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JAPAN INTERNATIONAL
COOPERATION AGENCY
(JICA)

THE PUBLIC WORKS
DEPARTMENT (JKR)
MALAYSIA

THE STUDY ON SLOPE DISASTER MANAGEMENT FOR FEDERAL ROADS IN MALAYSIA

GUIDE I

GUIDE TO ROAD SLOPE MAINTENANCE AND DISASTER MANAGEMENT

MARCH 2002

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CHAPTER 1 PREFACE

In accordance with rapid national economic development in Malaysia since 1970's, a road expansion programme has been planned and implemented throughout the country, with the construction of new roads and the upgrading and rehabilitation of existing alignments. Consequently, not only road network developments in urban areas, but more and more inter-city and rural roads have been constructed or upgraded. As a result, numerous road slopes have appeared, and some of these in mountainous or hilly areas bear possible problems of slope failure under heavy rain conditions.

Along with expansion of the road network, various kinds of industrial and regional development in sectors such as agriculture, forestry, industrial estates, residential complexes, resort facilities, etc. have been made. Sometimes these activities could lead to environmental deterioration, such as change of land shape, vegetation, or conditions of rainwater run-off. Occurrence of mud flow and debris flow causing damages to village houses and agricultural fields in the down-stream of the river have been reported. Further this could possibly lead to disaster by slope failure or debris flow. The tragedy, which claimed more than 20 lives on Genting Highland Road in 1995, was a typical example of this sort of disaster.

Turning to history of slope related disaster overseas, an unforgettable accident occurred in the Central part of Japan in 1968 ("Bus Fall Accident in Hida River"), claimed the lives of 104 victims in a public bus. The cause of the accident was debris flow down the slope on to a federal road. With this tragedy as an impetus, the Japanese Government initiated to seriously establish the road slope disaster management programme.

Initially, an inspection was carried out on all the slopes along the national roads, expressways and major local roads. Based on the results of slope inspection, all the slopes were rated by criteria of stability/ or failure risk, then a slope management plan was established consisting of prioritised implementation of preventive countermeasure work, monitoring by instrumentation, regular patrol and checking, and traffic control under heavy rain and snow storm conditions. Since then, a nationwide slope inspection program has continued to be executed on all the national roads, expressways and major local roads, at regular intervals of no longer than five (5) years.

Between the two countries Malaysia and Japan, there is much similarity in geology and monsoonal climate, which are among the most influential factors determining the stability of the slopes. Taking this point into consideration, Japanese knowledge and experience, which has been accumulated through many years' of battle against slope disaster, could certainly be extended for use on Malaysia.

This guideline handles most of the major items related to planning and implementation of the road slope disaster management program. In preparation of this material, together with

existing technical literature in Malaysia and Hong Kong, much technical and administration material related to slope disaster management was referred to. Careful selection and consideration was paid in reference to the criteria and rules in foreign countries so as not to adopt specifications or regulations inappropriate to the Malaysian environment. However, it is suggested that the details of each item be continuously and carefully studied with reference to the technical and social conditions in Malaysia, so that a more appropriate and practical management system could be established in the near future by local administrations and specialists.

It is desired that this guideline would be of some help as a starting point of establishment of such a management handbook;

MANUAL OF ROAD SLOPE DISASTER MANAGEMENT, MALAYSIA.

Contents of the Guideline

The guidelines consist of five (5) guides shown in Table 1.1.1(below).

Table 1.1.1 Contents of Each Guide

Name of Guide		Contents
Guide I	**Guide to Road Slope Maintenance and Disaster Management**	Overview of slope management Suggested procedures of slope maintenance and management.
Guide II	**Guide to slope Inspection**	Technical guide; suggested specification and procedures in each technical area.
Guide III	**Guide to Early Warning and Site Investigation**	
Guide IV	**Guide to Countermeasure Selection and Cost Estimation**	
Guide V	**Guide to Slope Information Management System (SIMS)**	User's reference of SIMS.

CHAPTER 2 OUTLINE OF ROAD SLOPE DISASTER MANAGEMENT

2.1 Mission of Road Slope Disaster Management

(1) Objectives

The objective of road slope disaster management can be expressed as follows:

1) To prevent the occurrence of large disaster causing casualties and losses related to road slope
2) To take necessary action for mitigation of loss as far as possible, once occurred

(2) Tasks

To fulfil the above objectives, the following tasks are required.

1) To plan and implement a comprehensive and rational program for disaster prevention
2) To maintain the slope and other road structures in good condition
3) To support the relief of life and to restore the road facility at the earliest (including traffic control, removal of debris for secure of traffic lane for the time of being, and prevention of expansion of failure site)

(3) Related matters with Slope Disaster Management

1) Communication with concerned organization within JKR, other governmental offices, local contractors and consultants, road user and local community.
2) Establishment and maintenance of database related to;
   Road slope and other road structures, rainfall and monitoring instruments, slope disaster, repair work, traffic control, and so on.

2.2 Basic Component of Road Disaster Management

Road Disaster Management has been studied in many organizations all over the world. Currently most of them are handled by Risk Management Planning approach. Emergency or Crisis Management is also studied as the planning for the occurrence of disasters.

In respect of Risk management, Road Slope Disaster Management can be summarized as shown in the work flow in Figure 2.2.1.

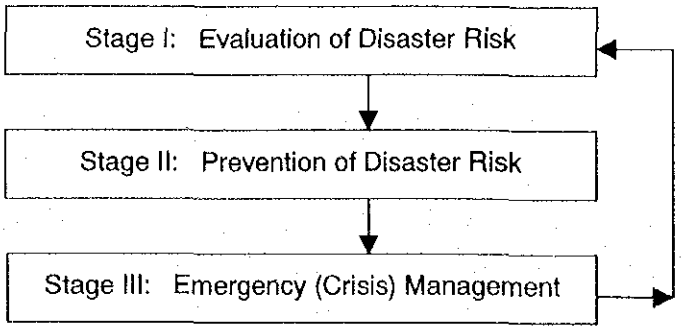


Figure 2.2.1 Basic Concept of Road Disaster Risk Management

Each of Stages I, II and III consist of various components as listed in Table 2.2.1 below as the basic components of Road Disaster Management.

Table 2.2.1 Basic Components of Road Disaster Management

Road Disaster Management	Risk Management	Evaluation of Disaster Risk	Establishment of the context Identify the risk Analyse the risk Evaluation of the risk
		Prevention of the Occurrence of Disaster Risk	Implementation Planning of Countermeasure Work (with Priority) Investigation and Design of Counter-measure Work Implementation of Countermeasure Regular Patrol and Periodical InspectionMonitoring Traffic Control under Heavy Rain
	Emergency (or Crisis) Management	Disaster Preparedness Plan	Organization Reporting/ Communication Coordination/ Corporation Logistics Training
		Emergency Response Plan	Organization Reporting/ Communication Coordination/ Corporation Logistics Others

In the following chapters and sections, actual concept and suggested procedures are described for each of the items shown in Table 2.2.1

2.3 Work Flow for Evaluation and Prevention of Slope Disaster Risk

Figure 2.3.1 shows the work flow for road slope disaster management, which consists of three stages as mentioned in the previous section.

In the Stage I, the risk rating of each slope will be determined on the basis of slope inspection. According to the Priority Risk Rating List, all the slopes of the study target will be divided into four (4) categories of management level as shown in Table 2.3.1.

Table 2.3.1 Category of Slope Management Level in terms of Risk Rating value

Slope Management Level	Value of Risk Rating	Basic Policy of the Slope management
Level I	Very High	Implementation of preventive countermeasure
Level II	High	Regular patrol, and instrumentation where it is appropriate
Level III	Moderate	Periodical inspection
Level IV	Low	Screening out of slope follow- up list

Note:

The boundary values of risk rating for each management level may be determined flexibly for each road, taking the importance of the road, volume and type of likely slope failure, allocation of budget for slope disaster management, and so on.

For an example, the boundary values were set in the case study along the East-West Highway, as 75, 65, and 50. However, in SIMS, the boundary values are tentatively set as 80, 60, and 40, which may be redefined when it is necessary.

