3.8 Method for the Evaluation of the Stability: Scouring of Bridge Foundations

3.8.1 General

(1) Evaluation of the Stability of Riverbed and Revetment, and Abnormality

1) Evaluation of the Stability of Riverbed and Revetment

The stability of the River bed, Revetment and Superstructure against scouring, should be evaluated for each abutment and pier and inferior structure with a focus on the characteristics of the river and the structure of the bridge. Then, evaluation ratings should be reviced according to the scale of previous disasters.

2) Evaluation of Abnormality

It should be evaluated and make a score for the scale of scouring of bridge foundations for each abutment and pier, and abnormality of the connected portion btween bridge and dike approaches should bi evaluated also.

3) Evaluation of Bridges

Ratings score for each abutment and pier should be made accroding to the method as per 1) and 2). Then, it should be compaired those score and adopted higer poin as the evaluation of Bridge.

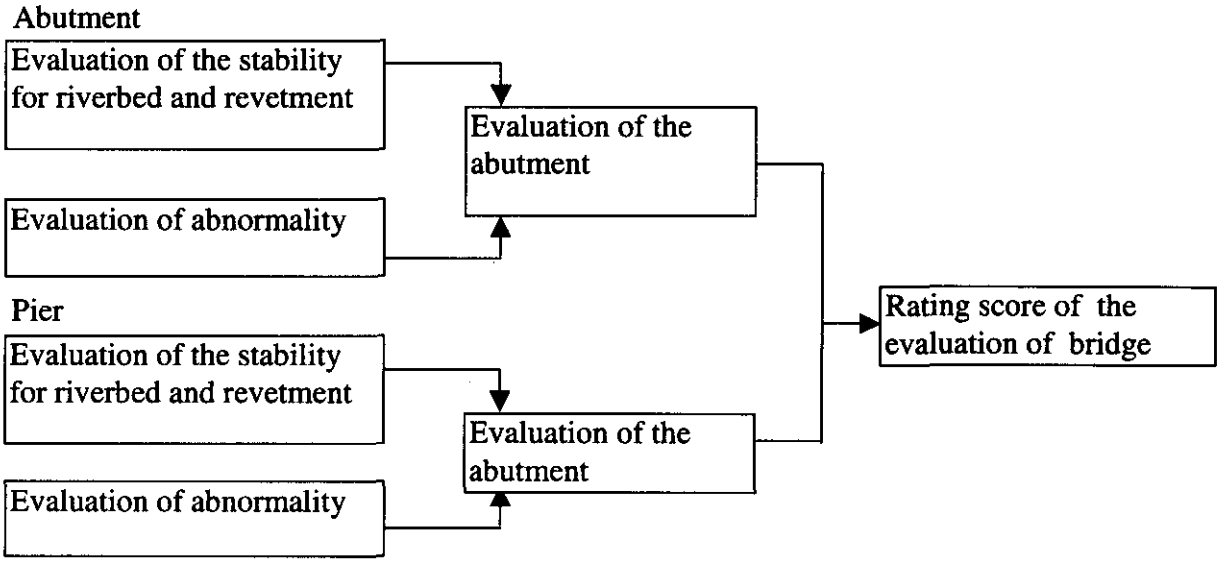


Figure 3.8.1 Concept of Evaluation for Stability Score (Scoring of Bridge Foundations)

(2) Integral Evaluation

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

i) Disaster factors,

ii) Efficiency for countermeasures,

iii) Disaster history, and

iv) The condition of scoring and abnormality

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 shows no disaster factors and there is no need to take new measures.

Table 3.8.1 Evaluation Criteria

Integral evaluation	Evaluation criterion
It is necessary to take measures	i) There are many disaster factors for stability of reverbed and revetment. ii) There ane many factors for stability of abutment and pier which have influence scouring and flood. iii) There are outstanding scouring and abnormalities under the inspection
To correspond with a table of the "Disasters Prevention Description Sheets"	i) There are disaster factors for stability of reverbed and revetment. ii) There ane factors for stability of abutment and pier which have influence scouring and flood. iii) There are scouring and abnormalities under the inspection
It is not necessary to take new measures	i) There are no disaster factors for stability of reverbed and revetment. It is a little symptom only, even if there are. ii) There ane no factors for stability of abutment and pier which have influence scouring and flood. It is a little symptom only, even if there are. iii) There are no scouring and abnormalities under the inspction . It is a little symptom only, even if there are.

(3) Objective Abutment and Piers under Inspection

The objective spot shall be inspected to selecting abutment and pier, which has worst condition for stability against water streams and scouring.

But, It shall be preferably inspected plural abuts and piers for reasons not to clarify stability due to river condition (changing the stream of waters due to sand banks, reduction due to taking gravel out or dredging) and difference of bridge structure (abutment, pier, foundation).

(4) Inspection Methods and Items

An inspection of the following items should be done through a review of the bridge registration book, as built drawings, data. The inspection should be also done through

interviews to the maintenance office, and a site survey (including topographical surveys).

When the details of the structure cannot be known due to lack of drawings and other documents, it is better to survey and measure at site. If it has some condition not to survey, a visual inspection should be done. And, if site condition is indefinite for evaluation , it is rather to apply the score high dangerous case.

1) Rating of the Stability of Evaluation to Abutment and Pier

a) Common Items to Abutments and Piers

i) Characteristics of river

If the bridge is located in the site where may be influenced by scouring and floods, it shall be evaluated. The evaluation should be carried out mainly through a review of as built drawings and other documents pertaining to the river. It is important to confirm at the site the occurrence of changes for the river condition, between as-built, drawings and present condition. It may be caused new scouring. It is preferable to inspect with the river management office with interview such as current situation of the river (stability of the channel, threat points), and the bridge's surroundings, etc.

[1] Inclination of the river bed

[2] Bridge location (bend point, scouring point)

[3] Position of piers and dike

[4] Other (high water level, river bed design level, current river water level, etc.)

ii) Bridge structure

It should be evaluated whether the bridge structure (dimension) is caused any resistance to the river flow, incrassation of flow speed, or scouring, etc. The evaluation should be carried out with as built drawings or other documents.

[1] Construction year

[2] Minimum span

[3] Blockage ratio by cross section area

[4] Free space under the beams

iii) History of previous disasters

It should be inspected for the frequency of previous disasters in the river and site around the bridge, and the rating score should be adjusted accordingly.

b) Abutment

It should be inspected of the conditions of the abutment with tendency for scouring, and the general status of revetment protection works, as well as countermeasures against scouring.

[1] Distance from the edge of the dike slope to the pier

[2] Position of the abutment (whether or not it is in the channel)

[3] Stability against scouring (penetration of foundations)

[4] Length, width and height of revetment for revetment in front and around the abutment.

c) Piers

An inspection should be done for the conditions of pier with scouring, and the general status of revetment countermeasures against scouring.

[1] Pier structure.

[2] Angle at which the current meets the piers in the river.

[3] Stability against scouring (penetration of foundations)

[4] Countermeasures against scouring

2) Rating Score for Abnormality

a) Abutment

i) Scouring, abnormality

An inspection should be done of the abnormality of revetment and dike protection works, since, if there are any abnormality in front and around abutment, the river flow erode revetment and filling soils of the abutment at which water penetrate the back of, and finally resulting scoring is caused the overturning, subsidence or lean of the abutment.

A inspection should be done by visual inspection

[1] Scouring and abnormality in the foundation of revetment.

[2] Abnormality in revetment.

[3] Subsidence and abnormality in the joints of revetment.

ii) Type of foundations

The type of foundations has much influence to the stability of abutments against the water current and scouring. The type of foundations should be inspected through as built drawings and documents.

When the type of foundation or pier cannot be determined, and the pile foundation is wooden pile case, the pier will be considered as "sprend foundation".

b) Piers

i) Scouring

The scale of scouring should be measured at site, because the degree of exposure of foundations is an important factor of their stability.

ii) Foundation type

Foundation types have great influence to the stability of foundations against water currents and scouring. Foundation types should be inspected through as built drawings and other maintenance documents.

When the type of foundation or pier cannot be determined, and the pile foundation is wooden pile case, the pier will be considered as "sprend foundation".

3.8.2 Record to the Stability Inspection Table and Guidelines

Table 3.8.3 shows the "Stability Inspection Table" for scouring of bridge foundations. Guidelines for filling the Table are as below.

It should be selected and inspected an abutment and pier which are considered to have a high possibility of scouring, and a rating score should be given for them (when inspection have several abutments and piers, it shall be chosen and inspected with the abutment and pier which have lowest satiability condition).

(Reference Materials for Inspection)

[1] Planning of the river channel
[2] River Cross-section (topographic survey data)
[3] Planning of the bridge
[4] Bridge inventory record
[5] General view of the bridge
[6] Inspection records (daily inspection, inspection for the prevention of disasters, inspection for earthquakes, etc)
[7] Drilling data (log), or geographical cross-section

Note: When collecting data, it is better use the data river maintenance office

(1) Rating Score for the Evaluation of Stability of Riverbed and revetment

An evaluation should be done for the possibility of scouring to the river bed around piers, the stability of revetment around the abutment and substructures, It is consider as the following factors;

1) Common Items to Abutments and Piers

a) Characteristics of river

i) River bed inclination.

The steeper inclination should be selected, which is either the surveyed river bed

inclination or the design river bed inclination, and it is adjusted in the follows rate; i) More than 1/100, ii) Less than 1/100 and more than 1/250, iii) Less than 1/250.

ii) Bridge location

It should be inspected whether the abutment and piers are located at the area or not where waters current concentrate to the bridge, or where subsidence part of riverbed. In this case, the piers and abutments are located at deepest part of the channel. The inspection should be done by cross-section plans of the channel. Such case, it is recoded with the column "Correspondence" (see Figure 3.8.2).

When the secular change of the channel is known, the evaluation shall be considered.

b) Bridge Structure

An inspection must be made of whether the bridge becomes a factor for interrupting the water flow, or increases the possibility of scouring.

i) Year of construction

If the bridge was built a long time ago, there is a high possibility of scouring due to changing conditions. In general, those bridge has not protection works, and/or the structure itself does not have resistance against scouring and floods. According to the year of construction, bridges should be classified as follows:

[1] Before 1945
[2] From 1946 to 1965
[3] After 1965

ii) Minimum span

An inspection should be done for minimum span (if the objective bridge has single girder, minimum span equivalents to bridge length), and distance is to be classified in three categories: i) less than 10 meters, ii) more than 10 meters and less than 20 meters, iii) more than 20 meters (Please see Figure 3.8.3).

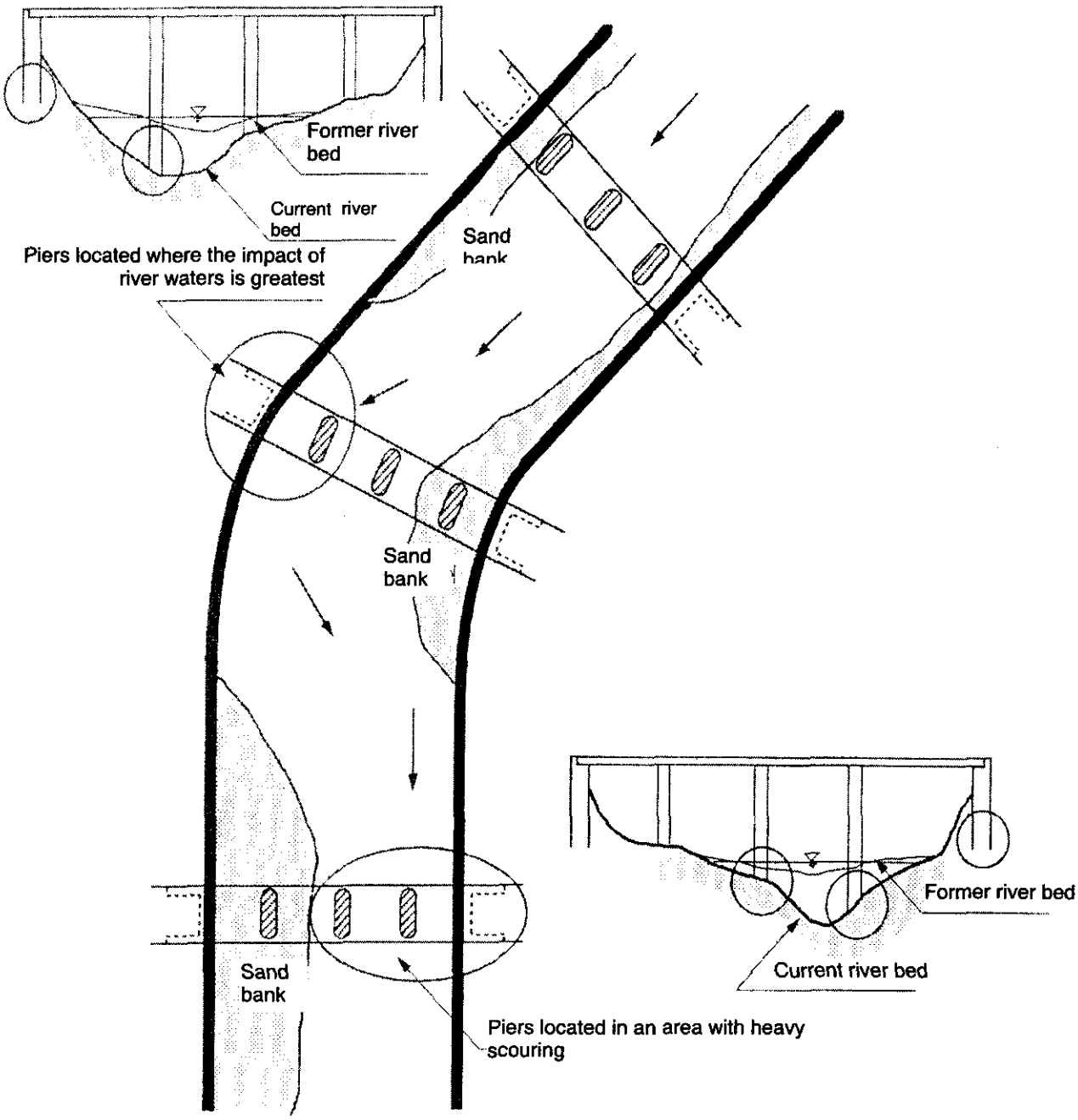


Figure 3.8.2 Example of the Sites which has high Impact of the River Flow with Heavy Scouring

