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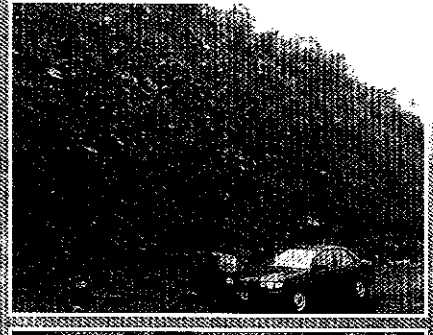
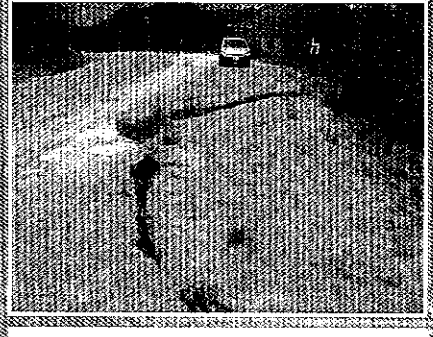
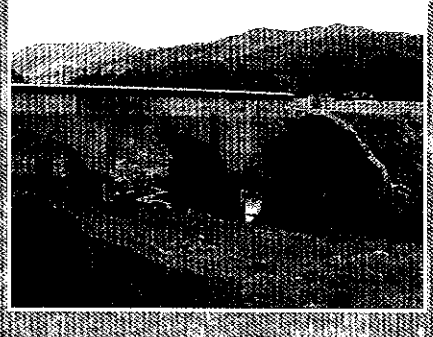
JAPAN INTERNATIONAL
COOPERATION AGENCY (JICA)

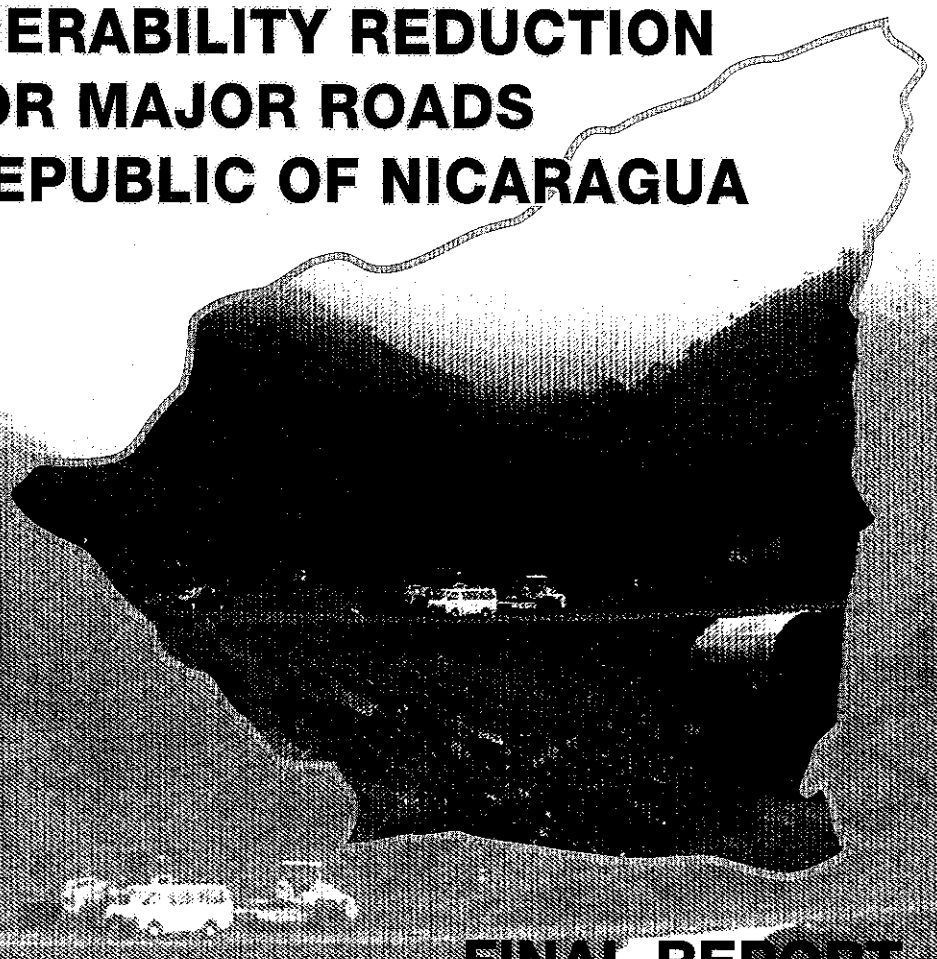
MINISTRY OF TRANSPORT AND
INFRASTRUCTURE
REPUBLIC OF NICARAGUA

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









FINAL REPORT

Volume 5 of 5 (1/4)

INSPECTION MANUAL

January 2003

Oriental Consultants Company Limited

Japan Engineering Consultants Company Limited

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COOPERATION AGENCY (JICA)

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List of Abbreviations
(In alphabetical order)

AADT	:	Annual Average Daily Traffic
AASHTO	:	American Association of State Highway and Transportation Officials
AHP	:	Analytic Hierarchy Process
ASTM		American Society for Testing and Materials
B/C	:	Benefit to Cost ratio
BH		Boring Hole
BHN	:	Basic Human Needs
BIT		Central American Development Bank
DID		Densely Inhabitant District
EIA	:	Environmental Impact Assessment
GDP	:	Gross Domestic Product
GRN	:	The Government of Republic of Nicaragua
ID		Identification
IDF	:	Rainfall Intensity Duration Frequency
IEE	:	Initial Environmental Examination
INETER	:	Institution of National Territorial Study
IRR	:	Internal Rate of Return
JICA		Japan International Cooperation Agency
MARENA	:	The Ministry of Natural Resources and Environment
MTI	:	The Ministry of Transport and Infrastructure
OD	:	Origin and Destination
PRSP	:	Poverty Reduction Strategy paper
QV	:	Volume capacity
ROW	:	Right of Way
STRADA		System for Traffic Demand Analysis
VAT		Value Added Tax
VOC	:	Vehicle Operation Cost
WB		World Bank
pcu	:	Passenger Car Unit

The following foreign exchange rate is applied in the study :

1 US dollar = 14.40 Cordovas = 125.00 Japanese Yen (October 2002), or

1 Cordovas = 8.68 Japanese Yen

CHAPTER 1 INTRODUCTION

1.1 General

This manual has been produced for the Ministry of Transport and Infrastructure (MTI), who will manage the road disaster prevention programme for major and rural roads in Nicaragua, assisted by the Japan International Cooperation Agency (JICA). The Direction of Road Maintenance, General Direction of Road, in MTI (GDR) has management responsibility for the maintenance works of all roads controlled by MTI. Therefore, in order to achieve the reliable maintenance works, all roads under GDR should be maintained in accordance with this manual.

Maintenance works for road disaster prevention are one of the fundamental factors in increasing the socio-economic performance of a nation. Therefore, economic activity of the populace and safety road users are dependent on the results of planned road maintenance. Efforts that do not slacken are important for securing the stable transport of people and products. GDR, Engineers, inspectors, technicians and maintenance staffs should execute road maintenance work based on consistent policies and methods.

This series of road disaster prevention manual are composed of four parts as follows;

Part I : Inspection Manual
Part II : Planning Manual
Part III : Design/ Execution Works Manual
Part IV : Maintenance Manual

This document is Part I "Inspection Manual".

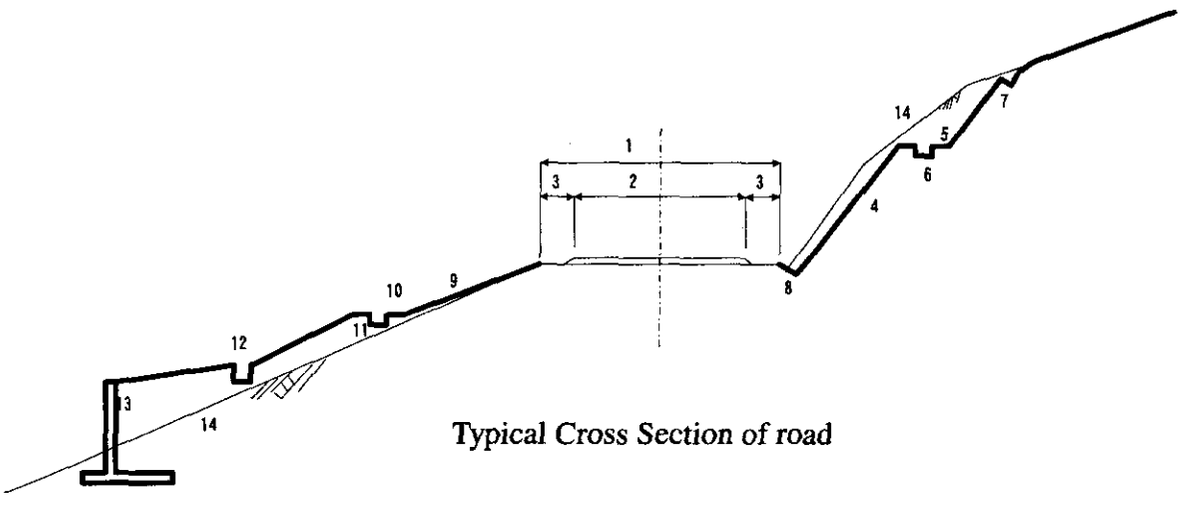
This Manual has been developed taking account of natural conditions, road geometries and environmental condition. Engineers, Inspectors, Technicians and maintenance staff should be kept on doing maintenance.

1.2 Glossary of Terms

This Chapter contains a glossary of terms that are used in this manual.

1.2.1 Cross section

The typical road cross section is as the following figure. Almost cut slopes, embankments and ditches, etc. are not enough safeguard against failure. Therefore, this manual contains proposals shown in following figure as bold lines.



Typical Cross Section of road

Key;

1. Roadway
2. Carriageway
3. Shoulder
4. Cut Slope
5. Berm
6. Berm Ditch
7. Crest Ditch
8. Roadside Drain
9. Embankment Slope
10. Berm
11. Berm Ditch
12. Berm Ditch
13. Structure
14. Existing Slope

1.2.2 Glossary of Terms

The main "Glossary Terms" are as follows.