The detailed procedures of each of management planning and implementation are described in the following Chapters as follows:

Chapter 4 Slope inspection and Risk Rating
Chapter 5 Implementation of Countermeasure
Chapter 6 Slope Maintenance for Early Warning and Disaster Prevention
Chapter 7 Early Warning System and Traffic Control
Chapter 8 Road Disaster Emergency Plan

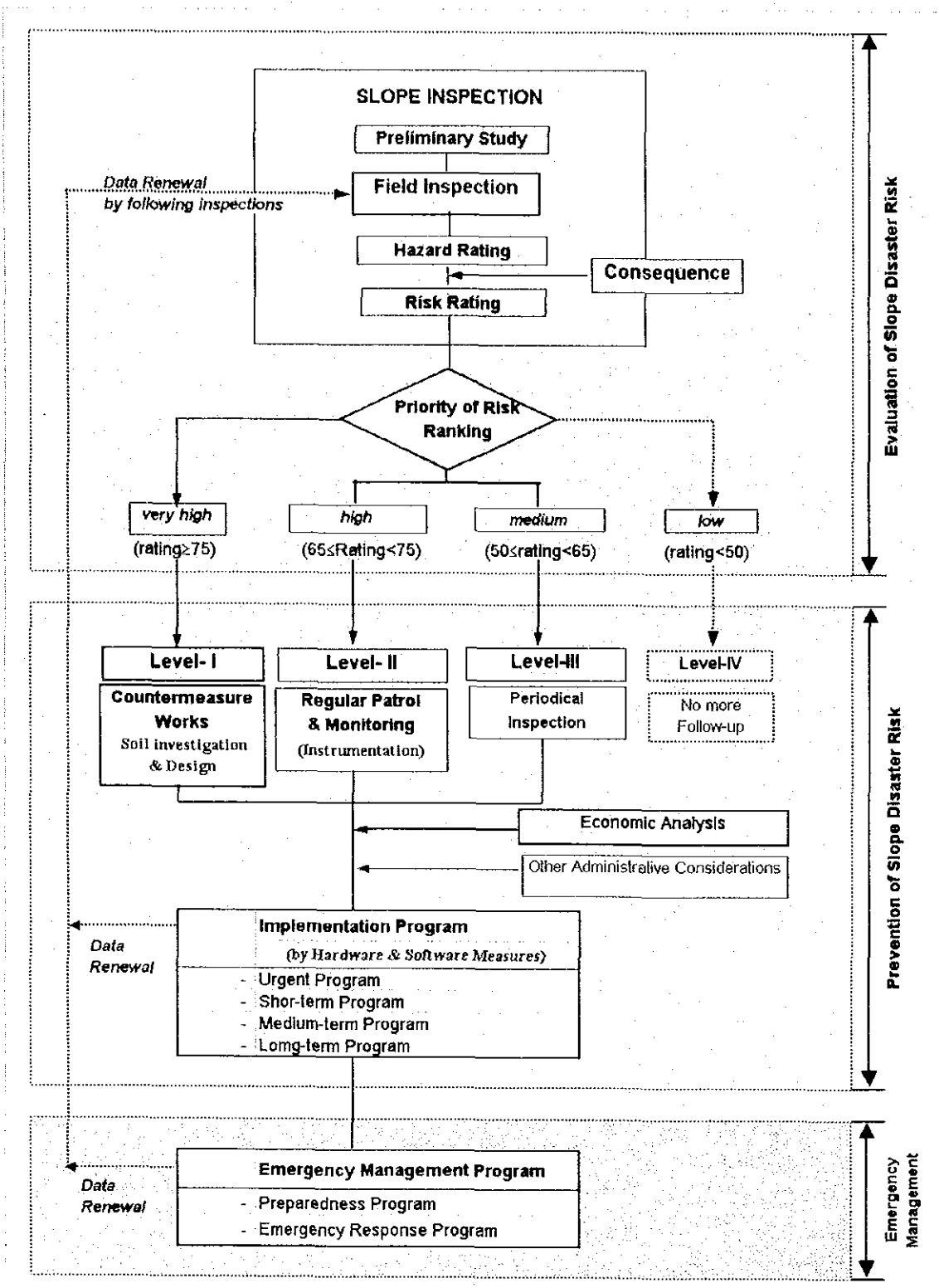


Figure 2.3.1 Basic Concept of Road Slope Disaster Management

CHAPTER 3 ORGANIZATION FOR ROAD SLOPE DISASTER MANAGEMENT

It is the responsibility of the Road Administrator to maintain the road in good condition for safety of public traffic. Prevention of occurrence of disaster related to road traffic should certainly be avoided. To accomplish this duty it is essential to establish the road management organization to cover disaster management, and to provide necessary human resources, equipment and material, and other resources.

3.1 Organization for Road Management

(1) Background

In accordance with the state policy of organization reform including privatisation, JKR has been implementing the privatisation of road maintenance. At the end of February 2001, the maintenance and management of paved federal roads in Peninsula Malaysia was entrusted to three private companies under concession contract between JKR and those companies. (Notes: The said contract does not cover the unpaved federal roads in the Peninsula, nor the federal roads in Sabah, Sarawak and Labuan.)

Those contracts specify the scope of works including routine road maintenance work and some emergency action including debris removal for traffic flow.

(2) Slope Disaster Management:

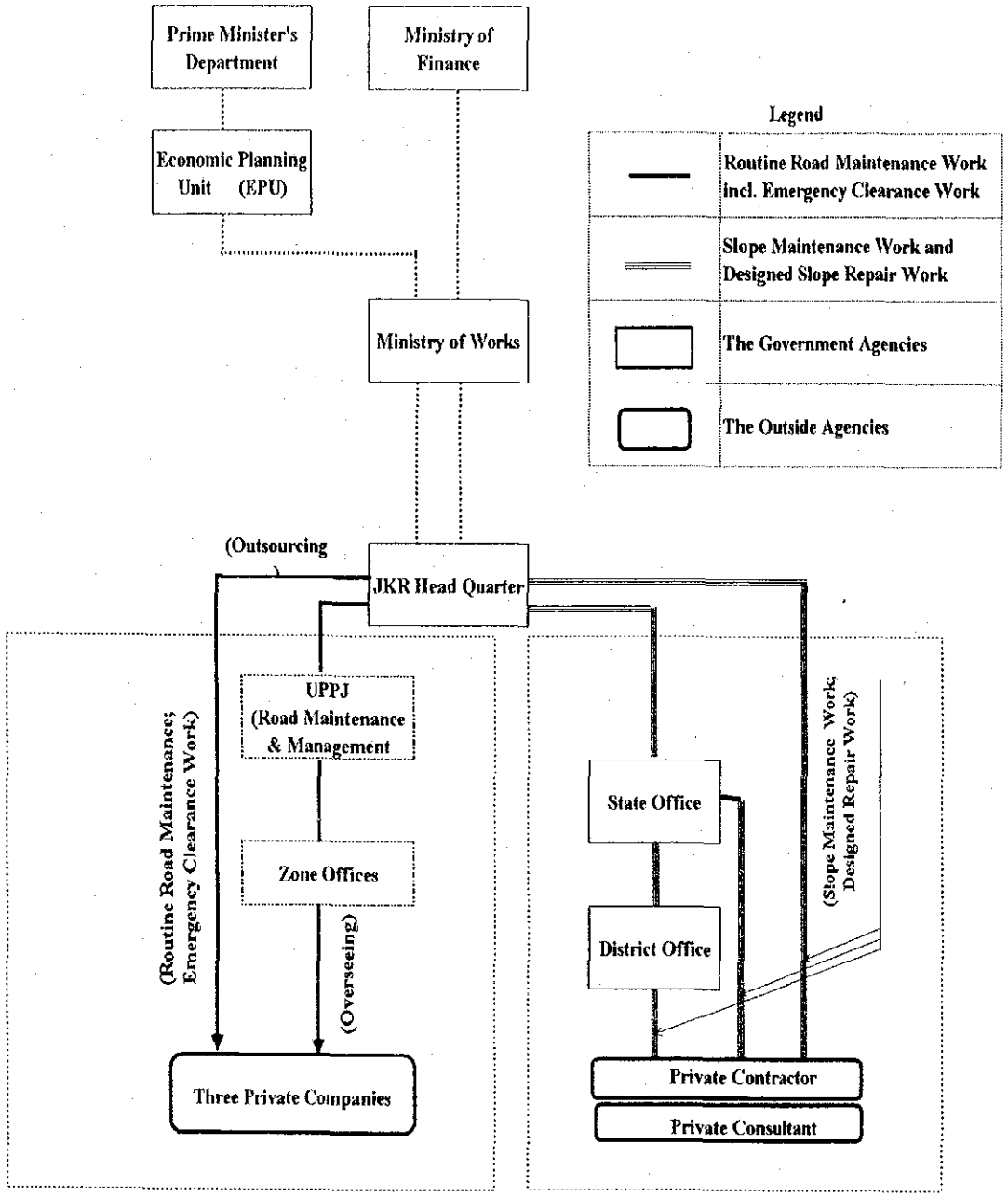
The above road maintenance contracts do not fully cover the slope disaster management, except for routine road maintenance and emergency action such as debris clearance etc.

Slope disaster management is of importance because it is possible not only to cause traffic obstruction by debris, but could sometimes lead to damage to vehicular traffic, or cause loss of human life.

Currently JKR has the responsibility for slope disaster management of federal roads in the entire country. Each office of JKR, the headquarters, the State Offices and District Offices has its own duties and responsibilities separately regulated.

Some of the field works and engineering works related to slope management are being carried out by private companies; contractors and consulting companies, etc. under the contract.

Figure 3.1.1 shows the organization chart for road management of Federal Roads in Malaysia, which explain the routine maintenance work being executed by concession companies, and slope management work done by JKR in support of private contractors and consultant companies.



