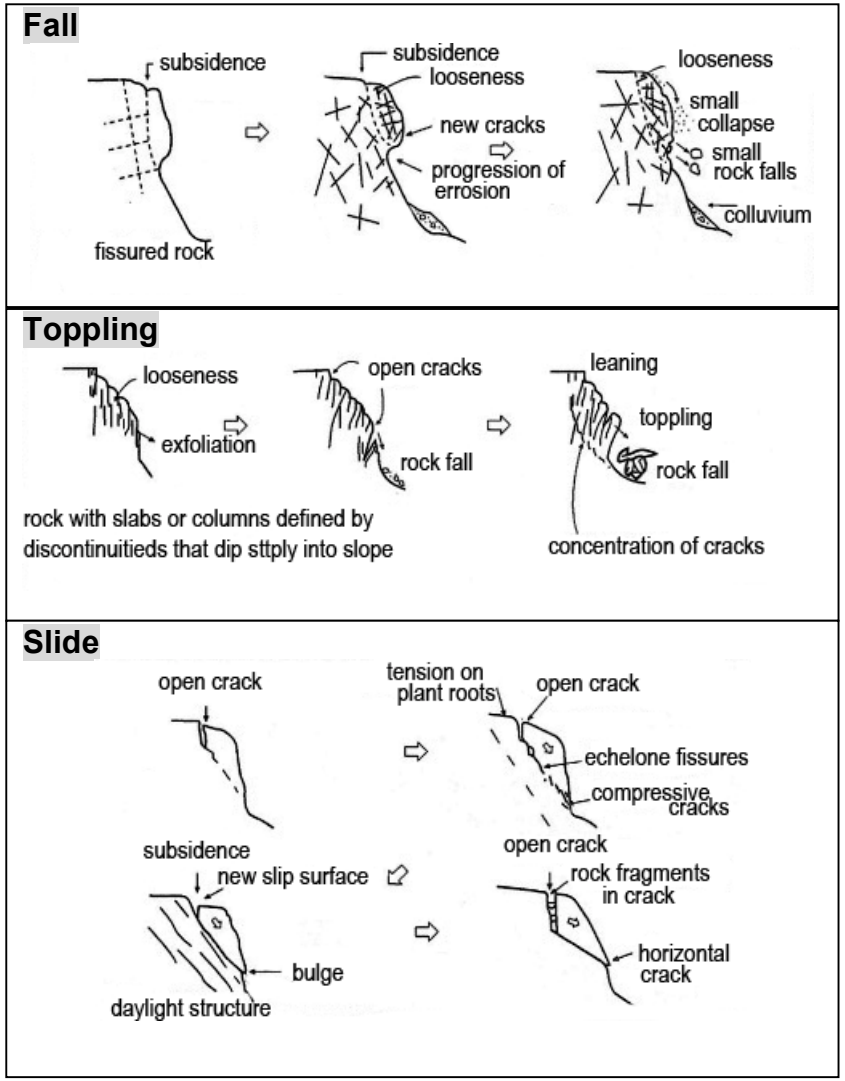
f. erosion of slope
   - by progression of erosion at the bottom of rock mass

g. subsidence
   - by rock mass moves downward, top of slopes subside
   - new depression appears on the top of slope

APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

The character of sign of rock mass failure is deferent on failure types.

FigureA2-2.2 Signs of Rock Mass Failure



APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

A2-4 UNSTABLE FACTORS –

TYPE 4 MASS MOVEMENT (DL)

If the following signs are seen, possibility of mass movement on the slope is high.

a. House-hoe shaped scarp on upper part of slope
b. Gentle gradient on middle of the slope
c. Sometimes hummock can be seen.
d. Depression, subsidence, cracks can be seen on top of the slope, row of depression can be seen.
e. Gradient at toe of the slope is steep, and there is upheaval of the ground, swelling horizontally of the ground

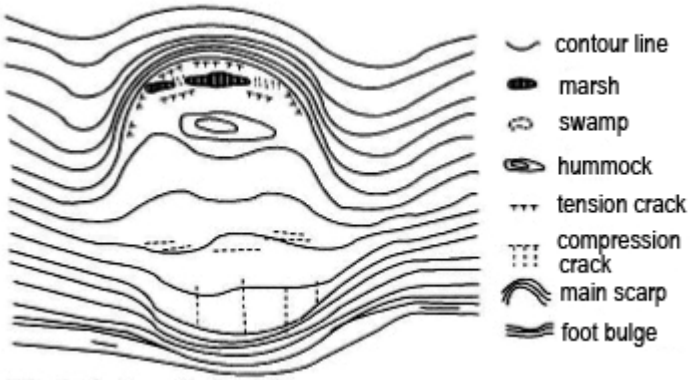


Figure A2-4.2 Plan of Mass Movement

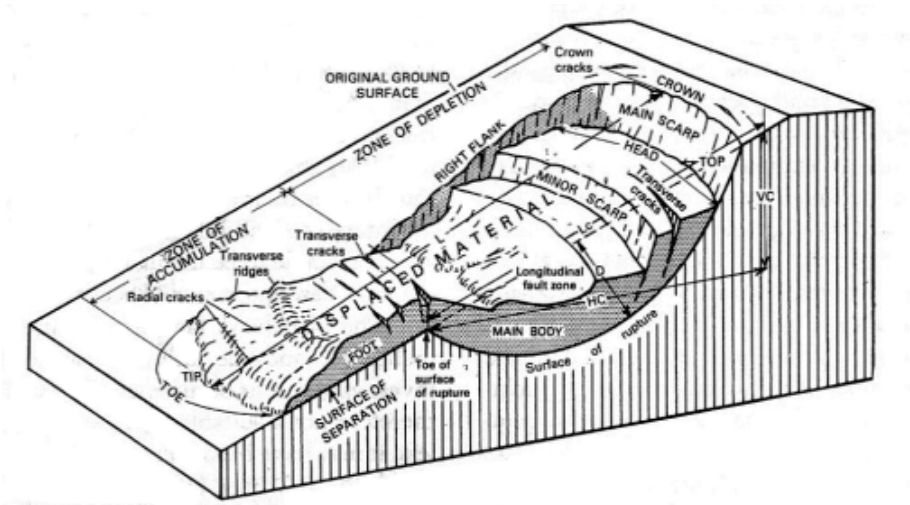


Figure A2-4.1 Typical Diagram of Mass Movement

APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

A2-5 UNSTABLE FACTORS –

TYPE 5 DEBRIS FLOW (FE)