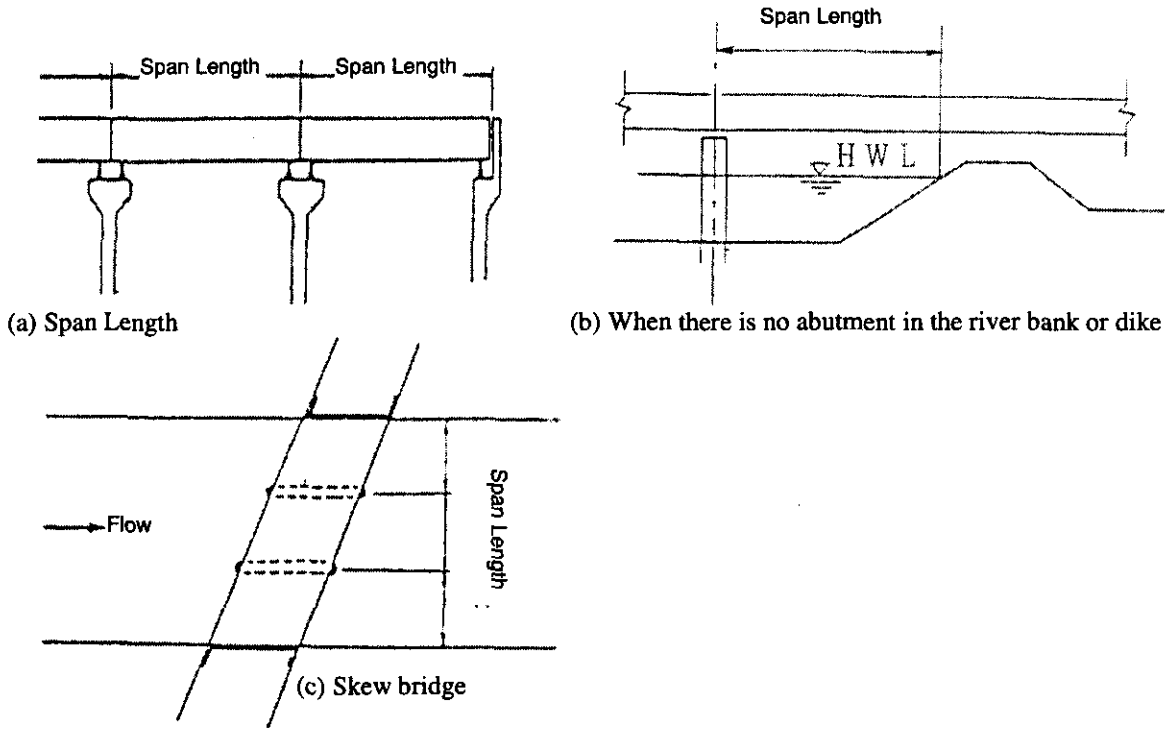


Figure 3.8.3 Span Length

iii) Blockage ratio

Calculate the blockage ratio with the following formula:

(ΣPier width meeting the river flow in a perpendicular direction: bi)/(river width under high water level)

Blockage ratio is then classified as follows (Figure 3.8.4);

[1] More than 7%

[2] More than 5% and less than 7%

[3] Less than 5%

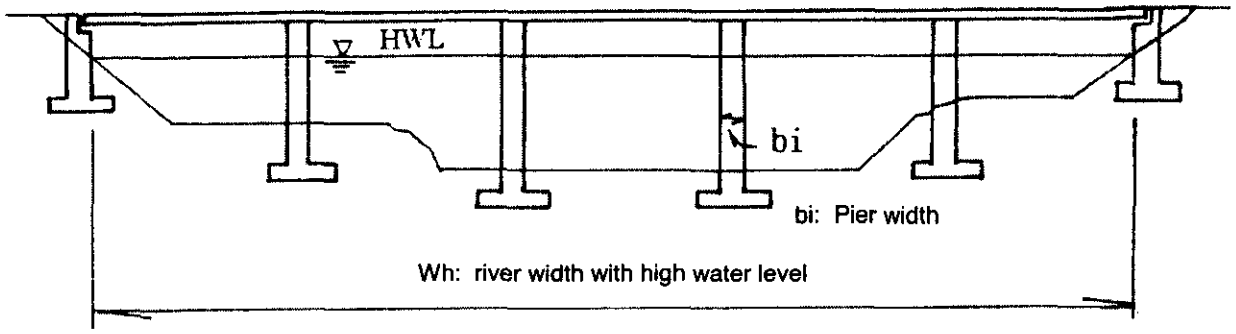


Figure 3.8.4 Method for the Calculation of the Blockage Ratio

iv) Free space under the beam

An inspection should be made of the free space (distance between the beam and the

high water level), and classified as: i)less than 30 cm, ii) more than 30 centimeters and less than 60 centimeters, iii) more than 60 centimeters. When the high-water level (HWL) is undefined, the free space can be estimated as same as length from the lower part of the beam to the top of the dike around it (Figure 3.8.6).

When the topside of the dike, is higher than bottom of free space, it will be classified as "less than 30 centimeters"; but when it has enough free space under the main beam, it is not be necessary to classify.

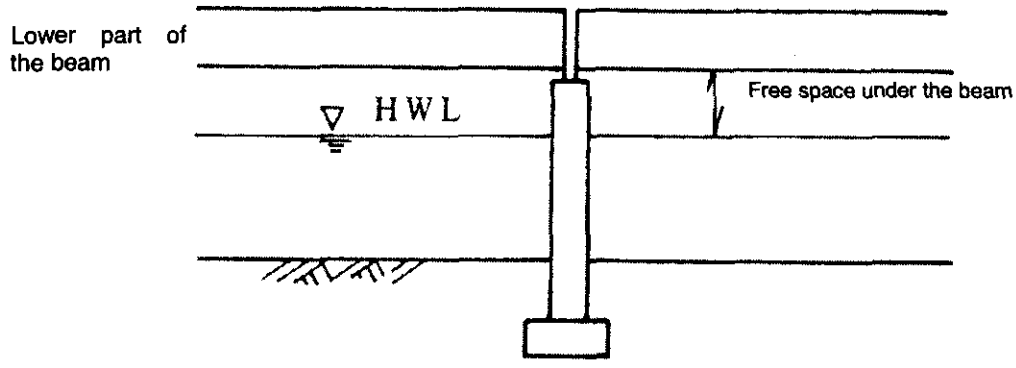


Figure 3.8.5 Free Space Under a Bridge's Beams

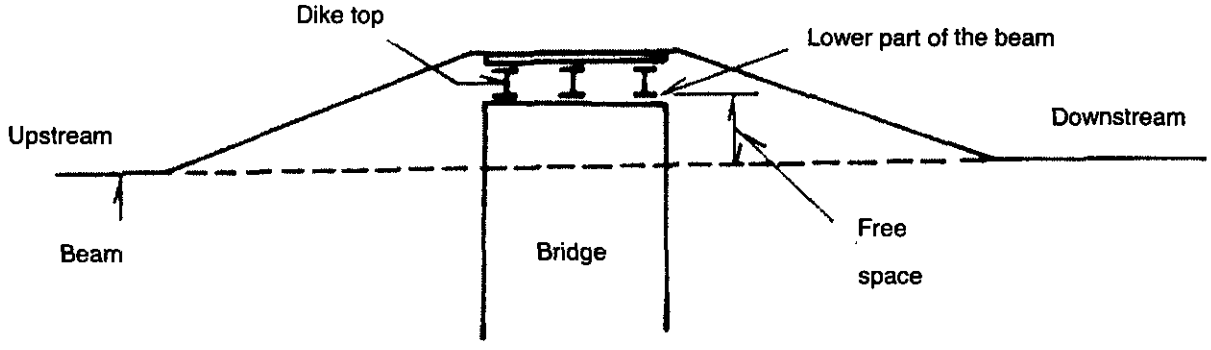


Figure 3.8.6 Unknown and Undefined High Water Case

c) Adjustments by the Frequency of Disasters

It should be inspected of the history of disasters. The frequency of disasters is inspected all those events happening in the river and around the bridge (within 500 meters upstream and downstream), and frequency should be estimated, and then a selection of the corresponding among the following items:

[1] There are disasters around the bridge more than once every ten years

[2] There are disasters in the objective river more than once every five years (in the same municipality where the river is)

[3] There are disasters in the objective river more than once every ten years (in the

same municipality where the river is)

[4] Do not apply

2) Abutment

a) Distance between the Pier and the Toe of the Dike Slope

An inspection should be done of the distance between the pier and the toe of the dike slope, to the river cross-section on bridge a cross-section. Then a classification of the distance is made, among three categories: i) less than 5 meters, ii) more than 5 meters and less than 10 meters, iii) more than 10 meters (See Figure 3.8.7).

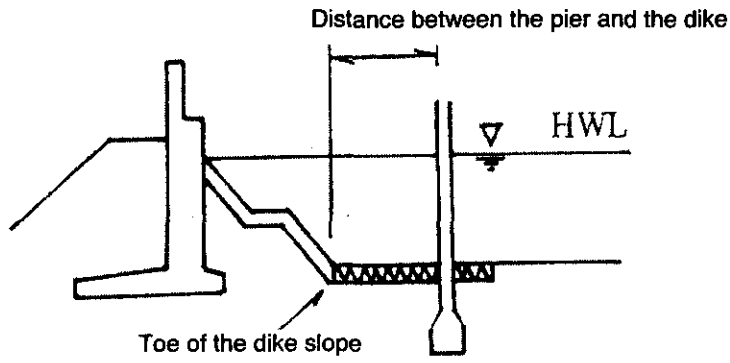


Figure 3.8.7 Distance between the Pier and the Dike Slope

b) Position of Abutment

An inspection should be done for the position of abutments, and the corespondence is sellected the following criteria: i) the abutment is inside of the crossing of the dike slope at the high water level, ii) the abutment is not in the river, but the river width around the bridge is narrow, with contrast of the width upstream and downstream side, iv) other cases.

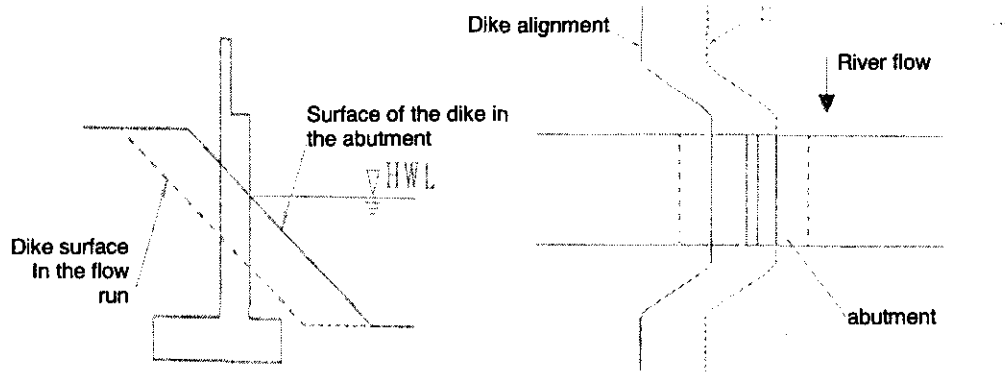


Figure 3.8.8. The Position of Abutment inside of the River

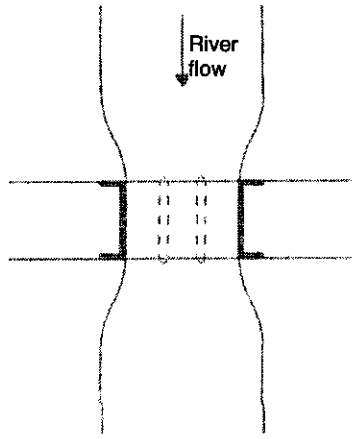


Figure 3.8.9 The Example River width around the Bridge is Smaller than Upstream and Downstream Side

c) Stability against Scouring (Penetration of Foundations)

It should be classified as "corresponds" and selected foundation type among the following conditions:

i) Sprend foundation

more than half of the footing penetrates the supporting layer (in sandy soils, the N value must be more than 30, and in cohesive soils, the N value must be more than 20), see figure 3.8.10.

ii) Pile foundations, caisson foundations, steel sheet piling,

The penetration depth must be more than 10 meters, from the deepest elevation eihter current river bed, or the design river bed to the bottom of the footing. Or, it must have a width five times greater than the pier width in the longitudinal direction to the bridge's axis (see Figure 3.8.11).

When the type and penetration of the foundation is not known, and the pile base is made of wood, the selection must be "does not correspond".

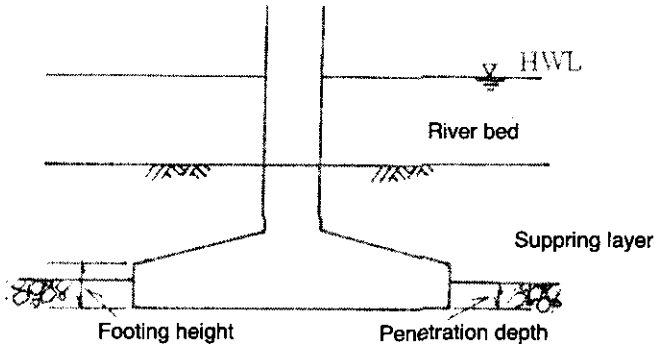


Figure 3.8.10 Penetration of Sprend Foundation in the Supporting Layer

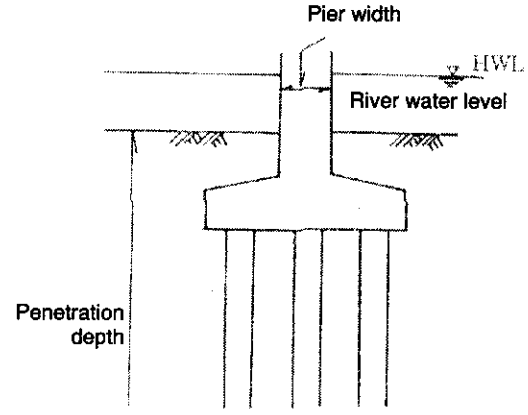


Figure 3.8.11 Penetration of the Pier Base, Caisson Foundation and Steel Sheet Piling into the Supporting Layer

d) Protection of River Banks around the Abutment

When any protection works have been done in the area which is indicated in Figure 3.8.12-3.8.14, it shoul be classified de of whether the works which fulfill the necessary length and width or not.