*Road Maintenance: For Paved Federal Roads in Peninsula Malaysia

*Slope maintenance: For All Federal Roads

*Road maintenance for Unpaved Federal Roads in Peninsula Malaysia and all Federal Roads in Sabah&Sarawak, Labuan (Federal Territory) shall remain to be handled by JKR and its Stae and Distric Offices.

Figure 3.1.1 Organization for Road Slope Management

3.2 Maintenance Contract (Privatization)

(1) Outline of Contract

Coming into effect on 26th February 2001, the general road maintenance work of federal roads, which had previously been handled directly by local offices of JKR, was privatised. Although the coverage of this arrangement is restricted only to the paved federal roads in the Malaysian Peninsula at this moment, this is a major shift in the road management of the country.

Although the maintenance of road slopes is not primarily included in the above maintenance contract, from the technical point of view, information collected through the routine road maintenance work often gives quite useful indications of the current and future stability of the slopes. In this sense some main points of the general maintenance contract are briefly summarized in the following pages with regard to the scope and procedures of slope maintenance and disaster management.

(2) Contents of Road Maintenance Contract

The contents of Road Maintenance Contract is described as below:

1) Contract Partner

Contracts for Road Maintenance were made between the Ministry of Works (Secretary General) and three contractors relating to the 3 regions in Peninsula, respectively.

2) Area of Coverage

Whole the Peninsula: with 3 contractors

Contract A (North) Perlis, Penang, Perak, Kedah

Contract B (Central and East Coast) Selangor, Pahang, Terengganu, Kelantan

Contact C (South) Johor, Melaka, Negeri Sembilan

3) Concerned Office of JKR

a) JKR HQ
b) UPPJ (Road Maintenance and Management Unit – Unit Pengurusan dan Penyelenggaraan Jalan), which is Under preparation. Subject to government authorization of the necessary budget
c) JKR State Office
d) JKR District Office

4) UPPJ: Organization and Staff (Plan and Current)

a) In the original plan, a director will control the entire UPPJ organization covering the 3 regions of the Peninsula. Besides the administrative sections, a number of J1 level engineers will be appointed and who will be responsible to monitor road maintenance work by contractors. In total 128 number of staff will be employed under UPPJ.
b) One J1 engineer shall be responsible to each State, who will be supported by a small number of J2-J3 level, and some others of J4, J5, J6 and J7 level.

c) At present, the formation of new organization, UPPJ has not been approved by the Malaysian Government including budget allotment for the organization and planned staff.

c) Accordingly only 7 heads of UPPJ have been appointed at present, who are in charge of each of the states of Selangor, Pahang, Terengganu, Kelantan, Johor Bahru, Melaka-Negeri Sembilan; and one who tentatively covers the entire Northern Region.

5) Function of UPPJ

a) UPPJ is responsible to monitor the contractor's work
b) JKR State Office and District Office are to help UPPJ

6) Scope of work by the Contractor includes:

a) Road patrol for general road maintenance purpose; frequency of patrol is regulated to twice a week
b) The scope of routine maintenance work is specified as to check the conditions of the following structures and to maintain them in the good condition:
   - Pavement
   - Shoulder
   - Grass
   - furniture; guard rail, km post, etc.
   - bridge, culvert, waterway
   - line marking
   - drainage, and others
c) Reporting
   The contractor is requested to report to UPPJ district engineer and JKR headquarters when any abnormal phenomenon (i.e. embankment failure, subsidence of pavement, collapse of culvert, flood, spilling of chemical hazardous material, etc) is noticed on the road structure or there is an obstruction to normal traffic
d) Emergency response
   When any slope failure is found, quick response such as temporary traffic control and work on removal of debris on/near the road is required of the contractor.

   However, further engineering countermeasure work shall be managed by JKR, who will study the implementation plan, and when it is confirmed actual engineering and execution of such slope work will be tendered. Normally it will take 3-4 months at least to implement the countermeasure work.

3.3 Job Description of Each Partner and Mutual Cooperation

(1) Toward Better Slope Disaster Management

As shown in Figure 3.1.1, many organizations and their staff can be involved in the disaster management of slopes along each road section.

Even the concession companies should hold quite important roles in slope disaster management, although the main target of their maintenance work is not specified as the

slope maintenance. In fact, even simple observation report on change of conditions in pavement and other structures including slopes will provide a good indication of approaching slope failures. Also regular maintenance work such as removing obstructive material from the drainage system or maintenance of slope vegetation will be effective preventive work for maintaining slope stability. Therefore regular reporting by concession company staff of any abnormal road conditions during road maintenance work to the regulated partners; UPPJ, district engineer, JKR Headquarters, are quite useful and essential. The job description of each partner related to federal road slope management shall be specified in detail separately:

(2) Duty of Each Involved Party

As mentioned before, good communication between the involved parties is essential for reliable and efficient road disaster management. Table 3.3.1 summarizes the duty of each party concerned with road slope management. Detailed concrete plan on how to utilize maintenance information for slope disaster management will be studied later after discussion with JKR headquarters and local offices with reference to scope of routine maintenance specification.

Table 3.3.1 Duty of Each Involved Partner

Main Function	Partner	Duty
General Road Maintenance	UPPJ	To monitor Concession's Work
	Concession Company	Routine Road Maintenance and Emergency Action such as removal of obstructions for traffic safety
Road Slope Management	JKR HQ	Planning of Slope Management
	State Office	Interfacing between HQ and District Office
	District Office	Execution of slope maintenance including road patrol, supervision of designed repair work, and traffic control
	Contractor & Consultant	Execution of field work and engineering work For slope countermeasure under contract.

CHAPTER 4 SLOPE RISK RATING AND DISASTER MANAGEMENT PLANNING

4.1 Slope Inspection

For effective and efficient planning of slope disaster management of a certain section of the road, the first task is to select the slopes with high risk of possible failure, and to assess the grade of risk using some rating system as precise and objective as possible.

With this objective, slope inspection shall be carried out carefully in accordance with the methodology specified in detail in the Guide II: SLOPE INSPECTION. As explained in the Guide, prior to Slope Inspection in the field, preparatory work including reconnaissance survey, collection and analysis of existing data, analysis of aerial photographs etc. is quite important to be done.

In the Slope Inspection specified in Guide II, one of the most characteristic features of this system is that all slope observations, slope ratings and suggestions of appropriate countermeasures are based on the classification of supposed slope failure. The entire slope along the road is to be classified according to the following six (6) categories shown in Table 4.1.1. (These six types of slope failure was determined as most common ones in Malaysia, based on reconnaissance survey and bibliographical study.)

Table 4.1.1 Classification of Slope Failure

Type of Slope	Type of Slope Failure
Cut & Natural Slope	1 Collapse (CL)
	2 Rock Fall (RF)
	3 Rock Mass Failure (RM)
	4 Landslide (LS)
Stream & River	5 Debris Flow (DB)
Embankment Slope	6 Embankment Failure (EB)

4.2 Risk Rating of Slope

Hazard Rating (H) is determined by the slope inspection based on the slope conditions and effectiveness of existing countermeasures.

Consequence (C) is the influential factor to the supposed results of slope hazard, and determined by surrounding conditions of the slope or the road section.

Risk Rating (R) is a function of Hazard Rating (H) and Consequence (C), and it is thought to be the most practical indication to assess the grade of disaster, and therefore as a suitable indicator representing the priority of countermeasure implementation.

There can be several formulae to calculate the value of (R). Further discussion and careful consideration will be made on this subject.

Risk Rating is determined by the following formula.

Risk Rating (R) = Hazard Score (H)* 0.9 + Consequence Attribute (C)

Where,

Maximum mark of (H) and (R) is 100, while that of (C) is 10.

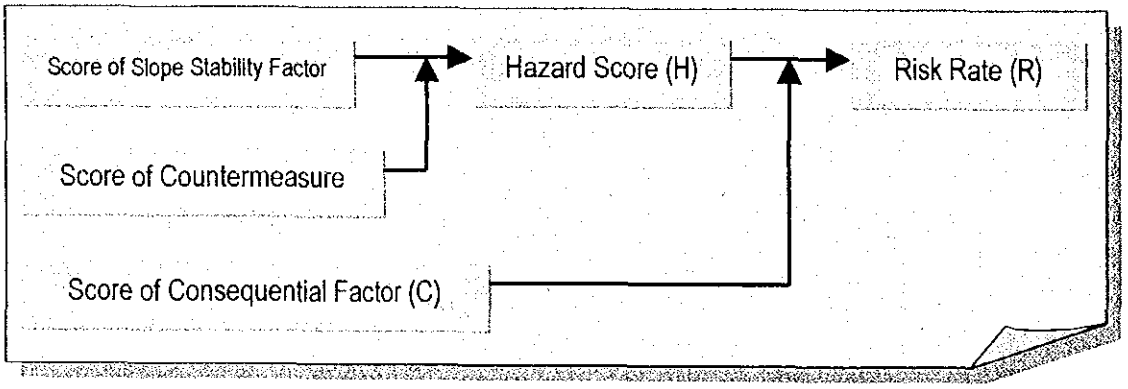


Figure 4.2.1 Determination of Stability Evaluation Score

Notes: Other factors such as the results of economic analysis and requirements from administration and politics will be taken into consideration at finalization of implementation planning.