AHP	This is one of evaluation method for selecting the high priority disaster spots. AHP is an abbreviation of the Analytic Hierarchy Process.
Catchment Area	The area from which water runs off by gravity to a collecting point.
Culvert	A duct, usually rectangular or circular, for carrying surface water under the road.
Gabion	The steel mesh cage filled with cobble stone or crushed stone. This is mainly used for revetment, foot protection and rockfalling protection.
Disaster Critical Spots	Disaster critical spots should be defined in consideration of the following items to the disaster potential spots: - Disaster scale/ records at area of spots, - Necessary spots for emergency, - Critical spots for third persons, - Topographic data by preliminary topographic survey, and - Sketch of site condition.
Disaster Potential Spots	Disaster potential spots are defined when there are: - boulders on slope surfaces, - many cracks on rock surfaces, - small rock fallings, and - historical disaster records regarding rock-fall, rock collapsing, slope slide, scouring of bridge foundation.
Disaster Prevention Spot	Where countermeasures against disaster are proposed, Which addressed the following: - Stability level of damage spots, - Traffic volume of objective road, - Environmental evaluation, - Natural condition, - Benefits/ Rough cost estimate, - Restoration level of damaged spot, and - Development situation.
Emergency Countermeasure	- It means that a serious and dangerous spot must be improved immediately. - The lifetime of countermeasures should be until the next rainy season or less than a half year. - It is necessary to decide upon the implementation of temporary countermeasures or permanent ones during the lifetime of the emergency countermeasures.

Emergency Inspection

<Time of Year>: The Emergency Inspection must be carried out just before any forecast hurricane or heavy rain.

<Spots> : Slope spots previously damaged, seepage water spots on slope and severe scouring spots at bridge foundations, must be carefully inspected and be written on the survey sheets by Inspectors.

<Frequency> : Just before hurricane or heavy rain.

Inspector

Inspector means a member of Inspection Team. Inspection team is composed of a Engineer and two assistants.

Periodic Inspection

<Time of Year>: The Periodic Inspection must be carried out before the rainy season (usually around September) or after earthquake occurred.

<Spots> : At least, whole slopes of disaster potential spots, and around the bridges at disaster potential spots must be inspected and be written on the survey sheets by Inspectors.

<Frequency> : Once every year

Permanent Countermeasure

- The lifetime of countermeasures should be least twenty (20) years during the maintenance work.
- An adequate budget for permanent countermeasures should be safeguarded at all times.

Routine Inspection

<Time of Year>: The Periodic Inspection must be carried out as general inspection throughout the year.

<Spots> : Whole slopes and bridges on the objective major road is inspected and be written on the survey, if some abnormality occur.

<Frequency> : Once for a week

Screening

The objective of screening is as follows:
- Objective inspection of vulnerable spots,
- Early detection of vulnerable spots, and
- Characteristic grasp of vulnerable spots.

Temporary Countermeasure

The lifetime of countermeasures should be at least ten (10) years during the maintenance work.

1.3 Relating Law

Each regulation for construction work of disaster critical spots is described in this Section. There are two regulations for construction work and for its transportation of materials and machines.

1.3.1 Law 337

National Committee has managed the National system for the Prevention, Mitigation and Disasters in Nicaragua. The following contents have extracted from the Creator Law of National system.

Chapter 1: General Dispositions

Art. 3 Basics Definitions

Numeral 7 Disasters:

In all situations that cause intense alterations for the social, physical, ecological and cultural society components, taking to imminent danger the human life and the personal and national goodness, surpass the local answer capacity to give efficiently attention to the consequences; it could be from a natural origin or caused by the man.

Numeral 8: Natural Disasters

This damages are caused by any natural phenomenon, this could be a hurricane, a twister, storm, high tide, inundation, tsunami, earthquake or volcanic eruptions, land slide, forest fire, agriculture blight, dried and others that as result will affect the population, the infrastructure and some productive sectors from the different economical activities, in a high scale that overcome the capacity for local answers and require the regional help; at the request of one or more of the affected parts to complete the able resources efforts on it, so that the damages and the loss could be mitigate.

Numeral 12. Disasters Prevention

It is call to the group of activities and measures from a technical and legal character that has to be done in a Socio- economical development Planning process, so that the loss of humans life and damages on the economy could be avoid as a consequence of the natural disasters.

Art. 7 National System Functions

Part 1.
Design, ratify and execute the disasters prevention plan.

Part 10

To establish the agreement for Scientific-Technical cooperation for countries with more experience on it.

Chapter II

From the National Commitment of the National System for Prevention, Mitigation and disasters attention

Art. 9. National Commitment of the National System.

The national commitment of the National system, from now on is call National Commitment; it is the ruling instance and the one who can establish the political, planning, direction and the system coordination all over their activities.

Art. 10. National Commitment integration.

The national commitment joint to the State ministries or their represent, is going to be presided by the president of the republic or the vice president. This National Commitment has a permanent character.
The sessions works of the national commitment have to be on the running time at least two times in the year and they will regulated themselves with the Rules established on the present law. This commitment is going to be conformed as follows:

1. President of the Republic or a representative
2. Secretary of Defend , companied with the Chief of the national army
3. Secretary of Interior , companied with the chief of the national police.
4. Secretary of state
5. Secretary of Treasure and public credit.
6. Secretary of Foment, Industry and business.
7. Secretary of health
8. Secretary of Transport and Infrastructure
9. Secretary of environment and Natural resources
10. Secretary of the Family

11. Secretary of Education, Culture and sport.
12. Director of Territorial Study institute.

Art. 11 Commitment functions

For the present law and their ruling, it is function of the National commitment the following aspects:

1. Definitions of the national system politics
2. Approve the national plan for the national system
3. Propose to the president of the republic the declaration of the disaster conditions.
4. Approve the annual purpose for the national disaster fond.

Propose the adoption of required measures and instruments to make useful the objectives of the national system, such as territorial order and education, and more.

5. Creation of the procedures on instruments for the control and distribution of the international help.
6. Approve the norms and regulation propose of the territorial order for the disasters prevention.
7. Convoke, such as adviser, to the governmental and non governmental organisms.
8. Approve the items and contents of the study that has to be include on the education programs of the Department of Education, culture and Sports, such as the others institutions of the technical education and superior, about prevention, mitigation, and disasters attention.

In the Department of Transport and Infrastructure exist a technical joint unity for disasters that are direct dependant from the Superior direction of the MTI and in case that disasters occur is attended by the General Director of Constructions Norms and urban Development.

1.3.2 NIC 2000

Sub division 100
Section 105 Work reach

1. General

105.07 Dispositions about the Traffic Control

The contractor can not close to the traffic for any reason publics routs or stretch or bridge without a previous writing approve by the engineer. Neither can start with the constructions works that for any reason left the public road on non adequate conditions for the traffic flow, with out a previous temporary construction approved by the engineer based on the commodity and security aspects.

Other wise it is arrange on a different way on the draws, preventive signs should be installed far away from the project limits, at least 150 meters from each side. And at least 150 m form another project site where the constructions works interfere with the public traffic that use the route.

During the night should be working flashing beacon, lanterns. Electrical and reflective instruments and any other approved light sign in the places where it is necessary.

Where it is necessary and the places where the engineer said, should be use a standard bearer , or pilots cars or routs savers with the purpose to guide and arrange the traffic and pedestrian circulation. The workers should be wearing uniforms or specials jackets and pennant or manual signs so that they could be easily seen by the drivers during the day and the night.

When the works are done on adjacent areas of lanes to open traffic areas, the borders of the lanes or of the pavement should be defined trough portable definers placed on the whole length and parallel to the border.

105.06 Traffic Maintenance

1. Construction of the Road by band.

Specially in case of paving or re-paving, the contractor could, if the engineer approve, proceed to work with band, leaving free a space with a enough wide for the secure and comfortable traffic pass and controlling trough the standard bearer or pilots car; on both opposites routs of traffic circulation.

Ruling for the load control and dimensions of the load carrying vehicles that transit on the Road network of Nicaragua (MTI) March 2002

Art. 9 It is establish that the carried load should respect the following aspects.

1. No load could be more than 1.0 m from the back side of a vehicle.
2. Any loaded or unloaded vehicle could exceed the follow dimensions:

Wide: 2.60 m.
Height: 4.15 m. (starting form the running surface)
Length: a) 2 axes : 11.0m.
b) 3 axes: 12.0 m.
c) half tow truck : 17.35m.
d) others combinations: 18.3 m.

Art. 19

When for any reason of general interest, had to be occasionally transported, heavy machines or other invisibles objects, on load carry vehicles allowed to use the country road network which load and dimensions exceed the indicated on appendix that are stipulated on this ruling, a special permission is granted by the Road General Direction at the request of the owner of the special load at least previously 3 days before the carry of the load, which has limited urgency just for the particular trip.

Art. 20

In each special permission it is going to be specify the type of load, the rout that is going to follow and the appropriate time, the circulation speed on the roads and specially on bridges, accompaniment of radio squad and others protections measures of the road network and safety of the others users.

Art. 42

Motorized vehicles or their combinations should have pneumatic tires or dispositives with enough elastic surface. It is prohibit to use metallic objects that are prominent on the running surface of the tire. The tires pressure on none case can exceed the load of 8.4 kg/cm^2. It is prohibit to circulate with chains or metallic bands.

1.3.3 Law for Vehicles and Traffic

Art. 61

It is totally prohibit to carry objects that are prominent from the external sides of vehicles and every time that they are prominent form the posterior side of the vehicle, they should be provide with a red scarf, if it is during the day; or a red light if it is during the night.

Note: Law approved on may 10, 1938

CHAPTER 2 PREPARATION OF INSPECTION

2.1 Objectives

After the screening of objective roads is completed, stability surveys should be carried out at the spots where inspection is needed. The data shown below should be recorded by every inspection survey. Besides, the data should be effectively used for maintenance work.

a) Stability survey sheets,
b) Tables of inspection result,
c) Figures of inspection result,
d) Record of each inspection spots, and
e) Past disaster record of each inspection spots.

2.2 Inspection Tools

The following tools should be brought to the inspection spots for stability survey.

- Stability sheets,
- Tables of survey result,
- Figures of survey result,
- Inventory data and map,
- Binocular,
- Camera,
- Rock hammer,
- Marking materials,
- Measuring tape, and so on.

2.3 Inspection Teams

The inspection team is composed for the spots where the survey is necessary. The following staffs are recommended.