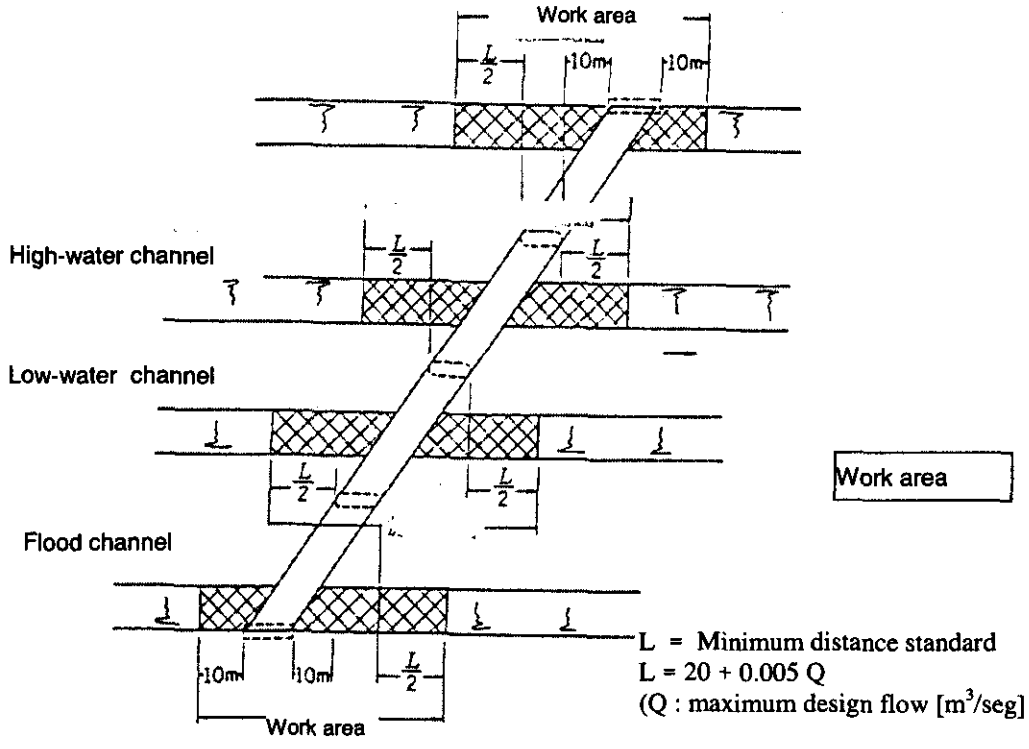


Figure 3.8.12. Necessary Length of Revetment for the Construction of a Bridge

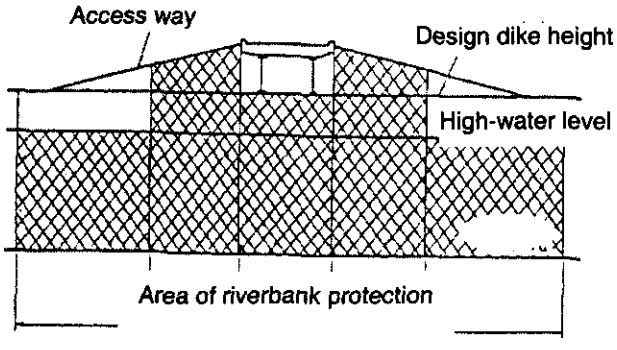


Figure 3.8.13 Necessary Height of River Bank Protection Dikes

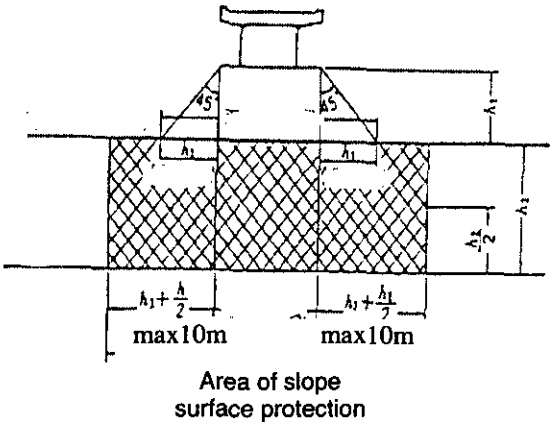


Figure 3.8.14 Area for Riverbank Protection, or Dike

3) Bridge Piers

a) Pier Structure

Pier structures should be divided in two types; the pier structure, which is prevented from the river flow, such as pile bents (Figure 3.8.15(a)) and rigid frame with no bulkhead (Figure 3.8.15 (b)), and others cases.

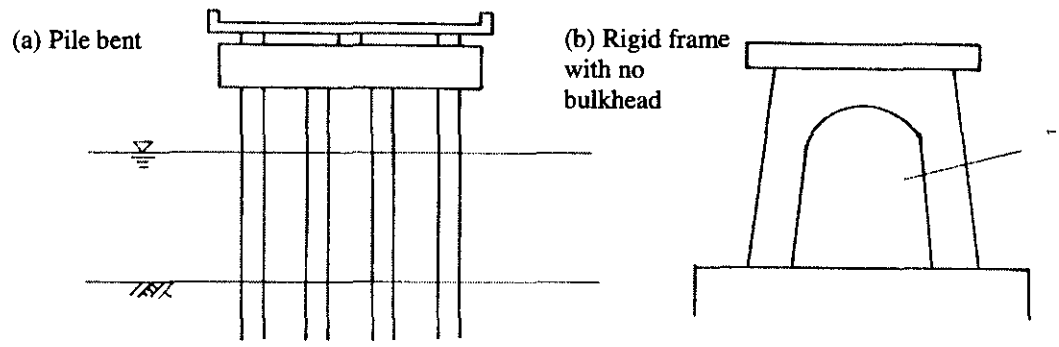


Figure 3.8.15 Pier Structure which Prevents Influence form Riveflow

b) The Angle at which the Flow of Water meets the Longitudinal Axis of the Pier

When the direction of the pier does not coincide with that of the flow of water, the angle should be classified into one of three categories: i) more than 20°, ii) more than 10° and less than 20°, less than 10°.

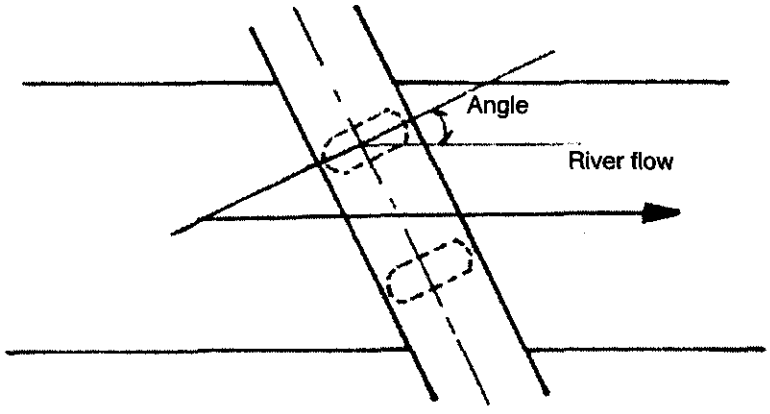


Figure 3.8.16 Angle at which the Water Meets Bridge Piers

c) Stability against Scouring (Penetration of Foundations)

When the foundation meets the conditions as below, it is sellected column as "corresponds". When the foundation type and penetration is unknow or wooden pile case, it is seleceted colunn as a "do not correspond";

i) Sprended foundation; more than half of the footing height penetrates into the support layer (in sandy soils, the N value must be more than 30, and in cohesive soils, the N value must be more than 20), see Figure 3.8.10.

ii) Pile foundations, caisson foundations, sheet pile foundations; the penetration depth must be more than 10 meters, from the deepest edge up to lower position ether the current river bed or design river bed. Or, it must have a width five times greater than the pier width in the direction of the longitudinal direction to bridge's axis. (see Figure 3.8.11).

d) Protection Works against Scouring

If there are adequate protection works against scouring, it is nesesary to add the efficiency on present countermeasure.

i) When reinforcement or repair works have been done around the piling or sheet pilings, the corresponding of countermeasure is recorded and selected column as "reinforcement of foundations"

ii) In case the pier is covered with riverbed protection blocks (block connection works)
When block connection works have a very strong and flexible connection and high coverage efficiency, and it is enough to cover around pier (nearly four times the pier width, i.e, pier width in the direction of the bridge's axis), the corresponding is recorded and selected column as "continuous pier protection". With other block types is recorded and selected column as "do not exist".

(2) Abnormality Evaluation Rating

An inspection should be done of scouring of the river bed around the abutment and piers, and also of the abnormality of approach portion and river dikes. The registration table should be filled with data of dimension and length of abnormalities in each site.

1) Abutment

a) Scouring and Abnormality

i) Scouring and abnormality of foundation of revetment around bases (Figure 3.8.17)
An inspection should be made around the foundation of revetment bases, as well as of the inclination of bases. Those are surveyed both visually inspection and measurement with pole, etc. The corresponding item such scoring shall be recorded.

ii) Abnormality on revetment (Figure 3.8.18- 3.8.19)
An inspection should be made of abnormalities such void, cracks on revetment in the front of the abutment, on displacement of riverbank protection blocks. The corresponding items such abnormality on revetment should be recorded.

iii) Subsidence and abnormality around the revetment and the river dike (Figure 3.8.19)
The abnormalities and deformities around the joint of revetment and the river dike consist of subsidence, cracks, and deformity of protection works and so on. The corresponding item such abnormality should be recorded and corresponded the influence of each items.

The extent of inspection shall be 20 meters, both upstream and downstream side,

from the edge of abutment.

b) Foundation Types

Foundations should be classified as sprended foundation, pier and caisson foundations. It should be checked. Steel sheet piling is classfied as caisson foundations. Foundations of ambigious type and wooden pile type are classified as sprended foundations.

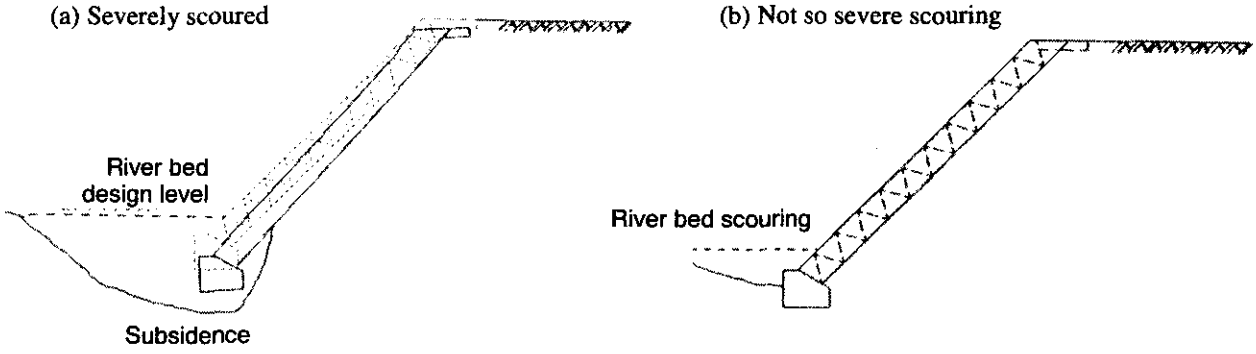


Figure 3.8.17 Example of Foundations of Foundations of Revetment around the Abutment, due to Scouring

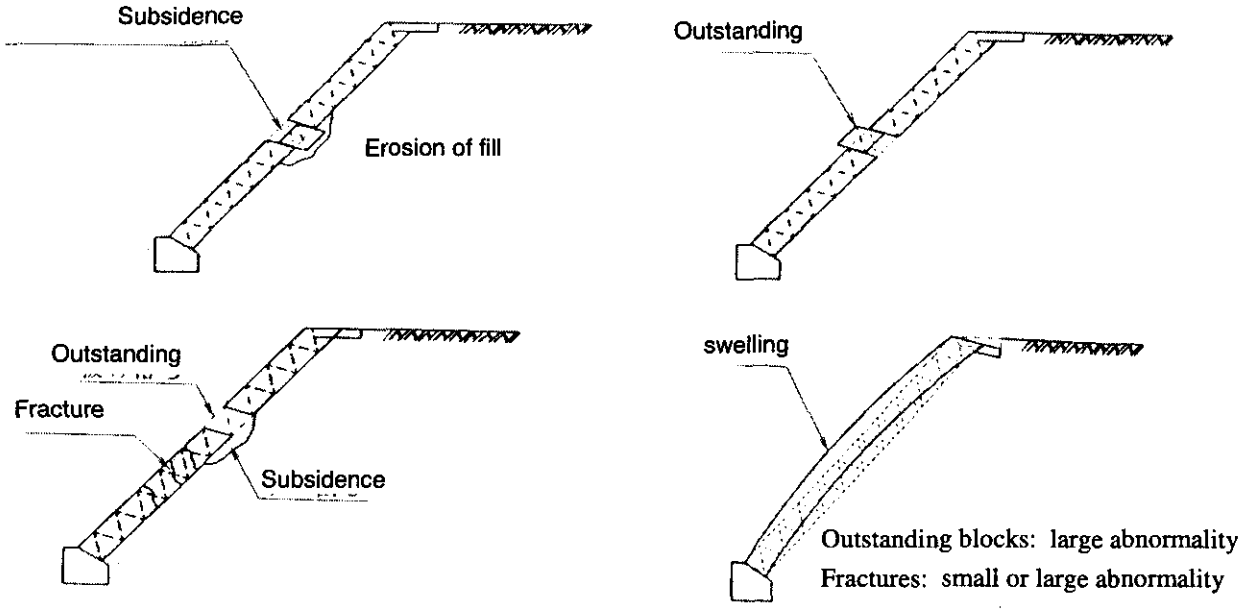


Figure 3.8.18 Examples of Abnormalities in Revetment, around of the Abutment

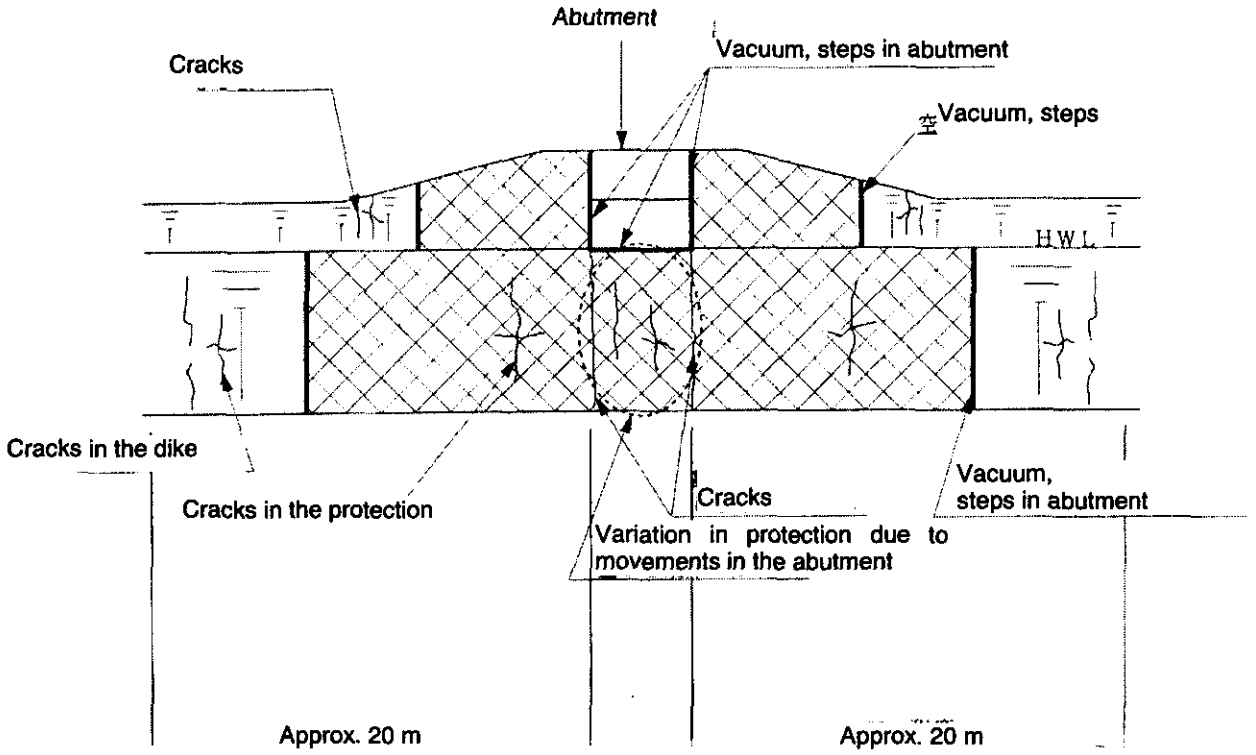


Figure 3.8.19 Example of Abnormalities in Revetment and the Cross Point between Revetment and Dike Protection