The detail of methodology of Risk Rating of slopes is described in:
<Guide II. Guide to Slope Inspection>

CHAPTER 5 IMPLEMENTATION OF COUNTERMEASURES

5.1 Priority in Implementation of Countermeasure Work

An implementation plan for countermeasures shall be prepared for the slopes evaluated as Very-High-risk to possible failure and placed into Management Level-I.

(1) Priority Risk Ranking List

Table 5.1.1 shows an example of Priority Risk Ranking List, in which slopes of very high risk are listed, together with some slopes of high risk. The priority for implementation of countermeasures can be decided;

1) Primarily based on the order in Risk Rating (R)
2) With reference to the breakdown of Hazard Ranking (H) and Consequence (C)
3) Estimated cost of countermeasures
4) Economic analysis and other administrative/political considerations.

Therefore the following table could work very usefully for finalization of a countermeasure implementation plan of short term and mid- or long-term, taking into consideration expected allocated budget for slope work.

Table 5.1.1 Example of Priority Risk Ranking List

No	Slope ID	New Score ID	Type of Slope	Type of Failure	Hazard Score	Conse-quence	Risk Rating	Risk Level	Estimated Cost (RM)	Economic Indicator (V_T/C)	Final Decision
1	-	0004/071/500RC	1	4	85	8	**85**	**V.H**	2,427,500		
2	1091	0004/081/150LC	1	4	85	7	**84**	**V.H**	727,000		
3	385	0004/031/460RC	1	1	82	7	**81**	**V.H**	356,935		
4	396	0004/032/080RC	1	1	79	7	**78**	**V.H**	995,000		
5	-	0004/072/680LC	1	4	77	8	**77**	**V.H**	674,606		
6	415	0004/033/300RC	1	1	79	6	**77**	**V.H**	120,755		
7	392	0004/031/920RC	1	3	77	7	**76**	**V.H**	309,600		
8	-	0004/069/520LC	1	1	77	7	**76**	**V.H**	2,108,267		
9	647	0004/050/900RC	2	6	75	8	**76**	**V.H**	206,938		
10	432	0004/035/530LC	1	3	74	6	73	H	1,312,314		
11	441	0004/036/140LC	1	4	69	8	70	H	1,428,400		
12	332	0004/027/350RC	1	1	70	7	70	H	191,267		
13	433	0004/027/810RC	1	1	71	6	70	H	214,812		
14	474	0004/038/600RC	1	1	72	5	70	H	264,318		
15	442	0004/032/950RC	1	1	71	5	69	H	152,143		
16	468	0004/038/530LE	2	6	68	7	68	H	422,521		
17	533	0004/042/380LC	1	1	69	6	68	H	130,023		
18	1083	0004/080/700RE	2	6	70	5	68	H	115,800		
19	345	0004/028/240RC	1	1	69	5	67	H	356,250		
20	628	0004/049/680RE	2	6	65	7	66	H	95,338		

(2) A Proposed Concept of Priority in Implementation Program

To avoid possible damage and loss by occurrence of slope disaster, implementation of preventive slope work is desired as soon as possible; at least within a couple of years. However, there exists high hurdle of limitation in budget for resolving all identified problems. Thus, it is necessary to determine the priority for implementation of the works. According to the above standards, there are 12 slopes on the case study route for preventive slope works to be implemented soon.

Figure 5.1.1 shows a suggested concept of priority for preventive work using the Hazard Rating (H), geotechnical factor, and other factors (consequence, and economic/social or political conditions). Using this procedure, both factors can be separately studied and a final decision taken.

Hazard Rating Score (H) / Importance of Road		Very High	High	Moderate	Low
		H≥ 75	65≤H<75	50≤H<65	H<50
Highly important road	Likely large impacts on industrial/ social activities	A	B	D	
Moderately important road	Likely moderate impacts on industrial/ social activities	B	C		
Less important road	Likely minor impacts on industrial/ social activities	D			
Notes:	1) Priority in Implementation should be in the order of A--->--> B--> C 2) Zone 'D' will not require preventive program, except for emergency. 3) Importance of road can be determined by consequence, economic analyais, and other administrative requirement.				

Figure 5.1.1 Concept of Priority in Countermeasure Implementation

(3) Definition of Importance of Road

This subject is the one to be continuously studied by JKR to establish a practical criteria for decision-making. Table 5.1.2 summarizes various kinds of indicator that may give impact on possible damage by slope disaster. In another words these items can be used to measure the importance of road/slope in disaster management. As the table shows, some of them are included as the part of Consequential factor, and others are being studied in economic analysis in this study. This table also shows other items which be taken into consideration in final decision-making in disaster management plan.

Anyway it is recommended to use **the traffic volume** as a basic indicator, in evaluation of importance of the road by simple and practical decision-making.

Table 5.1.2 Major Indicators of Importance in Management of Road Slope

	Consequence (SIMS)	Economic Analysis (under study)	Additional consideration
Evaluation of relevant Road condition	Traffic volume Alternative road Service & Public Utilities	Traffic volume Population Industrial and agro products	Other industrial activities (tourism etc.) Future Development Plan Local community requirements Administrative requirements
Evaluation of relevant Slope condition	Nearby Residential houses Geometry (slope crest/toe) By-pass availability Possible failure size	Countermeasure cost	

(4) Implementation of Slope Management Plan

Based on the concept of slope risk categorization (slope management level category) and the concept of priority in implementation, the implementation plan of countermeasure can be prepared. Table 5.1.3 shows a suggestion of implementation plan framework in respect of time schedule of implementation. Actual plan shall be set as a combination of scheduled countermeasure program and other maintenance measures such as regular patrol, monitoring using instruments and periodical inspection.

Table 5.1.3 Framework of Implementation Plan

Time Frame	Time Period	Slope Criteria [Risk Rate+Road Importance]	Note
a) Urgent Plan	To be implemented urgently (by this year's budget)	Rated as VERY HIGH on [Extremely] Highly important road	To be treated as similar to urgent repair work after disaster
b) Short-term Plan	Within 1 to 2 years (by the following years' budget)	Rated as VERY HIGH risk on HIGHLY important road	Zone 'A' (figure 3.6.2)
c) Medium-term Plan	Within 3 to 5 years	Rated as VERY HIGH risk on the road of Moderately important road or ---------- Rated as HIGH risk on HIGHLY important road	Zone 'B' (figure 3.6.2)
d) Long-term Plan	Within 6 to 10 years	Rated as HIGH risk on Moderately important road	Zone 'C' (figure 3.6.2)

5.2 Selection of Countermeasure Work

After finalization of the priority and annual implementation plan, detailed study of and design of countermeasure work of the most appropriate method and scale should be undertaken for the selections.

(1) Site Investigation

Prior to design work, it is recommended that an appropriate programme of site investigations be carried out in accordance with the classification of possible slope failure and slope conditions.

Basic policy and procedure of major types of investigation are described in:

<Guide II Guide to Site Investigation and Instrumentation>

(2) Selection of Countermeasure

The most appropriate methods of the selected countermeasures should be carefully studied, taking into consideration factors such as;

1) Classification of slope failure
2) Existing slope conditions
3) Access and working conditions of construction
4) Surrounding conditions and
5) Budgetary allocation

Basic policy and procedure of selection of method of countermeasure are described in accordance with classification of slope failure in:

<Guide IV Guide to Countermeasure Selection and Cost Estimation>

5.3 Cost Estimation of Countermeasure Work

The approximate cost of slope countermeasure can be estimated using SIMS (Slope Information System) based on the scope proposed during slope inspection by slope specialist. The Standard (or Typical) Rate Table was prepared through many discussions and careful consideration with JKR staff and local engineers. Appropriate amendments to the scope of this table is recommended in accordance with technological development, together with annual review of the rates reflecting up-dated economical conditions. The Standard (or Typical) Rate Table is attached in:

<Guide IV Guide to Countermeasure Selection and Cost Estimation>

CHAPTER 6 SLOPE MAINTENANCE FOR DISASTER PREVENTION

6.1 Outline of Road Slope Maintenance

(1) Objective

Among the maintenance work for roads, slopes are the most important target in respect of disaster management. As mentioned in previous chapters it is clear that implementation of a preventive countermeasure plan is most effectivefor avoiding the possible slope disasters. However, implementation of preventive countermeasure demands much budgetary funding to meet all the requirements. Thus the significance of slope maintenance work should be given much greater emphasis. It can give suggestions for review of risky slopes, or sometimes provide warning of impending failure.