1. Engineer : 1 person who is able to judge the disaster condition
2. Assistant : 2 persons who assist the engineer with survey tools

2.4 Survey Sheets

2.4.1 Stability Survey Sheets

The "Stability Survey Sheets" should be completed at each site. Data to be recorded differs by disaster type as follows:

- Rockfalls, collapsing : factors, countermeasure, disaster record, stability in case of earthquake and total evaluation
- Rock collapsing, : factors, countermeasure and total evaluation
- Slope slide : factor, disaster record, countermeasure and total evaluation
- Debris flow : factor, countermeasure, road structure, disaster record, assumed disaster type, total evaluation
- Scouring of bridge foundation : stability of riverbed and river embankment, situation of abutment and pier, transformation, total evaluation

A sample Stability Survey Sheet (for rock-falling, collapsing) is shown in the figure below. Other sheets are presented in page A1-5 to page A1-9 of the Appendix.

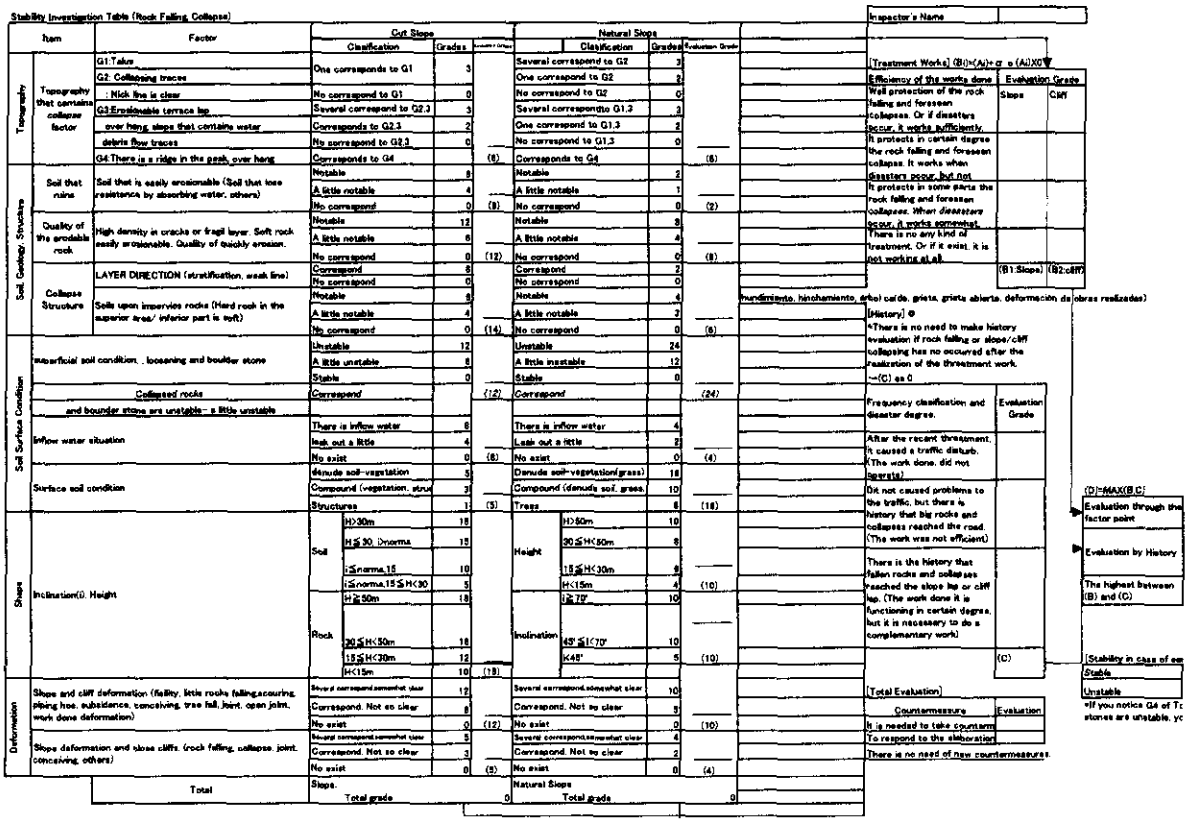


Figure 2.4.1 Sample Figure of Stability Survey Sheet (Rockfalls, collapsing)

2.4.2 Tables of Survey Result

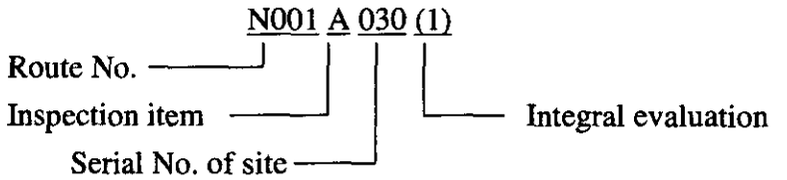
The survey results of inspection spots should be written up in the "Table of Survey Result" shown on page A1-1 of the Appendix. The following items should be compared.

- No. : number to be controlled
- Name of the Road
- Road Classification : National road, Rural road, etc.
- Name of the Site
- Inspection Item
  - A: Rockfalls, collapsing
  - B: Rock collapsing
  - C: Slope slide
  - E: Debris flow
  - H: Scouring of bridge foundation
- Traffic Restriction : In advance - 1, In special - 2, No - 3
- Restriction Criteria :
- Detour : Exist - 1, Nothing -2
- Inspection of result year **
- History of Disaster : Yes – 1, No but admitted – 2, No - 3
- Inspection Result of year 2002 : score of factor, countermeasure and disaster record
  Total evaluation : countermeasure necessary - 1
  : disaster prevention record necessary - 2
  : no necessary - 3
- Proposed Countermeasure work : type, norm, quantity, cost
- Stability in case of earthquake : stable - 1, unstable - 2.

2.4.3 Figures of Survey Result

The survey results of inspection spots should be entered on to maps of the "Figure of Survey Result" shown on page A1-2 of the Appendix. The following items should be completed:

A unique site identifier:



- Route No. : N001 (This means Nic. 1)
- Inspection item
  - A: Rockfalls, collapsing
  - B: Rock collapsing
  - C: Slope slide
  - E: Debris flow
  - H: Scouring of bridge foundation
- Serial No. of site : e.g. thirtieth (30) on Nic.1
- Integral evaluation
  - (1) : It is necessary countermeasures
  - (2) : It is necessary to consider prevention work
  - (3) : It is not necessary countermeasures

A symbol on the figure of each site as follows:

- ○,△,x : mark for site inspection
  - ○ : Inspection site in 2002
  - △ : Inspection site in before 2002
  - x : Inspection site where has the damaged record

2.4.4 Record of Inspection Spots

The survey records of inspection spots should be written in the table of "Record by inspection site". The sample table of inspection site is presented on page A1-3 of the Appendix.

2.4.5 Past Disaster Records of Inspection Spots

The past disaster records of inspection spots should be also written in the table of "Record by site of inspection". The sample table of record table is presented on page A1-4 of the Appendix.

2.5 Assessment of Items/ Scores in Survey Sheets

2.5.1 General

After the screening has been carried out against inspection spots, Inspection Teams should carry out a stability survey based on the result of screening. The Engineer and his staff should write the score to the survey sheet while on site. After surveying, it is very difficult to assess the inspection spots as a disaster potential spots or disaster critical spots.

2.5.2 Disaster Potential Spot

Disaster potential spots are defined as the following items.

- To exist boulder on slope surface,
- To exist many cracks on rock surfaces,
- To exist small rocks falling, and
- To exist disaster records regarding rock-fall, rock collapsing, slope slide, scouring of bridge foundation, and so on.

- **for bridge : seventy (70) score over.**

<Definition>

The score should be assessed with by rating 6 important factors on the stability survey sheet. Those factors are composed of riverbed incline (15), bridge location (20), minimum span length (15), ratio of river flow blocked by piers (15), and clearance under the deck (10). Giving a total score of each factor is 75 points. A score of 70 or more defines a potential disaster spots.

- **for cut/ embankment slope : sixty (60) score over**

<Definition>

The score of cut and embankment slope should be assessed with against 5 important factors on the stability survey sheets. For the rock-falls and collapsing, those factors are composed of soil structure (8) or rock structure (12), vulnerable mechanics (14), unfixed stones or boulder stones of slope surfaces (12), slope incline or height (18), and slope transformation (12), total score of 64 or 68 points. A score of 60 or more defines a potential disaster spots.

For the rock collapsing, the rated factors are crack scale of rocks (30), continuous horizontal cracks (10), condition of soft or hard rocks (11 or 15), and direction of bedrock (15), total score of 66 or 70 points. A score of 60 or more defines a disaster potential spots.

For the debris flow, the rated factors are area of basin (10), steepest mountain torrents incline

(10), area of slope incline in 30 degree over (8), and area of field grass or tree (8). The total score of each factor is 36 points. But total original scores are 56 points. The ratio of highly important factors and total original scores are 0.64 points. Therefore, the score of debris flow is possible to establish in 64 points. Therefore, the score, which is selected disaster potential spots of debris flow, should be established the lower limit as 60 scores.

2.5.3 Definition of Disaster Critical Spots

Disaster critical spots should be defined in consideration of the following items to disaster potential spots.

- Disaster scale/ records at area of spots,
- Necessary spots for emergency,
- Critical spots for third persons,
- Topographic data by preliminary topographic survey, and
- Sketch of site condition, etc.

As a result of decision, the score of disaster critical spots will be defined as ninety (90) points over against bridge foundation scouring and as seventy (70) points over against rock-falls, rock collapsing and slope slide.

2.6 Frequency of Inspection

Inspection of road disaster critical spots should be executed before disaster occurs. The following inspection schedule should be adhered to.

- **Emergency Inspection**
  - **<Time of Year>:** The Emergency Inspection must be carried out just before any forecast hurricane or heavy rain.
  - **<Spots>:** Slope spots previously damaged, seepage water spots on slope and severe scouring spots at bridge foundations, must be carefully inspected and be written on the survey sheets by Inspectors.
  - **<Frequency>:** Just before hurricane or heavy rain.

- **Routine Inspection**
  - **<Time of year>:** The Routine Inspection must be carried out regardless of season or occurrence of earthquake through the year.
  - **<Spots>:** Vulnerable spots on slope and vulnerable spots at bridge foundations must be inspected and be written on the survey sheets by Inspectors.
  - **<Frequency>:** Every week

- **Periodic Inspection**
  - **<Time of Year>:** The Periodic Inspection must be carried out before the rainy season (usually around September) or after earthquake occurred.
  - **<Spots>:** At least, whole slopes of disaster potential spots, and around the bridges at disaster potential spots must be inspected and be written on the survey sheets by Inspectors.
  - **<Frequency>:** Once every year

CHAPTER 3 SCREENING OF INSPECTION POINTS

3.1 Screening of Inspection Points

3.1.1 Method for the Selection of Inspection Points

(1) Method for The Selection of Inspection Points

Based on the study site, inspection points are selected according to Sub-section 3.1.2., "Criteria for the selection of inspection points".