2) Piers

a) Scouring

i) Scouring depth

An inspection should be done of the depth of scouring around the pier by visual inspection, or measurement with a pole. The deepest result is taken as record.

In case of appearance of the lower parts of footing, it is recorded and selected column as "appearance of the lower part of the footing". In case of appearance of the upper side of the foundation, it is recorded and selected column as "appearance of the upper side of the foundation". Even if there is no appearance of foundations, the riverbed around the pier is decreased more than 30 centimeters from the riverbed level. It is recorded and selected column as "little scouring" (see Figure 3.8.20).

Scouring depth is calculated to use from planning data and design riverbed level, or from the deepest of the actual river bed, as shown on Figure 3.8.21, and it should be measured in several points.

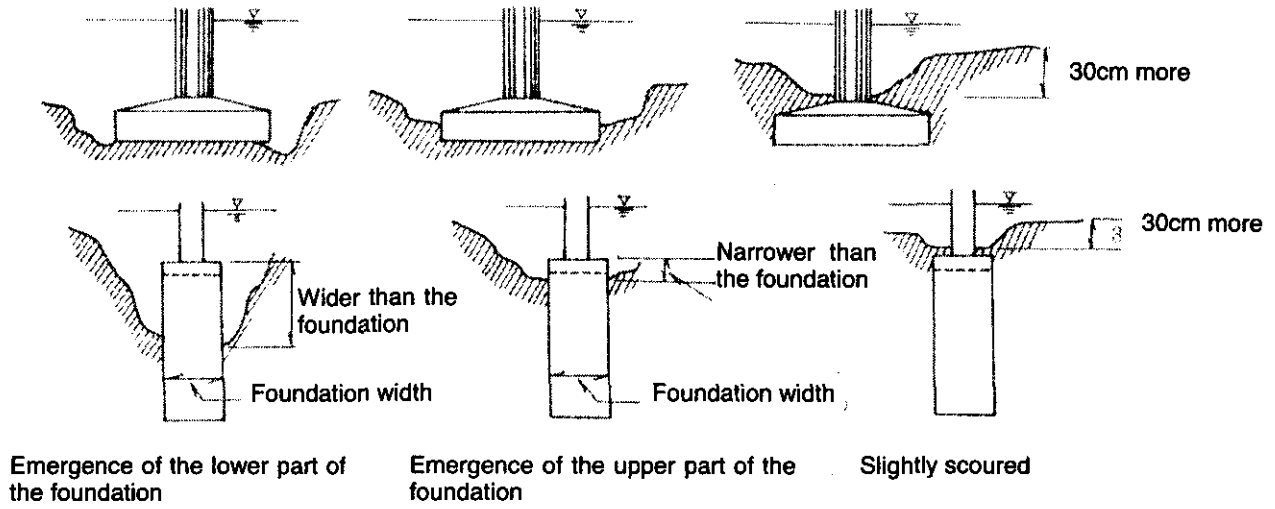
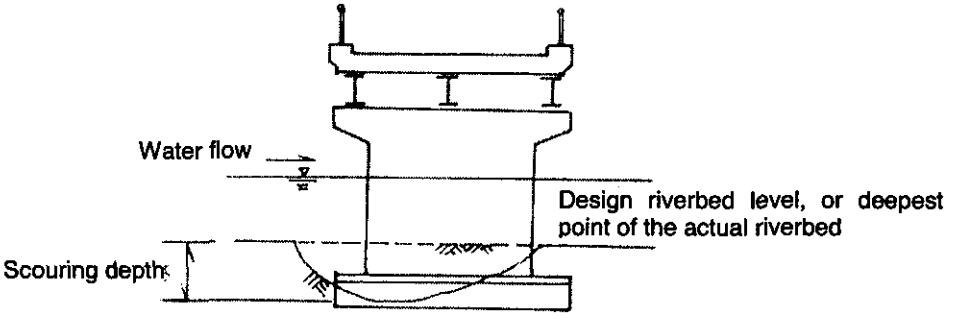


Figure 3.8.20 Scouring Elevation

(a) Method for the calculation of scouring depth



(b) Measurement area

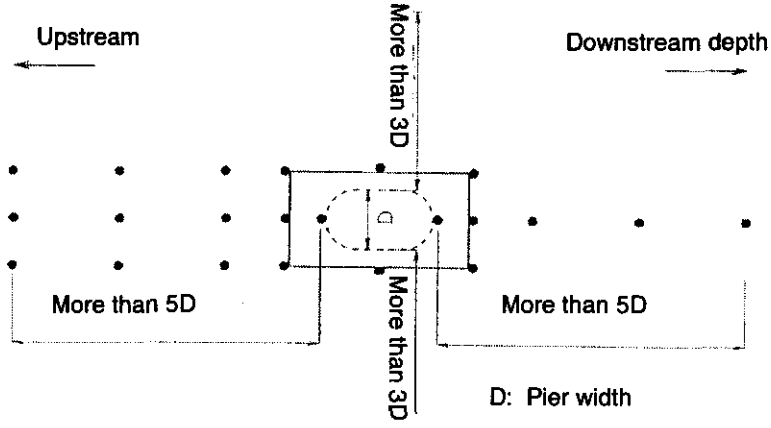


Figure 3.8.21 Measurement of Scouring Depth

In addition to scouring depth, the height of the upper and lower parts of the foundation should be recorded in the "Site Registration Table". If elevation is defined, that figure, that figure should be used it. However, it is unknown the elevation for the handrail, curb or pier height can be adjusted as control points to measure elevation. In this case, for actual and future measurements and management,

a benchmark should be made as the control point or one of the sides of the pier. The elevation will be able to measure to adjust benchmark. The control point and the benchmark must be recorded in the "Site Registration Table".

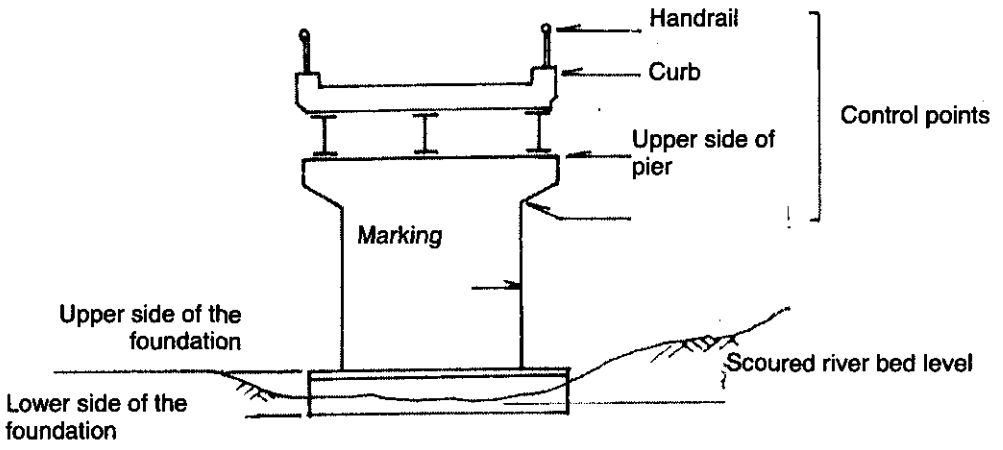


Figure 3.8.22 Unknown Height Cases

ii) Foundation type

Foundation types are shallow type foundation (sprend foundation) and deep foundation type (piles, caisson, steel sheet). When the foundation type is unknown, or when it consists of wooden piers, it shall be recorded as shallow type foundation.

3.8.3 Record by Inspection Site Sheet and Guidelines

The results of inspections are filled to a "Stability Investigation Table", one per inspected bridge, and then a comprehensive evaluation is made. At the same time, a "Record by Inspection Site", shown on Tables 3.8.2 and 3.8.3, must be filled, enclosing photographs and descriptions of the abnormalities.

If there were not enough space to enclose location maps and drawings, additional sheets must be appended and filed with the "Record by Inspection Site".

For bridges which had disasters, it should be made a "Record of the History of Damages" must be prepared, as shown on Table 3.8.4.

Table 3.8.2 Record by Inspection Site

Format 3-2

Name of the bridge		Length of the bridge	m.

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

Location map	Plane of the bridge	Scouring condition, abnormality (Sketch) (Indicate the inspection site, scouring deep and the existent works)

River description	Inclination of the river be		1/	Reason of the foundation selection 1) Using bridge plan, river plan, etc.	Position of the domineering point ( ) (Scouring situation)			
	Level of the river bed projection		m.					
	Level of the maximum depth of the river bed		m.					
	Blockage ratio		%					
	Minimum span		m.					
	Height under the girder (clearance)		m.	2) Site situation				
Bridge Description	Abut	Structure						
		Fundation			Maximum hight of fundation (HU)	m.	River bed hight in the scouring place (HS)	m.
	Pier	Structure		Taking in to account 1),				
		Fundation		Abut inspection	Lower height of fundation (HL)	m.	Scouring depth (DS=HU-HS)	m.
		Width of the pier	m.	pier ( )				

Remarks Inspection date: / / (Weather: Clear·Cloudy·Rain) Ispection Method: Note:	Disasters History	Yes 1. See damage record, 2. Unknow details:) Not
	Inspection result of	Score: (Completed · In execution · Not started) Countermeasure
	Inspection result of 2002 year	Score ( ) Integral evaluation: 1. It's necesary to take measures: 2. Respons making prescription of prevention: 3. It's not necesary to take measures:
	Forecast of the disasters prevention	
	Proposal countermeasures	Type of work: Norm: Quantity: Preliminary cost:
	others	

Table 3.8.3 Stability Investigation Table

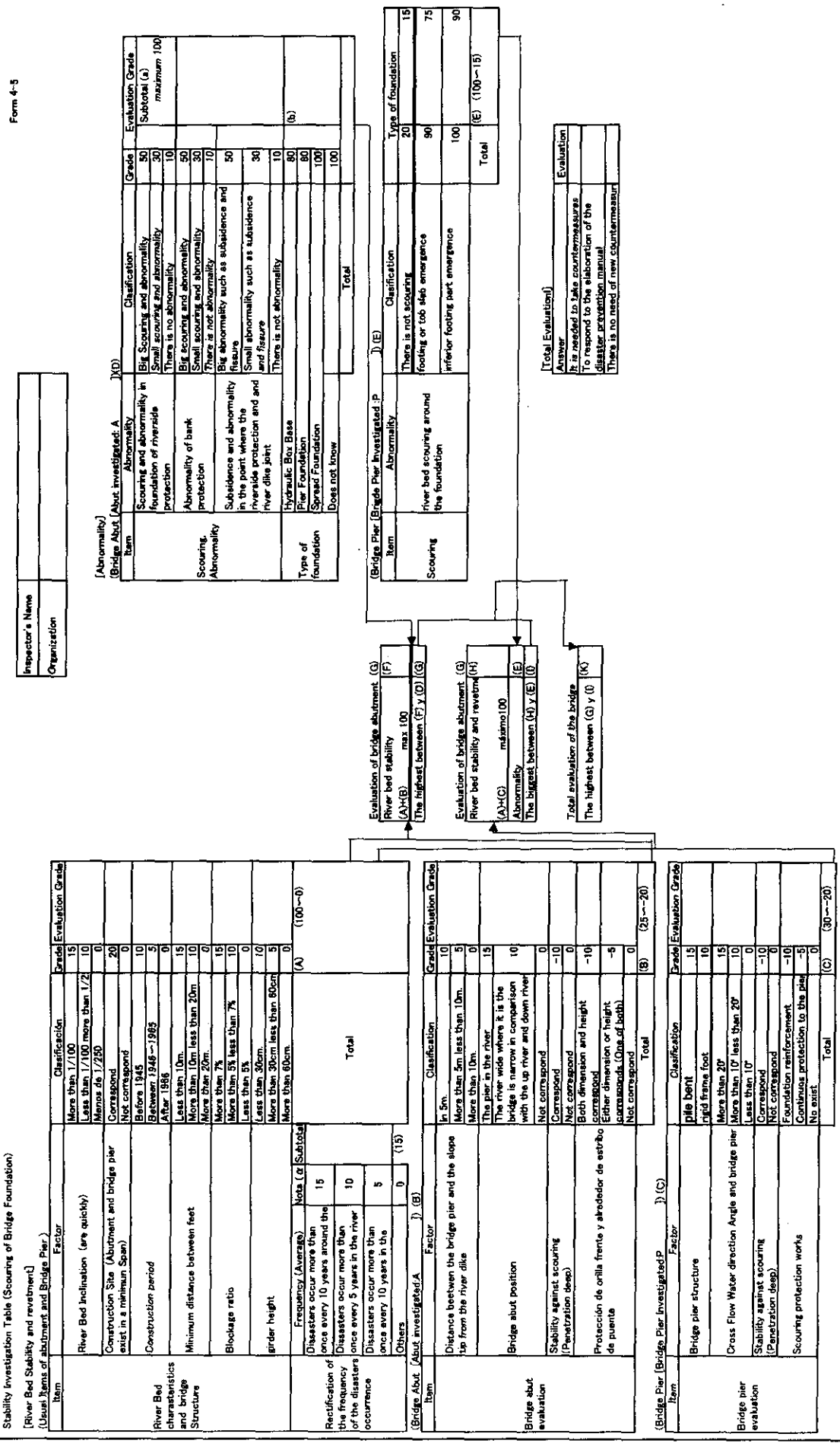


Table 3.8.4 Record of the History of Damages

(Scouring in the bridge foundation of the bridge) Form - 5-2

No.	Type of disaste		Kilometer post	(to)		From Managua to		
Inspection site year	Respond / Not Respond		Longitude		Latitude			
Name of the Bridge		Year of the constructio	Length of the bridge	m.	Span	m.	Name of the river	

Plane of the bridge (Damages, Measures)

1. Around pier foundation.
2. Protection of the sides around the about (left
3. Back embankment of the abut (left & right)
4. Others.