(2) Necessity for slope maintenance from geotechnical aspect

Slopes differ from road structures that are made of artificial material, steel, concrete, or bitumen. Slopes consist of natural material, soil and rock, , which has many uncontrollable factors. Following are some explanations on the uniqueness of slopes in road management:

1) Various factors concerned with slope stability:
   Slope stability is subject to many factors such as, topography, geological structure, type of rock and soil, grade of weathering, surface and ground water conditions, and so on, most of which contain many unknown factors. Accordingly, even though a slope has been designed to be stable, it has chances of becoming unstable due to natural or artificial conditions, leading to slope failure, during or after construction,
2) Aging effect:
   Aging effect is the deterioration with time, of strength and other properties of rock and soil after the completion of a slope. Therefore, after a road enters the period of operation, slope failure could sometimes occur, particularly within several years after the construction of the slope.
3) Effect of Heavy Rain:
   Heavy rain can be regarded as the most influential on slope stability in this country among several meteorological or natural features. Heavy rain can weaken ground resistance (or increase pore pressure at the sliding plane) and increase the weight of the ground mass , as well as causing direct damage to the slope surface.
4) Necessity for Continuous Follow-up:
   As mentioned above, slope stability is affected by many unknown factors and post-construction natural activities. Therefore it is very difficult to evaluate the status of the stability of each slope at the time of its design based on the site investigation results only. Follow-up maintenance after road operation is therefore indispensable.

(3) Follow-up of Road Maintenance

In the following sections 6.2 and 6.3, the scope of actual follow-up of slope maintenance will be described, and then in the section 6.4, suggested specification of recording system will be described since it is an important task for road maintenance office,.

- 6.2 Routine Maintenance of Road
- 6.3 Road Patrol for Slope Maintenance
- 6.4 Recording System of Slope Maintenance and Disaster Management

6.2 Routine Road Maintenance

As described in Chapter 3, routine maintenance work of paved federal roads in the Malaysian Peninsula has been privatised as of 26th February 2001. The scope and actual procedures of the work is regulated in the contract documents between Ministry of Works and the concession companies.

At this stage, the said contracts do not yet cover unpaved portion of federal roads in the Peninsula, and federal roads in East Malaysia. Thus, the responsibility of slope maintenance remains in the hands of the district office that covers each federal road.

However, from the point of slope disaster management, the actual work of routine road maintenance by concession companies has a very close relationship with slope maintenance done by the district office. In other words, routine road maintenance can offer quite useful information to JKR in respect of slope disaster management.

The scope and procedures for work handled by both sides should be well coordinated, and any findings related to slope stability should be reported to the concerned organizations of JKR as soon as possible.

Actual procedures of reporting by concession companies to JKR should be reviewed separately in reference to Slope Patrol Record, suggested in section 6.4.

6.3 Road Patrol for Slope Maintenance

6.3.1 Types of Slope Patrol

There are three (3) types of slope patrol for maintenance and disaster management, Regular SSSslope Patrol, Periodical Slope Inspection and Emergency Slope Patrol. The concept and main points of each are described in sections 6.3.2 to 6.3.4, respectively.

6.3.2 Regular Slope Patrol

(1) Outline

'Regular Slope Patrol' is defined as the normal road patrol done by JKR district office, with high attention to slope stability.

The frequency of regular patrol is recommended in general as twice a week. It may be adjusted in accordance with slope conditions, traffic volume and other engineering and social conditions, to be more or less than the recommended frequency. The major objective of this patrol 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.

(2) Scope of Regular Patrol

The scope of regular slope patrol can be summarised as below:

1) To check the smooth traffic condition
2) To check any obstacle on the road and roadside, and to check the risk of possible traffic obstruction; particularly of any stones/rock fragments or debris fallen from upper slope.
3) To check the condition of road structures, pavement, shoulder, drainage, wall, and in particular slope and slope works. When any damage or abnormality (unusual state) was found with road structure during patrol, it should be carefully observed and recorded for reporting and further follow-up.
4) To check general condition on the road or in the adjacent area which may likely affect the road traffic or slope stability.
5) To take necessary emergency action, in case any imminent eventis identified.

(3) Points for Observation and Recording

The following matters should be kept in mind before and after the regular slope patrol in order to carry out effective management of a slope disaster.

1) To see through, in advance, the risk rating result by slope inspection, which will be available in the database of SIMS (Slope Information Management System). A long list of slope with risk rating value can be printed out and brought along by the staff when on slope patrol.

2) To keep in mind the location and the status of selected slopes, particularly, which are rated as 'VERY HIGH' and 'HIGH'.
3) To report immediately to the concerned organizations, when any signs of imminent risk of slope failure are observed.

The points for observation and recording during regular slope patrol are summarized in Table 6.3.1 in respect of slope prevention of road slope disaster.

Table 6.3.1 Points of Observation and Recording during Slope Patrol

Position/ Structure		Points of Observation and Recording
Traffic Lane	Pavement	Depression, longitudinal or transversal cracks or any defects? (newly found or progressing?)
		Fallen rocks or debris on the road from upper slope ?
Road Side	Shoulder	Depression, opened cracks or any defects? (newly found or progressing much?)
	Drain & Culvert	Fallen rocks or debris inside, mal function 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	Slope (ground)	Rock fall or slope failure: (newly found or progressing much?)
		Depression, swelling, opened cracks, or any defects? (newly found or progressing?)
		Marked erosion of Gully type (newly found or progressing much?)
		Spring water 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?)

6.3.3 Periodical Inspection for Slope Maintenance

1) Periodical Inspection may be carried out at the same time with periodical slope inspection that is currently operated under SPRS system.
2) The interval of execution shall be at intervals of half a year, or sometimes one (1) year, periodically, depending on the importance of the road section.
3) The purpose of periodical inspection is to check the slope stability and to assess the damage and deterioration of each road structure.
4) The target slope shall be:
   a) The slopes rated as Very-High and High in the previous slope inspection, as well as the slopes rated as Moderate.
   b) Inspection shall be made basically by visual observation of the slope, as well as other road facility including vegetation, slope surface works, drainage (on-slope), wall and fence at toe, and

c) Pavement, drainage (roadside), shoulder, culvert, which are located beside the slope.

4) During the inspection, careful attention should be paid on the deformation/ settlement and existence of cracks on slopes and other road structures, together with fallen material on the road surface and walls or fences down the slope.
5) One of the inspections shall be scheduled during rainy season for the region, so that actual conditions of slope and drainage facilities could be assessed properly as far as possible.
6) From the characteristics of this work, inspection shall be made not out of window of patrol vehicle, but on foot, and if necessary to be extended up and down the slope.
7) The results of inspection shall be recorded and filed as a part of slope database.
8) The inspection shall be carried out by engineers and technicians who belong to JKR district office.
9) Training program shall be arranged in advance for the procedure of this periodical structure inspection.

6.3.4 Emergency Patrol for Slope Disaster Management

1) Emergency patrol shall be carried out at times of emergency or concentrated heavy rain.
2) The objective of this patrol is to promote proper planning and decision making for disaster prevention or restoration of disaster damage.
3) Patrol shall be made basically on the following locations:
   a) Actual site of falling of stone or debris, if any.
   b) Selected slopes rated as **Very-high** and **High** by the slope inspection.

   It is advised that Very high risky slopes shall be picked up in advance.
4) Information shall be collected on the site conditions, and shall be reported immediately to the office.
5) Necessary emergency action should be taken without delay, in accordance with the actual occurrence of failure, or the unstable condition of slope. (The contents of emergency action should be studied separately in a later Chapter.)

6.4 Recording System of Slope Maintenance

(1) Objective of Recording of Slope Maintenance

Recording and reporting on the slope maintenance work is an essential procedure in the slope disaster management.

The information collected during daily road patrol is sometimes a useful indication or preliminary signal of on-coming slope failure in the near future. In such a situation, suitable action should be taken as soon as possible in order to prevent occurrence of slope disaster that may cause damage and loss of vehicles, including reporting to concerned organizations and cooperation.

At the same time, it is important to keep historical records of disaster occurrences and countermeasure implementation. For further effective and efficient slope management plan, the record of slope maintenance shall be prepared and maintained by district office in accordance with the suggested format.

(2) Suggested Items of Slope Related Database

Besides the above record on slope patrol, disaster occurrences and countermeasure implementation, data on the following items are suggested to be collected and accumulated in the district office for slope disaster management planning, as shown in Table 6.4.1.

Table 6.4.1 Suggested Items of Slope Related Database

Group	Items of Database	Note
Record of Slope Patrol and Inspection	Regular Patrol for Slope	Twice a week in general; The suggested format can be used.
	Periodical Structure Inspection Record	Once or twice a year.
	Emergency Slope Patrol Record	At the time of emergency action; Format of Slope Disaster Record is suggested to be used.
Record of Monitoring	Rainfall data - continuous rain data) - data for the preceding two days before large slope failure	Besides the rainfall data from JKR's own rain gauge, data from nearest station of other agencies, like DID and MMS may be suggested to collect for the back data of disaster management.
	Other instrument measurement data, including extensometer, water level meter and so on.	
Other base data related to slope management	Topographical maps Soil Investigation Report Countermeasure Design Plan Construction Plan and Record	

(3) Suggested Format of Recording Sheet

The formats of recording sheet for slope maintenance are listed in Table 6.4.2. And the format of each type of sheet is attached on Appendix 6.4.