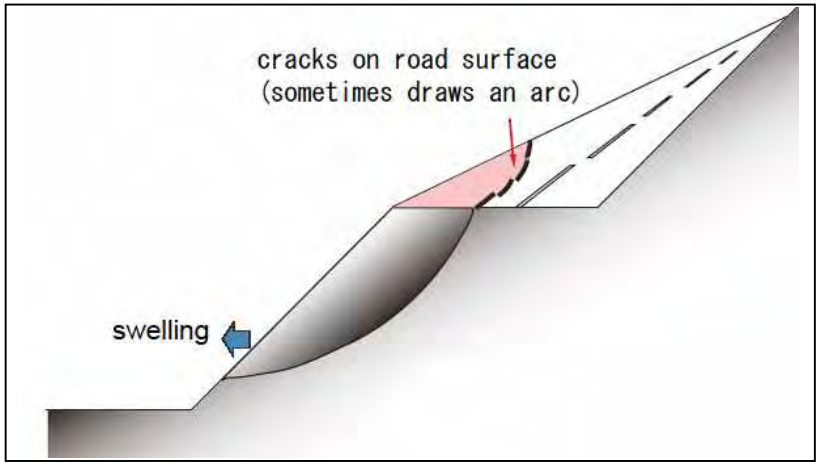
Debris flow repeats at a same stream. Debris flow may not occur newly on the stream, so long as the stream is not made an alteration artificially. Therefore, we can find occurrence of debris flow by the inspection at the point where the stream is crossing the road. Also, we can find scale of debris flow, size of debris, area of spread of debris flow by the detailed inspection at the point.

A2-6 UNSTABLE FACTORS –

TYPE 6 ROAD COLLAPSE (FP)

Abnormal occurs on embankment is sometimes caused by consolidation settlement of the embankment material or weight of structure such as retaining wall. They usually are not serious.
Another reason of abnormal is landslide at road shoulder. This can cause big embankment failure and can be serious. Therefore, when we find the abnormal on embankment, we must judge abnormal is caused by landslide or not. When crack draws an arc on the road surface, it can be sign of landslide. When toe of the slope swells, it can be sign of landslide.

Figure A2-6.1 Road Collapse



APPENDIX I-2 HAZARD LEVEL AND UNSTABLE FACTORS

APPENDIX I-3

ROAD DISASTER SCORING SYSTEM
IN
JAPAN

(FOR FUTURE REFERENCE)

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

The following inspection forms presents a standard procedure of road slope inspection and risk evaluation based on the Japanese Standard of Road Slope Inspection.

Main Information Obtained by the Slope Inspection

The following information will be obtained by the slope inspection.

(1) Score of Slope Hazard
(2) Score of Effectiveness of Existing Countermeasure
(3) Total Slope Hazard Score
(4) Consequence Score
(5) Risk Rate
(6) Rough Cost Estimation of Countermeasure

(1) Score of Slope Hazard is obtained by filling the inspection sheet prepared for this manual. It shows "the level of probability of slope instability without effect of existing countermeasure".

(2) Score of Effectiveness of Existing Countermeasure is obtained by evaluating the effectiveness of existing countermeasure for the slope inspected. This score shows "The level of effectiveness of existing countermeasures".

(3) Total Slope Hazard Score is defined in this slope inspection as "the level of probability of slope instability. the score is obtained by adding Score of Slope Instability to Score of Countermeasure.

(4) Consequence Score is defined as "the level of the consequential effect by the road slope disaster".

(5) Risk Rate is obtained by the following formula and shows "the priority level for treating countermeasure work".

Risk Rate = Hazard Score x 0.9 + Consequence Attribute

Where ;

Full mark of each score is as follows

Hazard Score	:	100
Score of Consequential Factor	:	10
Risk Rate	:	100

(6) Rough Cost Estimation of Countermeasure is done according to the result of planning countermeasure work for the slope inspected. Unit rate of countermeasure work is arranged i.e.

Disaster Type

Disaster Type is classified according to the following six types considering their mode of failure.

(1) Collapse (CL)
(2) Rock Fall (RF)
(3) Rock Mass Failure (RM)
(4) Landslide (LS)
(5) Debris Flow (DF)
(6) Embankment Failure (EB)

Inspection Forms

The record forms for inspection consists of six forms.

- Form A: General information and Location Map
- Form B: Slope Sketch Sheet
- Form C: Photograph Sheet
- Form D: Recording Slope Features
- Form E: Evaluation of Slope Hazard and Existing Countermeasure

(E 1 to E5 for each disaster type is prepared)

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

- Form F: Proposed Countermeasure, Consequence Attribute score and Local Information

Factors for Assessment of Slope Stability

The following factors are used to assess slope stability.
(a) Topography, (b) Geometry, (c) Geological structure, (d) Geological condition, (e) Deformation of slope, (f) Surface condition,
(a) to (f) : factors mainly for Collapse, Rock Fall, Rock Mass Failure and Landslide)
(g) Cover in Source Area, f) Deformation in Source Area, h) Trace,
(g) to (h): factors only for Debris Flow)
(i) Condition of Culvert (factor only for Embankment Failure)
(j) Countermeasure (factor for each failure type)
The weighting of each instability mainly refers to the Japanese Manual and some modification is applied in consideration of the geological conditions of Malaysia. Outline of weighting for instability factors is shown in Table A3-1.1