Pictures, Sketch of the actual situation

Special Note (After the inspection of the year)

Dimensio	1 Destroyed Bridge (Superior structure(ー)/Abut( )/Pier( ) 2 Inclination, bridge subsidence (Abut( )/Pier( )) 3 Subsidence of the back embankment (right side, left side) 4 Others: Comment
Inciting factor	Precipitation: Continuous mm/ hr-d Maximum mm/hr (Hurricane · Torrencial rain · Others)
Damages	Human damages: Dead Injured Material Damages Total losses: Comment:
Traffic Restriction	Complete Restriction: hours/Restriction of one track hours. Traffic Restriction in shoulder
Counter measures	Year of performance: Type of works: Works expenditures

3.9 Method for the Evaluation of Stability: Retaining Wall

3.9.1 General

(1) Evaluation of Factors, History and Conditions

The disaster to retaining walls is not drastic changing, such as rock fall, and generally deformation occurs for long term. Since walls are designed as resistant structures, and thus deformation of wall is not relative to the existence of abnormality directly.

The stability inspection should be carried out through the evaluation of the conditions of the areas surrounding the wall, the conditions of the wall itself, and the history of problems with the wall.

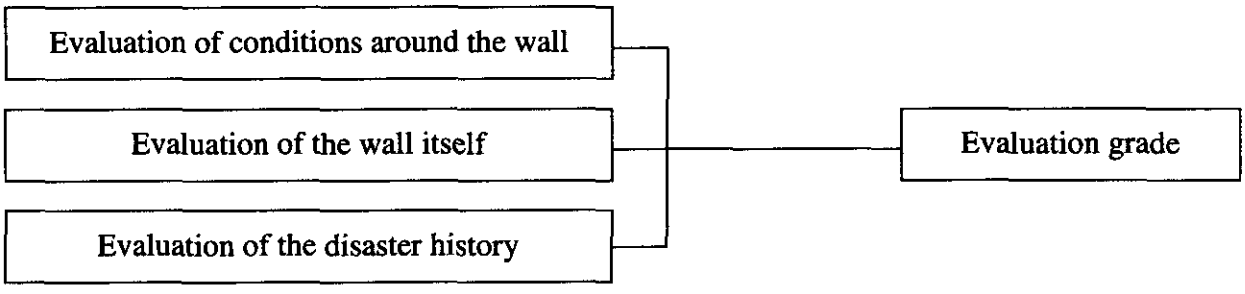


Figure 3.9.1 Concept of Stability Evaluation Ratings

(2) Comprehensive Evaluation

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

i) Disaster factors,

ii) Structures of wall,

iii) Scale of the deformation, and

iv) The conditions of the areas around the site.

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

● It is necessary to take measures ● To correspond with a table of the "Disasters Prevention Description Sheets"	There is a potential of disasters on the spots. 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 shows no disaster factors and there is no need to take new measures.

3.9.2 Record for Stability Inspection Table and Guidelines

(1) Evaluation of the Factor Related to the Conditions around the Wall

1) Topography

a) Slope slides

i) Partial disorder of contour lines along the slope. Slopes formed by the horseshoe-shap, undulating slopes and upheavals in the lower edge area of a slope are supposed to potential slope slide sites.

ii) With regard to the use of lands, attention should be paid to the existence of graded rice fields.

iii) The term "adequate measures" means the confirmatin for efficiency of prevention form slope slides. It should be classified as "unknown" in the case whick is not confirmed effecienty of precention from slope slide by structutres.

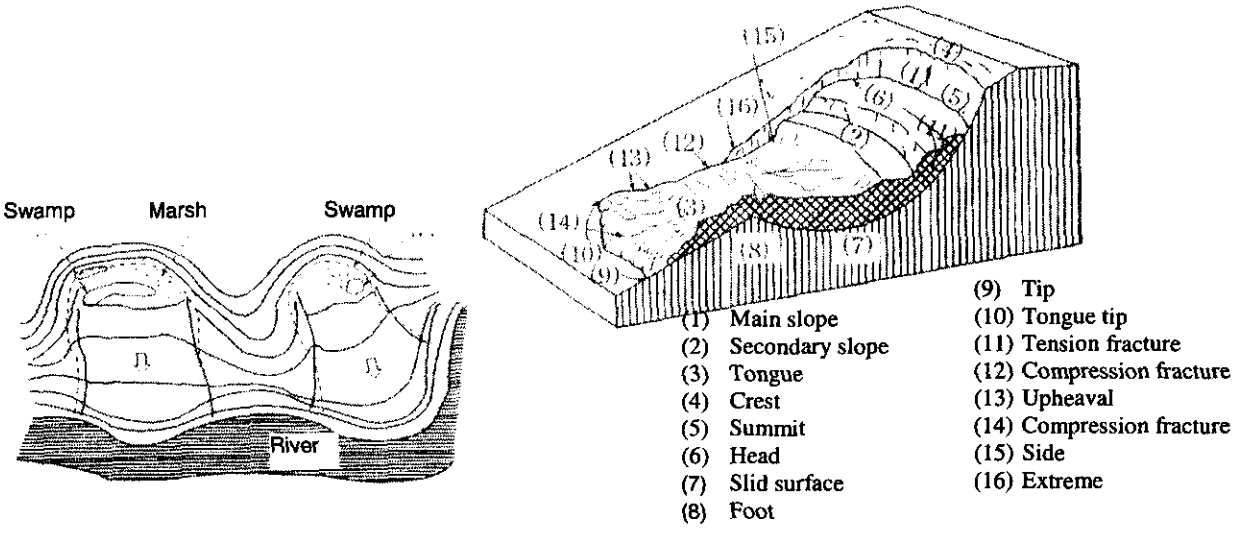


Figure 3.9.2 The site which has Potential of Slope slide

2) Bed Soils

a) Poor ground

i) The following sites has poosibility for poor gruond; terrains reclaimed from rivers, lakes, swampy areas in river dikes, recent filled areas, etc.

ii) The inspection should be done according to design specifications.

b) The Base

i) To confirm whether the wall is founded on a base rock or not

It is adopted records about works or the geological study report to be checked. In case that these documents do not exist, it is impossible to define that the wall is

founded on the base.

ii) In case the wall exists in a steep slope.

If the backyard in the front of the wall has not a enogh space, there is a possibility of rotational slips by the load of the wall.

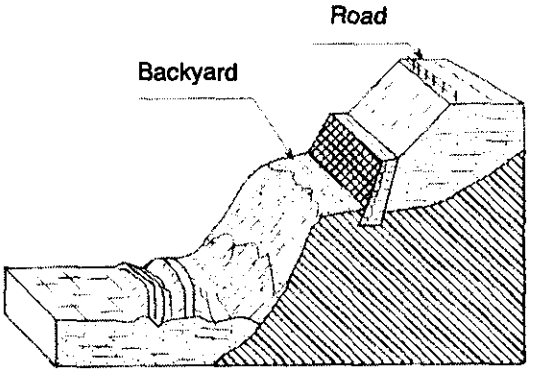


Figure 3.9.3 A Narrow Backyard in front of a Wall

iii) The base is on a colluvums deposit (Talus)

The natural slope with a slight inclination in its lower part is called a colluviums deposit (talus). The slope of colluvial deposits is formed by sediments that fell from the weathered layer and deposited by function of the force of gravity in the angle of repose. Therefore, the resistance to keep terrain is small, and there is a danger of slope slides due to the load of the road embankment and to rain.

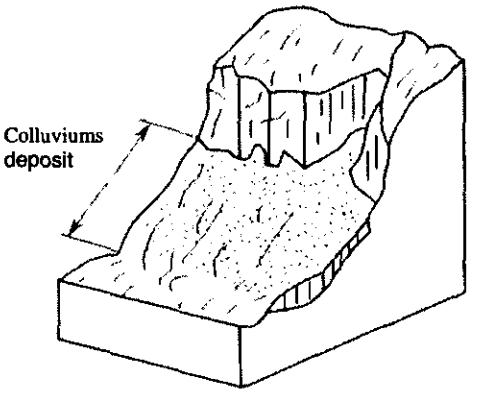


Figure 3.9.4 Colluviums Deposit (Talus)

iv) The base of the soil has an inclination more than 30°

When a retaining wall is built in a steep slope, there is the possibility that a rotational slip may begin in the base of the soil because of the load of the wall, which concentrates on the sole plate.

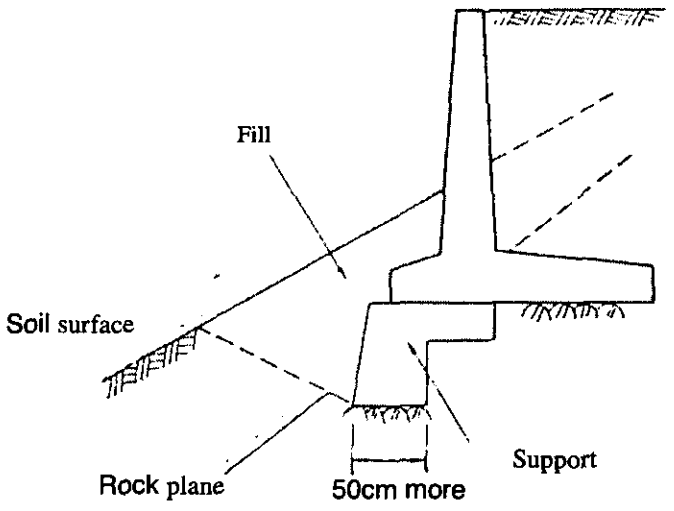


Figure 3.9.5 Wall on Inclined Soil Base

c) Bearing Capacity

The bearing capacity should be confirmed as follows; when resistance is confirmed through the plate loading tests, the N value is assumed by obtained boring data or result unconfined compression test. And if no data such as geological data or test such case is registrated as "undefined for bearing capacity".

3) Water

a) Ground Water

i) The existence of ground water should be confirmed through the site report of previous construction works.

ii) The ground water level should be confirmed through records of previous works or data from a preliminary study.

b) Drainage Facilities

Retaining walls have been desined with drainage systems to discharge water immediately entering into the filled soil behide wall. If the water entering the filled soil is remained for any reason, the wall face to the some abnormality such as destruction of the wall or soil base become weak due to high pressure to the wall.

i) For regard to the efficiency of drainage works, the Table should be filled on the basis of a survey of the site.

ii) Reasons why a drainage system may not work, through the drainage system are supposed as: it is not working or determination due to old, failure of construction.

iii) Some old type walls do not have built-in drainage pipes.

iv) In spite of facilitated drainage system in the soil surface behind the wall, they are not working because of clogged pipe with soil and leaves.

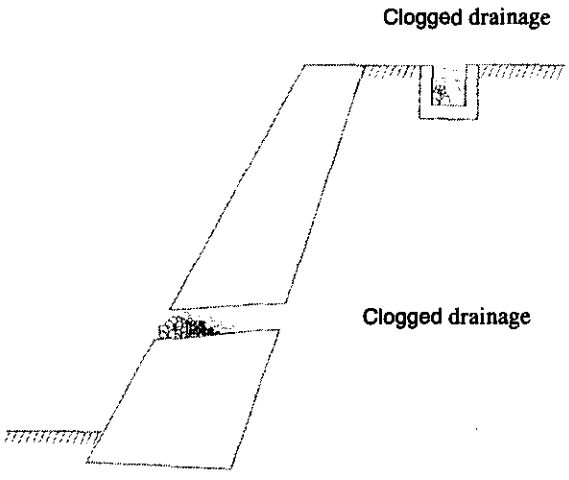


Figure 3.9.6 Functional Decadence of Drainage

4) Location

a) Scouring

It should be evaluated for existence of protection works for scouring and those efficiency to be inspected at site.

i) In the case "No scouring in front of wall" means there is no protection works against scouring, nor any scouring, even thousgh the stream of water exisitence in front of the wall.

ii) In the case"Scouring protection works in front of the wall are not effecieny" means that a part of the protection works is destroyed or flushed away due to scouring. This situation indicates a high possibility of advancement of the deterioration due to scouring and low stablity.

(2) Evaluation of Factors of the Wall Structure Condition

1) Type of Wall

It should be evaluated according to the design specifications.

a) Masonry (including Concrete Blocks), Mixed Type

In the case"Adequate filling is carried out" means that there are no abnormalities founded during more than five years after the completion of the constrcutions, or the stability of the slope has been confirmed with the results of geological survey. In the case that there are no quantitative analysis has been done, uknown about the quality of the filled soil condtion, or unknown abnormalities condtion, cannot be classified neither as "stable" nor as "good" .

Itr shouuld be evaluated as"unknown".

b) Concrete Wall (Gravity Retaining Wall, Leaning Type Retaining Wall)

These walls resist the pressure from the soil to be used their own weight.

c) Cantilever Walls

It consists of reinforced concrete, and it resists the pressure from the soil to be used one part of the filled soil.