Table 6.4.2 Recording Format for Slope Maintenance

	Name of Recording Sheet	Note
Recording Sheet	SLOPE PATROL RECORD	Any marked findings that likely lead to slope stability shall be recorded.
	SLOPE DISASTER RECORD	Each of slope failure which affected on road traffic shall be recorded at occurrence.
	SLOPE COUNTERMEASURE RECORD	Every construction work of countermeasure for each slope shall be recorded at the time of completion.
Summary Sheet	SLOPE PATROL SUMMARY	List of slope patrol operation, which shall be recorded regardless the filling in of RECORD sheet.
	SLOPE DISASTER SUMMARY	List of the above record of Slope disaster.
	SLOPE COUNTERMEASURE SUMMARY	List of the above record of slope countermeasure.

CHAPTER 7 MONITORING AND TRAFFIC CONTROL

7.1 Monitoring of High-Risk Slope for Early Warning

7.1.1 Outline

"Monitoring using instrument" is quite a useful measure of disaster management together with road patrol, traffic control, etc., following the implementation of countermeasure work. If we think about limitation of budget, the actual number of slope to be selected in urgent implementation program (within a year) should be quite small. It does mean great number of slopes, including 'highly' or 'very highly' risk rated slope is forced to remain unimplemented for countermeasure work. Here we should find a resort to regular patrol, monitoring, and traffic control and so on.

The detailed technical description of monitoring using instrument shall be referred to Guide III: Guide to Monitoring and Investigation for Design.

7.1.2 Items of Monitoring for Early Warning

The items for monitoring and typical instruments employed are summarized in the Table 7.1.1.

Table 7.1.1 Summary of Monitoring for Early Warning

Items	Instrument	Notes
1) Rock-fall/ Failure Detection	Rock-fall detector	For direct information of actual fall or failure occurrence
2) Slope Surface Movement	Wire extensometer etc.	For early warning based on large displacement exceeding the established standard criteria
3) Slope Surface Behaviour	Crack Gauge Surface Tiltmeter etc.	For getting information of accelerated change of the measured items (The standard criteria to be studied and determined for each slope.)
4) Subsurface Movement	Borehole Inclinometer Pipe Strain Gauge etc.	
5) Groundwater Level (Pore Pressure)	Ground water level meter Piezometer	For getting information of change of water level or pore pressure (The standard criteria to be studied and determined for each slope.)
6) Rainfall	Rain gauge	For analysis of relation with other measurement result; For traffic control;

7.1.3 Standard Criteria for Early Warning

Table 7.1.2 summarizes the suggested standard criteria of slope behavior for early warning of road slope disaster. (The detail is discussed in Guide III. Guide to Monitoring and Investigation for Design).

Table 7.1.2 Suggested Standard Criteria for Early Warning

Instrument	Careful Attention	Study for Traffic Control
Rock-fall detector	Detected single event of rock-fall, or single failure of less than 1m3.	Detected a failure of over than 1 m3, or more than two events of rock-fall or failure.
Wire extensometer, etc.	Monthly displacement > 10 mm	Daily displacement > 20mm, or Monthly displacement > 500 mm
Crack Gauge, Surface Tiltmeter etc.	(The standard criteria to be studied and determined for each slope.)	
Borehole Inclinometer, Pipe Strain Gauge etc.	Monthly displacement > 30 mm	
Ground water level meter, Piezometer	For getting information of change of water level or pore pressure (The standard criteria to be studied and determined for each slope.)	
Rain gauge	For analysis of relation with other measurement result; For traffic control;	Example in Japan: Accumulated rainfall: 170 mm Hourly rainfall: 30 mm (The standard criteria to be studied according to local conditions.)
Visual Observation on the Surface	1) Ever observed sometime rock fall or small failure. 2) Depression, cracks or any marked movement on pavement, road, shoulder, wall, drainage, slope or slope works. 3) Marked change of Spring water from slope or surface water in volume and turbidity.	1) Confirmed continuous rock falls; or occurrence of medium size failure which block the traffic pass. 2) Depression or large holes on the pavement of traffic lane

7.2 Traffic Control under Heavy Rain Conditions

7.2.1 Concept of Traffic Control

Traffic control, or blockade under heavy rain conditions is thought as one of effective measures to prevent possible occurrence of slope disaster, because great number of road slopes (which are rated as high-risk ore very high-risk) may remain un-implemented of countermeasure due to limitation of budget in mountainous region.

Although there still exist several issues to be cleared for reliability of this measure, continuous study should be made for establishment of the control criteria based on the accumulation and analysis of data related rainfall and disaster record.

7.2.2 Methodology

"The Traffic Control under Heavy Rain" is based on the experimental fact or statistical knowledge that the number of slope failures increases remarkably when the amount of rainfall exceeds a certain value.

However, in order to implement this traffic control system, if strictly speaking, it is necessary to determine the standard criteria of rainfall for each federal road or region, because the relationship between rainfall and occurrence of slope failure depend on the local conditions in several natural factors and road engineering design, construction and maintenance.

(1) Several Methods of Determination of Critical Rain

Several methods were proposed and have been applied as follows:

a) Hourly Rain Method (or Rain Intensity Method)
b) Accumulated Rain-Hourly Rain Method
c) Effective Rain Method
d) Surface Soil Water Storage Method, etc.

So far several advantages and disadvantages have been discussed for each method by many researchers in Japan. The main points in discussion are summarized in Table 7.2.1.

Table 7.2.1 *Summary of Traffic Control Method based on Rainfall*

Method of Traffic Control	Principle	Advantage/disadvantage
a) Hourly Rain Method	Hourly rainfall can be thought to represent well for the rainfall intensity indicator.	To be a good indicator causing shallow slope failure (generally thickness < 1m)..
b) Accumulated Rain Method	Accumulated rainfall (summation of precedent rain without break) reflects better on collapse or landslide than heavy rain of short term.	To be applicable to deeper slope failure (more than 1m in thickness), according to field data.
c) Combined Method of Hourly Rain and Accumulated Rain	Combination of methods of a) and b); more reliable than single application of method b).	To be adopted by many road administrator Japan, including Expressway and federal road.
d) Effective Rain Method	Effective rainfall is defined as the accumulated rainfall with attenuation by run-off effect of precedent rain.	To be demonstrated to be reliable, but inferior to c) in simplicity of procedure.
e) Water Storage in-Soil Method	Change of water volume in the soil is evaluated using Tank model analysis.	Being adopted in special program aerial disaster warning in use of weather forecast radar network

(2) Procedures of Determination of Rain Criteria

The detail of actual procedure for determination of rain criteria may differ according to the method to be adopted. But here is the common procedure in all methods as follows: (Refer to Figure 7.2.1 General Procedure for Determination of Rainfall Criteria.

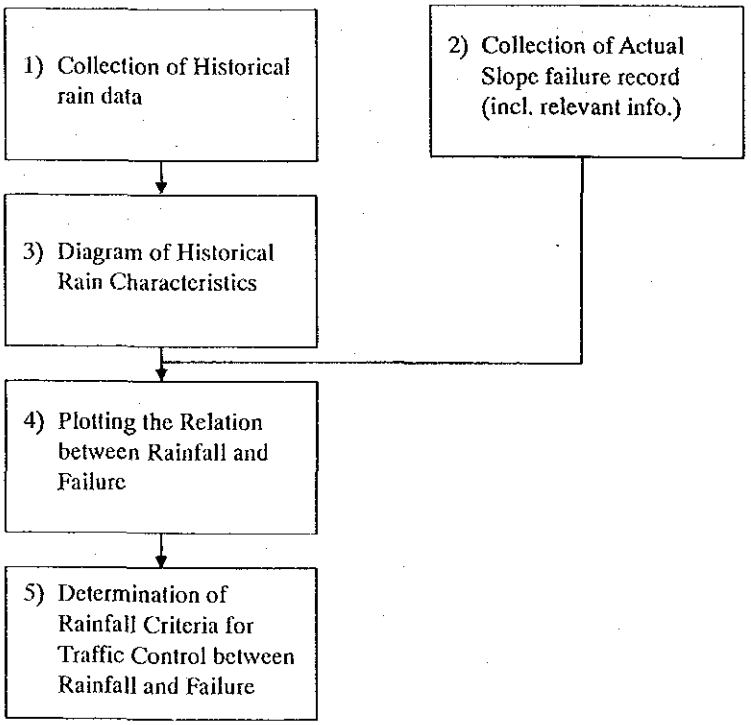


Figure 7.2.1 General Procedure of Determination of Rainfall Criteria

1) Collection of rainfall data: If available, historical data at least for 20 years are desirable. Hourly rain data is requested for analysis as well as daily rain data.
2) Collection of Slope Failure Record: Historical data about slope failure should be collected. Related information such as Time, Location, type of slope failure, size (volume, length, area), damage to person, vehicle, or facilities, influence to road traffic, and rainfall data for precedent two days.
3) Diagram of Historical Rainfall Characteristics:
   Hourly Rainfall (Hr) shall be plotted against Daily Rainfall (Hd) or Accumulated Rainfall ($\sum R$), grasping the characteristics of rainfall in the targeted region.
4) Plotting the relation between Rainfall and Failure:
   Actual events of slope failure in the past will be plotted against rainfall on the above diagram
5) Determination of Rainfall Criteria for Traffic Control
   From the above plots, the rainfall criteria for traffic control can be determined as the boundary of risky zone and safety zone.