The length of the inspection point is defined through an observation of topography and geology and the status of disaster-prevention treatments.

(2) Data and Appliances Necessary for Field Inspections

In addition to the tools and Inspection Tables described in Chapter 2, "Preparation of the Inspection", data and appliances necessary for field inspections are this Manual, topographic maps, inventories and plans of road structures. The desired scale for topographic maps is 1/25,000, but, should they not exist, it is possible to use maps to a scale of 1/50,000.

The determination of the latitude and longitude of the study site by using Global Positioning Systems (GPS) should facilitate future work.

3.1.2 Criteria for The Selection of Inspection Points

The criteria used for the selection of each item are indicated from (1) to (7). However, those points matching the contents of [1] to [3] below will be selected as inspection points.

[1] Points where a factor for potential disaster can be clearly seen

[2] Points where an inspection is deemed necessary because of a past history of disasters.

[3] Points whose status has changed because of treatment works and/or human intervention.

Selection criteria for each item:

(1) Rockfall/ Collapsing

Points matching one or more of these four items:

i) Over 15 meters of cut and/or natural slope, or over 45° of natural slope

ii) Points where loose rocks and/or boulders are found on the surface layer

iii) Points with soil, rock and structure collapse

iv) Points where existing works have become obsolete, or where the efficacy of works need reviewing

Any point where the cut slope is lower than 15 meters or inclination is under 45° will be selected as inspection point if a high potential for disasters is observed.

(2) Rock Collapsing

Points with outcrops of rock masses in the slope and/or slopes with height greater than 15 meters.

Points with a slope height lower than 15 meters will be selected as inspection points if there are over hangs and/or cracks due to the movement of rocks.

(3) Slopeslides

i) If the point matches one of the following:
   [1] Points with potential slopeslides, and/or
   [2] Slopeslide protection zones

ii) If symptoms of slopeslides are observed (abnormality of road structures and points with slide symptoms within sight, including topography)

(4) Embankment Slope

Embankments with a height greater than 5 meters and matching at least one of the following items:

i) The location of the site complies with at least one of the following conditions:
   [1] Terrain formed by land slides
   [2] Catchments area
   [3] Terrain formed by weathering
   [4] Steep slope
   [5] River front
   [6] Lowlands in the bottom of valleys
   [7] Terrain reclaimed through filling
   [8] Terrain reclaimed from the sea
   [9] Soft terrain (lowlands of alluvial deposits matching one of the following:)
   [10] Former or current channel
   [11] Lowlands in dunes, or sand banks
   [12] Swamp formed by a spillway
   [13] Former swamp or lake
   [14] Access way to a bridge

ii) There are problems for the installation of drainage.

(5) Debris Flow

Ravines or small rivers crossing the road and matching the following conditions:

i) The road crosses the ravine through a bridge, a box culvert or an overflow bridge, with the exception of bridges crossing the ravine through a tunnel with more than 10 meters of clearance under its pier, and, also, ravines with a width greater than 20 meters.

ii) The surface of the catchments area must be greater than 1 hectare (0.01 Km^2).

iii) The maximum inclination of the ravine bed upstream must be greater than 10°.

iv) Inclination at the crossing point must be greater than 2°.

(6) Scouring of Bridge Foundations

Bridges built in the river area must be the object of inspections, with the exception of the following:

i) The bridge exists in a zone of stagnant water, and there is no possibility of scouring.

ii) The bridge consists only of an abutment, which means it has no piles, and bank protection works are being made in both sides of the bridge

iii) Adequate works to protect against scouring have been made, and no abnormality is found in the works.

iv) If the foundation consists of piers, caisson, or steel tubes, and the penetration (depth from the river bed to the supporting layer) is enough (over 15 meters, and more than eight times the distance between piles meeting the current in a straight angle)

v) The stability of the foundations has been confirmed, and there are no changes in the current because of river regulation works, etcetera.

vi) The bridge's length is under 15 meters. However, it must be submitted to inspection if it has a history of damages caused by natural disasters, or if there is a high possibility of disasters in view of the river's status and the bridge's structure.

(7) Retaining Walls

Points meeting, at least, one of the following conditions:

i) Retaining wall whose abnormality has influence over the surrounding areas (in case of a masonry wall, blocks, mixed, gravity and cantilever, their height must be greater than 3 meters; height must be greater with other kinds of walls).

ii) The location of the site meets at least one of the following conditions:

[1] Terrain formed by land slides

[2] Catchments area

[3] Terrain formed by weathering

[4] Steep slope

[5] River front

[6] Lowlands in the bottom of valleys
[7] Terrain reclaimed through filling
[8] Terrain reclaimed from the sea
[9] Soft terrain (lowlands of alluvial deposits matching one of the following:)
[10] Former or current channel
[11] Lowlands in dunes, or sand banks
[12] Swamp formed by a spillway
[13] Former swamp or lake
[14] Access way to a bridge

3.2 Calibration of Results of the Inspection

3.2.1 Objectives of Calibration

In case to realize the stability inspection through of the plurals technician, it will appear the individual difference in the results of the inspection and this will difficult the evaluation as same criterions. When only a technician realized the inspection, the evaluation of the cut slope and the natural pendent probably depend of the relative appreciation of the natural condition in the studies places. For that is necessary to rectify, comparing some of the results of the stability inspection.

This manual, with the object to standard the criterions of evaluation stable the calibration of the results of the stability inspection that will be make in the study phases.

3.2.2 Time and Meted to Realize the Calibration

(1) Time to Realize the Calibration

a) In the beginning phase of the inspection, when the inspection have been finished in more that ten places who are locate in the same rout (including the lindantes routs) with the same items of inspection the results must be ordering by the final scoring of each inspection table. Them consulting the inspection table and the total evaluation, by necessity.

In case that the quantity of the inspectional place be less that ten by each technician, the calibration shall be realize at the end of the inspection of all the places.

b) Is possible that appear the difference of the stability evaluation by the conditions of the slope of each route, by each month after the inspection beginning or when will have change the inspection technicians, it must order the places from first to tenth. After that we will verify the ordering pertinence and they check the scoring of each inspection item of the table and the total evaluation, by necessity.

c) Having in count the scouring and the integral evaluation of the places where they realized the calibration, they have to continue examinering the other places.

(2) Calibration Method

In the initial phase of the execution of the stability inspection, when more of the ten inspection places have finished with the same items as we show in the Figure-3.2.2, the results will be order as we can see in the Table-3.2.2.

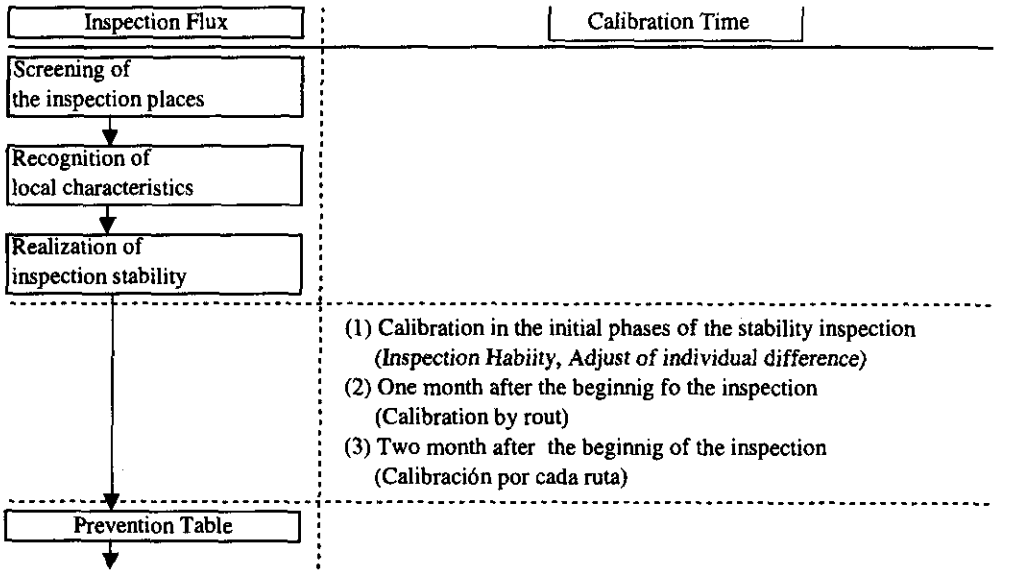


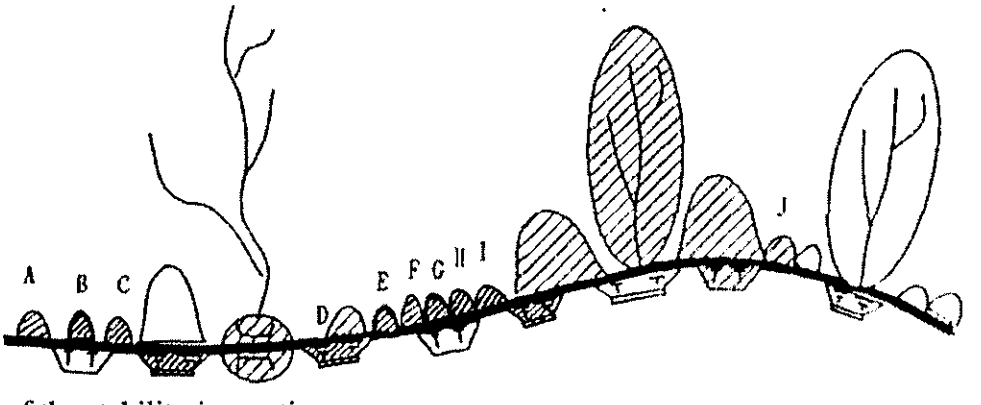
Figure 3.2.1 Inspection Flux and Calibration Time

Table 3.2.1 Calibration of Initial Phases of the Inspection (Example)

Order	1	2	3	4	5	6	7	8	9	10
Places of Inspection (Score)	A (80)	F (80)	G (60)	B (55)	D (50)	C (50)	H (40)	I (30)	J (20)	E (20)
Calibration Ejecution	Ídem	Ídem	Ídem	B (70)	Ídem	C (60)	Ídem	Ídem	J (40)	Ídem

Commentary	As a result of the calibration, appear a doubt of the order of B, C, J. Them review and change the scoring and the order.