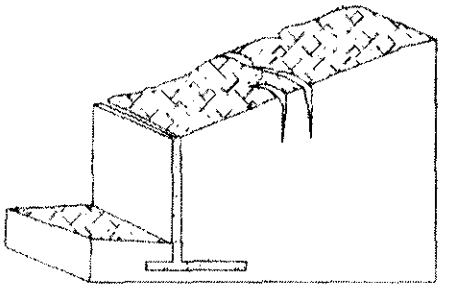
(3) Evaluation of Disaster History

1) Abnormality in the Wall

Abnormalities which affect the stability of a wall are the following;

a) Cracks in the Surface of the Soil behind the Wall

When an abnormality is occuerd in a wall, circular cracks appear in the surface of the soil behind the wall.



(a) There is a slope behind the wall

(b) There is a paved road behind the wall

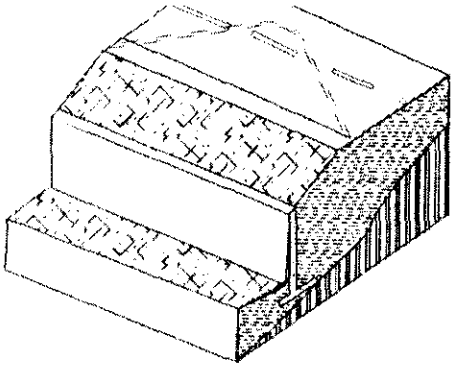
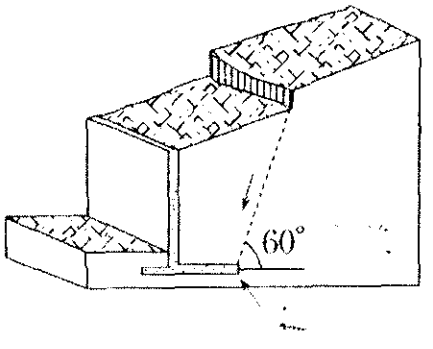


Figure 3.9.7 Cracks in the Surface of the Soil behind the Wall

b) Graded Slopes appear in the Surface of the Soil located behind the Wall

When an abnormality appears in the wall, graded slopes appear in the surface of the soil behind the wall.

(a) There is a slope behind the wall



(b) There is a paved road behind the wall

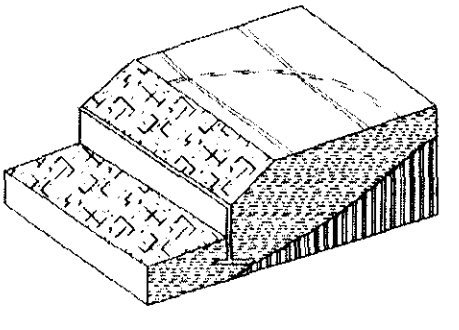
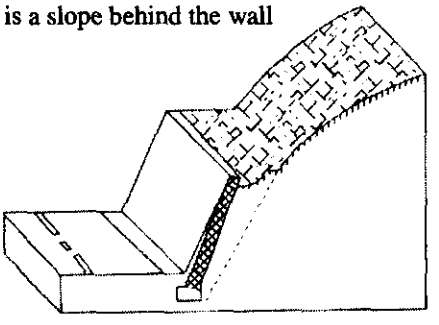


Figure 3.9.8 Deformation with Graded Slope in the Surface of the Soil behind the Wall

c) Subsidence of the Surface of the Soil behind the Wall

When this abnormality appears in a wall, often the soil behind the wall subsides. When the wall is new, this phenomenon can be appreciated to observe the soil condition behind the wall.

(a) There is a slope behind the wall



(b) There is a paved road behind the wall

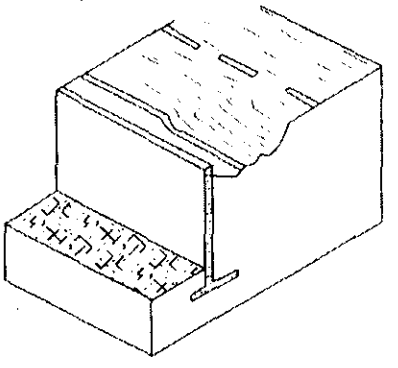


Figure 3.9.9 Subsidence of the Surface of the Soil located behind the Wall

d) Lifting up the Front Side of a Wall

When this abnormality appears in a wall,often soil located in front of the wall is lifted up. The lifting is due to failure by passive presure case or fault by circular slip case.

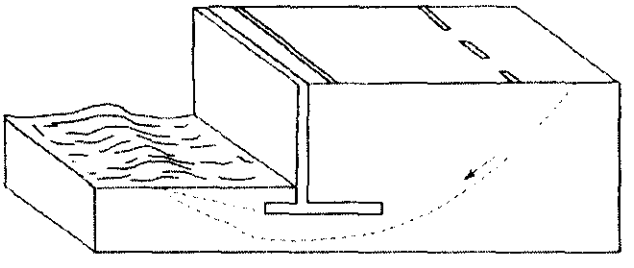


Figure 3.9.10 Lifting up the Front Side of a Wall

e) Staggered displacement of construction joints, Graded

When an abnormality appears in a wall, often construction joints are displaced in a staggered manner. It shoud not be complicated the the displacement which is happened at the construction, and it is necessary to observe its advancement.

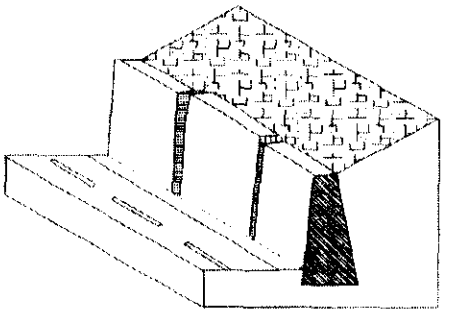


Figure 3.9.11 Staggered Displacement of Construction Joints

f) Swelling

With masonry works, there is a case to be occured swelling due to long-term pressure by the filled soil.

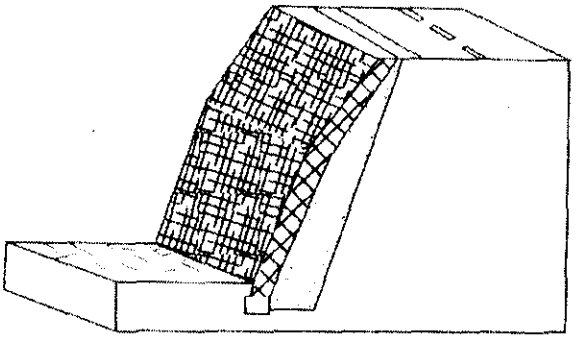


Figure 3.9.12 swelling

g) Cracks

When this abnormality appears in masonry or concrete blocks, often cracks appear at construction joints. In leaning-type and gravity retaining walls, cracks appear at the midpoint of their height. Cracks appear at construction joints well. In walls with concrete structures, such as cantilever walls, cracks appear at the lower part, ,or the part in which the amount of reinforcement are changed.

2) Advancement of Abnormalities

The advancement of abnormalities should be evaluated through periodical and continuous observation, with topographical surveys with markings.

It is the case that advancement of abnormalities is not surveyed with periodical and continuous observation, or no observation, it should be commented as "Not confirmation for abnormality or No data".

Table 3.9.1 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 3.9.2 Stability Investigation Table

Inspector's Name	
Organization	

Stability Investigation Table (Retaining Wall)

[Factor of conditions around the retention wall] (A)

Item	Factor	Clasification	Grade	Evaluation Grade
Topography	Landslide	It is not landslide terrain	0	
		Landslide terrain with adequate threatment	5	
		Landslide terrain without threatment or does not know	30	(30)
Soil	Soft soil	It is not soft soil	0	
		Soft soil with adequate threatment	5	
		Soft soil without threatment of does not know	20	(20)
	Foundation ground	It is constructed in fixed soil.	0	
		The yard from the front soil of the retention wall is	5	
		It is in the talus zone	10	
		The soil has more than 30° inclination	10	(10)
	Soil Resistance	Is confirmed the prove of soil resistance by the soil prove by plate bearing test	0	
		The resistence is calculated by value N	2	
		It is not proved	5	(5)
Drainage	Grounwat	Inflow water around the retention wall is not noticea	0	
		There is inflow water around the retention wall	10	
		Soil groundwater level is near the bottom	10	(10)
	Drainage	There is effective drainage in the sourroundings and there is not rain water flow, etc.	0	
		Drainage from the sourrondings does not work	20	
		There is not drainage and the rainwater flows	25	(25)
Site	Scouring	There is no river in front of the retention wall	0	
		There are not scouring protection works, but the foundation is always upon the water level	5	
		There are effective scouring protection works in front of the retention wall	5	
		There are not scouring protection works	10	
		The scouring protection work of the front side of the retention wall is not effective.	20	(20)
		Total The maximun grade is 50	(A)	

[Factor of the same retention wall] (B)

Item	Factor	Clasification	Grade	Evaluation Grade
Type of retention wall	dry walling, mixed retention wall	It is used to the soil stability or the cut slope protection	5	
		The adequate embankment was done.	5	
		Others	10	
		Dry masonary	20	
	Concrete	See the inspection manual	5	
	Wall cantilever	See the inspection manual	0	
		Total The maximum grades is 20	(B)	

[History] (C

Item	Factor	Clasification	Grade	Evaluation Grade
Abnormality of the retention wall	There is not abnormality		0	
	There is abnormality	To confirm that there is not advance of abnormality more than 2 years	10	
		After the threatment work there is not advance of abnormality (Less than 2 years)	10	
		There is not threatment , but there is not advance of abnormality (Less than 2 years)	20	
		Not confirm the abnormality detention	50	(50)
		Total The maximum grade is 50	(C)	

(D)=(A)+(B)+(C

Evaluation grade by the factor of conditions around the retention wall	(A)
Evaluation grade by the factor of the same retention wall	(B)
Evaluation grade by history	(C)
Total evaluation grade	(D)

[Total Evaluation] ANSWER

It is needed to take countermeasures	
To respond to the elaboration of the disaster prevention manual	
There is no need of new countermeasures.	

Table 3.9.3 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:

CHAPTER 4 METHOD OF INFORMATION COLLECTION

4.1 General

In order to prevent the main road network from being damaged by natural disaster, it is necessary to follow the maintenance plan, to endeavor to gather and update information, and to maintain status without difference between diagnoses records of frangibility and actual condition. In addition, it is also necessary to analyze the records of the similar natural disaster, to grasp the trend, and to figure out the sufficiently effective counter measure. It is possible to say that both of which highly depends on the information gathering.

It is necessary to consider sufficiently the characteristics of face of slope and basic background of social impact of each roads, to grasp the actual site condition through the inspection task, to implement disaster prevention measure based on the acquired information, to endeavor to maintain the soundness of face of slope and road structures at any time, and to prevent possible disaster from happening. The flow of road maintenance is as follows:

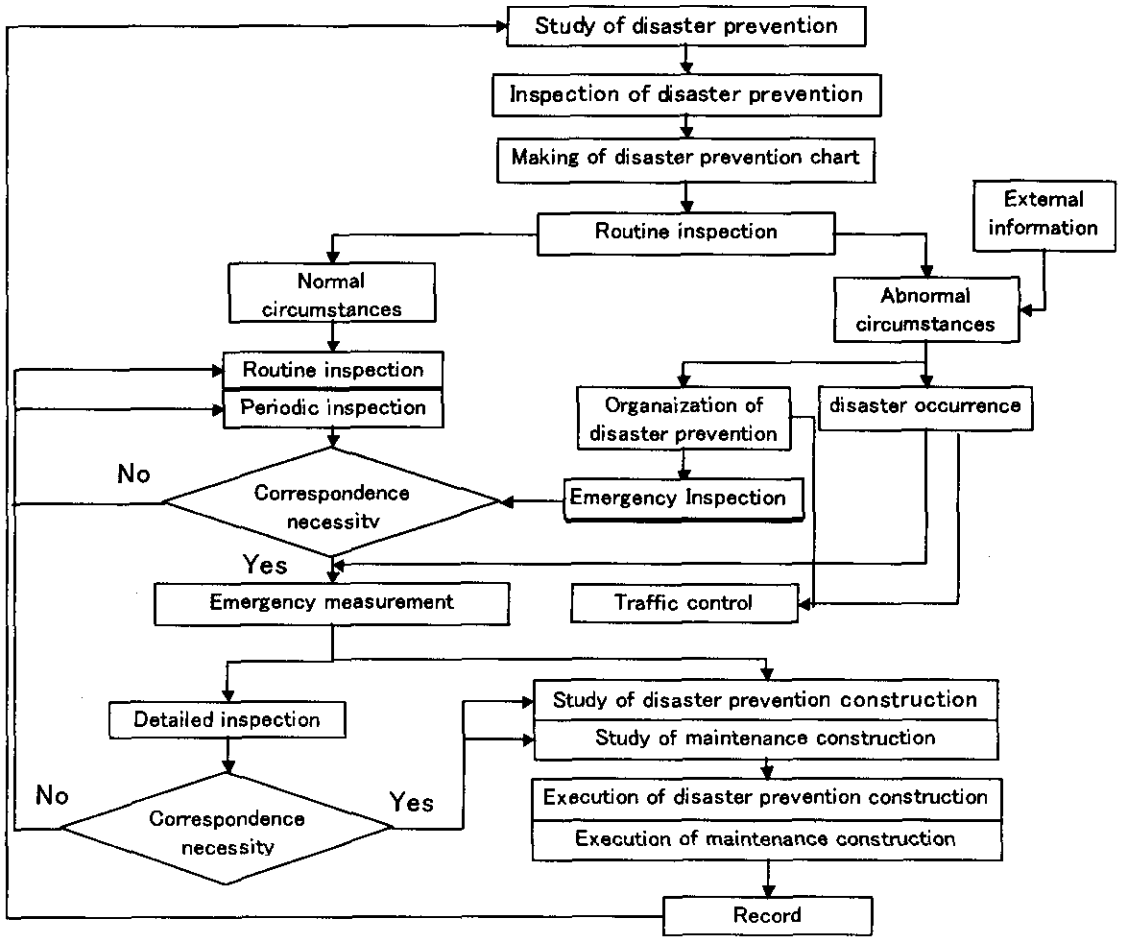


Figure 4.1.1 Flow Chart of Maintenance Management

4.2 Information Collection

4.2.1 Classification of Survey and Inspection

1) Inspection for Disaster Prevention

The inspection for disaster prevention is a full-scale inspection including a implementation of stability survey. The details and procedures are explained in the 'Chapter 3 Inspection'. The interval of this inspection is as follows:

In case the survey records don't exist: The inspection shall be implemented based on the survey plan. It is advisable to implement this inspection immediately, depending on the importance of the road.