7.2.3 Determination of Rainfall Criteria

The value of rainfall criteria shall be finalized in accordance with various conditions of each federal road section as follows:

a) Rainfall characteristics of the region
b) Slope failure history of the region (connected with geology and other conditions)
c) Traffic Volume of the road section
d) Social, economical importance of the region
e) Age of the slopes after construction (In general toad slope newly constructed within 5 years tends to show higher probability of causing failure.)

For application this system in Malaysia, the criteria should be determined based on the analysis of local data. A tentative recommendation for the criteria for traffic control is described in Guide III (Chapter 2 Recommendation for Malaysia).

7.2.4 Suggested Further Task

Following works shall be necessary to continue to improve the reliability of traffic control system as below:

(1) Accumulation of Data

The necessary data to be accumulated is regarding rainfall (hourly and daily) and slope failure along the targeted road. In general accumulation of data at least 10 to 20 years is desirable for more reliable analysis for implementation of traffic control system. He suggested subject for this are:

a) Rainfall Data collection of rainfall sourced from DID (Department of Irrigation and Drainage) and MMS (Malaysian Meteorological Service)

b) Installation and maintenance of Rain gauge station network at selected locations along important federal roads

c) Accumulation of slope failure record, which shall be achieved by strict observance of recording at each event by the staff in charge at district office. (Please refer to 6.4 Recording System of Slope Maintenance and Disaster Management, in this Guide I.)

(2) Analysis of Data

Accumulated data on rainfall (hourly and daily) and slope failure shall be analysed in respect of :

a) Mutual relationship between hourly rainfall, daily rainfall and accumulated rainfall without break

b) Mutual relationship between each value of rainfall and slope failure occurrence

(3) Review/ Revaluation of Method of Traffic Control and Its Criteria

In accordance with the result of above analysis, method and criteria for traffic control shall be revaluated to be more suitable to the targeted region and road.

CHAPTER 8 ROAD DISASTER EMERGENCY PLAN

8.1 Outline

(1) Objective

Study of emergency plan is one of essential components in road disaster management, because disaster prevention program by slope countermeasure work, maintenance, monitoring measures, etc. cannot perfectly avoid occurrence of disaster by technical and financial limitation.

Emergency plan should be studied to cope with the actually occurrence of disaster, minimizing its damage and achieving soonest recovery of road traffic.

To make the emergency plan to be efficient, the study of preparedness program should be emphasized. In this context, it is suggested to establish the emergency plan consisting of two portions as below:

1) Disaster Preparedness Plan
2) Emergency Response Plan

(2) The Roads to be Applied

This plan shall be basically applied to whole the federal roads in Peninsula and East Malaysia. Detailed plan should be studied for each level of offices in JKR. Also actual procedures in the plan may be defined according to local conditions in each road or office, under direction of JKR Headquarters.

(3) Review and Announcement

This plan shall be reviewed annually and when it is necessary, so that it could work more practical and concrete. Any change should be announced to each of concerned offices and staffs without fail.

In the following sections, 8.1.2 and 8.1.3, major items to be defined in the disaster emergency are listed with brief explanation.

8.2 Disaster Preparedness Plan

Prior to the occurrence of actual disaster, comprehensive preparedness plan shall be studied and established.

It is recommended that this plan shall be studied in good coordination with countermeasure work, routine maintenance, monitoring, etc.

Major items to be studied in the disaster preparedness plan as below:

(1) Education/Training Programme
(2) Establishment of Cooperative Relationship with Other Organizations
(3) Collection and Delivery of Information
(4) Public Announcement for Disaster Prevention
(5) Roadside Space for Emergency Action and Evacuation
(6) Storage and Procurement Plan
(7) Information and Communication System
(8) Facilities Necessary for Disaster Management
(9) Supports to Working Staff at Emergency Action

Here are brief notes on the above major items in the disaster preparedness plan as below:

(1) Education/Training Programme for Disaster Preparedness

It is requested that all the concerned offices and their staff take appropriate and quickest action at the time of emergency. To ensure efficient action at such time, an education and training programme shall be planned and executed at each concerned office. In the program, necessary arrangements and procedures shall be understood and confirmed by each staff. Basic education programme for JKR staff shall be included the following items:

1) Knowledge and understanding on the features and risk of slope failure to be anticipated in the road section in charge, including the database of SIMS, if available.
2) Knowledge on emergency quick action; such as reporting and communication system with concerned organization, support to injured person, necessary road traffic instruction, restoration of traffic passage, etc.
3) Role of staff at emergency, including call-out of staff.
4) Other necessary emergency actions

(2) Establishment of Cooperative Relationship with Other Organizations

To cope well with road disaster properly, not only between concerned offices within JKR, best coordination and cooperation with other organizations is necessary and shall be established in the preparedness plan.

Exchange of information and mutual support shall be arranged in advance in the area of public announcement, personnel dispatch, provision of machine and material, provision of

transportation and so on, between JKR and other organizations in the governmental, public and private sectors.

To expect effective and efficient cooperation with other organizations at the time of emergency, good discussion through exchange of ideas and information shall be maintained before the occurrence of disaster.

The organizations to be cooperation in connection with disaster emergency plan includes the followings:

1) Headquarters, State/District Offices, etc. of JKR
2) Road Maintenance Concession company
3) Other governmental offices, including Police
4) Municipal offices and local communities
5) Public utility companies who own any properties within road area.
6) Contractors and material suppliers:
7) Mass Media

(3) Collection and Delivery of Information

For quick response in emergencies, detailed plan of scope, method, procedures should be established in connection with collection and delivery of information in advance of occurrence of slope disaster.

(4) Public Announcement for Disaster Prevention

Public announcement should be made as quickly and correctly as possible. Announcement should be made on possible slope failure and traffic safety, possible emergency action to be taken at emergencies, requesting for understanding and cooperation in such event.

The target of announcement will be the followings:

1) Municipal offices/local communities
2) General road users

(5) Roadside Space for Emergency Action and Evacuation

To help the evacuation of vehicles and quick response action upon disaster, roadside space shall be secured within a certain distance along federal roads.

(6) Storage and Procurement Plan

Storage and procurement plan shall be established regarding tools and materials necessary for emergency action. For a quick action, the plan should include the information on private sectors as well as JKR offices.

The procedures of procurement and mobilization of tools and materials, etc. shall be defined, including personnel necessary for its operation.

(7) nformation and Communication System

For quick and efficient action, following system should be implemented and improved to be as latest as possible..

1) Information system such as personal computer network with internet, with power back-up system, and slope database of the Slope Information Management System (SIMS)
2) Communication system such as telephone line, mobile telephone, and satellite communication system.
3) Remote monitoring system for slope road traffic, behaviour of risky slope and rainfall.

(8) Facilities Necessary for Disaster Management

For immediate starting of emergency action control, proper arrangement of facilities should be made such as management control room, equipped with necessary furniture, information and communication equipment.

(9) Supports to Working Staff at Emergency Action

To support the working staff for emergency operation, arrangement should be made for permanent storage of items such as drinking water, food, portable gas bottle, first-aid-kit, working clothes and shoes, sleeping facilities, drinking water tank and so on.

8.3 Emergency Response Plan

Emergency response plan shall be studied for efficient action upon the occurrence of disaster. It should be noted that most of the items of emergency plan is the same ones studied in emergency preparedness plan, *mentioned in* 8.3:

(1) Organization of Emergency Operation
(2) Mobilization of staff
(3) Reporting and Information Exchange
(4) Cooperation with Other Concerned Organizations
(5) Public Announcement
(6) Mobilization and Procurement
(7) Supports to Road Users and Neighbouring Residents

(1) Organization for Emergency Operation

When any disaster may occur, the manner of its handling depends of the size of damage caused by the disaster. If a disaster causes great damage and loss giving huge impact to wide region, emergency operation and subsequent restoration may be directed by the national

government organization. But it is expected that most of slope related disasters, in general, would be handled by JKR, headquarters, state office and district office.

In this context it is suggested that the emergency response related with slope disaster would be categorized by JKR into three different levels as below:

Emergency Level I [Big Slope Disaster]: To be directed by JKR headquarters (Emergency response is requested against the occurrence of disaster causing big damage and loss.)

Emergency Level II [Minor Slope Failure]: To be handled by district office, with reporting to headquarters and state office (Emergency response is requested against the occurrence of disaster causing minor damage and loss.)