Order	1	2	3	4	5	6	7	8	9	10
Places of Inspection (Score)	A (80)	F (80)	B (70)	G (60)	C (60)	D (50)	H (40)	J (40)	I (30)	E (20)



Realizing of the stability inspection ⟶

⟵ Review of the inspection results (Calibration)

Figure 3.2.2 Calibration of the Results of the Stability Inspection

After made the stability inspection, each month they will have to do the calibration by rout and check the inspection score with the objective of do the evaluation.

Table 3.2.2 Calibration by Route (Example)

Order	1	2	3	4	5	6	7	8	9	10	Note
Rout A: Place of Inspection (Score)	A (80)	F (80)	B (70)	G (60)	C (60)	D (50)	H (40)	J (40)	I (30)	E (20)	
Ruta B: Place of Inspection (Score)	e (90)	h (90)	a (70) ↓ (80)	b (70) ↓ (80)	i (70)	c (60)	i (50)	d (30) ↓ (40)	f (30)	g (20)	In contrast of rout A, the evaluation of the rout B is a little lower
Rout C:											

(3) The Inspection of the Same Rout and the Same Items should Pass through Two or more Inspectors

The inspection of the same rout and the same items should pass through two or more inspectors in the time that here are indicated in Sub-section 3.2.2, Item a), b) of (1), them they will review and comparer the ordering of each one and by necessity make a modification of the scoring with the objective of adjust the evaluation.

3.2.3 The Inspections Items that should be Submited to the Calibration

The inspection items that should be submited to the calibration are three: Probably in them are deviation of score and mayor quantity.

[1] Rockfall/ Collapsing

[2] Rock Collapsing

[3] Retaining Wall

3.3 Method for the Evaluation of Stability: Rockfall/ Collapsing

3.3.1 General

(1) Evaluation Factor, Measures and History

The purpose from the inspection of Rockfall/ Collapsing, cover the phenomenon of natural disaster that occur on the cut slopes and the natural slopes, besides the Rock collapsing, Slope slide and Debris flow.

The inspection should be done through two parallels evaluations:

First one is evaluation depends on the factors of the topography, geology, inclination of the slopes, height, currently abnormality and efficiency of the existing measures. Another one is the evaluation of the historical disasters, which occurred after execution of the works of countermeasures. And both evaluations should be given score. After comparing evaluation of both factors, higher score should be adopted, as the score for the stability survey evaluation

To decide the unit of cut slope and/or natural slope, it is necessary to consider the following aspects:

[1] That is no variation on the condition of the cut slope and/or natural slope. It seems to be same ones.

[2] It is continuous cut slopes and natural slopes without separation by valley.

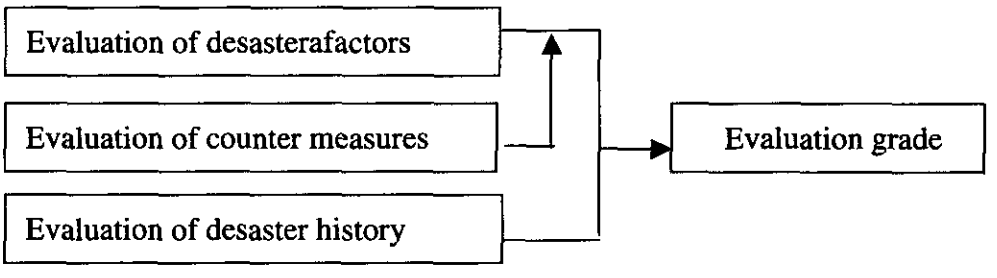


Figure 3.3.1 Concept of Stability Evaluation Rating

(2) Integral Evaluation

The engineer considers the scale and the influence of natural disasters from following items;

i) Disasters factors,

ii) Effective of the countermeasures,

iii) Disasters history, and

iv) Conditions around the site.

After consideration the engineer make a policy of correspondence among the three as follows;

● It is necessary to take measures	There is a potential of disasters on the spots.
● To correspond with a table of the "Disasters Prevention Description Sheets"	There is a need to take measures in the future. But at the moment, control is exercised through vigilance as per the "Disasters Prevention Description Sheets".
● It is not necessary to take new measures	The site show no disaster factors and there is no need to take new measures.

(3) Stability in Case of Earthquake

Mark with a circle the corresponding item :

[Example of Unstable Case]

[1] Peak Hill

[2] Cut Slope and/or natural slope which have convex shape and over hang.

[3] The slope which have unstable rocks and boulders exist and/or boulder.

(4) Factors to be consider for the Evaluation Score of Stability Survey

1) Topography

The site have frequently Rockfall / Collapsing to be occurred, could be observed the particular topographic feature which composed by the result of those phenomenon, or the topography which provoke the Rockfall / Collapsing. Therefore, the spot which has those physiognomys can be classified as a potential spots of Rockfall / Collapsing. Those topographies are called Topography with collapsible factors such as;

[1] Talus

[2] Talus which is compounded with collapse

[3] Clear Knick Line,

[4] Plateau flap

[5] Erosion around toe of slope

[6] Over hang

[7] Water collective slope

[8] The site which are compounded by debris flow

2) Soil, Geology and Structure

The soil , geology and the colapsable structure where collapse occur easily (the rapid cycle of Rockfall / Collapsing) are classified as;

a) Collapsible Soil

[1] Erodable Soil

[2] Soil strength degrade after absorbing water

[3] Others

b) Quality of Collapsible Rocks

[1] High density of the fissures and loose layer (joints, fault, fragile bedding plane, schistosity layer, penetration layer, etc.),

[2] Soft erodable rock

[3] Quality of rocks change easily weathering

[4] Others

c) Collapsible Structure

[1] "Dip slope" structure

[2] Soil above impermeability layer

[3] Rock that on his top side is hard and the bottom side soft

[4] Others

3) Conditions of the Surface Layer

The items, which are shown next, should be taken the inspection. These items are very important, and some times they are a key factor for the stability survey evaluation.

a) Conditions of the Surface Layer, Unstable Rocks and Boulder Stone

The Existence of an unstable soil surface, unfixed stone and boulder stone are material for direct evaluation for stability. It seems the cut slopes and /or natural slopes which has the tendency to happen Rockfall / Collapsing at the earthquake in case of recognition of existence of unstable rock and boulders.

b) Inflow Water

Where lots of inflow water exist, many wholes- gutters that under the surface layer caused some cracks. It can be consider that a high volume of inflow water,

[1] High water pressure of a inflow water is high,

[2] The diameter of a natural waterway of inflow water is quite big,

[3] High possibility to connect of waterway of inflow water,

[4] High capacity of catching water.

Therefore, the existence of inflow water means a sing of existence weathered layer, open cracks and tendency catching capacity of groundwater.

c) Conditions of the Surface Layer

The uncover ground consist of rocks, gravel and soil, is ground that is very erosed and caused the instability of the natural slope especially Rock fall/Collapsing. Particularly, it is easily occurred for the rill erosion (the gutter of rainfall water) on the soil ground, and rill erosion expand and become gully erosion, which cause the usability and large scale collapsing. On the

natural slopes with a vegetal cover, mainly with herbs, have not so many superficial erosion. However, it remain the possibility of collapse depending on caractaristic of soil, as that case is without slope protection by the trees roots. On a natural slope with pampas grass or bambu, maybe exist abundant underground water , and caused slope easily to slide. The natural slopes, which are, occurred with trees shows that there is no any collapse for a long time. But, it are not mean stable slope. The slopes stock the weathered layer, because it has no occurred collapse for a long time, and it is danger that collapses occur even though small-scale rainfall.

4) Form (Inclination, Slope Height and Natural Slope)

On the same conditions concerning the topographic, geological and hydrological conditions, a sharp slopes and/or high slopes should be unstable conditions.

However, the regulation of inclination of the cut slope, is used the standard proportion such as experienced value depending on quality of the soil and rocks. Therefore, it is necessary to evaluate the stability related with the inclination and height of the slope mentioned before.

5) Abnormality

The abnormality on a cut slope and a natural pendant shall be criterion to evaluate the stability. The abnormality on a cut slope can be recognized easily, but it is difficult to find out the abnormality on a natural slope. Therefore, the slopes in vicinity should be observed and referred for the evaluation it.

a) Slope Abnormality and/or referred spot

If the following abnormality exist, it should be taken as directs criterion for the stability evaluation, and it will be necessary evaluate as a unstability.:

[1] Fracture,
[2] Small rocks falls,
[3] Gully erosion,
[4] Scouring,
[5] Piping hole,
[6] Sinking,
[7] Swelling,
[8] Turn of root
[9] Three fall
[10] Crack,
[11] Fissure,
[12] Abnormality of existence works of countermeasures (Flaking off of the shotcrete, Fissures and move of joint in the work for the slope protection).

b) Abnormality of Adjacent cut slope and natural slope

In many cases, a slope and an adjacent natural slope have same topographic and geological conditions as objective site. As there are tendency of existence of the weak point around side of objective site, it is necessary to evaluate the condition and record of rockfall and abnormality around adjacent of objective.

6) Disasters History

After the recently works for countermeasure, if any rockfall/collapsing on the cut slopes and/or natural slope exist, it should be evaluated by using the grade of frequency of disaster and traffic obstruction.

3.3.2 Stability Inspection Table and Guidelines

"Stability Survey Sheet" is shown on Table 3.3.4.

For the evaluation of disaster's factor, firstly, it is necessary to specify the inspection object to the cut slope, natural hill or a combination of both.

If the case of inspection object is a cut slope, the comments for the natural slope in the sheet keep a blank, and if the case of inspection object is a natural slope, the comment for cut slope in the sheet keep a blank. In the case that a natural slope exists above a cut slope, both slopes have to be observed and fill comments in the both column on the survey sheet. A score has to be given for each evaluation item. The score that is shown in blanket "()" indicate the maximum score for each item. Then, it has to be made with the total of scores of the slope and/or natural slope or both as the evaluation; it shall be final score of each spots.