In case the survey records exist: The interval depends of the actual site condition. Generally speaking, the inspection shall be implemented once in about 5 years.

2) Survey and Inspection Necessary under Normal Circumstances

The survey and inspection is separated into the routine inspection and periodic inspection.

a) Routine Inspection:

To implement as occasion demands, based on the disaster prevention patrol plan.
The interval of disaster prevention patrol plan usually shall not be longer than follows:

Table 4.2.1 Interval of Inspection by Targets of Routine Inspection

Targets	Frequency of inspection	
	Arterial national highway	Other national highway
Road main part	1 week	1 month
Face of slope	1 week	1 month
Embankment	1 week	1 month
Road structures	1 week	1 month
Bridge foundation	1 week	1 month
Other structures	1 week	1 month

b) Periodic Inspection:

To implement it once a year at least.

MTI shall implement the periodic inspection of all disaster prediction spots in the arterial road network, which have frangibility in the face of natural disaster, and observe if there is any abnormality. The periodic inspection shall be implemented generally one times a year.
If it is possible to execute it about 2-3 times a year, it is still acceptable.

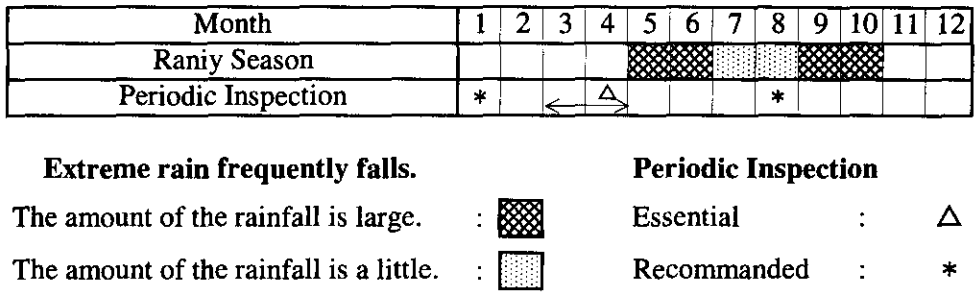


Figure 4.2.1 Interval of the Periodic Inspection

i) The first stage to the middle stage of dry season (from November to January, recommended):
To grasp the condition after rainy season.
Because the precipitation is small and the danger in survey is little, sufficient surveys shall be implemented on the exposed part of face of slope, the bridge foundation suffering from river scouring, and so on.
To examine the validity of counter measure against coming rainy season

ii) Just before rainy season sets in (from March to April, essential):
sufficiently in the dry season.
To check if there is disasters or signs of disasters in the target spots.
To check the effect of counter measure

iii) The middle stage of latter half of rainy season (from August to September, recommended)
To check the condition of inflow water on the rainfall, which is not checked
To check if there is disasters or signs of disasters in the target spots.
To check the effect of counter measure

3) Survey and Inspection Necessary under Abnormal Circumstances

When the abnormal sign is foreseen, the extraordinary inspection shall be implemented. The extraordinary inspection applies mainly to the case in which the meteorological condition and actual site condition change. When the occurrence of natural disaster is foreseen, as for

example typhoon season or storm season, the disaster prevention patrol shall be implemented on occasion demands, in addition to the periodic inspection, in order to grasp the signs of disaster occurrence at the target spots.

As a result of inspection, it shall be judged whether the treatment (temporary measure) is necessary or not, depending on the actual site conditions. Temporary measures include traffic control, disaster prevention construction work, maintenance construction work (for the moment, temporary works and rehabilitation), and so on.

4) Survey and Inspection Necessary in the Detailed Survey

If any problem is found in the periodic inspection under normal circumstances, if any problem is pointed out in the extraordinary inspection under normal circumstances, it shall be judged whether the counter measure is necessary or not.

At that time, if the details are not clear, the detailed natural condition survey shall be implemented. After rough range for counter measure is estimated, the natural condition survey on each survey target shall be begun. The inspection range shall cover clearance around the target spots, depending on the situation, in order to make it possible to plan the counter measure sufficiently. Further more, the geological conditions adjacent to the target spots shall be grasped for the evaluation. The survey shall include topographic survey, geological survey, and so on. When the survey target is a bridge foundation, the survey on the velocity of water flow shall be implemented.

5) Inspection Related to the Construction works of Disaster Prevention Counter measure and Maintenance

In the case it is judged that the emergent counter measure is necessary, or in the case some disaster occurs, the disaster prevention construction works and maintenance construction works shall be examined. Then, temporary rehabilitation work would be necessary to implement in order to ensure and enable transportation. The minimum amount of information necessary for implementation of temporary counter measure for the moment shall be gathered. When the permanent structure is planned, the basic design shall be done after the detailed survey, which is devised sufficiently in advance.

4.2.2 Materials and Information Necessary for the Survey and Inspection

1) List of Materials on the Inspection for the Disaster Prevention

The purpose of this survey is to select disaster prediction spots through the stability survey after screening. The information necessary for implementation of survey and inspection is as follow:

a) Topographical Data:

Through this data, the topographical condition of target sites shall be grasped. Because it is necessary to study the river basin (watershed) in the case the survey target is in danger of the avalanche, it is advisable to acquire the topographical map and aerial photograph on large scale.

Table 4.2.2 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Topographical Characteristics)

Data	Purpose	Source	Notes
Location map or guide map	To grasp the location of survey target spots	INETER	The guide map is drawn on 1/525,000. The road network map can be applied.
Geological map (drawn on larger than 1:50,000)	To grasp the location and geological characteristics of survey target spots	INETER	
Aerial photograph	To grasp the geological characteristics of survey target spots	INETER	
River basin map	To grasp the river basin containing survey target spots.	INETER	
Land use map and vegetation map	To grasp the land use and vegetation in the survey target spots. This makes it possible to assume the outflow condition in rainfall.	MARENA Forestry Agency	

b) Geological Data:

Through this data, the geological condition of target site shall be grasped. Because Nicaragua belongs to the volcanic area and the strata are formed complicatedly, it is necessary to take care of using even data of adjacent area. It is advisable to use data of concerned area for the purpose of no more than reference.

Table 4.2.3 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Geological Characteristics)

Data	Purpose	Source	Notes
Abstract map of geology	To grasp abstract of the geological characteristics of survey target spots and their outskirts	INETER	Map of whole Nicaragua
Section of stratification or geological column	To grasp the geological condition of survey target spots	MTI, Waterworks bureau, other	In the case with survey records

c) Meteorological Data:

Through this data, the meteorological condition of the target sites shall be grasped. Especially, it is advisable to acquire data on precipitation for long term, because the data on precipitation often represent the most direct factor of disaster. In addition, it is advisable to select data that measured at the nearest meteorological observatory to the target site.

Table 4.2.4 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Meteorological Characteristics)

Data	Purpose	Source	Notes
Data on precipitation	To grasp the precipitation condition of survey target spots and their outskirts	INETER	Daily precipitation, Monthly precipitation, Annual precipitation, continuous precipitation, Maximum precipitation per hour
Precipitation map	To grasp the average precipitation of survey target spots. To select meteorological observatories whose data are referred to as representative near the spots.	INETER	
Other meteorological data	To grasp the meteorological condition of survey target spots	INETER	Temperature, humidity, wind velocity, and so on
Record of High Water Level	To grasp the record of High Water Level at the survey target spots. For the use of survey of scouring of bridge foundation.	INETER, MTI	

d) Records of Past Disasters:

Through the records of past disasters, the trends of similar disasters occurrence in the adjacent area shall be judged.

Table 4.2.5 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Disasters Records)

Data	Purpose	Source	Notes
Reports on the type and condition of disaster (disaster cased by wind or flood, or a landslide)	To grasp the records of the disasters at the survey target spots. To grasp the trend of natural disaster occurrence in the adjacent area.	INETER, MTI, Municipal office, Others	Storm, flood, falling rocks and collapse, collapse of rocks, landslide, avalanche of sand gravel, and so on
Reports on the type and condition of disaster (collapse of structures)			Survey of bridge foundation, survey of revetment
Reports on the type and condition of disaster (Earthquake)			Center of the earthquake, magnitude, and so on

e) Records of Former Survey

If some surveys were implemented in the past, and if the stability survey sheets were recorded and preserved, the records of former survey could be used as most reliable comprehensive data.

Table 4.2.6 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Survey Records)

Data	Purpose	Source	Notes
Stability survey sheets based on the stability survey, and the other set of survey sheets	To grasp the stability of survey target spots. The stability survey sheets can be used as references.	MTI	
A set of survey sheets other than those mentioned above.	These survey sheets can be used as references	MTI, Others	

f) Records of Counter measures Taken in the Past

This does not apply to the case in which no construction work was implemented after the survey recorded in the past (above-mentioned), and in which sufficient information was reported.

Table 4.2.7 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Records of Counter measures)

Data	Purpose	Source	Notes
Drawings	To grasp the effects of counter measures concerning with the survey target spots	MTI, Municipal office	Layout plan, structural drawings, and so on
Other information and data		MTI, Municipal office	Year of installation, project cost, design documents, pictures, and so on

g) Structural Drawings (when the structures including road, bridge, culvert, revetment is the survey target)

Without drawings, it would be impossible to see the such conditions as type of bridge foundation, backfilling of revetment, and foundation of revetment. For that reason, through these data, the conditions that can be checked by visual inspection shall be tried to grasp.

Table 4.2.8 Necessary Materials and Information on the Inspection for the Disaster Prevention (Data on Structural Drawings)

Data	Purpose	Source	Notes
Drawings	To grasp the conditions of structures concerning with the survey target spots	MTI, Municipal office	Layout plan, structural drawings, and so on
Other information and data		MTI, Municipal office	Year of installation, project cost, design documents, pictures, and so on

* Based on above-mentioned information a)-g), the stability survey shall be implemented, and the result of survey shall be summarized and analyzed.

2) Materials and Information Necessary for the Inspection under the Normal Circumstances (Routine Inspection and Periodic Inspection)

a) Methods of Inspection

The routine inspection and periodic inspection under the normal circumstances shall contain the followings:

Table 4.2.9 Necessary Materials and Information on the Inspection under the Normal Circumstances

Type	Scope	Methods
Routine inspection	Patrol of the complete length of the study roads	Visual inspection by motor vehicle. If some information is provided, the concerned spot shall be identified, and hearing on the informants and concerned local resident shall be conducted carefully.
	Inspection of disaster prediction spots	Visual inspection shall be done, getting out of the survey vehicle
Periodic inspection	Patrol in the whole target roads	To inspect spots that cannot be surveyed by usual routine inspection. (i.e. spots that cannot be checked by visual inspection by motor vehicle. e.x. the scouring of bridge foundation)
	Inspection of disaster prediction spots	Visual inspection by using materials. If the data on precipitation are lacked in the stability survey of survey target, the impacts from spring water and the stability shall be reviewed.

b) Organization for Natural Disaster Prevention for Study Roads

The beforehand materials necessary on the patrol of the study roads include the location map, guide map, and beforehand information. In order to the beforehand information, the local cooperators for disaster prevention shall be recruited from not only organs concerned to the road management but also local adjacent residents, and by doing so, a organization that makes it possible to gather information of disaster prevention shall be established.

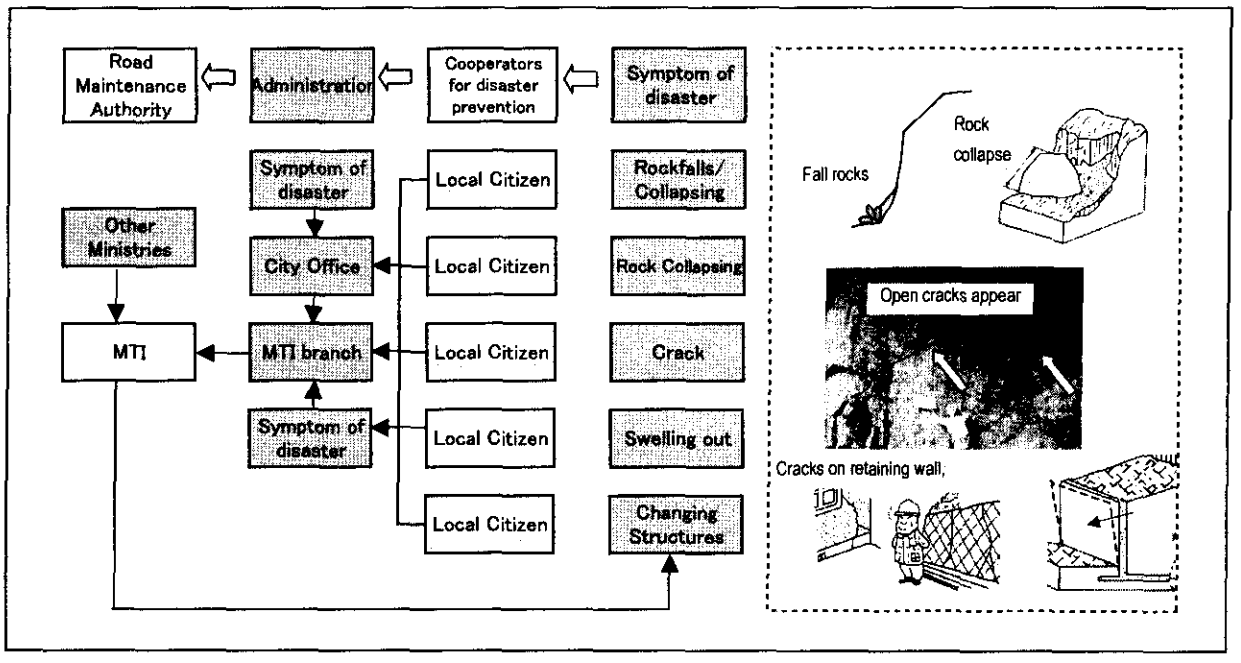


Figure 4.2.2 Organization for Natural Disaster Prevention for Study Roads

Cooperators for disaster prevention (1 representative and 2 deputy representatives) shall be recruited from local citizens along the each target roads, and 1 or 2 persons who are in charge of disaster prevention shall be stationed at the municipal office. In order to ensure to keep in immediate contact in case of the sign of disasters, the information network shall be connected up to the MTI personnel who are in charge of disaster prevention. In addition, a seminar on the disaster prevention shall be held for the cooperators for disaster prevention once a year in order to teach a general way of identifying the signs of disaster and to notify the emergent information network.

c) Necessary Materials on the Inspection of Disaster Potential Spots

The records including disaster prevention description sheets that are suppose to be made after above-mentioned stability survey shall be used for the inspection of the disaster potential spots. In order to implement the inspection efficiently, the survey forms shall be classified by each target road. The existence of signs of disaster occurrence shall be included in survey object of inspections.