Emergency Level III [Alert Status]: To be handled by district office, with reporting to headquarters and state office (This is not for the action against actual occurrence of disaster, but for standing-by position in alert. Under the condition of heavy rain or finding sign of imminent occurrence of slope failure, administrative traffic control and emergency patrol should be carried out.)

The organization of emergency operation of each emergency level shall be defined in advance according to the condition of the relevant office. In general following task force is required to assign to the staff concretely.

Emergency operation director; deputy director; general & administration; procurement; public relations; information collection and communication; site inspection and emergency patrol, emergency response work supervision, and so on.

(2) Mobilization of staff

Mobilization plan shall be established in detail in each office for emergency operation in accordance with the level of emergency. The person to be called up shall be nominated precisely in advance.

When it is judged as necessary, despatch of supporting staff shall be called for from neighbouring office, with approval of higher organization.

(3) Reporting and Information Exchange

When any first report about slope failure occurrence or imminent its sign is delivered to district office, the level of emergency response should be judged by district office director and shall be immediately reported to higher organization.

Information related to slope failure, possibly causing road traffic obstruction, should be exchanged between concerned parties including police, municipal office, local community. (Agreement should be arranged in this matter one another within the parties.)

(4) Cooperation with Other Concerned Organization

Cooperation between other concerned organizations should be well organized in efficient performance of emergency response.

For this purpose maintenance of good relationship between the parties is indispensable, including regular communication and exchange of information.

(5) Announcement

Timely public announcement about occurrence of slope failure is required to be delivered particularly to road users and local residents without delay for avoiding subsequent damage and loss and confusion. Announcement should include current situation of slope failure and traffic passage, and expected schedule of traffic restoration. When it is necessary, cooperation of mass media should be made use of for public announcement.

(6) Mobilization and Procurement

Mobilization of personnel and machinery together with procurement of necessary material shall be quickly carried out as specified in emergency preparedness plan, including the involvement of the general contactor and other private sectors.

The conditions and procedures of cooperative works by private sectors should be confirmed in advance.

(7) Supports to Road Users and Neighbouring Residents

Besides the first saving action of direct victim by slope failure, quick action should be made for supports to road users and neighbouring residents influenced by the slope failure in the proper form of information service and others.

APPENDIX 8 EXAMPLES OF SUPPORTING TOOL TO DISASTER MANAGEMENT

For establishment of more efficient and reliable road slope disaster management, various kinds of supporting tool have been developed in Japan in respect of high technology hardware system and software system, utilization of human resources.

Here are brief introduction of some examples of such tools.

(1) Hardware Tool for Supporting Disaster Management

Road Traffic Information System is quite usefully utilized in Japan to provide information to both of road administrator and of road user. Currently the traffic information system is widely used to get the location and situation of traffic jam and to remake the trip schedule or to find suitable detour for road user. One of such system is name as **VICS (Vehicle Information Communication System).**

However, from the point of road disaster management, it can provide the road users with many kinds of information related to road slope disaster; its occurrence, imminent risk of possible failure, traffic control instruction such as administrative road closure, slow down of limited speed, restriction of driving lane and so on.

Latest technology in information and electronic area have been introduced for more sophisticated traffic information system, with the combination of GPS based car navigation, mobile phone, internet, radio beacon, FM wave broadcasting, electronic announcement sign board for road user and control centre. The system is based on the monitor cameras for road traffic, and monitoring instrument of rainfall and slope behaviour observation.

It is suggested to apply some part of these information systems to the federal road identified as prone to slope failure, in particular **electronic traffic warning board** to road user, based on the observation data of rainfall and slope behaviour.

(2) Software Tool for Supporting Disaster Management

Cooperation with experts in slope disaster or local residents can be good support to higher efficiency and reliability of slope disaster management. Several kinds of such systems have been adopted In Japan.

Some experts are registered to Japanese Ministry of Land, Infrastructure and Transportation, under the name of '**Disaster Doctor**', or '**Disaster Prevention Expert**'. They are requested to carry out field survey for assessment of failed area after occurrence of disaster as volunteer.

Another example is the registration system of '**Road Monitor**', who lives or works in the building along federal roads, being requested to report to the Ministry the situation and any problems in road traffic also as voluntcer.

The volunteer activity of these registered people is valuable as they can fill the shortage that public office cannot complete in some areas in road disaster management.

SLOPE PATROL RECORD

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	

Pavement	**Depression**, longitudinal or transversal cracks or any defects? (newly found or progressing?)	
	Fallen rocks or debris on the road from upper slope ?	
Shoulder	**Depression, opened cracks** or any defects? (newly found or progressing much?)	
Drain & Culvert	**Fallen rocks or debris inside, mal function** 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?	
Slope	**Rock fall or slope failure**: (newly found or progressing much?)	
	Depression, swelling, opened cracks, or any defects? (newly found or progressing?)	
	Marked erosion of Gully type (newly found or progressing much?)	
	Spring water or running water on Isope or in drains:(any change of volume, turbidity?)	
	Fall or tilting of tree on the slope (newly found?)	
On-slope Works	**Breaking, deformation**, cracks, tilting, depression, ill-interlocking, or any defects? (newly found or progressing?)	
Any Others Comments: - any points for careful follow-up		

A.Figure 6.4.1 Slope Patrol Record

SLOPE DISASTER RECORD

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 Recorded	/ / 200
Field ID		Recorded by	
Route Name		Date Checked	/ / 200
District Name / State Name	/	Checked by	

Date and Time of Occurrence	**Date:** / / 200 **Time:** am / pm
Type of Failure (May circle more than one)	1-a. Collapse 1-b. Rock Fall 2. Rock Mass Failure 3. Landslide 4. Debris Flow 5. Embankment Failure
Dimension of Failure on slope	**Length:** m in longitudinal direction of road **Height :** m (both approximate figures)
Volume of Fallen Debris or Rocks	(Approximately) m3
Damage and Loss	**Vehicles/ other facilities:** **Death or Injury:**
Emergency Operation	Scope of Operation:
	Traffic Block Duration (No or Yes) (hours ; days ; months)
Rainfall (before the failure or rock fall)	24 hours Rainfall of the Day: mm (Date: / / 200) Maximum Hourly Rainfall: mm (Date: /) (am / pm : -) Total for Proceeding 3 days: mm (Date: from / to /)
[Data Source]	1. JKR 2. MMA 3. DID (Station Name:)
	4. Other sources ( )
Remarks *1) Related causes 2) Expected countermeasure 3) Others*	
Rough Sketch of Failure or Fallen Rocks (Not compulsory)	

A.Figure 6.4.2 Slope Disaster Record

SLOPE COUNTERMEASURE RECORD

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 Recorded	/ /
Field ID		Recorded by	
Route Name		Date Checked	/ /
District Name / State Name	/	Checked by	

Month of Implementation	**Month:** **Year: 200__ (Completion)**
(Month of Last Failure)	**Month:** **Year: 200__**
Type of Failure (May circle more than one)	1-a. Collapse Landslide 1-b. Rock Fall 2. Rock Mass Failure 3. 4. Debris Flow 5. Embankment Failure
Major Objective of Implementation this time	

Scope of Countermeasure	Name of Work	Q'ty	No.	Notes
1)				
2)				
3)				
4)				
5)				

Remarks	

[Reference Data] **Summary of Contract**	Contract No: ( )
	Contracting Office: Headquarters/ State Office( )
	Supervising Office/ Officer: (/)
	Name of Contractor: ( )
	Contract Period: (/ /) to (/ /)
	Ammount of Contract: RM ( )
	Chainage of Works: from ( ) to ( )
	Number of Slopes to Work: ( )
	Notes:
Rough Sketch of Implemented Work (Not compulsory)	

A.Figure 6.4.3 Slope Countermeasure Record

SLOPE PATROL SUMMARY

(For Regular Patrol, and for Special or Emergency Patrol)

Route Name		From (M/Y)	/ 200
Chainage	km - km	To (M/Y)	/ 200
District (State)		Checked by	(date:)

No	Date	Month	Day-week	Name of Person to Patrol	Marked Findings, if any	Tick, if record is filled-in
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

Remarks	

A.Figure 6.4.4 Slope Patrol Summary

SLOPE DISASTER SUMMARY

(To be prepared at each time of filling-in of SLOPE DISASTER RECORD)

Route Name		From (M/Y)	/ 200
Chainage	km - km	To (M/Y)	/ 200
District (State)		Checked by	(date)

No	Disaster Occurrence					Name of recording	Comments
	Date	Month	Year	Location (Chainage) Start km	End km		
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
Remarks							

A.Figure 6.4.5 Slope Disaster Summary

SLOPE COUNTERMEASURE SUMMARY

(To be prepared at each time of filling-in of SLOPE COUNTERMEASURE RECORD)

Route Name		From (M/Y)	/ 200
Chainage	km - km	To (M/Y)	/ 200
District (State)		Checked by	(date)

No	Completion of Countermeasure				Name of Person	Comments
	Month	Year	Location (Chainage) Start km	End km		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
Remarks						

A.Figure 6.4.6 Slope Countermeasure Summary