(1) Evaluation of disaster's factors

1) Topography

It shall be evaluated the topography with collapsing factors of cut slopes and/or natural slope for object spot including the topside and surroundings of it. The topography with collapsing factors is classify from **a)** to **h)** as is shown follows. The cut slope has to be classify as a talus formed by weathered (deposit of weathering materials) and others. The natural slopes, has to be classify as a terrain constituted by collapse, knick line and others. To apply the score is depending on type of topographic forms and number of items. On the inspection site, the most unstable spot with collapsing factors should be adopted as a evaluation object. Moreover, the slopes with a convex form and over hang form are necessary to mark on G4 (the case of without score).

a) Talus (Figure 3.3.2)

It is the natural slope that has a gentle inclination around the foot of slopes. The talus is formed by the rockfall or collapsing of weathered rocks, gravel and loosing materials.

b) Terrain Constituted by the Collapse (Collapsing Trace) (Figure 3.3.4)

The natural slopes which have been observed collapsing trace , trade of debris flow, valley head and spoons, etc.

c) Clear Knick Line (Figure 3.3.5)

The knick line is the line , which changes inclination from gentle slope to steep when it is observed from topside. Generally the slopes, which exist clear knick line, it has tendency collapsing due to erosion strongly. It is necessary to observe most clear knick line, as it is not only single line.

d) Toe of Plateau, Slope of Terrace (Figure 3.3.3)

It means the case of either toe plateau or slope of terrace , which are parallel to the river or the sea. Generally, the topside of these natural slopes is flat.

e) Remarkable Erosion of foot of the slope (Figure 3.3.6)

The spot were the river curve and make a erosion around the bottom side of cliff have observed uncovered soil and rocks. It is observed same situation at the natural slop where have erosion on the bottom side caused by the wave of the sea.

f) Over Hang (Figure 3.3.7)

The topographic feature of superficial soil and the rock is three-dimensional abundant to the ruggedness, and overhang shall be observed (inclination shall be more than 90°)

g) Water Collective Slope (Ravine) (Figure 3.3.8)

The slope goes from a valley, and that downstream side is narrow.

h) Natural Slope with a Convex Form

The contour line indicate a convex form at the toe of ridge of topographic features

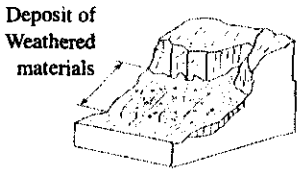


Figure 3.3.2
Talus

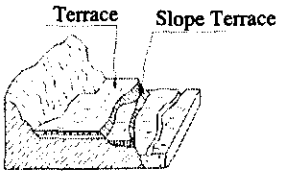


Figure 3.3.3
Toe of Plateau

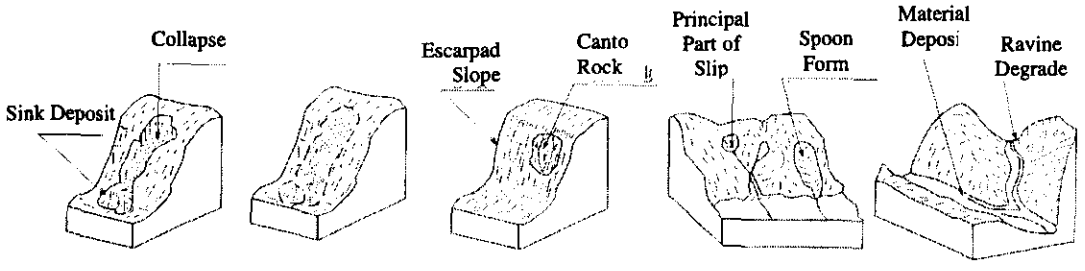


Figure 3.3.4 Collapsing Trace

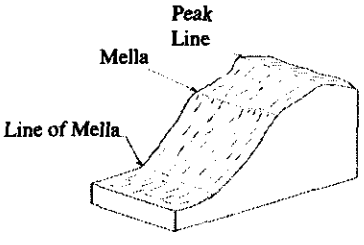


Figure 3.3.5
Clear Knick Line

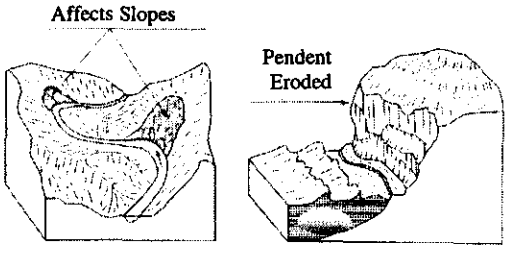


Figure 3.3.6
Remarkable Erosion of foot of the slope

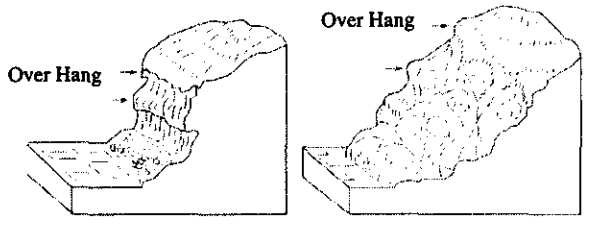


Figure 3.3.7 Overhang

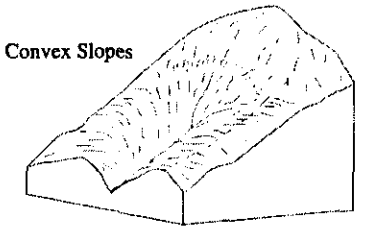


Figure 3.3.8
Water Collective Slope (Ravine), and Convex Slopes

2) Soil, Rocks Quality and Structure

About the quality and structures of collapsing the soil or rocks shall be evaluated as following instructions. It is effective to observe the surrounding parts of the objective slope and to check the existing data. It is too difficult to identify factor of quality and structures of slopes, because it is hidden inside of slope surface.

The judgment might be different because of geological features not homogeneous depending on the observation part. It shall be evaluated objective spot in the part, which seems to be the most unstable position.

a) Collapsing Soil

If the main parts of the cut slopes and/or natural slopes are corresponded to the following items, it seems to be a collapsing soil. It shall be evaluated and classify as three stage as "Notable", Little Notable" and "No Corresponding". The spot where cannot be clearly defined, has to be evaluated as "little Notable".

i) Characteristic of soils, which do not have resistance concerning erosion.
Volcanic Soil, Decomposed Granite, Mountain Sand, etc.,
It has composed by sandy soil mainly.

ii) Characteristic of soils, which t decrease strength after contain water
Silty sand, Sandy Silt, Silty Clay, etc.,

iii) Others
Colluvial soils which are not solidified, the soil of the site where provoke the rockfall / collapsing in particular.

b) Quality of the Collapsing Rocks

Evaluation Method is as same as the part **a)** above.

i) Remarkable soft Rock
The rocks, which can be easily broken by knock by hammer. Those repeat little collapse like fisility in a short cycle. The cycle of collapsing depends on the thickness of the topsoil. In the case of thin topsoil, it shall be earlier for the cycle of the collapsing.

ii) Rock shall be loose easily by weathering
Expanded Rocks (the Serpentine, the mudstone, the shale the sedimentary Rocks, Weathering, Andesite, etc.)
This rocks contains lots of minerals clay quantity. The fresh part of those rocks is strong, but on the weathering part is vulnerable and become subdividing and clay easily. And the rocks which become weathering easily, and contain much weathering layer is categorized it also.

iii) Rocks with a high density of cracks and fragile layer.
The cracks and the fragile layer (joint, faults, vulnerable bedding plane, schistodity,

penetration, etc.) can be observed every 20 or 30 cm interval; and comes into blocks with a laminar, columns or dice form.

iv) Others

The rocks, which seems around friability zone or hot spring

The rocks of the site where provoke the rockfall / collapsing in particular.

c) Collapsible Structure

The structures that correspond the following aspects and evaluation method is as same as the part **a)** above.

i) Soil over impermeable rocks

It is shown as Figure 3.3.9

ii) The rocks which is constituted dip slope by fissure and the fragile layer

The dip slope, which is refereed here, is limited at Figure 3.3.10.

iii) Rocks which is strong of topside and the fragile of bottom side.

This is categorized the structures which is shown as Figure 3.3.11. However, it shall be evaluated not only this structure but also the deformation around foot due to the erosion and the vertical fissure of the upper strong part.

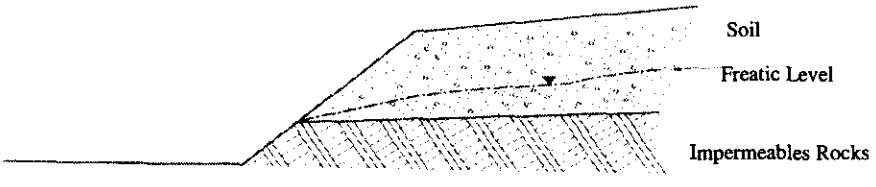
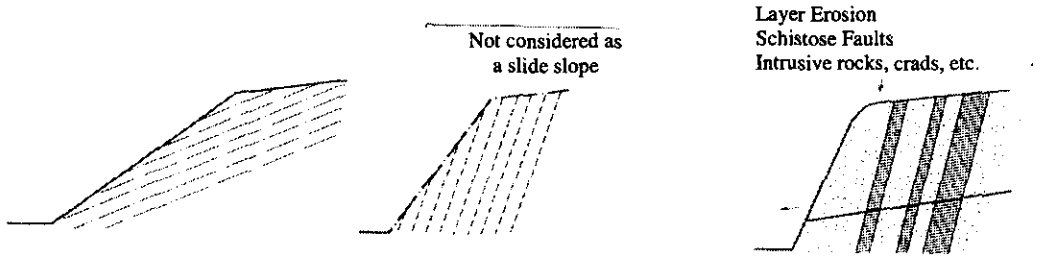


Figure 3.3.9 Soils over Impermeable Rocks



(a) Common slide structure (b) More steep Inclination of the natural slope (c) Compounded Structure

Figure 3.3.10 Slope with a Slide Structure ((a) and (c))

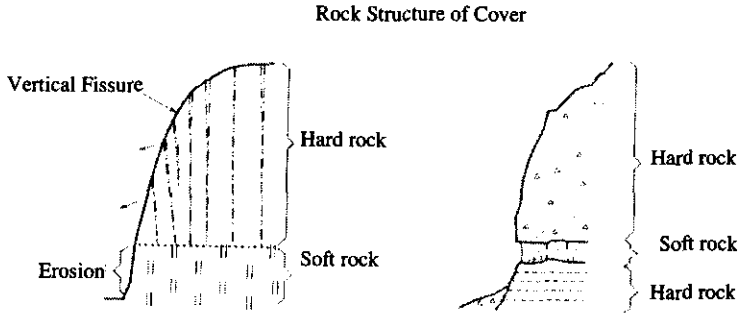


Figure 3.3.11 Upper Side Strong, Soft Rocks on the Bottom

3) Superficial Layer Situation

a) Condition of Top Soil, Rock and Bolder

The conditions of the superficial ground, loosening of rocks and boulder stone, are a very important factor to evaluate the stability of a cut slope and/or natural slope, and it is necessary to observe these factors in detail. It shall evaluate the superficial ground, loosening rocks and boulder stone in Table 3.3.1.