Table 4.2.10 Necessary Materials and Information on the Inspection of Disaster Potential Spots

Data	Purpose	Source	Notes
Set of survey forms	To grasp the arrangement of survey target spots	MTI	Table list of all survey result, Chart of all survey results, table of records by each target spot, table of records of danger, and so on
Record sheet of disaster	When the survey target spot suffered from some disaster.	MTI	
Disaster prevention description sheet	For routine inspection use, because all materials of survey forms can be substituted by a sheet of this description sheet.	MTI	

3) Necessary Materials on the Inspection under the Abnormal Circumstances (Emergency Inspection)

a) Method of inspection

The extraordinary inspection under the abnormal circumstances contains the followings.

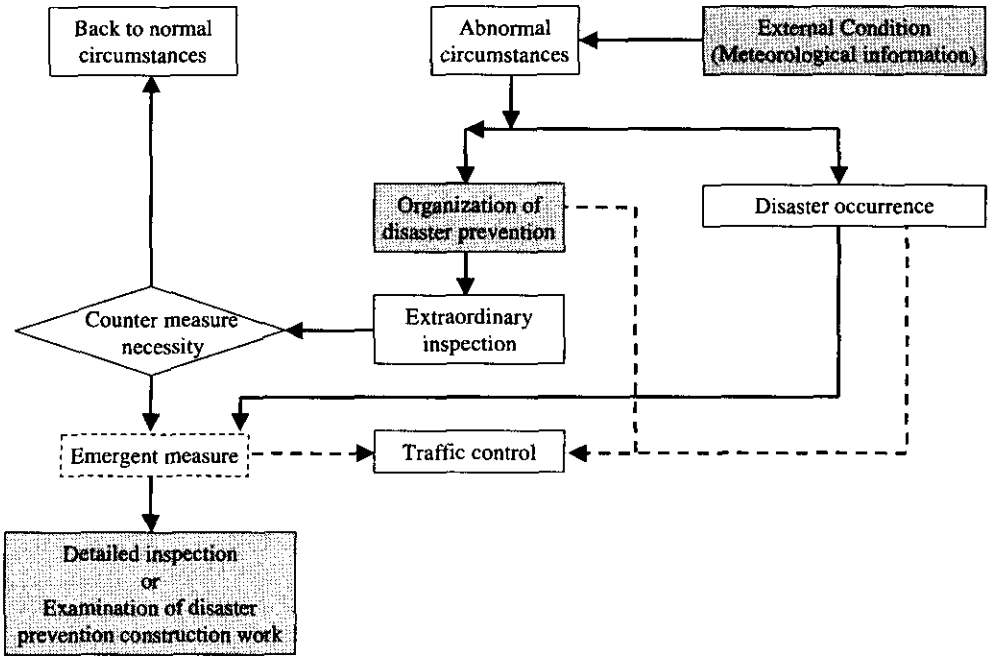


Figure 4.2.3. Flow Chart of Disaster Prevention Organization in Emergency Case

When the disaster occurs, the traffic control shall be taken, and preparation for the emergent measure (Emergency rehabilitation work) shall be started.

When the external factors reach to abnormal status even without disaster occurrence, the disaster prevention organization shall be established in order to get ready for implementation of extraordinary survey. The standards of abnormal level shall be decided by MTI, the following standards (plan) shall be applied until the formal regulation is decided.

Table 4.2.11 Standards for Establishing Disaster Prevention Organization

Externality	Source	Application
Storm	INETER	The precipitation per hour exceeds 40mm/hour.
		After the continuous precipitation amounts to more than 100mm, the precipitation per hour exceeds 20mm/hour.
Flood	Citizens, Cooperators for disaster prevention, report submitted by organs concerned	When the flood occurs
		In the river basin where the flood was caused by rainfall in the past and the danger of flood has not yet been eliminated, when the flood damage is predicted. The precipitation per hour reaches to the amount that can be measured once in 10 years.
Others		Other abnormal situation. Depending on the MTI personnel who is in charge of disaster prevention

After establishing the disaster prevention organization, cautions (warning and alarm) shall be issued to general travelers on the roads, and the extraordinary inspection shall be implemented, taking into consideration the danger of disasters. On the extraordinary inspection, because the time spent for the survey is insufficient, minimum and necessary survey shall be conducted quickly. At least, measurement of target spot range and visual inspection of the site condition shall be conducted, and the results of these inspection shall be recorded in digital image and videotapes. The simple topographic survey shall be conducted in order to clarify the rough location, topography, and range of target spots. The geological survey shall be conducted by visual inspection.

If the sign of disasters is not observed, the organization for disaster prevention shall be dismissed and management under normal circumstance shall resume. If the sign of disaster is observed, the organization for disaster prevention shall be maintained. If immediate treatment is required due to the extremely abnormal condition identified on the face of slope or structures, the Emergency counter measure shall be done by temporary structures and the introduction of traffic control shall be examined at the same time.

Table 4.2.12 Necessary Materials and Information on the Examination of Traffic Control and Emergent Measure

Data	Aim	Source	Notes
Guide map and road network map	To examine the identification of target spots and traffic control	MTI	
Traffic survey data		MTI	
Topographical data 1	To examine temporary counter measure	MTI	Survey map and simple survey map
Other natural conditions		Measurement in actual site	Topography, geology, water level, and so on
Range of disaster		Measurement in actual site	For the range of dangerous spots
Design standards	To examine temporary counter measure	MTI	Including other cases
Standard design		MTI	Including other cases
Standard unit price		MTI	Including other cases
List of machineries and materials		MTI	For direct management use ,for public cooperation use, for the private cooperation use

4) Necessary Materials and Information on the Detailed survey

a) Natural Condition Survey (Topographic Survey):

The natural condition survey shall be implemented for the purpose of grasp of the detailed topographical condition. The standard scale shall be 1:200, but the scale shall be decided arbitrarily depending on the range of the natural condition survey. So that the survey result can be utilized as illustrated fundamental materials in examining counter measure, the crosssectioned survey shall be done on occasion demands. In addition, in order to prepare for the construction work and maintenance of counter measure in the future, temporary station shall be put for each construction site based on the common coordinates system. If there is no station based on the common coordinates system near the construction site, the arbitrary coordinates shall be introduced. Because the temporary station can be used for many purposes including observation of displacement of actual site condition by referring to the temporary station, the temporary stations shall be put on the following position:

i) A position that is not in the way of traffic
ii) A position that commands a view of whole target spot
iii) A position whose foundation is stable

The state of preservation of lining concrete placement for stabilizing temporary stations shall be checked carefully.
If the survey target spot is a bridge, taking into consideration possibility of total replacement of bridge in the future depending on the situation, the alignment of access road shall be surveyed. In addition, because hydrological analysis of river is also required, the longitudinal leveling and crosssectioned survey (3 spots) of the river over which the bridge is built shall be implemented.

b) Natural Condition Survey (Geological Survey):

Although there are many methods for geological survey, depending on the results of simple survey and geological visual survey, the method and plan shall be devised. Because Nicaragua belongs to the volcanic area and the strata are formed complicatedly, the number of spots like large-scale face of slope that the seismic prospecting is suitable for is little. It is advisable to apply the laboratory tests including boring investigation, sounding, and sampling, which make it possible to distinguish the strata.

In implementing the survey methods that have been devised, it is important to select the location at each survey target spot. Although, in order to select the location of survey, the criteria based on the viewpoint of engineering are important, the safety of investigators in bringing machineries and implementing surveys is also taken into consideration. In implementing sounding, the condition of survey target spots, including whole trend and details, shall be surveyed, jointly taking visual inspection.

c) Natural Condition Survey (Hydrological Survey):

This hydrological survey shall be implemented on the survey target spots like a bridge subject to the scouring. In this survey, the velocity and volume of water flow, and correlation between the present bridge and the river shall be grasped. In order to implement the hydrological analysis, the longitudinal leveling and crosssection of the river shall be acquired through topographical survey.
In addition to the materials shown in Table 4.2.4 *Necessary materials and information on the inspection for the disaster prevention (Data on meteorological characteristics)*, after selecting the observatory station (meteorological observatory), if the IDF curve were acquired and the flood concentration time were calculated, it would be possible to calculate the statistical rainfall volume easily and then to calculate the flood flow based on the rational formula easily.

5) Necessary Materials and Information on Examining the Construction works for Counter measure for Disaster Prevention and Maintenance

The construction plan of permanent structure shall be examined based on the materials and information shown the following table 4.2.8 as well as the materials shown in Table 4.2.7. Because the budget allocation is the most concerned matter in examining the permanent structures, the construction plan shall be devised through the sufficient discussion among personnel inside MTI and organs concerned.

Table 4.2.13 Necessary Materials and Information on Examining the Construction works for Counter measure for Disaster Prevention and Maintenance

Item	Aim	Source	Notes
Disaster prevention plan and budget	To examine budget allocation To examine object and size of rehabilitation	MTI, Other organs concerned	
Past cases of counter measure construction work		MTI	
Design standards	To examine construction of permanent structure	MTI	
Environmental lows	To examine the EIA To examine environmental care	MARENA	
Location map of national parks		MARENA	
Rare animals habitat map		MARENA	

6) List of Materials and Information Useful for Others

a) Abstract of Natural Disasters Suffered by Major Road Network (Damage caused by wind and flood, and earthquake)

i) Location of natural disaster occurrence
ii) Abstract of natural disaster occurrence (date and year of occurrence, type, situation, supposed direct factors)
iii) Size of natural disaster occurrence (mortality, number of missing, physical damage)
iv) Impacts on roads (type and condition of impacts, duration of closing road, the contents of temporary rehabilitation work, time required for installing temporary rehabilitation work, contents of the full-scale rehabilitation work, time required for the full scale rehabilitation work)
v) Analyses of supposed direct factors (precipitation, magnitude, and so on)
vi) Analyses of supposed indirect factors (condition of face of slope, condition of the scouring)

vii) Analyses of the effect and working process of the counter measure (when the counter measure has been taken)

d) The Abstract of Performance Records of Counter Measures against Natural Disasters suffered by Major Roads Network

i) Implementation of various plans concerning national conservation project (disaster prevention project)
ii) Chronicle of annual cost of damages of concerned facilities caused by disasters by type of disaster
iii) Chronicle of the measures and cost of project taken for the disaster occurrences
iv) Principal disaster rehabilitation projects
v) Principal projects and measures to support victims of disasters

h) System for Natural Disaster Prevention

i) Abstract of lows concerned to disaster prevention
ii) Chronicle of budget concerned to disaster prevention
iii) Local organization of disaster prevention
iv) Establishment of headquarters of emergent counter measures (past 5 years in MTI)

7) Official Notice for Disaster Prevention (draft)

a) Issue of Natural Disaster Warning (Traffic on Roads)

MTI shall establish the disaster prevention organization as manager of arterial national roads and take measures including traffic control on occasion demands in the following case.

i) When the meteorological phenomenon involving storm or typhoon is forecasted in advance.
ii) When it is forecasted that the precipitation per hour would be over 40mm/hour.
iii) When it is forecasted that the precipitation per hour would be over 20mm/hour after the continuous precipitation has already amounted to about 100mm.
iv) Other cases personnel concerned to disaster prevention judge that it is necessary.

b) Review of Disaster Potential Spots

MTI shall implement the survey on complete length of roads, screening, and selection of new disaster Potential spots in addition to existing disaster prevention spots from the viewpoint of frangibility of arterial roads network against natural disasters.
The survey shall be implemented once in 5 years.

c) Designation of Disaster Critical Spots

MTI shall select and register the disaster critical spots to the 'disaster prevention description sheets' among disaster prediction spots.

8) Provision of Registrations Useful for Disaster Prevention

a) Variety of Survey Forms (stability survey form, record sheet by each disaster prevention spot, Sheet of history of disaster)

b) Disaster Prevention Description Sheets (see Table 4.2.14.)

Table 4.2.14 Disaster Prevention Description Sheets

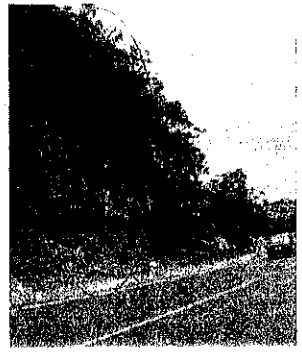
Authorities	MTI (Ministry of Transport and Infrastructures)
Departments	
Sections	

ID-No.	N001B170		Inspection Items	Rock Collapse		Route No.	NIC.1	Km post	171.3km		Length	460m (Heith 30m, Angle 60deg.)	
Type	Toll / (Common)	Route Type	National, Class A			Location	Condega,	Land mark	↑ Red arrow mark at beginning point and ending point		N.L. ?		E.L. ?
Traffic Restriction	Yes (No)	Restriction Criteria	N/A		Traffic Volume	Day of the week	AADT Esteli 3,261 Somoto 1,479 (June 2002)	Holiday	No data	Bus route	(Yes) No	Alternative	(Yes) No

Inspection Date	(Feb / 2002)	(Jun / 2002)
P3 Crack	Big	Big
Difference with last time	No	Marginal rise
P1 Collaspe	Much	Much
Difference with last time	No	Marginal rise
P.2 Talus	Much	Much
Difference with last time	No	Marginal rise
P.3 Inflow water	Not confirmed	Much
Difference with last time	No	Appearance
Score	78	81
Difference with last time	No	3points up
Recommendation		
Difference with last time	No	

P.1

P.2



P.3

Description
20 Feb, 2002 : There are tuff breccia and open cracks.
15 June, 2002 : Cracks become big size, becouse white tuff, which is sandwiched by hard andsites,
are easily affected by rain and flash out,
20 June, 2002 : According to Boring survey result, the tendency of becoming soil can be seen up to
about 4m depth. The firm part ensured to be around 10m depth. The formative condition is bad on the
face of slopes.

Inspector's comment

Integral Evaluation
It is necessary to take measures: (Feb,2002)
It is eagered to take measures, because the situation become serious more and more.

Type of Disaster	Time of Inspection	Remarkable	Countermajor
Rock Collaspe	No.1 (Feb 2002) Dry Season No.2 (June 2002) 1st Month of Rainy Season	No.1 (Feb 2002) Rock falls No.2 (June 2002) Rock falls, Inflow water,	No.1(Feb,2002) Recommandation Recutting and Shotcrete 8,754m2

Name (Inspector)	Shikano, Kojima(JICA Study Team) 20 Feb,2002, Kojima 15 June 2002