Table A3-1.1 Maximum Point of Instability Factor of Slope

Items	Collapse/ Rock Fall	Rock Mass Failure	Landslide	Debris Flow	Embankment Failure
Topography	5	11	50	43	0
Geometry	30	14	0	0	10
Geological Structure	14	33	10	0	0
Geological Condition	16	31	3	0	5
Deformation	15	7	32	34	26
Surface Condition	20	4	5	23	51
Others	0	0	0	0	8
Total	100	100	100	100	100

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

Form A: General information and Location Map (1/50,000)

SLOPE INSPECTION SHEET	input **FORM A** GENERAL SLOPE DATA

General Slope Data

Most Likely Failure Type	*1. Collapse / Rock Fall 2. Rock Mass Failure 3. Landslide 4. Debris Flow 5. Embankment Failure 6. No Action Needed (Form A only)*		
Chainage	Start km - End km	Type of Slope	*Cut / Embankment / Natural*
Side of Road	*Right / Left*	Distance from Road Centre-Line	*m*
JKR Slope ID		Date Inspected	/ /
Field ID		Inspected by	
Route Name		Date Checked	/ /
District Name / State Name	/	Checked by	
Realignment Event (Description)	*Yes / No (if 'yes', describe)*		
Disaster Record			

Location Map (1:50,000)

Date Entered in SIMS	/ /
Entered by	

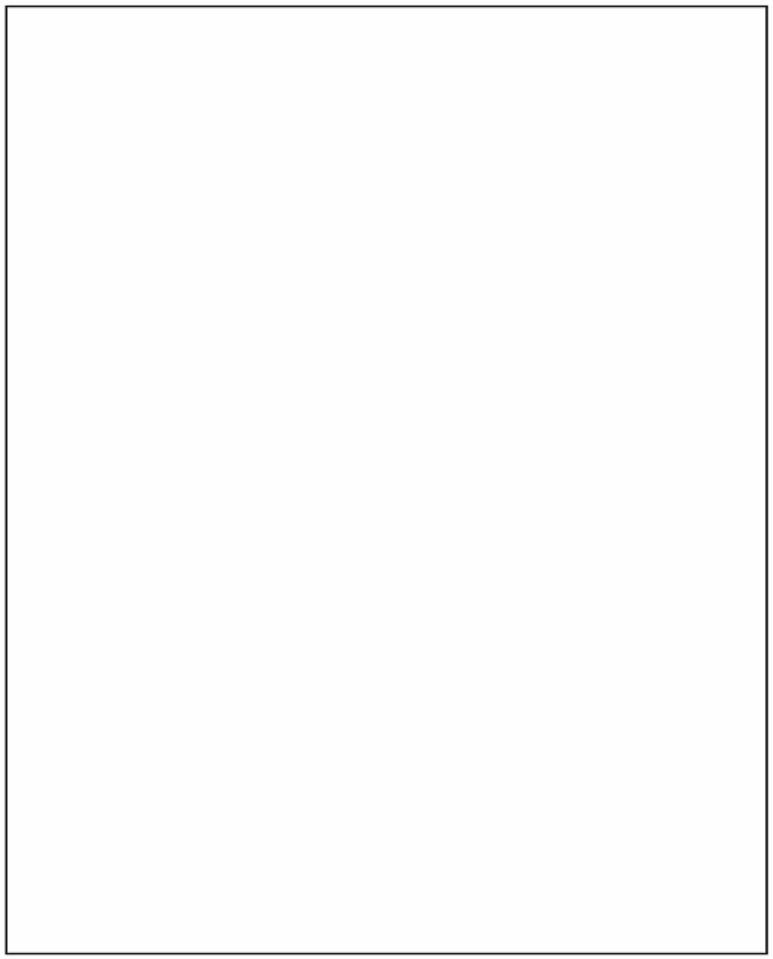
Form B: Slope Sketch Sheet

SLOPE INSPECTION SHEET		input **FORM B** SLOPE SKETCH	
JKR Slope ID :	Chainage: Start km - End km	Side of Road : *Right / Left*	Date:

Form C: Photograph Sheet

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

SLOPE INSPECTION SHEET		input **FORM C** PHOTOGRAPH	
JKR Slope ID :	Chainage: Start km - End km	Side of Road : *Right / Left*	Date:



Form D: Recording Slope Features

SLOPE INSPECTION SHEET				input **FORM D** SLOPE FEATURE	
JKR Slope ID :		Chainage: Start km - End km		Side of Road : *Right / Left*	Date:
GEOMETRY	Height of Slope	m		No. of Berms	
	Angle of Slope (range)	- deg		Width of Berms	m
	Average Angle of Slope	deg		Berm Height	m
GEOLOGY	Soil Name (if soil)	*Gravel / Sand / Silt / Clay / Peat / other ( )*			
	Geological Name – Sedimentary	*Sandstone / Mudstone / Siltstone / Conglomerate / Limestone / Chert / Shale / Alternation of Sandstone & Mudstone / other ( )*			
	Geological Name – Igneous	*Rhyolite / Dacite / Andesite / Basalt / Granite / Granodiorite / Diorite / Gabbro / Ultrabasic Rocks / Tuff / Pyroclastic / other ( )*			
	Geological Name – Metamorphic	*Slate / Phillite / Schist / Marble / Hornfels / Gneiss / other ( )*			
	Weathering Grade	*I, II, III, IV, V, VI*		Composition Ratio of Rock : Soil (%)	
	Discontinuties Type	*1, 2, 3, 4, 5, 6, 7, 8*		*Rock : Soil = :*	
EROSION	Sheet Erosion	*Severe (>40%)*	*Moderate (10%-40%)*	*Minor (<10%)*	
	Rill Erosion	*Severe (0.2-0.5m depth)*	*Moderate (<0.2m depth)*	*Minor*	
	Gully Erosion	*Severe (>one berm)*	*Moderate (one berm)*	*Minor*	
	Fretting Erosion	*Severe (>40%)*	*Moderate (10%-40%)*	*Minor (<10%)*	
COVER / EXISTING COUNTERMEASURE	Type	*Trees / Shrubs / Grass / Gunite / Dental Concrete / Others ( )*			
	Engineering Features			Percentage covered	%
	Gabions	*H= m, L= m*		*Rock Bolts*	m^2
	Crib Wall	*H= m, L= m*		*Netting*	m^2
	Concrete Wall	*H= m, L= m*		*Soil Nail*	m^2
	Masonry	*H= m, L= m*		*Piles*	*m interval, m extension*
	Others			*Comments*	
DRAINAGE	Roadside Drains	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Cascade Drains	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Berm Drains	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Cut-Off Drains	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Horizontal Drains	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Culvert Passageway	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Culvert Inlet	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Culvert Outlet	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Culvert Wingwalls	*Good Condition / Needs Desilting / Needs Repair / Not Present*			
	Culvert ID				
	Hydrological Condition	Seepage from Slope Face or Ground?: *Yes / No*			
		Natural Surface Runoff?: *Yes / No*		Ponding Water Nearby?: *Yes / No*	
	Comments				
PAVEMENT	Cracks?:	*Yes / No*	Depression?:	*Yes / No*	
	Cracks Sealed?:	*Yes / No*	Shoulder Depression?:	*Yes / No*	
	Shoulder Cracks?	*Yes / No*	Cause of Cracks?:	*Pavement / Slope failure*	
INSTRUMENTATION (type & condition, if any)	*Inclinometer*	*Piezometer*	*Tensiometer*	*Rain Gauge*	*Pressure G.*	*Others( )*
	Good / Bad	*Good / Bad*	*Good / Bad*	*Good / Bad*	*Good / Bad*	*Good / Bad*