For the evaluation of the supporting layer, it is necessary to verify the existence of recent boulder falling, the condition of rock quality or the soil around the loosening rock or the boulder stone. It is necessary to observe the vegetal conditions too (Figure 3.3.12).

Table 3.3.1 Evaluation Method for the Stability for Top Soil, Loosening Rocks and Boulder

Evaluation	Top soil<Superficial layer>	Loosening rock, Boulder stone
Unstable	● The superficial layer is thick (more than 50cm.). It is observed for movement of the superficial layer and trace of erosion.	● In case of existing lot of the following; i) Two third of the diameter is exposed from the surface ii) It is completely loose, and can be moved by human strength
Little unstable	● The superficial layer is thick. However, it is not observed for movement of the superficial layer and trace of erosion. ● The superficial ground layer is not thick. However, it is exist for the possibility of movements of the superficial layer and erosion.	● Not so existence as i) and ii) above. ● The degree of loosing of rocks is small. ● The rock is bit loose. However it can not be moved by human strength.
Stable	● The superficial layer is not thick or not existence and it is satiable according to the vegetal conditions.	● Not existence of loosing rock and/or boulder ● It is stable for loosing rock and/or boulder, in spite of existence.

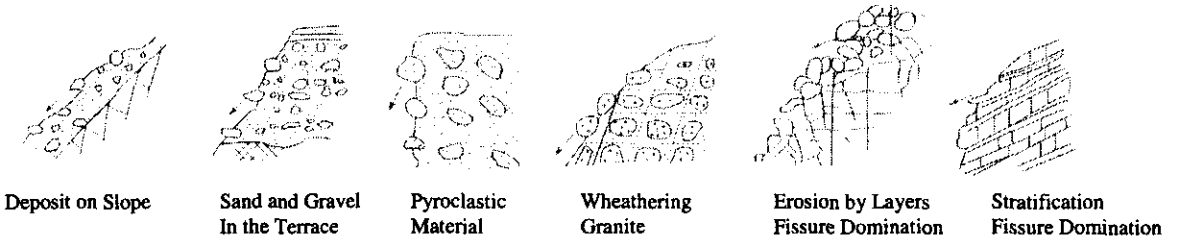


Figure 3.3.12 Example of Falling Rocks and Rounded Border

b) Condition of the Inflow Water

The part of inflow water and the amount of inflow water changes before and behind the rainfall., and it shall be evaluated and classified among three categories as follows. In case of any difficulty for determination, it has to be evaluated as "ii) Ooze water case".

i) Existence of Inflow water

The term "inflow water" is defined as the volume of water that comes out and caused the loose of ground reduction of strength it.

In the case of some artificial condition on the upper side of the natural slope, seems existence inflow water also.

ii) Oozing water or leak out

The cut slope and/or natural slope is wet, but it does not meet the requirement of above-mentioned as I)..

iii) No existence

c) Conditions of the Superficial Cover

The evaluation criterio is different between the cut slope and the natural slope. It is recommendable to select of general viewpoint for the observation of condition of superficial cover on slopes.

i) Conditions of the covering on a cut slope.

It shall be selected one among the three aspect as follows;.

[1] Uncovered ground of vegetal cover; slope without treatment or slope with work of a vegetal cover.

[2] Compound; vegetation is combined with cribwork, Rock-net is combined with retaining wall and so forth.

[3] Structures; it has mainly coved by structures (Shotcrete, Cribwork, Retaining wall).

ii) Conditions of the covering on a natural slope.

It shall be selected one among the three aspect as follows;.

[1] Uncover ground- Vegetal cover (herbs); natural slope which is uncovered and consist of rocks, gravel. or which is covered by herbs with their roots. It is not

expected the resistance power for superficial layer on the slope.

[2] Compound; the covering conditions are not uniform; slope is covered by herbs and trees.

[3] Trees; the almost of slope is covered by trees.

4) Form (Inclination and Height of Cut Slope and Natural Slope)

The evaluation criterion is different between a cut slope and a natural slope.

a) Inclination and Height of The Cut Slope

The evaluation shall be done for the cut slope with the characteristic of main material, which are categorized either soil or rock.

i) Slope that consist of soils

It shall be evaluated for the combination of the inclination and height of the cut slope. It is indicated in table 3.3.4, which are classified consistence with the standard inclination of the cut slope for each soil type.

[1] Slope height is more than 30m (H>30m.)

[2] Slope height is less than 30m. However, inclination is more sharp than standard (H ≦30m, i > normal (Standard))

[3] Inclination is within the standard type, height is more than 15m, less than 30m. (15≦H < 30m, i ≦normal (standard))

[4] Inclination is within the standard type, height is less than 15m. (H<15m, i ≦standard)

ii) Slope that consist of rocks

Evaluation shall be done with classification of the height.

[1] Slope height is more than 50m. (H≧50m.)

[2] Slope height is more than 30m. Less than 50m. (30≦H<50m.)

[3] Slope height is more than 15m. Less than 30m. (15≦H<30m.)

Slope height is less than 15m. (H<15m)

Table 3.3.2 Standard Inclination of the Cut Slope

Slope soil		Cut Height	Inclination
Hard Rock			1: 0.3- 1: 0.8
Soft Rock			1: 0.5- 1: 1.2
Sand	No dense and bud size distribution		1: 1.5-
Sandy soil	Dense	Less than 5m	1: 0.8- 1: 1.0
		5m- 10m	1: 1.0- 1: 1.2
	No dense	Less than 5m	1: 1.0- 1: 1.2
		5m- 10m	1: 1.2- 1: 1.5

Sandy soil with gravel and rocks	Dense, or good size distribution	Less than 10m	1: 0.8- 1: 1.0
		10m- 15m	1: 1.0- 1: 1.2
	No dense, or bad grain distribution	Less than 10m	1: 1.0- 1: 1.2
		10m- 15m	1: 1.2- 1: 1.5
Silty soil		Less than 10m	1: 0.8- 1: 1.2
Silty Soil with boulder and rock		Less than 5m	1: 1.0- 1: 1.2
		5m- 10m	1: 1.2- 1: 1.5

Note: i) In the case that the slope have plural inclination which due to the soil composition, the height and inclination of the cut slope are determined follow and figure 3.3.13.
ii) Silt shall be included to silty soil.
iii) Other soil type is separately considered.

b) Inclination and Height of the Natural Slope

The evaluate shall be done for the natural slope with height and inclination (figure 3.3.13).

The height of natural slope which existe above cut slope is measured as total height of the cut slope and natural slope. Meanwhile, the inclination of natural slope which exist above cut slope is measured natural slope protion only without cut slope.

i) Slope height

Evaluation shall be done with classification of the height.

[1] More than 50m. (H≧50m.)

[2] More than 30m. Less than 50m. (30≦H<50m.)

[3] More than 15m. Less than 30m. (15≦H<30m.)

[4] Less than 15m. (H<15m.)

ii) Hill Inclination

[1] More than 70° (i≧70°)

[2] More than 45°, less than 70° (45° ≦ i <70°)

[3] Less than 45° (i <45°)

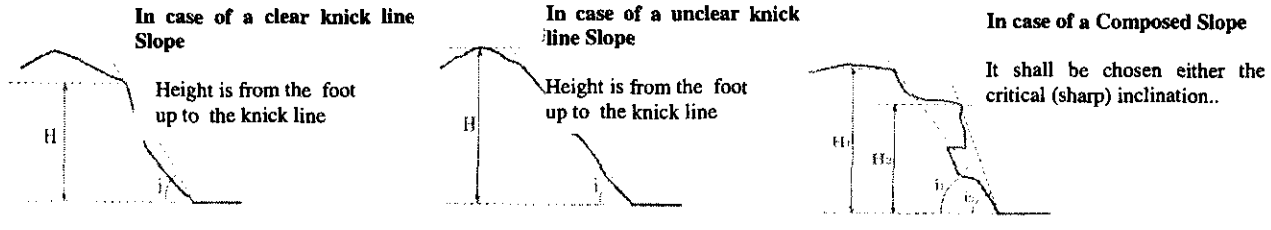


Figure 3.3.13 Measure Meted of Inclination and Height of The Natural Slope

5) Abnormality

a) Abnormality on a Cut Slope and/or Natural Slope

Inspect the existence of the following abnormality related with the rocks following and

collapse.

i) Fracture (Figure 3.3.14)

The case in which it is existed sediments deposit by a fisility around the bottom of the cut slope and/or natural slope, or trace of the fisility is observed on the cut slope and/or natural slope.

ii) Small scale rock falling (Figure 3.3.15)

The case in which it is existed rock falls (the diameter may be several centimeters) around the bottom side of the cut slope or natural slope.

iii) Gully erosion, Scouring (Figure 3.3.16)

The case in which it is existed outstanding trace such as gully, rill erosion and scouring.

iv) Piping hole

The case in which piping hole exists (the diameter may be several centimeters) . It is not necessary to confirm inflow water.

v) Sinking

The case in which it is existed sinking or subsidence (the wide is more than 10cm). This phenomenon is produced by tension crack of natural slope, the expansion of a piping hole, the partial scouring and so forth.

vi) Swelling

The case in which it is existed swelling (the wide is more than 10cm). It is observed phenomenon tension crack abnormality of a protection around upper side of a slope.

vii) Roots twisting (Figure 3.3.17)

The abnormal condition, which is observed around root. The twisted of tree has been caused by a superficial creep or slope slide. It is predicted the tendency of change of topsoil of slopes by observation the annual ring, even though the tree is deforested.