Form E1: Evaluation of Slope Hazard and Existing for Collapse

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

SLOPE INSPECTION SHEET input **FORM E1**
COLLAPSE / ROCK FALL

JKR Slope ID :	Chainage: Start km - End km	Side of Road : *Right / Left*	Date:

Condition of Slope ✔ tick one

TOPOGRAPHY	Alluvium Slope		Yes		2
			No		0
	Trace of Collapse		Yes		1
			No		0
	Clear Knick Point or Overhang		Yes		1
			No		0
	Concave Slope or Debris Slope		Yes		1
			No		0
GEOMETRY Select Higher Point of A or B	A : Soil Slope H : Height of Soil i : Angle of Slope	*H > 30m*			30
		H ≤ 30m i > 45 deg			24
		15m ≤ H < 30m i ≤ 45 deg			20
		H < 15m i ≤ 45 deg			10
	B : Rock Slope H : Height of Rock	*H > 50m*			30
		30 m ≤ H < 50m			26
		15 m ≤ H < 30m			20
		H <15m			10
MATERIAL Select A and B	A : Soil Character Swelling Clay Contents	*Conspicuous*			8
		Slightly			4
		No Swelling Clay			0
	B : Rock Quality Sheared Rock, Weathered Rock	*Conspicuous*			8
		Slightly			4
		Not Available			0
GEOLOGICAL STRUCTURE	Daylight Structure (Planar, Wedge)		Yes		8
			No		0
	Soft Soil over Base Rock				6
	Hard Rock over Weak Rock				4
	Others				0
DEFORMATION	Slope Deformation Gully Erosion, Rill Erosion, Sheet Erosion, Fretting Erosion, Rock Fall, Exfoliation, Swelling	*Visible*			10
		Obscure			8
		No Slope Deformation			0
	Deformation at Adjacent Slope Rock Fall, Collapse, Crack, Swelling, Other deformation	*Visible*			5
		Obscure			3
		No Slope Deformation			0
SURFACE CONDITION	Condition of Surface	*Unstable*			8
		Moderate			6
		Stable			0
	Ground Water	*Natural Spring*			6
		Water Seepage			3
		Dry			0
	Cover	*No-vegetation, Grass*			4
		Complex (Grass + Structure)			3
		Structure			1
	Surface Drainage	*Available (good)*			0
		Available (need repair)			2
		Not Available			1
				Score	

Countermeasure ✔ tick one

Effective		-20
Partially Effective		-10
Not effective or No Countermeasure		±0
	Hazard Score	

Form E2: Evaluation of Slope Hazard and Existing for Rock Mass Failure

SLOPE INSPECTION SHEET input **FORM E2**
ROCK MASS FAILURE

JKR Slope ID :	Chainage: Start km - End km	Side of Road : *Right / Left*	Date:

Condition of Slope ✔ tick one

TOPOGRAPHY	Slope Type	*Convex Slope*			4
		Debris Sediment			3
		Concave Slope			1
		Other			0
	Knick Point	*Visible*			7
		Moderate			4
		No Knick Point			0
GEOMETRY	Angle of Slope	*Overhang*			4
		> 60°			2
		< 60°			0
	Height of Slope	*> 100m*			10
		50 < H ≤ 100m			7
		30< H ≤ 50m			4
		< 30m			2
GEOLOGICAL CONDITION	Scale of Open Crack	*Large*	*≥ 20 mm*		25
		Small	*< 20mm, ≥ 5mm*		15
		No Open Crack	*< 5mm*		0
	Upper Part : Hard Rock / Lower Part :Soft Rock				6
	Upper Part : Soft Rock / Lower Part : Hard Rock				4
	Wholly Soft Rock				4
	Wholly Hard Rock				2
	Others				0
GEOLOGICAL STRUCTURE	Crack	*Regular Cracks : interval > 1 m*			18
		Regular Cracks : interval ≤ 1 m			12
		Irregular			6
	Daylight Structure or Non-Daylight Structure (Fault, Joint, Crack, Bedding)	*Daylight*			15
		Non-Daylight			5
		No Plane			0
DEFORMATION	Trace of Small Collapse or Small Rock Fall		Yes		7
			No		0
SURFACE CONDITION	Spring or Seepage on Slope		Yes		2
			No		0
	Surface Drainage	*Available (good)*			0
		Available (need repair)			2
		Not Available			1
				Score	

Countermeasure ✔ tick one

Effective		-20
Partially Effective		-10
Not effective or No Countermeasure		±0
	Hazard Score	

Form E3: Evaluation of Slope Hazard and Existing for Landslide

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

SLOPE INSPECTION SHEET input **FORM E3** LANDSLIDE

JKR Slope ID :	Chainage: Start km - End km	Side of Road : Right / Left	Date:

Condition of Slope ✔ tick one

TOPOGRAPHY	History of Landslide		Yes		10
			No		0
	Anomaly Disturbed Contour Lines Geographical Features like Scarp at Top of Slope		Obvious		40
			Partially		30
			Uncertain		10
GEOLOGICAL STRUCTURE	Fault, Sheared Zone				10
	Alteration Zone				10
	Daylight Structure				6
	Non-Daylight Structure				3
	Intrusive Structure, Cap Rock Structure				3
	Others				0
GEOLOGICAL CONDITION	Shale or Schist				3
	Others				2
DEFORMATION	Bulging at Toe		Yes		8
			No		0
	Depression or Subsidence		Yes		8
			No		0
	Cracks on Surface, Diagonal Tension, Shear Cracking		Yes		8
			No		0
	Deformation of Countermeasure		Yes		8
			No		0
SURFACE CONDITION	Spring, Natural Waterpath		Yes		3
			No		0
	Surface Drainage	Available (good)			0
		Available (need repair)			2
		Not Available			1
			Score		

Countermeasure ✔ tick one

Effective		-20
Partially Effective		-10
Not effective or No Countermeasure		±0
Hazard Score		

Form E4: Evaluation of Slope Hazard and Existing for Debris Flow

SLOPE INSPECTION SHEET input **FORM E4** DEBRIS FLOW

JKR Slope ID :	Chainage: Start km - End km	Side of Road : Right / Left	Date:

Condition of Slope ✔ tick one

TOPOGRAPHY	Contributory Area of Occurrence (Gradient of Stream ≥15deg)	≥ 0.50 km²			15
		0.15 ≤ A < 0.50 km²			10
		< 0.15 km²			5
	Extreme Steep Gradient of Stream	≥ 40°			15
		30° ≤ θ < 40°			10
		< 30°			0
	Area of Slope Gradient more than 30° in Source Area	≥ 0.20 km²			13
		0.08 ≤ A < 0.20 km²			8
		< 0.08 km²			4
COVER IN SOURCE AREA	Area of Grassland and Bush	≥ 0.20 km²			13
		0.02 ≤ A < 0.20 km²			8
		< 0.02 km²			0
	Existence of Earth Works/ Ponds/ Logging activity/Seepage		Yes		10
			No		0
DEFORMATION IN SOURCE AREA	Existence of New Crack, Scarp		Yes		10
			No		0
	History of Collapse		Yes		15
			No		0
TRACE	Trace of Debris Flow		Yes		9
			No		0
			Score		

Countermeasure ✔ tick one

Effective		-20
Partially Effective		-10
Not effective or No Countermeasure		±0
Hazard Score		

Form E5: Evaluation of Slope Hazard and Existing for Embankment Failure

APPENDIX I-3 ROAD DISASTER SCORING SYSTEM IN JAPAN

SLOPE INSPECTION SHEET input **FORM E5**
EMBANKMENT FAILURE

JKR Slope ID :	Chainage: Start km - End km	Side of Road : *Right / Left*	Date:

Condition of Slope ✔ tick one

GEOMETRY	Angle of Slope	*> 45 deg*			10
		> 33 deg, ≤ 45 deg			5
		≤ 33 deg			0
BASE GROUND	*Unstable Toe*				8
	Poor Subsoil				5
	Alluvium				5
	Stable Toe				0
	Uncertain				3
FILL MATERIAL	*Sandy Soil*				5
	Clayey Soil				0
	Gravel				0
	Unknown				3
GROUND WATER AND SURFACE WATER	Wet at Toe of Fill Slope		*Yes*		8
			No		0
	Trace of Water Flow on Slope Surface		*Yes*		8
			No		0
	Seepage from Fill Slope		*Yes*		8
			No		0
	Surface Drainage	*Need Repair*			5
		Not Available			3
		Good			0
CONDITION OF CULVERT	Insufficient or No Culvert		*Yes*		10
			No		0
	Insufficient Treatment at End of Culvert		*Yes*		7
			No		0
	Bending or Reduction of Culvert		*Yes*		5
			No		0
DEFORMATION	Cracks, Creeping		*Yes*		10
			No		0
	Surface Erosion		*Yes*		8
			No		0
	Existence of Repaired Portion		*Yes*		5
			No		0
	Swelling on Slope		*Yes*		3
			No		0
			Score		

Countermeasure ✔ tick one

Effective		-20
Partially Effective		-10
Not effective or No Countermeasure		±0
Hazard Score		

SLOPE INSPECTION SHEET input **FORM F**
PROPOSED COUNTERMEASURE & CONSEQUENCE

JKR Slope ID :	Chainage: Start km - End km	Side of Road : *Right / Left*	Date:

Proposed Countermeasure

Countermeasure	Amount	Remarks
Comments		

Consequence Data ✔ tick one

Services, Public Utilities	*Yes*		2
if gas, oil, telecom, electric or water pipelines are available, mark "Yes"	*No*		0
Danger to Building Occupants	*Yes*		2
only mark "Yes", if distance from toe of slope < 2H (H : Height of Slope)	*No*		0
Volume of Traffic	*> 1,000 AADT*		2
(AADT = Annual Average Daily Traffic)	*200 - 1,000 AADT*		1
	< 200 AADT		0
Angle ∅	*> 30°*		1
(road at centre-line to crest or embankment toe)	*≤ 30°*		0
Failure Size (a) Cut Slope (m^3)	*(a) > 3,000 or (b) > 1,000*		1
(b) Embankment (m^3)	*(a) ≤ 3,000 or (b) ≤ 1,000*		0
Construction Period of Temporary Diversion	*> 1 day*		1
	≤ 1 day		0
Length of Alternative Roads	*> 50km*		1
	≤ 50 km		0
	Consequence Score		

Local Information

Building Type	*Residential / Hotel / Commercial /Hospital / Factory / School / Others( )*			
Vegetation / Cultivation	*Primary Forest / Secondary Jungle / Grass / Rubber / Oil Palm / Coconut / Paddy Field / Others ( )*			
Rainfall Information	Annual Average		(mm)	
	Monthly Average	Maximum	(mm)	
			Month	
		Minimum	(mm)	
			Month	
	Daily	Maximum	(mm)	
			Month	
	Nearest Station			

Form F: Proposed Countermeasure, Consequence Attribute score and Local Information

ROAD DISASTER PREVENTION MANAGEMENT MANUAL

GUIDE II

DISASTER PREVENTION WORKS IN ROUTINE MAINTENANCE

ABC
JICA

CONTENTS

GUIDE II DISASTER PREVENTION WORKS IN ROUTINE MAINTENANCE

CONTENTS

OUTLINE

This is a guide for daily maintenance against the disasters such as daily observation and detection of anomalies.
The daily observation is the basic work for early anomalies detection in the ordinary time. The Micro-empresas are appropriate organization to detect these anomalies in ordinary time. The detailed inspection will be executed anomalies detected by the daily observation. The Supervisors will execute the inspection to confirm the emergency. If an emergency is recognized, the Supervise shall advise to ABC.

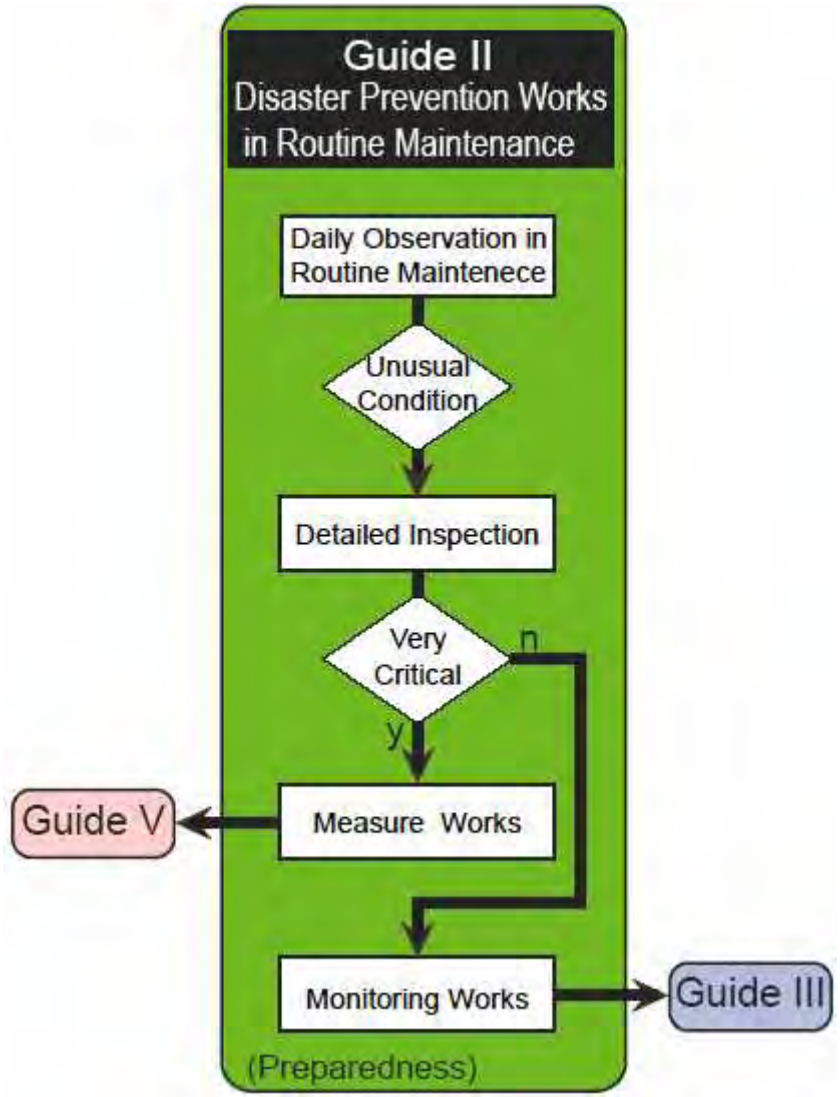


Figure 0.1 Contents of Guide III

1 SCOPE OF WORKS

1.1 WORK FLOW

The major objective of daily observation is to check the slope stability for safe movement of vehicles, and to take immediate and suitable action for prevention of disasters related to vehicular traffic.

Although fewer disasters occur in dry season in the country, road disaster can occur in dry season. The spots where unusual or anomalies identification was found in dry season are sometimes suffer from serious disasters. The daily observation at all times is important even in dry season to find unusual conditions on and along the highways.

The following table is the flow of disaster prevention works in routine maintenance.

The Micro-empresas who always walk on and maintain the highway could find unusual conditions on the highway. Once the Micro-empresa find the unusual on the highway, they shall communicate with the Supervisor who is in charge of the section. Also the Micro-empresa shall take any action of temporary measures in order to prevent any more vehicles are involved in.

The Supervisor who received report from the Micro-empresa shall rush to the spot, improve Micro-empresa's temporary works, and examine the spots.

If the Supervisor decides that the spot is critical, the Supervisor shall communicate with the Follow-up Engineer, and decide the permanent measures.

Table 1.1 Flow of Disaster Prevention Works in Routine Maintenance

	Action	by	note
1	***Finding of Unusual Condition***	Micro-empresa	
	↓		
2	**Report**	Micro-empresa	Supervisor moves to the spot
	↓		
3	**Temporary Measures**	Micro-empresa	
	↓		
4	**Correction / Addition of Temporary Measures**	Supervisor	Supervisor arrives at the spot
	↓		
5	**Examination**	Supervisor	
	↓		
	If Serious		
	↓		
6	**Discuss with Follow-up Engineer**	Supervisor	
	↓		
7	**Design of Emergency Work**	Supervisor Follow-up Engineer	

1 SCOPE OF WORKS

1.2 PERSONNEL INVOLVED

The persons concerned with the daily observation on the highway as disaster preparedness are the Micro-empresas and the Supervisors. The daily observation shall be simple method carried out by non-professional people who observe the road every day. The daily observation can be done in the course of ordinal Micro-empresas' road maintenance works.

Only when the Micro-empresas find unusual conditions on roads such as crack on road, demolition of retaining wall and existing of unstable rock, slopes, they shall report to the Supervisors. If an unusual condition on road, slopes was found by the Micro-empresas, the Supervisor shall check the spot.

1.3 OBJECT SECTIONS FOR DAILY OBSERVATION

The locations / sections where the daily observation is executed are High Hazard Control Sections and High Risk Control Sections (refer Guide I).

2 DAILY OBSERVATIONS

The daily observation shall be carried out by the Micro-empresas in the course of their road maintenance works. The daily observation focuses on unusual or anomalies identification on road surface, cut slopes, foot slopes on river contact, drainage systems, retaining walls, gabions, etc. in the Micro-empresas's ordinary works on their section of the highway. To do so, the Micro-empresas shall enter slopes above the road and below the road as shown Figure 2.1.

The type of disasters are identified graphically and attached in this guide for easy understand of the road disasters for the Micro-empresas.

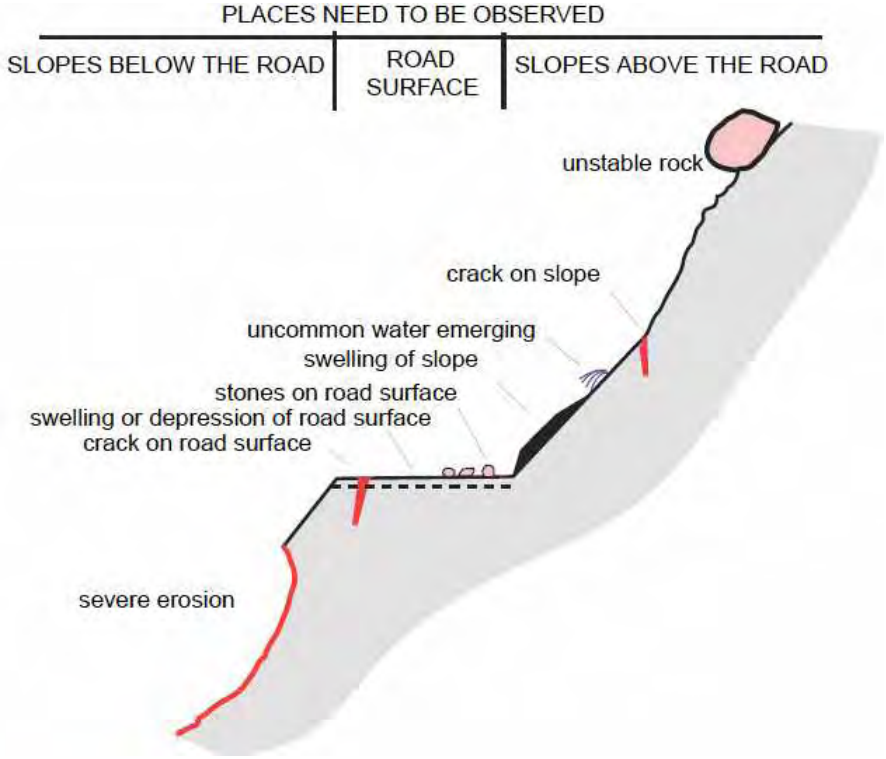


Figure 2.1 the area shall be observed and example of unusual condition

3 UNUSUAL CONDITIONS

The following symptoms shall be paid attention to by the Micro-empresas in daily observation and the Supervisors in detailed examinations.

Position/ Structure		Points of Observation
Road Surface	Dirt / Pavement	**Swelling or Depression**?
		Longitudinal or transversal **cracks** or any **defects**? (newly found or progressing?)
		Fallen **rocks** or **debris** on the road surface from upper slope?
Road Side	Shoulder	Serious **erosion**?
		Depression, open **cracks** or any defects? (newly found or progressing?)
	Drain / Culvert	Fallen **rocks** or **debris** inside, **malfunction** due to blockade or break, or any defects?
	Wall and Gabion	Fallen material in **pocket**, **breaking**, **deformation**, **cracks**, **tilting**, **depression**, **ill-interlocking**, or any defects?
On- slope above road	Slope (ground)	**Unstable** rocks?
		Trace of rock fall or slope failure?
		Depression, **swelling**, open **cracks**, or any defects? (newly found or progressing?)
		Marked **erosion** or gullies? (newly found or progressing much?)
		Water emerging or running water on slope or in drains? (any change of volume, turbidity?)
		Fallen or tilting of **trees** on the slope? (newly found?)
	Slope Works	**Breaking**, **deformation**, **cracks**, **tilting**, **depression**, **ill-interlocking**, or any **defects**? (newly found or progressing?)
On- slope below road	Slope (ground)	**Trace** of slope failure?
		Depression, swelling, open **cracks**, or any **defects**? (newly found or progressing?)
		Marked **erosion** or gullies? (newly found or progressing much?)
		Water emerging or running water on slope or in drains? (any change of volume, turbidity?)
		Fallen or tilting of **tree** on the slope? (newly found?)
	Slope Works	**Breaking**, **deformation**, **cracks**, **tilting**, **depression**, **ill-interlocking**, or any **defects**? (newly found or progressing?)

Table 2.1 Points of Observation and Recording during Ordinal Maintenance Works

4 MEASURES

4.1 COMMUNICATION

Once the Micro-empresa found the anomaly, the Micro-empresa shall communicate to the Supervisor in charge.
The Micro-empresa shall transmit the following information to the Supervisors.

1. location (station number)
2. what happened.
3. condition of road surface
4. passable or impassable at the spot
5. any vehicle or passenger involved in the spot
6. necessity of traffic control
7. outlook for the moment

The supervisor who received the report from the Micro-empresa shall rush to the spot except when he decides the spot is not critical according to the Micro-empresa's report.

4.2 TEMPORARY MEASURES

In order to protect vehicles passing-by, the Micro-empresa shall conduct temporary measures such as bellow with their judgement before the Supervisor's arrival.

Example of Temporary Measures

Obstructions on Road Surface

1. Dislodge the obstructions from road surface
2. if it is not possible to dislodge, control the traffic
   with proper signs in order to prevent the vehicles involved in.

Cracks or Depression on Road Surface

1. Control the traffic
   with proper signs in order that the vehicles could avoid the cracks or depression.

2. Prevent water from cracks or depression
   cover the cracks or depression with waterproofing sheet

Cracks on Slopes

1. Prevent water from cracks
   cover the cracks with waterproofing sheet
   ditch around the cracks

Unstable Rock on Slope

1. Dislodge the rock from slope
   if there is possibility of falling of the rock, traffic must be temporally closed.
2. Wait for the Supervisor, if it is not possible to dislodge by hand,

4 MEASURES

4.3 EXAMINATION ON THE SPOT

Once the anomalies are identify and informed from the Micro-empresa to the Supervisor, the Supervisor shall make a detailed examination, observing the anomalies characteristics and also realizing its monitoring, filling the disaster record form "HOJA DE INSPECCION DE DESASTRES" attached to Guide IV in this manual, and decide crisis level of the location, Low Critical, Middle Critical, High Critical and should take necessary actions as shown in Table 4.1 with discussion with the Follow-up Engineer of ABC regional office.

The Supervisor must communicate with the results to the Follow-up Engineer in the regional office and also realize the prevention measures for the section in risk.

4.4 PERMANENT MEASURES

In case that the anomaly is ascertained in the condition of critical, the supervisor should decide the necessary actions to be taken based on the critical level, such as followings;

- Verify anomalies characteristics
- Anomaly type (disaster type)
- Anomalies Evolution characteristics
- Determine the needs on monitoring (monitoring system installation)
- Determine the needs of elaborating work prevention design
- Give immediate alert to authorities in emergency cases depending of anomalies gravity

Table 4.1 Crisis Level and Actions

Crisis Level	Description	Actions
Low Critical	It is not be in danger.	Request the Micro-empresa to be concerned with the location.
Middle Critical	Some measures are required, however, the measure should not be large	Study emergency measures
High Critical	The location is in the critical situation and it is danger to traffics. Traffic control should be made.	Traffic Control Study emergency measures

Once the prevention measure works are determined for the stabilization of the road in discussion, the Follow-up Engineer shall manage the approval, and realization of the design, and manage for ABC the necessary budget for the execution of the prevention measure works on the spot.

5 MONITORING WORKS IF NOT SERIOUS

If the Supervisor decided that the spot where the unusual condition reported is not serious, temporary measures shall be kept to a minimum, and no more permanent measure shall be carry out.

Because disasters are repetitious and small disasters are omen of large scale disasters, the spot would be given emphasis in the course of daily observation in the routine maintenance.

6 DAILY MAINTENANCE WORKS

The significance of slope maintenance work shall be given much greater emphasis, since implementation of preventive countermeasure demands much budgetary funding to meet all the requirements. Slopes differ from road structures that are made of artificial material, steel, concrete, or bitumen, consist of natural material, soil and rock, which have many uncontrollable factors. Because most of the road disasters relate to water, the things what we have to do related to the disaster prevention works in the routine maintenance works is deal with water as follows.

- Clean gutters
- Clean cross drain pipes
- Prevent slopes from surface water
- Prevent road surface from surface flow
- Prevent surface water flowing over road shoulder (prevent road shoulder erosion)

6 DAILY MAINTENANCE WORKS

APPENDIX II-1

DISASTER OBSERVATION GUIDE FOR THE MICRO-EMPRESAS

(OBVERSE AND REVERSE)

PREVENCION DE DESASTRES EN CARRETERA

MANTENIMIENTO RUTINARIO Y ALERTA TEMPRANA

¡Necesita cuidado! ¡Signos de desastre!

Posibilidad de **Derrumbe (DR) / Caída de rocas (CR)**

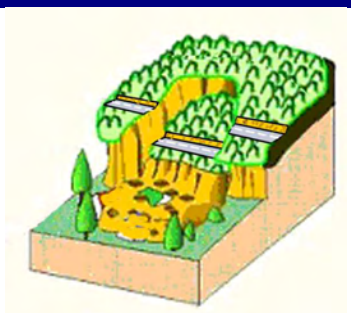
- Caída sucesiva de **rocas pequeñas o piedras.**
- **Grietas** que pueden ser vistas en el talud.
- **Emana Agua** del talud.
- **Sonido** de raíces rompiéndose.

Posibilidad de **Falla de Terraplén (FT)**

- **Grietas / subsidencia** en la superficie de la carretera.
- Se pueden ver **Agrietamientos / Inclinación del** muro de contención.
- **Agua** fluye sobre la superficie de la carretera y se acumula en un solo lugar.
- **Los desagües longitudinales** se deforman.

Posibilidad de **Deslizamiento (DS)**

- **Árboles y postes** de energía se inclinan.
- Se puede ver **Agrietamiento / Inclinación del** muro de contención.
- **Grietas / subsidencia** en la superficie de la carretera.
- **Brotes de agua** en el talud.
- Vertientes o agua de arroyos cercanos se vuelven cafés y **fangosos.**



Posibilidad de **Flujo de Mazamorra (FM)**

En arroyos cercanos a la carretera.

- Se pueden oír **Sonidos de bajo tono.**
- **Lodo** mal oliente (en descomposición).
- **Nivel de agua** del arroyo se vuelve menor aunque haya llovido.
- Agua del arroyo se **vuelve fangosa** y hay Madera flotando en el agua.

Si usted encuentra reacciones anormales como las que mencionamos anteriormente por favor contáctese con el **Supervisor.** (Debe siempre revisar la carretera)

Julio 2006, manual de prevención de desastres en carretera, Guía II mantenimiento rutinario.

Por favor anote sus teléfonos más importantes a continuación.

Supervisor: _____

ABC Oficina regional: _____

Policía: _____

Otros: _____

Grupo: _____