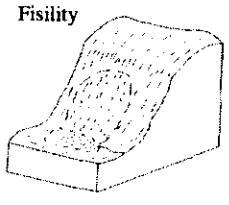


Figure 3.3.14 Fracture

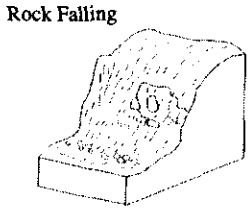


Figure 3.3.15 Rock Falling

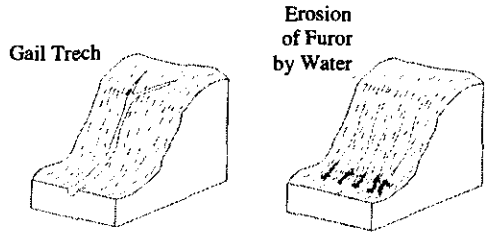


Figure 3.3.16 Gully and Rill Erosion, Scouring

Figure 3.3.17 Twisted Root

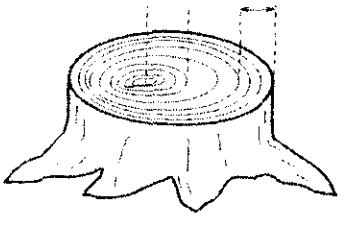


Figure 3.3.18 Deflection of the Annual Ring

viii) Tree fallen dawn

Tree felled down because of erosion of the superficial soil or deformation.

ix) Open crack

Existing remarkable open crack on the mass rock. The open crack on the soft rock should not be considered as a criterion.

b) Abnormality on the Adjacent Slope and/or Natural Slope

The past and present abnormality should be evaluated on cut slope and/or natural slope adjacent, which have the same topographic and geological characteristics as same as objective spots. The inspection items are tree groups as: rockfall/collapsing, cracks and swelling. It should be evaluated as three grades as;

i) Abnormalities can be observed very clear.

ii) Abnormality can be observed, not so clear.

iii) No existence

(2) Evaluation to the Effectiveness of Existing Countermeasure Works

1) Effectiveness of the Existing Works

The evaluation of the efficiency for existing measure works should be done with the prospective for type of disaster, the scale and frequency measure works and also through the inspection, aged and damages of the structures and the clearlance form the cut slope and/or natural slope.

Moreover, the ranking of efficiencies on the countermeasure works should be evaluated as the criterion that are shown below. Specially, the height of the rock fence for the rocks falling. Either it has more than 2 meters height or not to the vertical direction slope. the abnormal deformation of the shotcrete, protection net of the rocks falling and anchor works on slope

a) "Adequate Effectiveness"

Where the effectiveness for the countermeasure works is expected against prospective disasters. For example;

i) There are rockshed works for the rockfall, or other protection for rockfall (Retention wall, prevention net, etc.). It covers the influenced area of rockfall.

ii) The countermeasures such as retention wall prevent disasters from the rockfall/collapsing by colluviums and soil sediments and so forth, and also the existence effective drainage system. Abnormality deformation is not observed.

b) "Inadequate Effectiveness" or "Expectation Portioned Effectiveness"

There are the countermeasures. However, effectiveness is inadequate. The countermeasure works is expected portioned effectiveness against prospective disasters. For example;

i) Protection Works for the rockfall cover the influenced area incompletely.
ii) Some portion of the colluviums and soil sediments are protected by retention walls with other protection. However, effectiveness is inadequate.
iii) The disasters are hardly occurred. However the countermeasures is not effective against the disasters, which are some cases besides prospective disasters.

c) "Not effective" or "Not existence of Countermeasures"

It is not expected effectiveness around influuenced area for the some existing measure works to the prosective disasters and , there is the site where is no existence countermeasure works. For example;

i) There is not existence of countermeasures and the rockfalls interrupt traffic directly.
ii) The height of the structures of countermeasures is not enough against the rockfall, and it cannot prevent road disaster from the rockfall.
iii) Unstable soil sediments exist around the place, which is higher than structures, and it is inadequate prevention for the disasters. Abnormality deformation can be observed on the structures and it is not expected for the effective against prospective disasters.

(3) Evaluation from the Disasters History

It is necessary to evaluate the history of rockfall and the collapse on objective cut slope and/or natural slope, and it shall be classified four categories that are shown as below;

i) Any disaster record for traffic obstruction has occurred after completion countermeasure works recently.
ii) Existence historical record of rockfall/collapsing, which was large scale and influence up to road area. However, it was no obstruction for the traffic.
iii) Existence historical record of rockfall/collapsing, which was small scale and influence around edge of slopes only.
iv) No existence of any historical record of rockfall/collapse.

The "obstruction for traffic" means significant damages to the vehicles and /or pedestrian, and restriction of the traffic such as one way restriction due to the rockfall/collapsing and felling down colluviums.

Table 3.3.3 Record by Inspection Site

Format-3-1

No.		Inspection Item		Name of the road		Kilometer post (of)		(to)		From Managua / To		Total m.	
Clasification	Toll / Common	Category		Name of the site		Site mark		Latitude		Longitude			
Traffic Restriction	Yes (Crossing/Special) Not	Restriction Criteria		Traffic Volume	Day of the week	Holliday		DID	Yes No	Bus Route	Yes No	Detour	Yes Not

Pictures of the site, Sketch (to indicate the location of the existimg works and the site mark)	Location map (scale 1/50,000)

Special remarks: Inspection Date: / / (Weather: clear・cloudy・rain) Method of inspection: Note:	Disasters history	Yes (1. See damage record, 2. unknow details:) Not
	Other inspection objectives	Exist or Not Rock fall, collapse, rock mass collapse, land slide, debris flow, embakment, retention wall, bridge, others
	Inspection result of year	Score: (Completed・In execution・Not started) Countermeasure:
	Inspection result of 2002 year	Score: Integral evaluation: 1. It's necesary to take measures: 2. Response, making prescription of prevention: 3. It's not necesary to take measures:
	Forecast of disasters dimension	
	Proposal countermeasures	Kind of work: Norm: Quantity: Preliminary cost:
	Stability in case of seism (for rock fall & collapse only): stable / unestable	

Table 3.3.4 Stability Investigation Table

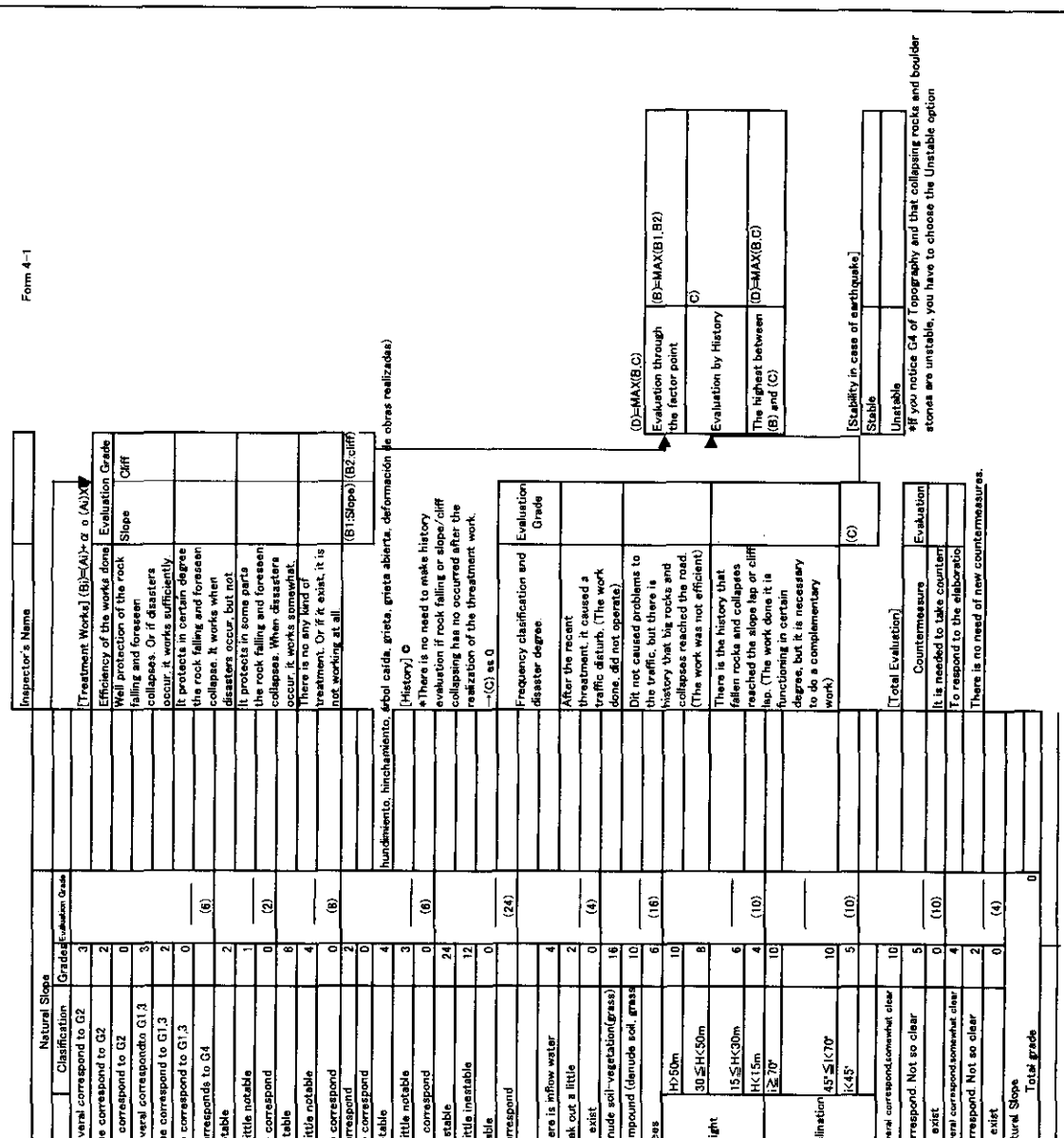


Table 3.3.5 Record of the History of Damages

Form - 5-1

No.		Type of disaster		Site	Kilometer post (of)	(to)		From Managua/ To	
Inspection Site Year	Respond / Not Respond				East longitude		North Latitude		

Plane (Damages, Measures)	Seccion (Damages, Measures)

Pictures, Sketch of actual situation	Remarks	
	Date of disasters	
	Dimension	Wide, Long, Depth (m) m, m, m
	Inciding factor	Precipitation: Continue mm/ hr-d Maximum m Earth quake: Magnitude
	Damages	Human damages: deads Injuries: Material damages: Total cost of damages loss: Comments:
	Traffic restriction record	1.Full restriction: hours 2. One way road restriction: hours. 3. Others:
	Countermeasure	Year of construction: Type of works: Approximate Cost: