# Inspection Procedure of Steep Slope Failure Hazard Area, etc.

November, 1999

Slope Conservation Division, Sabo Department, Ministry of Construction

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## I Area to be investigated

If it shall be steep slopes (all steep slopes inclusive of artificial slopes) of 30° or more in slope angle and 5 m or more in height, and if the number of houses in the estimated damage area is 5 or more (including the case in which, even when the number of houses is less than 5, there are administrative offices, schools, hospitals, railroad stations, Japanese-style hotels, etc., or otherwise facilities related to people vulnerable to disasters such as social welfare facilities), then it shall be investigated as Steep Slope Failure Hazard Area (I), and if the number of houses in the said area is 1 - 4, it shall be investigated as Steep Slope Failure Hazard Area (II). Moreover, even when there is no house in the said area, it shall be investigated as a Slope of a Quasi-hazard Steep Slope Failure Area (III) provided that the conditions specified separately (see Fig-3) are satisfied. These shall be called the "Steep Slope Failure Hazard Area, etc." hereafter.

## II Method of investigation

The investigation of the Steep Slope Failure Hazard Area, etc. shall be carried out by following the procedure given below.

(i) Extract the Steep Slope Failure Hazard Area, etc.
(ii) Classify the Steep Slope Failure Hazard Area, etc. into natural slopes and artificial slopes.
(iii) Select the slopes to be investigated in the Steep Slope Failure Hazard Area, etc.
(iv) Carry out the investigation on investigation items in the slope to be investigated, and enter its result separately for each of the natural slopes and artificial slopes.

Note that when implementing the investigation of hazard areas, aerial photographs are extremely useful, and hence aerial photographs shall be taken as much as possible, which shall be utilized for setting especially hazard areas, grasping houses, etc.

In that case, in order to distinguish houses and to classify their structures into wooden and non-wooden, an appropriate scale of taking photos shall be 1/10,000 or 1/12,500.

### 1 Steep Slope Failure Hazard Area, etc.

(1) Steep Slope Failure Hazard Area (I)

Areas in the estimated damage area, in which the number of houses is 5 or more (including the case in which, even when the number of houses is less than 5, there are administrative offices, schools, hospitals, railroad stations, Japanese-style hotels, etc., or otherwise facilities related to people vulnerable to disasters such as social welfare facilities), shall be extracted as Steep Slope Failure Hazard Area (I).

The number of houses being 5 or more shall mean that there are 5 or more houses in a district with densely built houses on a series of steep slopes.

In general, when a straight line is drawn on a topographical map of 1/25,000 as shown in Fig-1, an area of l (depth) > B (width) shall be regarded as a torrent, and not as a series of steep slopes.

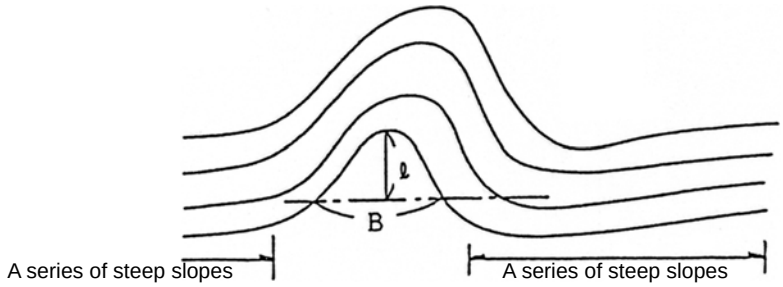
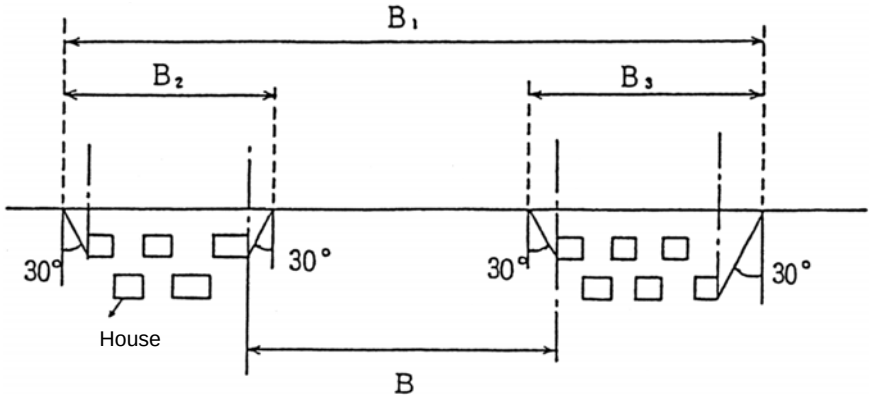



Fig-1 Way of thinking of a series of steep slopes

Also, if houses are 50 m or more apart from one another, the district shall not be called the district with densely built houses, and the steep slope failure hazard areas shall also be handled as different areas (see Fig-2).




1) B > 50 m: The hazard area shall be handled as 2 places called $B_2$ and $B_3$.
2) B ≤ 50 m: $B_1$ (The number of hazard area shall be 1.)

Fig-2 Way of thinking of a series of steep slopes

(2) Steep Slope Failure Hazard Area (II)

Extract areas where the number of houses is 1 - 4 in the estimated damage area as Steep Slope Failure Hazard Area (II). The way of thinking of the extraction of areas shall be the same as that of Steep Slope Failure Hazard Area (I).

(3) Slope of a Quasi-hazard Steep Slope Failure Area (III)

Extract areas where there is no house in the estimated damage area as the Slope of a Quasi-hazard Steep Slope Failure Area (III). A Slope of a Quasi-hazard Steep Slope Failure Area shall be a slope of which length (B) exceeds 100 m. Note that the selection of the slopes to be investigated, investigation, etc. shall be carried out by means of an investigation on maps (maps of a scale of 1/25,000 or larger).

Upon selecting the range of investigation, the selection shall be made by the following criteria given below by means of the investigation of drawings, etc. (see the flow given in Fig-3)

(i) Investigate areas within the city planning area
(ii) Investigation shall not be carried out on areas not designated as the city planning area within municipalities in the underpopulated region.
(iii) Investigate areas where population is increasing in recent years, and those in which the number of hazard areas increased in the last investigation.
(iv) Investigate areas where development plans and/or advancement plans have been devised.
(v) The area to be investigated shall be within the range of approx. 100 m from the roads located in an area of 1 $km^2$ that surrounds a village.
(vi) Mountainous areas shall also be investigated if they are sightseeing areas and there is a possibility that resort condominiums will be built there.

(Note)

1) Areas where there is no possibility of houses being built such as mountainous areas with no houses at all and uninhabited islands shall be excluded from investigation.
2) Areas, etc. of which land use is restricted, such as national park special areas shall be excluded from investigation.
3) Existing roads shall mean the roads indicated by double lines (3.0 - 5.5 m) or larger on a 1/25,000 scale topographical map.

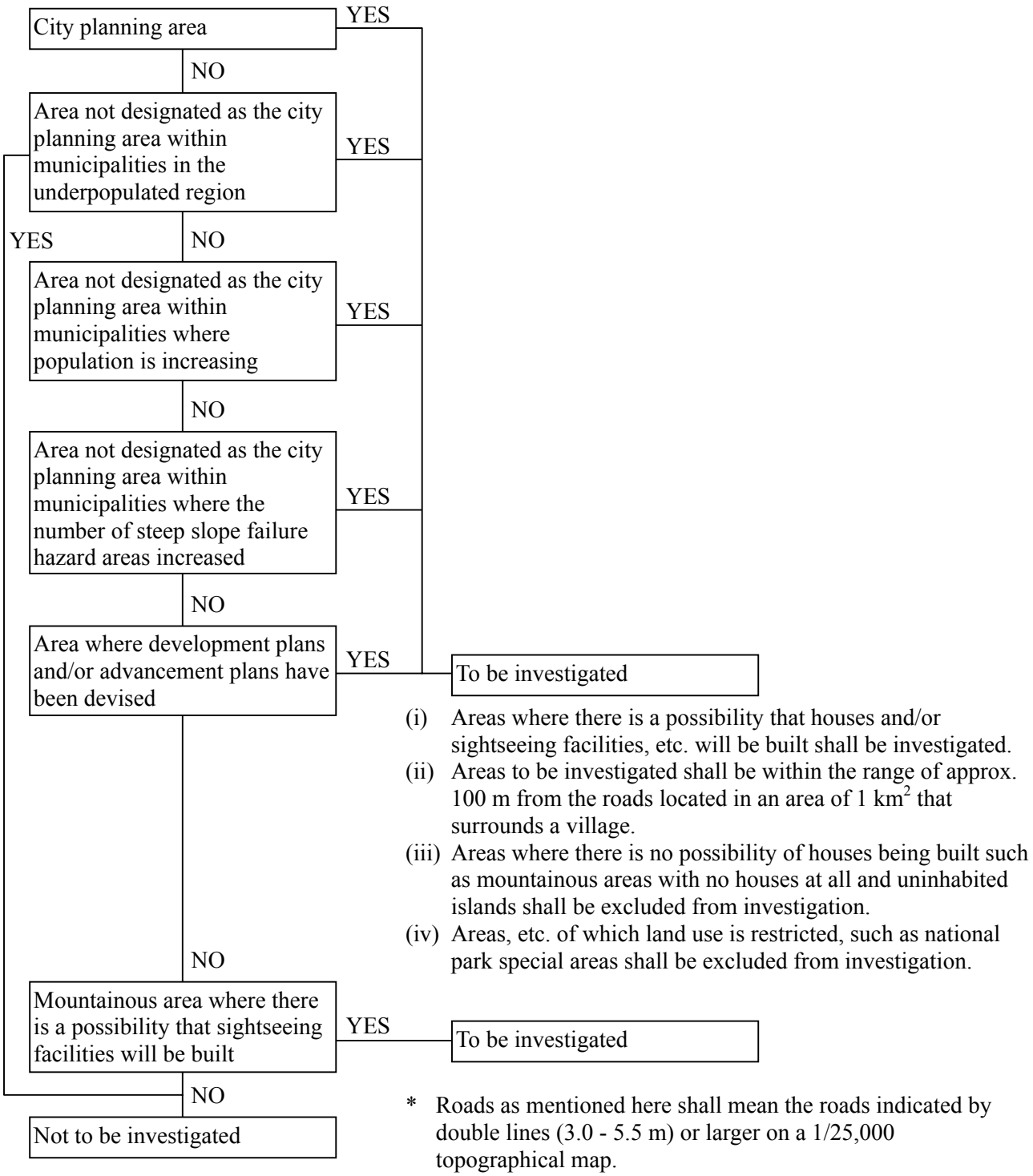
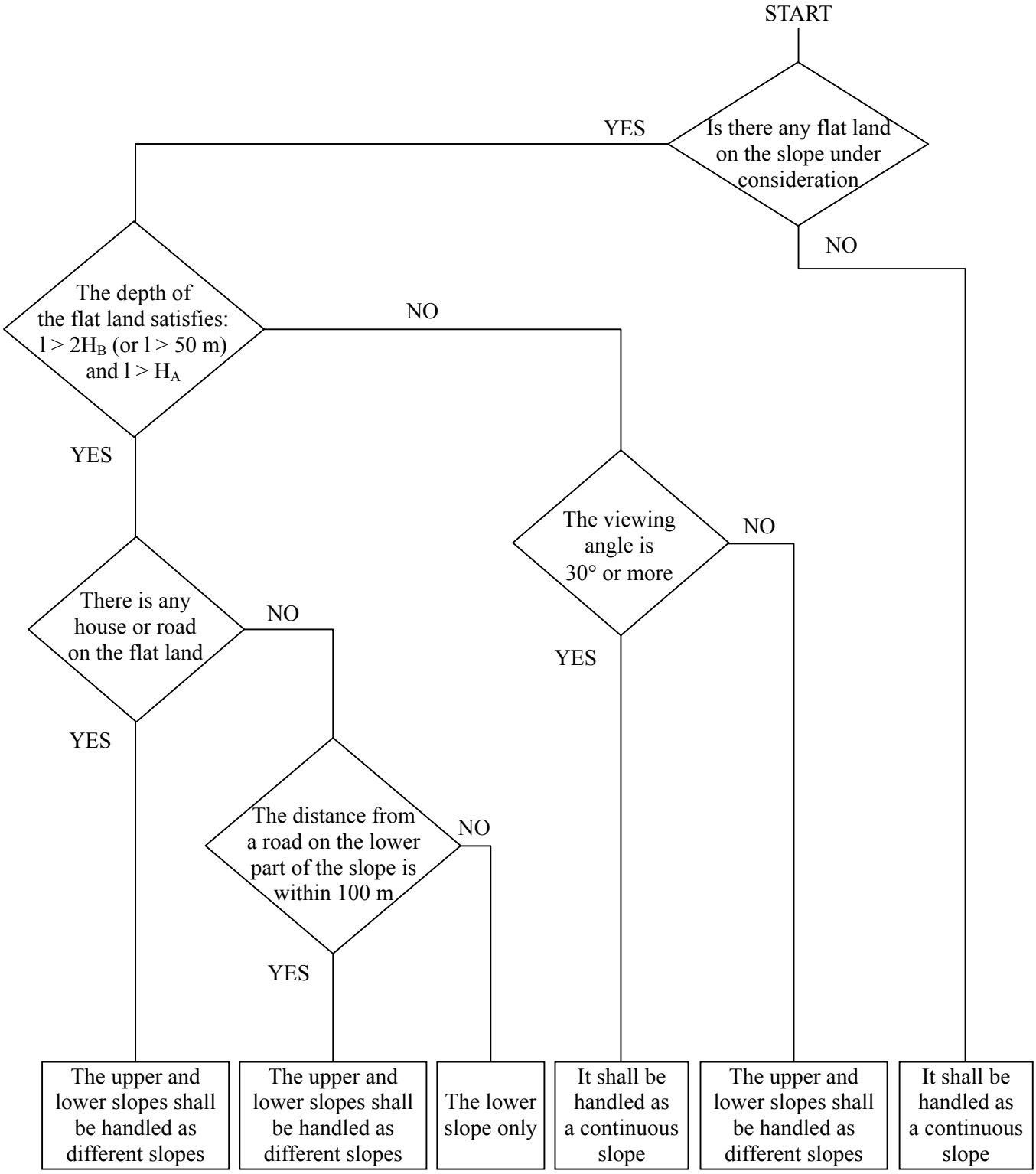



Fig-3 Image of the selection of the range to be investigated on a Slope of a Quasi-hazard Steep Slope Failure Area

**[Demarcation when there is a flat land in the middle of the slope]**




**[Classification of the hazard area, etc.]**

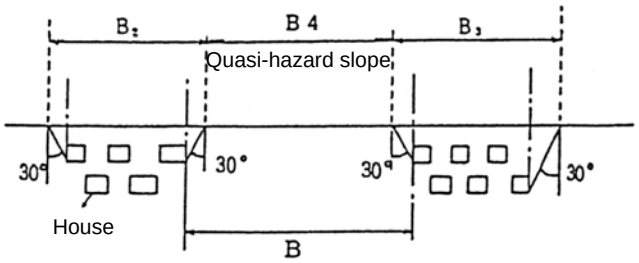
If there is any house on the flat land: Steep Slope Failure Hazard Areas (I) and (II)
If there is no house on the flat land: Slope of a Quasi-hazard Steep Slope Failure Area (III)

## 2 Demarcation when there is any adjoining steep slope failure hazard area, etc.

(1) Planar shape

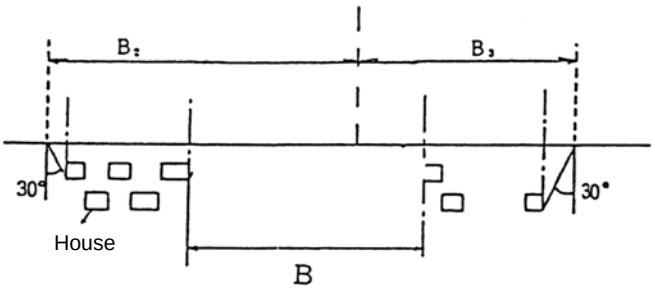
If there is any slope of a quasi-hazard steep slope failure area between steep slope failure hazard areas (I or II), demarcation shall be done under the following way of thinking (Fig-4).

The steep slope failure hazard area shall be handled as two places (B2 and B3), and the number of the slope of a quasi-hazard steep slope failure area shall be one (B4) (a).



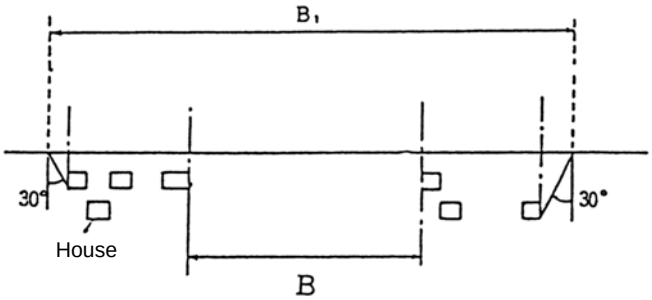

(a) In the case of B > 100 m

The steep slope failure hazard area shall be handled as two places (B2 and B3). At this time the changing point of topography, etc. shall be handled as a boundary (b).




(b) In the case of 100 ≥ B > 50 m

The steep slope failure hazard area shall be handled as one place (B1) (c).




(c) In the case of B ≤ 50 m

Fig-4 When there is any adjoining steep slope failure hazard area, etc.

Moreover, if there is any adjoining slope of a quasi-hazard steep slope failure area, its slope length toward both sides up to 50 m shall be included in the steep slope failure hazard area (I or II).

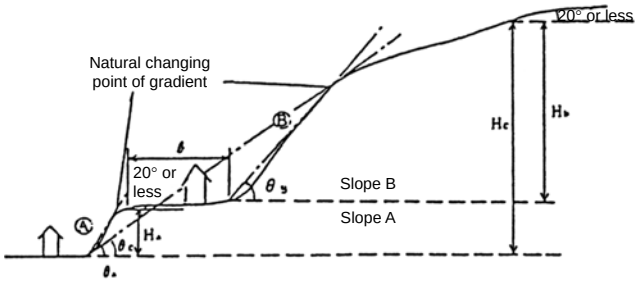
(2) Longitudinal shape

When there is any flat land (with its average angle of slope being roughly 5° or less) in the middle of the slope in a steep slope failure hazard area, etc, the slope shall be demarcated by the following classification (Figs-5, -6, -7 and -8).

1) In the case of a steep slope failure hazard area (I or II)

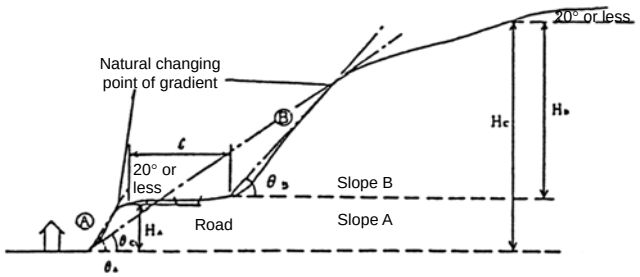
(i) If the depth of the flat land in the middle of the slope (l) exceeds the height of the lower part of the slope ($H_A$), and it exceeds 2 times of the height of the upper part of the slope ($H_B$) ($l > 2H_B$ (or $l > 50$ m) and $l > H_A$)

The two parts shall be handled as different slopes (a).




(a) When there is any flat land including a house in the middle of the slope

The two parts shall be handled as different slopes (b).

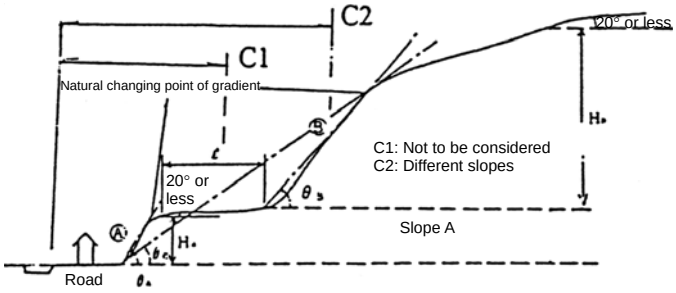



(b) When there is any flat land including a road in the middle of the slope

To be judged by the distance from the road lying in the lower part of the slope (c).

C1: If the distance from the road to the lower end of the upper part of the slope is roughly longer than 100 m
→ Not to be considered

C2: If the distance from the road to the lower end of the upper part of the slope is roughly shorter than 100 m
→ To be handled as different slopes

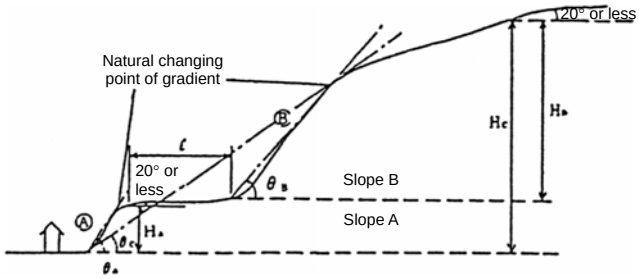



(c) When there is a flat land only in the middle of the slope

Fig-5 When a steep slope failure hazard area (I or II) and the flat land satisfies $l > 2H_B$ and $l > H_A$

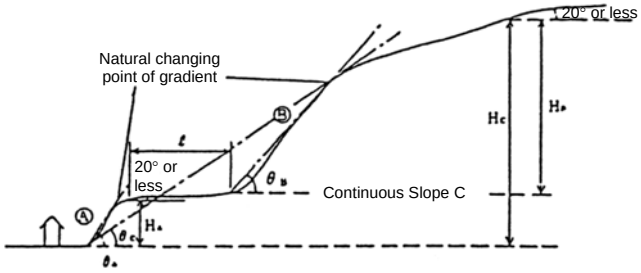
(ii) In a case other than (i) above ($l \leq 2H_B$ (and $l \leq 50$ m) or $l \leq H_A$)

The two parts shall be handled as different slopes (a).




(a) When the viewing angle is less than 30° ($\theta_c < 30°$)

It shall be handled as a continuous slope (b).



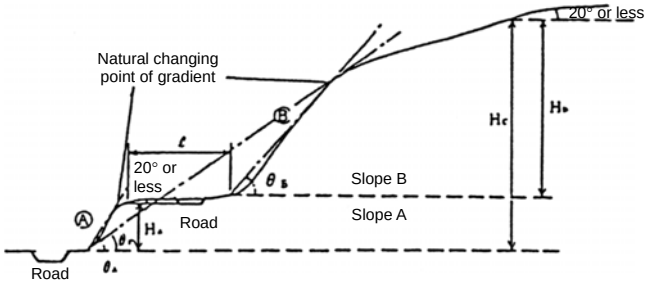

(b) When the viewing angle is 30° or more ($\theta_c \geq 30°$)

Fig-6 When a steep slope failure hazard area (I or II) and the flat land satisfies $l \leq 2H_B$ or $l \leq H_A$

(2) In the case of a slope of a quasi-hazard steep slope failure area

(i) If the depth of the flat land in the middle of the slope (l) exceeds the height of the lower part of the slope ($H_A$), and it exceeds 2 times of the height of the upper part of the slope ($H_B$) ($l > 2H_B$ (or $l > 50$ m) and $l > H_A$)

The two parts shall be handled as different slopes (a).

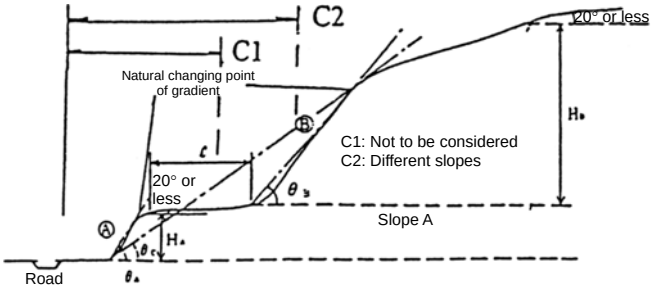



(a) When there is any flat land including a road

To be judged by the distance from the road lying in the lower part of the slope (b).

C1: If the distance from the road to the lower end of the upper part of the slope is roughly longer than 100 m
→ Not to be considered

C2: If the distance from the road to the lower end of the upper part of the slope is roughly shorter than 100 m
→ To be handled as different slopes

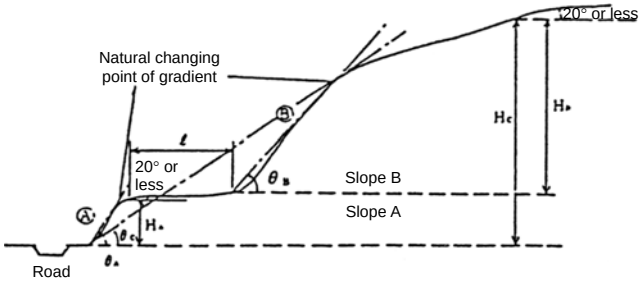



(b) When there is a flat land only

Fig-7 When a flat land on a slope of a quasi-hazard steep slope failure area satisfies $l > 2H_B$ and $l > H_A$

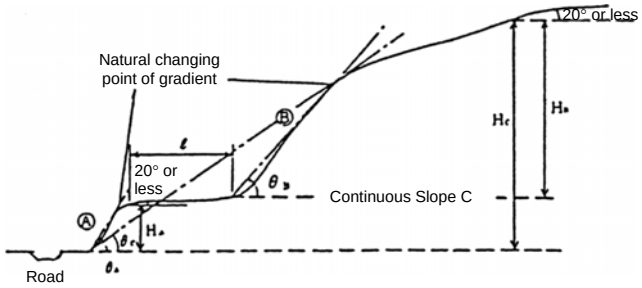
(ii) In a case other than (i) above ($l \leq 2H_B$ (and $l \leq 50$ m) or $l \leq H_A$)

The two parts shall be handled as different slopes (a).




(a) When the viewing angle is less than 30°

It shall be handled as a continuous slope (b).




(b) When the viewing angle is 30° or more

Fig-8 When a flat land on a slope of a quasi-hazard steep slope failure area satisfies l ≤ 2HB or l ≤ HA

## 4 Classification into natural slopes and artificial slopes

Classify the steep slope failure hazard areas, etc. as extracted in "1 - Steep Slope Failure Hazard Area, etc." into either natural slopes or artificial slopes.

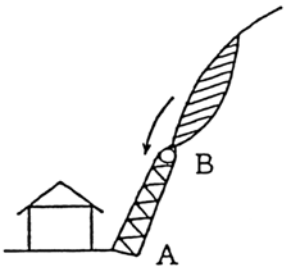
If both natural slopes and artificial slopes exist within a series of steep slope failure hazard areas, etc., they shall be handled as natural slopes. Also, quasi-hazard slopes shall be judged on maps.

(i) Natural slope (natural cliff)····· A slope formed by the force of nature.
However, it shall include the one that cannot be distinguished from a natural slope, although artificial force was applied to it in the past, as a result of deformation, etc. caused by the force of nature thereafter.

(ii) Artificial slope (artificial cliff) ····· A slope formed by applying artificial force as by cutting, embankment, the installation of structures, etc.
However, the one for which steep slope failure prevention works, sabo works, erosion controls works, etc. have been implemented shall be handled as a natural slope.

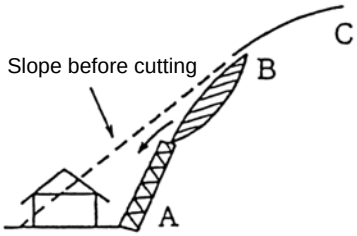
If natural slopes and artificial slopes exist on the same cross-section in a mixed way, a judgment shall be made by focusing on which one has a greater degree of influence on a failure, the natural part or the artificial part (see Fig-9).

Case 1



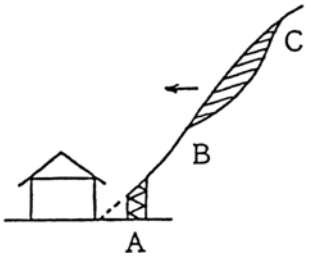

The one provided with a low masonry wall or the like only, and not cut into its slope, judging from the present topography, shall be deemed to be a natural slope.

Case 2



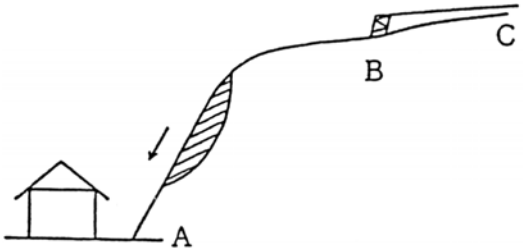

Between A and B····· Artificial slope
Between B and C ···· Natural slope
Since the greater part of the slope is an artificial one, it shall be handled as an artificial slope.

Case 3



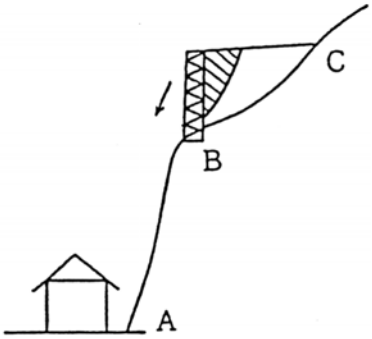

Although there is a cut into the present topography, it forms a very small amount, with the greater part being in a natural state, and hence the slope shall be handled as a natural slope.

Case 4




Between B and C····· Embankment
Between A and B····· Natural slope
The scale of the embankment between B and C is small, and its influence on a failure is thought to be smaller than that given by the slope between A and B, and hence it shall be handled as a natural slope.

Case 5




Between A and B····· Natural slope
Between B and C····· Embankment
The scale of the embankment between B and C is great, and its influence on a failure is thought to be greater than that given by the slope between A and B, and hence it shall be handled as an artificial slope.

Fig-9 Examples of Classification into natural slopes and artificial slopes

## 5 Slopes to be investigated

In each of the steep slope failure hazard area, etc., a cross-section that is considered to have the greatest danger of a failure shall be selected as a slope subject to judgment of the degree of hazard (slope to be investigated), by referring to the following matters. Note that an entire steep slope failure hazard area, etc. may become the slope to be investigated if the width of the steep slope failure hazard area, etc. is small.

Also, if an artificial slope exists in the steep slope failure hazard area, etc. that have been classified as a natural slope, and such artificial slope is judged to have the greatest danger of an occurrence of a failure, then an investigation shall be carried out in such slope.

- A slope in which a failure has occurred and slopes in its vicinity
- A slope with a clear knick line
- A slope on which spring water is found
- A slope with collapsing soil, rock, and geological structure
- A slope of which upper part is utilized as a road, waterway, pond, swamp, or the like
- A slope consisting of non-uniform vegetations such as bare land, grassland, a bamboo forest, a juvenile forest, etc.
- A slope of which shape is like that of a valley
- A slope that is thought to have a lot of cracks in its bedrock or a thick surface soil
- A slope having a large gradient or an overhang
- A slope of a great height
- A slope of which failure prevention works have abnormality
- A slope having a clear convex shape

## III Contents of the investigation

Carry out the investigation according to the contents of the investigation shown below, and organize its result on Form 1-1 and I - III of Form 1-2 by classifying each of the steep slope failure hazard areas, etc. into a natural slope or artificial slope. Note that, of the investigation items for the slope of a quasi-hazard steep slope failure area, only those items that can be investigated on maps shall be entered (see the Procedure of Data Entry (Slope of a Quasi-hazard Steep Slope Failure Area)).

### 1 Actual situation of a slope failure disaster

Check the link between the steep slope failure hazard areas and the investigation of the actual situation of a slope failure disaster. Those to be investigated shall be disaster reports stored by your department (those that have been submitted to our ministry), and the period shall be up to 1997.

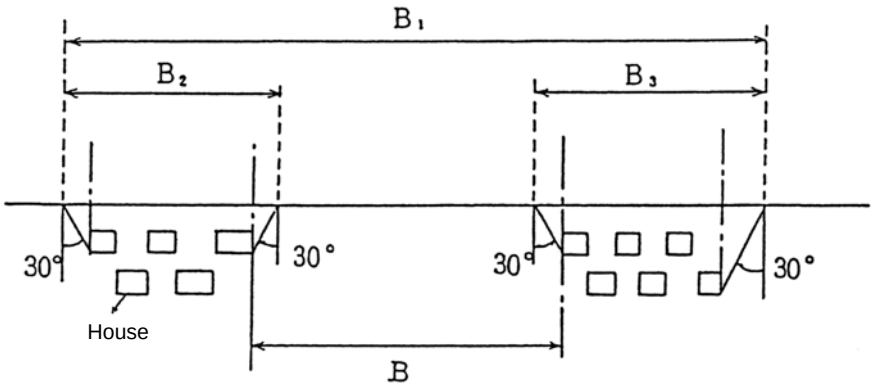
1) Whether a link with the actual situation of a slope failure disaster is available or not
   Enter whether a link between the list of the investigation of slope failure disasters (a copy of the list of the investigation shall be prepared by the Public Works Research Institute) and the steep slope failure hazard area, etc. is available or not.
2) Area number of the actual situation of a slope failure disaster
   As for areas on which a link is available, enter the year of occurrence and the area number of the actual situation of a slope failure disaster.
3) Latitude and longitude of the area of a slope failure disaster
   Enter the latitude and longitude of the lower end (upper end if the object of protection is located at the upper end) of the slope of disaster described in 2) above.
   Example
   In the case of Longitude 123° 45’ 01”: 1234501

### 2 Latitude and longitude of the steep slope failure hazard area, etc.

Enter the latitude and longitude of the lower end (upper end if the object of protection is located at the upper end) of the slope to be investigated (a cross-section that is considered to have the greatest danger of a failure).

### 3 Length of the steep slope failure hazard area, etc.

It shall be the length of a place related to a district with densely built houses on a series of steep slopes (see Figs -4 and -10).




1) B > 50 m: The steep slope failure hazard area shall be handled as 2 places, and their lengths shall be $B_2$ and $B_3$.
2) B ≤ 50 m: It shall be the length of $B_1$ (The number of steep slope failure hazard area shall be 1.)

Fig-10 Length of the steep slope failure hazard area, etc.

## 4 Contents of investigation in the slope to be investigated

As for each of the investigation items in the slope to be investigated, select 1 applicable item and write it down.

(1) Investigation items on topography

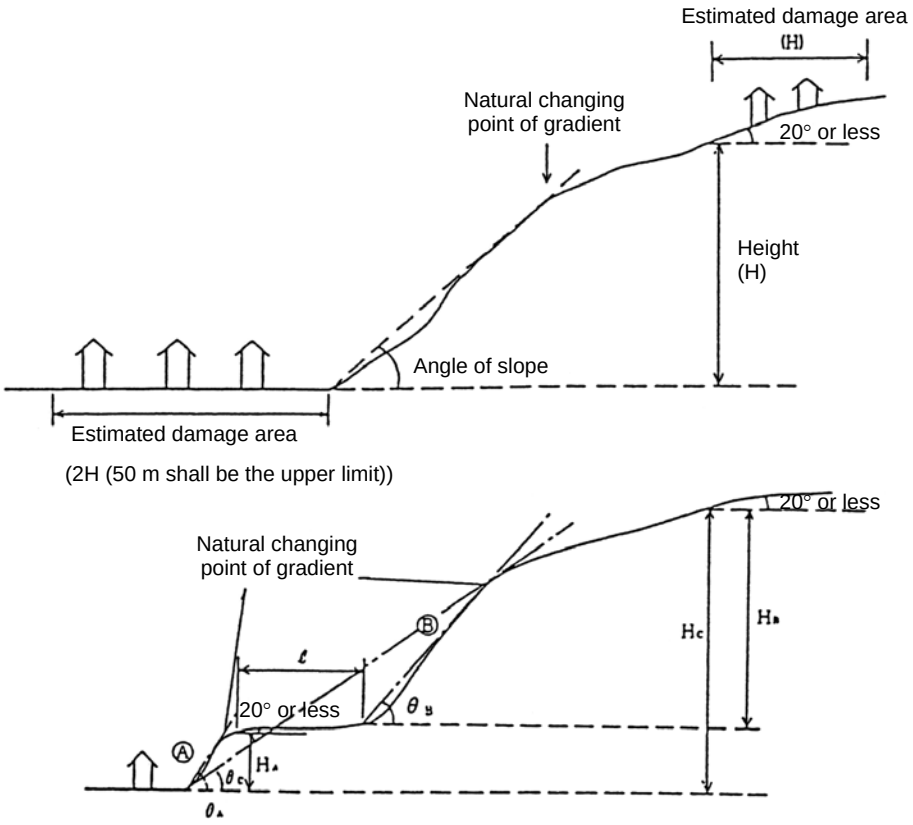
a) Angle of slope

It shall be an angle formed by a line that connects the slope toe with the natural changing point of gradient, and the value of such angle shall be entered (see Fig-11).

b) Height

It shall be a height at which an occurrence of a failure is expected, and its value shall be entered. The height shall be estimated on the basis of site investigation by considering topography, geology, and a failure that has occurred in its vicinity or the topography of the traces of a failure, or the like.

If it is difficult to determine the angle of slope or height, refer to the following example (see Fig-11).




1) $l > 2H_B$ (and $l > 50$ m) or $l > H_A$
   Slopes [A] and [B] shall be handled as different slopes.
2) $l \leq 2\ H_B$ (and $l \leq 50$ m) or $l \leq H_A$)
   a) $\theta c \geq 30°$
      Slopes [A] and [B] shall be handled as 1 slope.
      Slopes [A] and [B]: Cliff height Hc, angle of slope: θc
   b) $\theta c < 30°$
      Slopes [A] and [B] shall be handled as different slopes.

Fig-11 Angle of slope / height

c) Direction of slope on the avalanche hazard slope

It shall mean the direction when turning one's back on a slope. In this investigation, it shall be the 8 directions of east, southeast, south, southwest, west, northwest, north, and northeast, and the applicable direction shall be entered. (See Fig-12 and Table-1; The direction of slope in the figure is southeast)

Table-1 Direction of slope

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Slope facing east | 2 | Slope facing southeast | 3 | Slope facing south | 4 | Slope facing southwest |
| 5 | Slope facing west | 6 | Slope facing northwest | 7 | Slope facing north | 8 | Slope facing northeast |

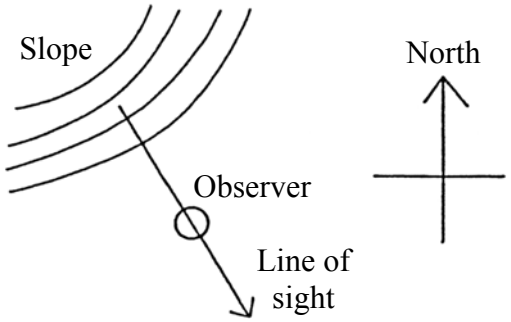



Fig-12 Direction of slope

d) Shape of slope

The shape of slope in this investigation shall be classified into the 9 types as shown in Fig-13 from the transversal shape (straight line type, ridge type, and valley type) and the longitudinal shape (convex slope, straight line slope, and concave slope), and the number of the applicable shape of slope shall be entered.

Note that if it is difficult to select the shape of the slope being investigated due to its complex shape, the shape of the slope shall be selected by judging its outline from the situation of the slope.

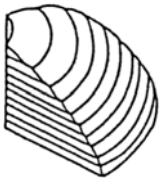
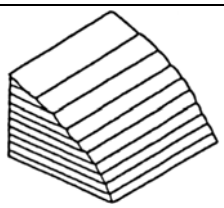
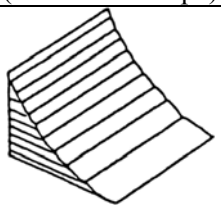
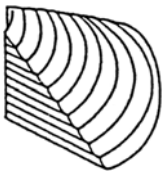
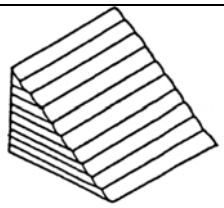
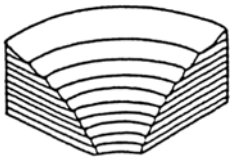
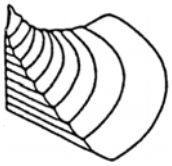
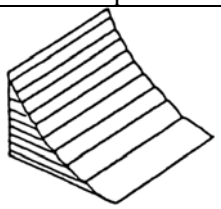
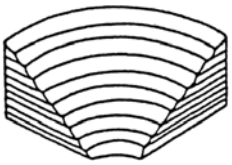
| Viewpoint | | | State of change in the direction of the maximum gradient (water flow path) | | |
|---|---|---|---|---|---|
| | Classification criteria | | Classification of slope by the horizontal cross-sectional shape (planar shape of contour lines) | | |
| | | Classification | Ridge type slope (Sprinkling slope) | Straight line slope | Valley type slope (Catchment slope) |
| State of change in the magnitude of the maximum gradient (inclination) | Classification of slope by the vertical cross-sectional shape | Convex slope | [1]  Convex ridge type slope | [4]  Convex straight line slope | [7]  Convex valley type slope |
| | | Straight line slope | [2]  Straight line ridge type slope | [5]  Straight line straight line slope | [8]  Straight line valley type slope |
| | | Concave slope | [3]  Concave ridge type slope | [6]  Concave straight line slope | [9]  Concave valley type slope |

Fig-13 Way of thinking of the shape of slope

e) Direction of the upper level topography

If the slope being investigated is included in a ridge, the direction of the ridge containing such slope shall be entered, as shown in Fig-14. If the upper level topography is not in the form of a ridge, it shall be entered as 'Others'.

In Fig-14, the direction of the ridge containing such slope becomes east.

Table-2 Direction of the upper level topography

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Facing east | 2 | Facing southeast | 3 | Facing south | 4 | Facing southwest |
| 5 | Facing west | 6 | Facing northwest | 7 | Facing north | 8 | Facing northeast |
| 9 | Others | | | | | | |

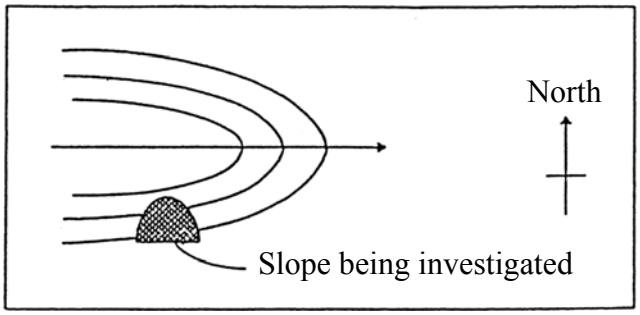



Fig-14 Direction of the upper level topography

f) Transversal shape

The slope being investigated shall be classified into the 5 types as shown in Fig-15, and the applicable number shall be entered.

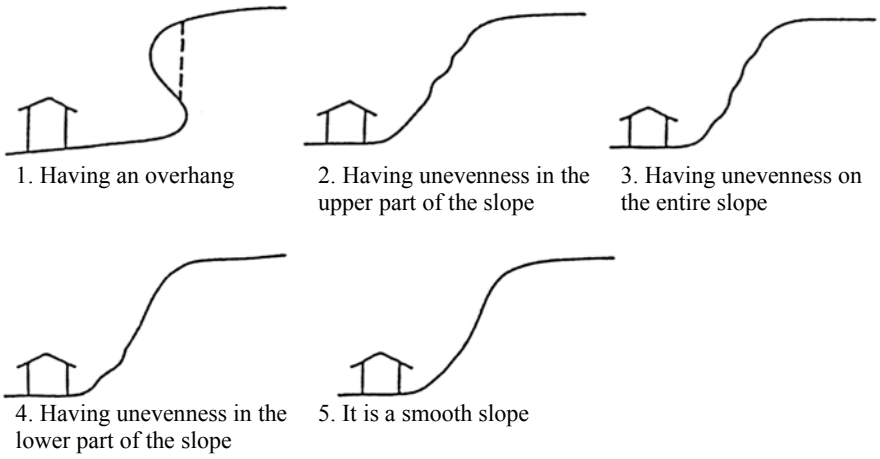
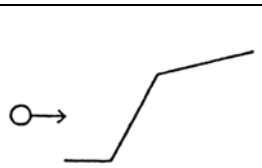
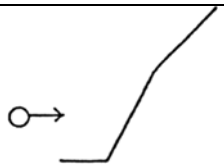
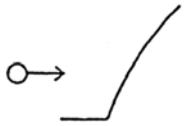
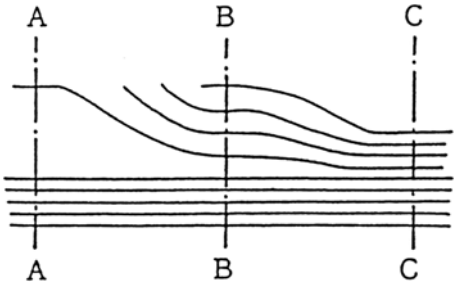



Fig-15 Types of transversal shapes

g) Knick line

A knick line is the line that connects the points at which the gradient changes from gentle to steep abruptly when viewed from above the slope. In this investigation, the clearness of a knick line shall be classified into the 3 types shown in Table-3, and the applicable number of the knick line shall be entered.

Table-3 Classification of a knick line

| Number | 1 | 2 | 3 |
|---|---|---|---|
| Explanation of classification | Very clear knick line | Clear knick line | Unclear knick line |
| Cross-sectional sketch of the shape |  Section A - A |  Section B - B |  Section C - C |
| Plan |   | | |

h) Position of the knick line

If a knick line is very clear or clear, the position of the knick line shall be entered. The slope height shall roughly be divided into 3 equal parts, and the position shall be written as the upper part, the intermediate part, or the lower part, depending on to which part the position belongs. And if the knick line is unclear, it shall be written as 'Not applicable'.

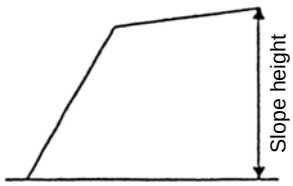
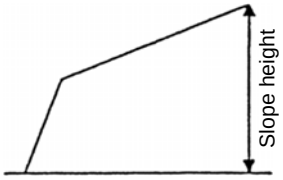
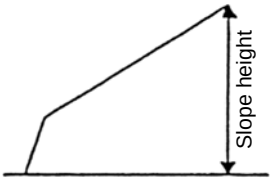
| | | | |
|---|---|---|---|
|   |   |   | |
| 1. Upper part | 2. Intermediate part | 3. Lower part | 4. Not applicable |

Fig-16 Position of the knick line

(2) Investigation items on geology and soil

a) Situation of the ground surface

The situation of the ground surface means the situation of a slope such as cracks, and weathering as well as the types of geology / soil that form the slope, and it shall be classified into the 5 types as shown in Table-4, and the applicable number shall be entered on the basis of the result of site investigation.

Where a boulder and loose rock shall denote those sticking out from the ground surface. If the number of those applicable is more than one, a lower number shall be entered.

Table-4 Situation of the ground surface

| Number | Situation of the ground surface |
|---|---|
| 1 | Cracks have developed with openings, and boulders and loose rock stud there |
| 2 | Consisting of rock that has been weathered and with developed cracks |
| 3 | Soil mixed with pebbles; sandy soil |
| 4 | Clayey soil |
| 5 | Consisting of rock that is unweathered and with undeveloped cracks |

b) Thickness of the surface soil

Surface soil shall denote humus soil, organic soil, and weathered soil on the surface. However, if very loose collapsed soil, etc. is found beneath the surface soil, then its thickness shall also be included in the thickness of the surface soil, and the value of such entire thickness shall be entered.

Note that if it is difficult to verify the thickness of the surface soil in the slope to be investigated, it shall be estimated by referring to the information on the surrounding slopes having similar topology and topography, and the value obtained by such estimation shall be entered.

c) Situation of the bedrock

The situation of the bedrock shall mean the types of geology, soil, and rock that form the slope, and it shall be classified into the following 6 types, and the number of applicable geology, soil, or rock on the basis of geological maps and site investigation shall be entered (see Table-5).

Also, their modes of failure are shown in Fig-17.

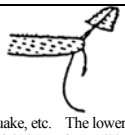
a) Collapsed soil
b) Volcanic detritus (shirasu, loam, etc.)
c) Strongly weathered rock (decomposed granite, etc.)
d) Terrace deposit
e) Soft rock
f) Hard rock

Table-5 Situation of the bedrock

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Collapsed soil | 2 | Volcanic detritus | 3 | Strongly weathered rock | 4 | Terrace deposit | 5 | Soft rock | 6 | Hard rock |

## (a) Collapsed soil

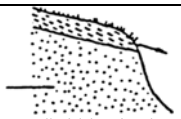
### Falling of surface soil



It occurs by the force of wind, rain, earthquake, etc. The lower layer of the surface soil is hollowed out by erosion or artificially, and the part in which the surface soil is overhanging collapses.

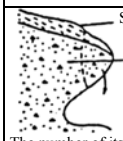
### Sliding down of surface soil

Rock (including weathered rock);
volcanic detritus, volcanic eruption
(loam, decomposed granite, shirasu, etc.).



It is the one in which only the surface soil slides down, such as a colluvial deposit and a terrace deposit, and the sliding surface lies in the boundary between the surface soil and the lower layer (it shall be the one that does not slide simultaneously). Its examples are the greatest in number in failures.

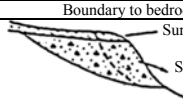
### Falling of a colluvial deposit




The number of its examples is relatively small, and it can be found occasionally at the end of a landslide, or the like.

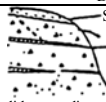
### Sliding down of a colluvial deposit

#### Boundary to bedrock




It is the one in which a colluvial deposit slides with a bedrock, which is its lower circle, or its weathered band, serving as a boundary plane, and it can be regarded as landslide on a small scale. The lower circle is often a bedding containing sedimentary rock (shale, sandstone, conglomerate, schist, etc.). In general, the entire surface of the cliff often slides at a time. Spring water is often found at the foot of the cliff.

#### Discontinuous plane

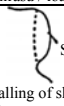



It is the one that slides on a discontinuous plane in a colluvial deposit. It is the one in which a colluvial deposit slides, after having contained different grain sizes, having caught volcanic ash, or having caught organic soil during the process of its formation, with these serving as a boundary plane. In site investigation, if any discontinuous plane (seam) has been found within such cliff planes, it is advisable that its grain size, hue, and the situation of spring water in such a place should be entered.

## (b) Volcanic detritus

### Falling of volcanic detritus

#### Shirasu / loam



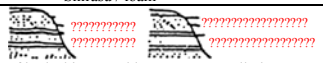

It is best characterized by the falling of shirasu, but similar phenomena occur in loam as well if sandy layers are caught by it. It is especially vulnerable to earthquakes.
It is caused by the erosion of spring water, which is generally found in the lower part of shirasu or loam. Also, flowing water may erode the lower part in some cases.

#### Weathered agglomerate / tuffaceous breccia, etc

The part except pebbles of rock is subjected to advanced erosion, and the remaining pebbles of rock fall.

### Sliding down of volcanic detritus

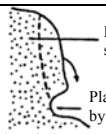
#### Shirasu / loam



The sliding down of both shirasu and loam can generally be seen when the entire layer is not uniform and it contains a sandy permeable layer with spring water, or it has a relative aquiclude such as a solidified silt layer.
Rainfall induces sliding by raising water pressure in the piping or pore pressure inside the shirasu or loam that lies above the aquiclude.

## (c) Strongly weathered rock

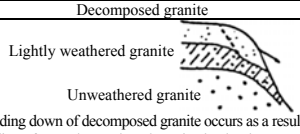
### Falling of strongly weathered rock




Although there are very few examples, it can be seen when the lower part of a cliff has been eroded by flowing water.

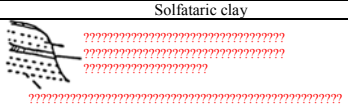
### Sliding down of strongly weathered rock

#### Decomposed granite




The sliding down of decomposed granite occurs as a result of the sliding of strongly weathered granite that has been changed to a sandy layer on its boundary plane with lightly weathered granite, and its thickness is up to a maximum of 2 m.

#### Solfataric clay

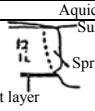


In a zone altered by hot spring, andesite, agglomerate, etc. are subjected to alternation, being acted upon by hot water, hot air and hot spring, to become softer as a whole, and among them, those that have been altered to clayey soil (solfataric clay) especially along a certain flow structure or bedding will slide along such a layer.

## (d) Terrace deposit

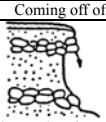
### Falling of a terrace deposit

#### Aquiclude



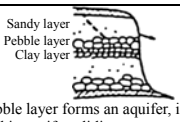

Although there are very few examples, it may be found out when there is spring water around a layer containing much silt.

#### 4--(1)-b Coming off of pebbles



The erosion of those other than pebble layers is advanced and the remaining pebbles fall.

### Sliding down of a terrace deposit



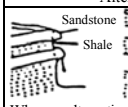

Since a pebble layer forms an aquifer, if groundwater cannot be held in this aquifer, sliding occurs. It is likely to occur topographically in places where water tends to flow in.

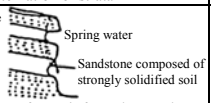
(Note) The failure of debris flow deposits can be handled in roughly the same way as colluvial deposits or terrace deposits.
Debris flow deposits are relatively unlikely to form a problematic cliff surface.

## (e) Soft rock

### Falling of Rock (II)

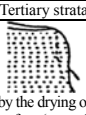
#### Alternation of strata




When an alternation of strata is formed, strata that are resistant to erosion remain and then fall.

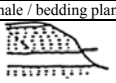
#### Tertiary strata



Cracks caused by the drying of the surface occur near the surface (normally within 30 cm) parallel to the surface, and a fall occurs with such cracks forming a boundary.

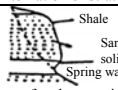
### Sliding down of Rock (II)

#### Shale / bedding plane



Shales in the Tertiary strata are very vulnerable to weathering. Weathering often advances from the bedding plane, causing sliding along the bedding. When there are strata having high permeability such as sandstone, this tendency is strengthened.

#### Alternation of strata of sandstone and shales

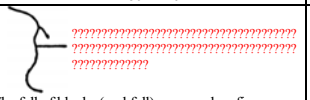



It can often be seen in such a case in which the degree of solidification of sandstone in the Neogene strata is low and is hollowed out after having been washed away by spring water.

## (f) Hard rock

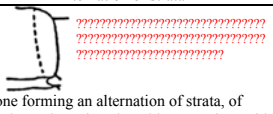
### Falling of Rock (I)

#### Block-like



The fall of blocks (rockfall) occurs when fissures have been loosened by rainfall, freezing, etc. It often occurs at the time of an earthquake.

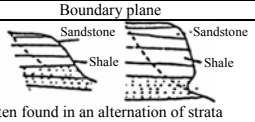
#### Alternation of strata



The one forming an alternation of strata, of which lower layer is vulnerable to erosion, with the upper layer remaining.

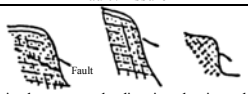
### Sliding down of Rock (I)

#### Boundary plane




It is often found in an alternation of strata especially having different strengths and permeability, such as the combination of sandstone and shales.

#### Fault / fissure




Its main elements are the direction, density and state of faults and fissures (joints / cracks), and the combination of these form various sliding planes.

### Falling of Rock (I)

#### The upper part is weak

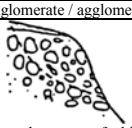

In a stratum, the lower part is vulnerable to erosion, with the upper layer remaining.

#### Lava


It often occurs at the end of a lava (especially of andesite), etc., which forms a very high cliff, and the coming off and falling occur at its joint (columnar joint) plane. It can be seen on riverbanks and coasts in a volcanic zone.

### Sliding down of Rock (I)

#### Conglomerate / agglomerate



It is a conglomerate or agglomerate, of which sliding occurs along the boundary of a part in which pebbles are cemented with clay, limestone, volcanic ash, etc.

Fig-17 Situation of the bedrock

d) Cracks on the bedrock slope

a. Space between cracks

In this investigation, the situation of cracks on bedrock is represented by the space between cracks on bedrock, and it shall be classified into the following 4 types, and the applicable number shall be entered (see Table-6).

Table-6 Cracks on bedrock

| | | | |
|---|---|---|---|
| 1 | The space between cracks is 10 cm or less | 2 | The space between cracks is 10 cm - 30 cm |
| 3 | The space between cracks is 30 cm - 50 cm | 4 | The space between cracks is 50 cm or more |

b. Scale of open cracks

(a) Method of investigation

Stand at a position that commands a view of the whole bedrock slope, check the inside of the slope for any open cracks. Especially attention shall be paid to the cracks that are parallel to, or intersect obliquely with, the cliff plane.

Even if no open cracks on a large scale can be seen, climb up the upper part of the cliff plane of a slope on which joints and beddings have developed, as long as there will be no danger, to check if any cracks can be found around the shoulder of the cliff.

(b) Investigation criteria

Based on whether there are any open cracks and their scale, classification shall be made into the 3 categories, i: large, ii: small, and iii: none.

i: "Large" open crack

"Large" open cracks shall be defined as given in (i) – (iii) below. Note that Fig-18 shows the photos of the examples that are classified as "large" open cracks. All the cracks presented as examples here shall be handled as "large" ones.

(i) Top of the moving rock mass
- Open cracks of which depths can be viewed
- Those which are obviously separated
- Open cracks which are continuous lengthwise even if their widths are small
- Those which have bumps
- Those which are not judged to be open cracks, but with continuous bumps, accompanied by dents at the base of the bumps

(ii) Side of the moving rock mass
- Open cracks running obliquely, although not being separated

(iii) End of the moving rock mass
- Those with rock mass protruding along the weak plane of the opening

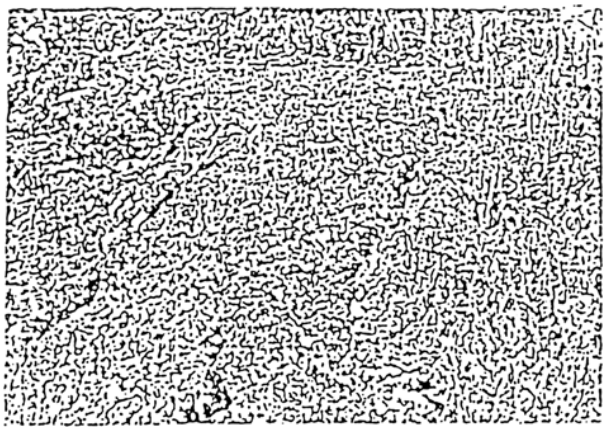
ii: "Small" open crack

A "small" open crack shall be defined as follows.
- Open cracks that can be found only in the vicinity of the surface
- Open cracks with small widths and without continuity, which cannot be judged to be separated
- Those generally having plenty of crushed cracks, even though having no open cracks

Note) If plenty of cracks in the vertical direction can be seen at an overhang, it is especially important to fully study the continuity and separateness of such cracks to evaluate the sizes of the cracks.

iii: "None"

That there is "none" of open crack shall be defined as follows.
- No crack can be seen.



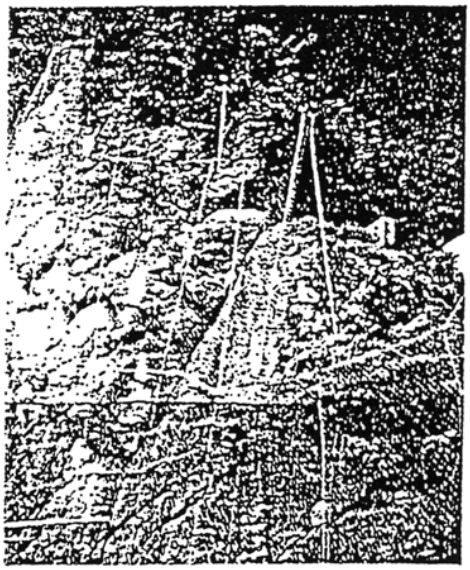
Cracks running obliquely without continuation

Open cracks in a steep slope joint and a gentle slope joint

Open cracks running continuously on the bottom surface of an overhanging rock mass

Cracks formed by the sliding movement of a rock mass due to toppling

Cracks formed by the leaning forward of a huge rock mass due to toppling



Cracks with open square joints

Fig-18 Examples in which open cracks are classified into “large” ones

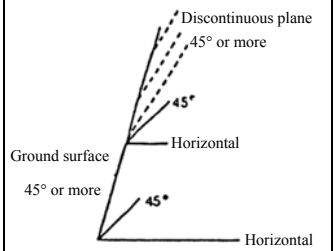
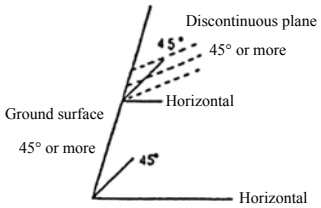
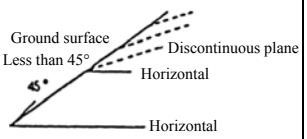
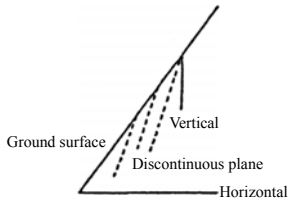
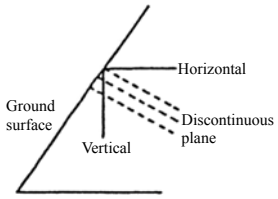
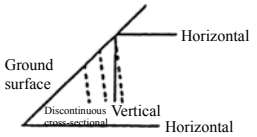
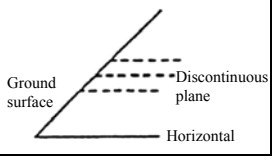
e) Relation between a slope and a discontinuous plane

It means the relation of inclination between a slope and a discontinuous plane, and it shall be classified into the 7 types shown in Table-7, and the number of the applicable type shall be entered.

Note that a discontinuous plane means a bedding plane, joint plane, fault plane, cracks, etc. If it is difficult to check it on the slope being investigated, it shall be estimated by referring to the information on the surrounding slopes having similar topology and topography.

And the number of Type G shall be entered for a stratum having no discontinuous plane.

Table-8 Relative inclination between a slope and a discontinuous plane

| 1 Type A | 2 Type B | 3 Type C | 4 Type D |
|---|---|---|---|
|  |  |  |  |
| 5 Type E | 6 Type F | 7 Type G | |
|  |  |  | |

f) Fault / shattered zone

It means whether there is any clear fault / shattered zone in the slope being investigated, and the applicable number shall be entered (see Table-8).

Note that if it is difficult to check it on the slope being investigated, it shall be estimated by referring to geological maps and the information on the surrounding slopes.

Table-8 Fault / shattered zone

| | | | |
|---|---|---|---|
| 1 | Clear fault / shattered zone - existent | 2 | Clear fault / shattered zone - nonexistent |

g) Situation of the weathering of slopes

In the slope being investigated, the situation of the weathering of slopes shall be estimated, and the applicable number shall be entered (see Table-9).

Note that if it is difficult to check it on the slope being investigated, it shall be estimated by referring to geological maps and the information on the surrounding slopes.

Table-9 Situation of the weathering of slopes

| | | | |
|---|---|---|---|
| 1 | Rock is very hard and has not weathered at all. | 2 | Rock is very hard and unweathered, but alteration resulting from weathering can be recognized along fissures. |
| 3 | Rock has slightly been altered by weathering. Fissures have developed and caught clay. | 4 | Partially changed to clay due to weathering actions. Fragments of rock are generally soft and contain hard rock fragments in part. |
| 5 | Totally weathered and have turned into soil. Hardly any hard rock fragments remain. | | |

(3) Investigation items concerning environmental factors

a) Type of vegetation

The types of ground cover on the slope being investigated shall be classified into no vegetation (bare land), grassland, bamboo forest, conifers, broad-leaved trees, and mixture of conifers and broad-leaved trees, and the number of the ground cover having the highest composition ratio there shall be entered (see Table-10).

Table-10 Type of vegetation

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | No vegetation (bare land) | 2 | Grassland | 3 | Bamboo forest | 4 | Conifers |
| 5 | Broad-leaved trees | 6 | Mixture of conifers and broad-leaved trees | | | | |

b) Ages of trees

An average age of trees in the slope being investigated shall be estimated, and the applicable number of tree age shall be entered according to the classification given below (see Table-11).

Note that number 1 shall be entered in the case of grassland, bamboo forest, or bare land.

Table-11 Ages of trees

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Less than 10 years | 2 | 10 - 20 years | 3 | 20 - 30 years | 4 | 30 - 40 years |
| 5 | 40 - 50 years | 6 | 50 years or more | | | | |

c) Situation of stumps

Concerning whether there any stumps on the slope being investigated, enter the applicable number (see Table-12).

Table-12 Situation of stumps

| | | | |
|---|---|---|---|
| 1 | Slope with stumps | 2 | Slope without stumps |

d) Situation of the history of failures of the slope being investigated and its adjoining slopes

Concerning the period of a failure that occurred in the past on the slope being investigated and its adjoining slopes as well as its position on the slopes, the applicable number shall be entered.

Note that, an old failure shown here shall denote a failure that is estimated to have occurred more than 10 years ago, and a new failure shall mean a failure that occurred 10 years ago or thereafter. (See Table-13; Fig-19)

Table-13 Situation of the history of failures of the slope being investigated and its adjoining slopes

| | | | | | | |
|---|---|---|---|---|---|---|
| History of failures | 1 | With an old failure area | 2 | With a new failure area | | |
| | 3 | No failure area can be recognized | | | | |
| Position | 1 | Failure of the lower part of the slope | 2 | Failure of the intermediate part of the slope | | |
| | 3 | Failure of the upper part of the slope | 4 | Failure of the whole slope | 5 | No failure |

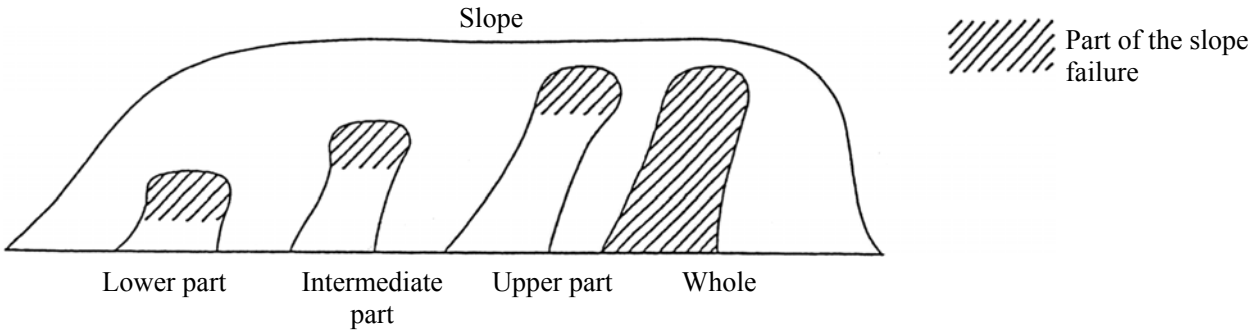



Fig-19 Position of an occurrence of a failure

e) Spring water

Show the situation of spring water on the slope being investigated, and enter whether there is any spring water. Also, enter the applicable number of the situation of spring water, according to the following classification (see Table-14).

Note that if more than one situation is applicable, a lower number shall be entered.

Table-14 Spring water

| | | | |
|---|---|---|---|
| 1 | Always with spring water | 2 | With spring water at the time of rainfall |
| 3 | The slope is always damp | 4 | The slope is dry |

f) Preventive works

If any preventive works have been done on the slope being investigated, the applicable number as to the present situation of such preventive works shall be entered, concerning whether there is any abnormality in the preventive works or not (see Table-15).

Where abnormality in preventive works shall denote the situation such as the one shown below.

a Situation in which the filling materials of the grating crib, etc. have come out.

b Situation in which cracks, sliding, etc. can be seen in the preventive works.

Table-15 Preventive works

| | | | |
|---|---|---|---|
| 1 | With abnormality in the preventive works | 2 | Without abnormality in the preventive works |

g) Situation of the upper part of the preventive works

If any preventive works have been done on the slope being investigated, concerning the situation of the upper part of such preventive works, the applicable number according to the height of cutting as to the stability of the slope above the preventive works shall be entered. And if there are no preventive works, the column shall be left blank (see Table-16; Fig-20).

Table-16 Situation of the upper part of the preventive works

| | |
|---|---|
| 1 | With a slope that has been left as it is after a length of 10 m or more has been excavated |
| 2 | With a slope that has been left as it is after a length of 5 m or more has been excavated |
| 3 | With a slope that has been left as it is after a length of less than 5 m has been excavated |
| 4 | Without any slope that has been left as it is after excavation |

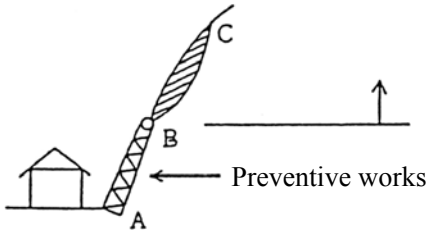



Fig-20 Position of the upper part of the preventive works

h) Situation of land use in the upper part of the slope

The situation of land use in the upper part of the slope being investigated is shown below. The topography in the upper part of the slope shall be classified into ridge / plateau, and the situation of its use into road / waterway / pond or swamp / house / farmland / mountain forest / others. Fig-21 shows the classification into ridge / plateau, and Table-17 shows the classification of the situation of use. It shall be classified into either ridge or plateau, and the applicable number of the situation of land use shall be entered.

Note that if there is more than one situation of land use in the upper part of the slope, a lower number shall be entered.

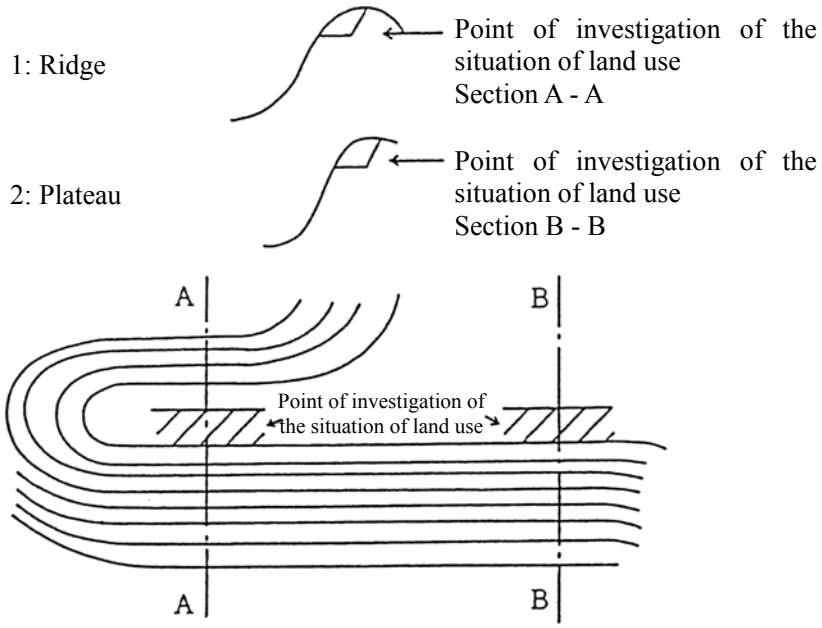



Fig-21 State of the upper part of the slope

Table-17 Situation of land use in the upper part of the slope

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ridge-like | | | | | | | | | | | | | |
| 1 | Road | 2 | Waterway | 3 | Pond or swamp | 4 | House | 5 | Farmland | 6 | Mountain forest | 7 | Others |
| Plateau-like | | | | | | | | | | | | | |
| 1 | Road | 2 | Waterway | 3 | Pond or swamp | 4 | House | 5 | Farmland | 6 | Mountain forest | 7 | Others |

(4) Rating of the degree of hazard

In accordance with the "Slope Hazard Rating Evaluation by Using Fuzzy Theory".

## 5 Contents of investigation on the areas to be protected

(i) Population of municipality

The population of the municipality to which the said hazard area belongs shall be classified according to the following, and the applicable number shall be entered.

1: Government ordinance designated city
2: City of which population is 300,000 or more (exclusive of government ordinance designated city)
3: City of which population is 200,000 or more and less than 300,000
4: City of which population is 100,000 or more and less than 200,000
5: City of which population is less than 100,000
6: Town
7: Village

(2) Number of houses

The number of houses and the converted number of houses in the Steep Slope Failure Hazard Area (I or II) shall be investigated. Also, if there is any house within 10 m of a steep slope, the number of houses and the converted number of houses shall be investigated according to the construction of houses (wooden; non-wooden).

a. The number of houses and the converted number of houses in the Steep Slope Failure Hazard Area (I or II)

The "number of houses" shall denote the number of houses in the estimated damage area, and shall not include the number of facilities related to people vulnerable to disasters. The number of an apartment house, etc. to be protected shall be the number of households at the 1st floor in the case of an RC made one, and it shall be the number of the entire households in the case of a wooden one. Note that it shall not include the number of sheds, huts, etc.

The "converted number of houses" shall denote the number of houses obtained by adding, the number of facilities related to people vulnerable to disasters, to the "number of houses". The number of facilities related to people vulnerable to disasters shall be counted as one-third of the maximum number of people that can reside there.

b. The number of houses within 10 m of a steep slope

As for the number of houses within 10 m of a steep slope, the number of houses and the converted number of houses shall be counted for each of the positions on the slope (the upper part; lower part of the slope), and for each of the constructions (wooden; non-wooden).

(3) Buildings of a public nature

The types and numbers of buildings of a public nature such as administrative offices, schools, medical facilities, Japanese-style hotels, railroad stations, and facilities related to people vulnerable to disasters shall be entered.

(4) Description in the regional disaster prevention plan

Enter whether or not there is any description in the regional disaster prevention plan.

(5) Related evacuation area

Enter whether or not there is any evacuation area placed in the regional disaster prevention plan.

(6) Related evacuation route

Enter whether or not there is any evacuation route placed in the regional disaster prevention plan.

(7) Public facilities

Enter the types and lengths, etc. of roads (national roads, prefectural roads, municipal roads, etc.), railways, rivers, etc.

(8) Designation of areas for other projects

If the entire area of the said steep slope is a sabo designated area, enter “Sabo (Entire)”, if it is a landslide prevention zone, “Land (Entire)”, if it is a dump failure prevention zone, “Dump (Entire)”, if it is a protection forest, “Protection (Entire)”, and if it is a protection facility district, “Protection Facility (Entire)”.

Note that if only part of the said steep slope falls under the above sabo designated area, etc., enter “Sabo (Partial)”, “Land (Partial)”, “Dump (Partial)”, “Protection (Partial)”, and “Protection Facility (Partial)”, respectively.

(9) Designation of a steep slope failure hazard area

If it has been designated as a steep slope failure hazard area, enter “Steep” as well as its date of designation, and if it has been designated as a disaster hazard area, enter “Disaster” as well as its date of designation.

(10) Whether or not an investigation was conducted last time

Write down whether or not the area was included in the investigation of steep slope failure hazard areas that was implemented in 1996.

If an investigation was conducted last time, enter its rating of the degree of hazard (A, B, or C), and if no investigation was conducted, enter “None”.

(11) Areas requiring construction work

If it is appropriate to carry out construction work as a subsidized project of the national government, enter “Nation”, if it is appropriate for a local government to carry out construction work independently, enter “Independent”, and for those other than the above, enter “Others”.

(12) Situation of construction work

For those under construction out of the areas requiring construction work, enter the fiscal year of the start of work as well as “Under Construction”, for those of which construction work has not yet started, enter “Not Yet”, and for those which have roughly been completed, enter the fiscal years of the start of work and completion as well as “Roughly”.

Note that whether it has roughly been completed or note shall be considered as of March 31, 2002.

Those of which work has been suspended shall be handled as under construction.

(13) Situation of construction work of other projects

For those of which failure prevention works are under construction in other projects, enter “Under Construction”, and for those of which construction work has roughly been completed, enter “Roughly”, and add the name of each of such projects.

(14) Rating of the degree of hazard

Only that for steep slope failure hazard areas shall be given by the attached “Slope Hazard Rating Evaluation by Using Fuzzy Theory”.

(15) Those related to special legislation, and others

- Heavy snowfall area
  If it falls under the heavy snowfall area pursuant to the “Law for Special Measures against Heavy Snowfall Areas”, enter “Heavy”, and in which case if it falls under the specially heavy snowfall area, enter “Special”.

- Earthquake disaster prevention area with strengthened measures
  If it falls under the earthquake disaster prevention area with strengthened measures pursuant to the “Law for Special Measures against Large-scale Earthquakes”, it shall be marked with a circle.

- Peninsula advancement district / isolated island advancement district
  If it is the area subject to peninsula advancement measures pursuant to the “Peninsula Advancement Law”, enter “Peninsula”, and if it is the area subject to isolated island advancement measures pursuant to the “Isolated Island Advancement Law”, enter “Isolated”.

- Typhoon prone area
  If it falls under the typhoon prone area pursuant to the “Law for Special Measures Concerning the Prevention of Disasters in Typhoon Prone Areas”, it shall be marked with a circle.

- Special soil area
  If it is the shirasu area out of the special soil areas pursuant to the “Law for Provisional Measures for the Prevention of Disasters and Advancement in Special Soil Areas”, enter “Shirasu”, and if it is a special soil area other than the above, enter “Others”.

- Underpopulated area
  If it is within the underpopulated area pursuant to the “Law for Special Measures for the Advancement of Underpopulated Areas”, it shall be marked with a circle.

- Technopolis area
  If it is within the development planning area that has been approved by the competent minister pursuant to the "Law for the Promotion of the Development of Collective Industrial Areas with Advanced Technologies", it shall be marked with a circle.

- Resort area
  If it is the specified area pursuant to the "Law for the Improvement of Comprehensive Health Resort Areas (that has been approved by the competent minister), enter "Resort", and amongst which if it is especially within the prioritized improvement district, then enter "Prioritized".

- Restricted residential land development area
  If it is within the restricted residential land development construction work area pursuant to the "Law for the Restriction of Residential Land Development and Others", it shall be marked with a circle.

- DID district
  If it is the district of concentrated population pursuant to the "Statistics Law", it shall be marked with a circle.

- City planning area
  If it falls under the area designated for urbanization pursuant to the "City Planning Law", enter "City", if it falls under the controlled urbanization area, enter "Controlled", and if it falls under the undemarcated area, then enter "Undemarcated".

(16) Designation of areas subject to environmental measures

- National park, quasi-national park and prefectural national park
  If it is a national park, quasi-national park, or prefectural natural park pursuant to the "Natural Park Law" and falls under the one located within a special area, enter "Special", and if it is within an area other than the foregoing, then enter "Ordinary".

- Scenic district
  If it falls under the scenic district pursuant to the "City Planning Law", it shall be marked with a circle.

- Green space conservation district and suburban green space conservation district
  If it falls under the suburban green space district pursuant to the "Law for the Conservation of Suburban Green Space in the Metropolitan Area", enter "Suburban", and if it falls under the green space conservation district pursuant to the "Law for the Conservation of Urban Green Space", then enter "Green".

- Historical landscape preservation area
  If it falls under the land within the historical landscape preservation area pursuant to the "Law for Special Measures Concerning the Preservation of Historical Landscape in Ancient Capitals", etc., enter "Historical", and amongst which if it is located within the special preservation district, then enter "Special".

## IV Others

The above inspection procedure is an inspection procedure of hazard areas at the time of rainfalls and earthquakes.

## V Documents to be submitted

(1) Table of investigation of steep slope failure hazard area, etc. (Form 1-1; Form 1-2): A3 size, 1 copy each

(2) Coding sheet: A3 size, 1 copy each

(3) Positional drawing: 1 copy each

When preparing positional drawings, the procedure given below shall be followed. Note that the drawings for reference in the attached sheets shall be referred to.

i. Drawing to be used: 1/25,000 scale topographical map issued by the Geographical Survey Institute

ii. On the entry of the steep slope failure hazard area, etc.

(i) Framing and coloring of the hazard area, etc.

The framing of the hazard area, etc. shall be indicated by a solid line drawn with a black ball-point pen, and its coloring shall be done with a marker according to the classification given below.

a. Steep Slope Failure Hazard Area (I)
Orange: The slope under consideration and the estimated damage area

b. Steep Slope Failure Hazard Area (II)
Yellow: The slope under consideration and the estimated damage area

c. Slope of a Quasi-hazard Steep Slope Failure Area
Blue: The slope under consideration and the estimated damage area

(ii) Area number of the steep slope failure hazard area, etc.

The area number of the steep slope failure hazard area, etc. shall be entered with a black ball-point pen.

Example In the case of No. 2 of Steep Slope Failure Hazard Area (II): II-2

(iii) Area number of the investigation of the actual situation of a slope failure disaster

The area number of the investigation of the actual situation of a slope failure disaster shall be entered with a black ball-point pen.

Example In the case of No. 3 of 1985 (the 60th year of the Showa era): 60-3

(iv) Positions of the cross-section to be investigated and the slope on which a failure has occurred

The cross-section of the slope to be investigated (a cross-section that is considered to have the greatest danger of a failure) shall be indicated by a straight line on a drawing with a blue ball-point pen, and the cross-section of the slope on which a failure has occurred (area where an investigation of slope failure disasters has been conducted) shall be indicated with a red ball-point pen.

(v) Latitudes and longitudes of the steep slope failure hazard area and of a slope failure disaster

The positions of the latitude and longitude of each steep slope failure hazard area (at the lower end (upper end if the object of protection is located at the upper end) of the cross-section to be investigated) and the positions of the latitude and longitude of a slope failure disaster (at the lower end (upper end if the object of protection is located at the upper end) of the slope to be investigated), which have been entered in the report, shall be indicated with a circle, with a red ball-point pen.

## Attached Sheet - 1

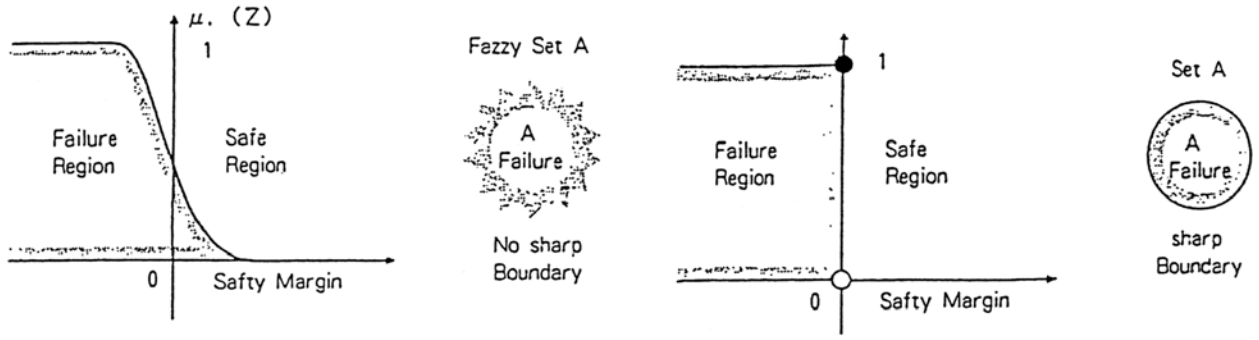
## Slope Hazard Rating Evaluation by Using Fuzzy Theory

### 1-1 Outline of fuzzy theory

Fuzzy theory is a theory proposed by L. A. Zadeh in 1965, and is a theory that handles "ambiguity" caused by the subjectivity of humans.

Before describing the outline of fuzzy theory, the meaning of "fuzzy" is explained.

The meaning of the word "fuzzy" is that the boundary is ambiguous and blurred. This can be represented by a figure as shown in Fig-1.




(a) Representation by means of a fuzzy set (b) Representation by means of an ordinary set

Fig-1 Concept of fuzzy theory

The subjectivity handled in fuzzy theory does not denote the one that has traditionally been handled probabilistically, namely, the randomness that can be evaluated objectively and processed probabilistically, but denotes the fuzziness that cannot be processed statistically or probabilistically, as is typified by the ambiguity of language.

The semantical difference between randomness and fuzziness can be explained by using examples as follows.

It shall be explained by means of the difference between the uncertainty of the expression, "looks like it'll be fine tomorrow", and the expression, "that person is rich".

The former means uncertainty about the event that will occur hereafter, or uncertainty when surmising before carrying out investigation. The latter shows the uncertainty of a concept, namely the fact that an uncertain situation remains without being made clear, howsoever investigation and observation are carried out.

Fuzzy theory handles the uncertainty of the definition of the concept of the latter.

Fuzzy theory is featured by the representation of the boundary by using the membership function, $\mu\lambda(X)$, and by the representation of the degree of belonging of the element X to the set A by using a number within the range from 0 through 1. Fig-2 shows the concept of the membership function by using a concrete example. This shows that the degree of belonging of a person who is 170 (cm) tall to a set of "tall persons" is around 0.5, and the boundary between "tall persons" and "short persons" is ambiguous. Thus fuzzy theory is to carry out calculation and analysis by representing a set by means of a membership function.

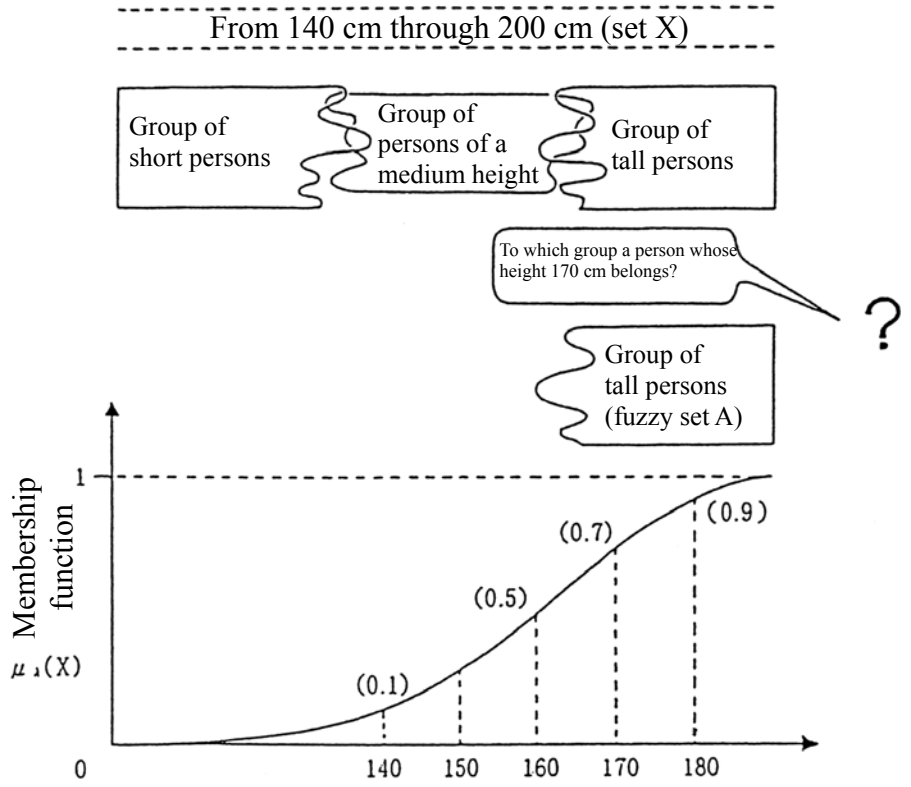



Fig-2 Example of the membership function (language function)

### 1-2 Application of fuzzy theory

At present fuzzy theory is applied to a wide variety of fields. Table-1 summarizes concrete analytical techniques used in the application of fuzzy theory and their fields of application.

Table-1 Analytical techniques of fuzzy theory and their fields of application

| Classification | Concrete analytical technique | Field of application |
|---|---|---|
| Fundamental theory of fuzzy set | Fuzzy number<br>Extension principle<br>Fuzzy probability<br>Fuzzy statistics<br>Fuzzy set | System analysis, landscape analysis<br>Socioeconomic analysis and evaluation<br>Regional city planning<br>Market analysis in marketing |
| Fuzzy OR | Fuzzy linear planning<br>Fuzzy dynamic planning<br>Possibility regression analysis<br>Fuzzy quantification | Distribution of traffic demand, traffic network planning<br>Planning theory, CAD<br>Plant relocation planning |
| Fuzzy inference<br>Fuzzy control | Fuzzy inference<br>Fuzzy control<br>Fuzzy expert system | Traffic flow, traffic control,<br>Bidding system<br>Pattern recognition<br>Understanding of language, control of water purification plants<br>Automatic operation of trains, diagnosis of failures |
| Others | Fuzzy integration<br>Fuzzy clustering<br>Fuzzy structure model | Data processing<br>Consciousness investigation and analysis<br>Evaluation of the soundness of bridges<br>Reliability design, plant diagnosis<br>Environmental assessment |

It can be seen from Table-1 that the range of application of fuzzy theory encompasses a wide variety of fields such as social science, diagnosis, and control.

On the other hand, to take a look at the development of fuzzy theory in the filed of civil engineering, it has begun to be utilized in the evaluation of the soundness of structures in terms of their maintenance and management, the safety evaluation of structures during their construction work, the forecast of slope failures, the safety evaluation of earth dams, the analysis of influences on lifeline at the time of an earthquake disaster, the analysis of the runoff of rivers, and others.

### 1-3 Procedure for the evaluation of the degree of slope failure hazard by using fuzzy theory

When an experienced person determines the degree of hazard of phenomena like slope failures that occur as a result of various factors being linked with one another, the person makes a judgment in the light of his/her experiences in the past while combining individually various factors such as the height of the slope, whether there is a knick line or not, and the transversal shape. Techniques for determining the degree of hazardous slope failures by using fuzzy theory are the techniques that enable the degree of hazardous slope failures to be calculated quantitatively by making an analysis from the ambiguous information that is based on the subjective judgment of humans by using fuzzy theory, on the basis of the thinking process of such an expert of slope investigation.

Now by taking the techniques for determining the degree of hazardous slope failures at the time of rainfall as an example, the contents of such techniques are explained below according to their construction procedure.

1) Selection of slope investigation factors

The factors of slope investigation when an experienced person makes a judgment of the degree of hazard have been studied by experts of slope investigation (brainstorming), and 19 factors given in Table-2 have been selected.

Table-2 Factors of failures related to slope failures at the time of rainfall and membership functions

| Slope failure factor | Membership function | Setting | Slope failure factor | Membership function | Setting | Slope failure factor | Membership function | Setting |
|---|---|---|---|---|---|---|---|---|
| Knick line | Degree of hazard, great ↕ Degree of hazard, small | Very clear | Situation of bedrock | Degree of hazard, great ↕ Degree of hazard, small | Collapsed soil | Spring water | Degree of hazard, great ↕ Degree of hazard, small | Always with spring water |
| | | Clear | | | Volcanic detritus | | | With spring water at the time of rainfall |
| | | No knick line | | | Strongly weathered rock | | | The slope is damp |
| Angle of slope | Degree of hazard, great ↕ Degree of hazard, small | Very steep | | | Terrace deposit | | | The slope is dry |
| | | Steep | | | Soft rock | Situation of land use | Degree of hazard, great ↕ Degree of hazard, small | Road |
| | | Ordinary | | | Hard rock | | | Waterway |
| | | Gentle | Relation between a slope and a discontinuous plane | Degree of hazard, great ↕ Degree of hazard, small | Type A | | | Pond or swamp |
| | | Very gentle | | | Type B | | | House |
| Overhang | Degree of hazard, great<br>Degree of hazard, small | With an overhang | | | Type C | | | Farmland |
| | | Without an overhang | | | Type D | | | Mountain forest |
| Height of slope | Degree of hazard, great ↕ Degree of hazard, small | Very high | | Degree of hazard, great ↕ Degree of hazard, small | Type E | Type of vegetation | Degree of hazard, great ↕ Degree of hazard, small | Bare land |
| | | High | Crack in bedrock | | Extremely many cracks | | | Grassland |
| | | Ordinary height | | | Many cracks | | | Bamboo forest |
| | | Low | | | Slightly few cracks | | | Conifers |
| | | Very low | | | Few cracks | | | Broad-leaved trees |
| Shape of slope | Degree of hazard, great ↕ Degree of hazard, small | Convex valley type slope | Thickness of surface soil | Degree of hazard, great ↕ Degree of hazard, small | Very thick | | | Mixture of conifers and broad-leaved trees |
| | | Concave valley type slope | | | Thick | Situation of vegetation | Degree of hazard, great<br>Degree of hazard, small | Slope with stumps |
| | | Straight line valley type slope | | | Ordinary | | | Slope without stumps |
| | | Concave straight line slope | | | Thin | Preventive works | Degree of hazard, great ↕ Degree of hazard, small | With abnormality in the preventive works |
| | | Straight line straight line slope | | | Very thin | | | Without abnormality in the preventive works |
| | | Convex ridge type slope | Fault / shattered zone | Degree of hazard, great ↕ Degree of hazard, small | With a clear fault / shattered zone | Ages of trees of vegetation | Degree of hazard, great ↕ Degree of hazard, small | Less than 10 years |
| | | Convex straight line slope | | | Without a clear fault / shattered zone | | | 10 years - less than 20 years |
| | | Straight line ridge type slope | History of failures of the adjoining slope | Degree of hazard, great ↕ Degree of hazard, small | Lower part of the adjoining slope | | | 20 years - less than 30 years |
| | | Concave ridge type slope | | | Intermediate part of the adjoining slope | | | 30 years - less than 40 years |
| Direction of slope | Degree of hazard, great ↕ Degree of hazard, small | Slope facing south | | | Upper part of the adjoining slope | | | 40 years - less than 50 years |
| | | Slope facing southeast | | | Entire adjoining slope | | | 50 years or more |
| | | Slope facing southwest | | | No failure | | | |
| | | Slope facing west | History of failures of the slope being investigated | Degree of hazard, great ↕ Degree of hazard, small | Failure of the lower part of the slope | | | |
| | | Slope facing east | | | Failure of the intermediate part of the slope | | | |
| | | Slope facing northwest | | | Failure of the upper part of the slope | | | |
| | | Slope facing northeast | | | Failure of the whole slope | | | |
| | | Slope facing north | | | No failure | | | |

2) Structurization

Next, Fig-3 shows structurization, which represents concretely, through discussions by experts, the thinking process whereby an experienced person makes a judgment of the degree of hazard in the light of his/her experiences in the past.

For instance, the group of topographical factor represents the thinking process of the judgment of the degree of hazard by means of a combination of failure factors such as “although the slope is very high, it has no knick line, and its transversal shape is a flat slope, and its gradient is gentle, and so there is little possibility that a failure will occur”.

Also, this structurization places the factor of having a great degree of influence on slope failures at the lowest layer, and it represents that, as factors are rated to an upper layer, their degree of influence becomes smaller. Namely, by taking the group of topographical factor as an example, the thinking process is placed that the height of the slope and the knick line have a greater degree of influence than the transversal shape and gradient.

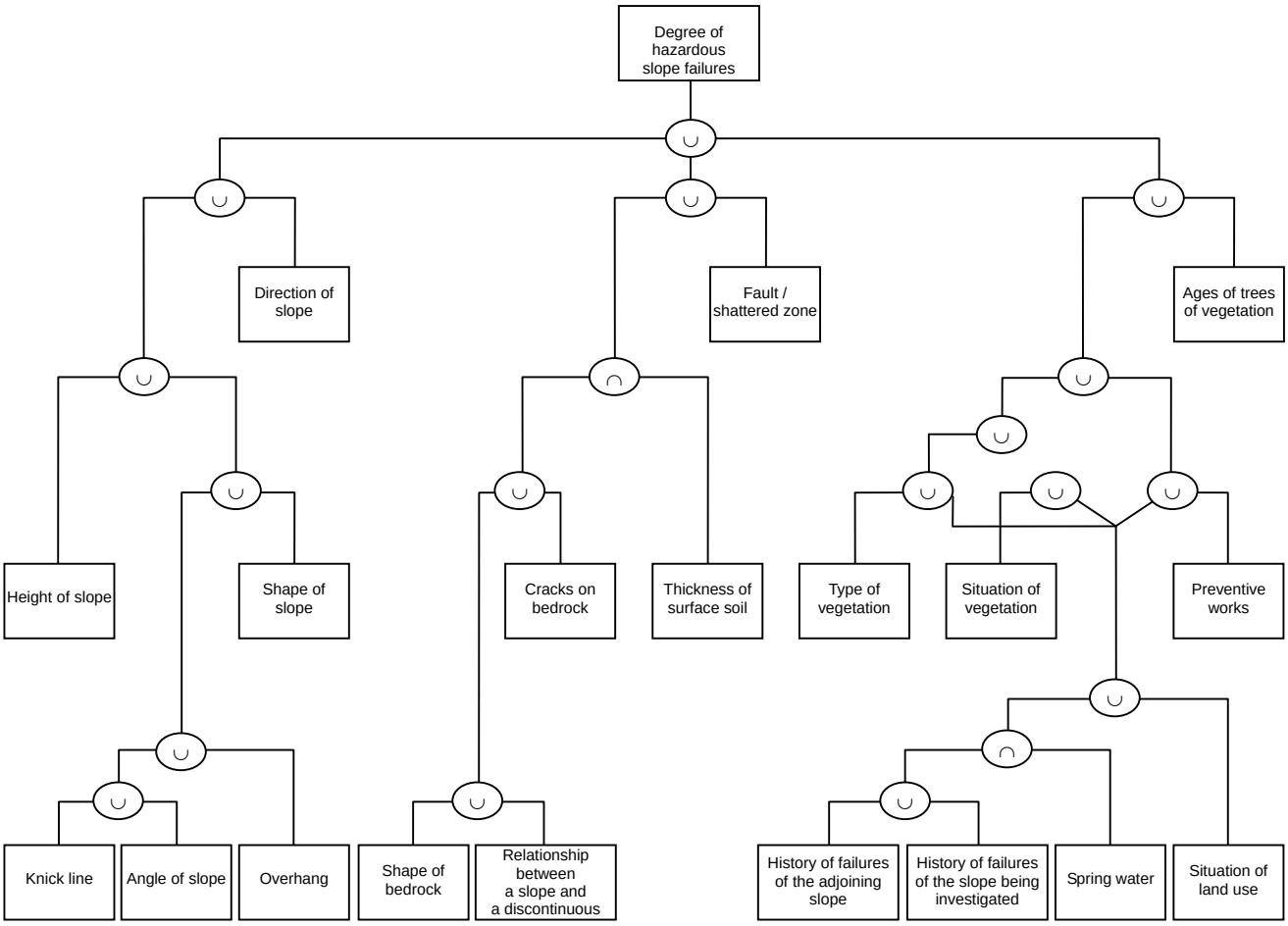



Fig-3 Structurization of slope failures at the time of rainfall

3) Selection of membership functions

The degree of hazardous slope failures by using fuzzy theory can be calculated by inputting the information on slope investigation factors as given in 1) above, into the structurization as given in 2) above, to obtain the final degree of hazard.

This information as the slope investigation factors is ambiguous information based on the subjective judgment of humans (information of which conceptual definition is ambiguous) such as “the height of the slope is very high”, “the knick line is very clear”, or “there is unevenness in the upper part of the slope”, and it is often difficult to demarcate its boundary distinctly. Fuzzy theory employs a membership function in order to process such information with a blurred boundary by computer quantitatively. Namely, a membership function is a function to represent the subjectivity

(ambiguity) of humans.

In the membership function shown in Fig-4, the horizontal axis represents the degree of hazardous slope failures, and as the abscissa approaches 1, the degree of hazard increases. And the vertical axis represents the certainty of the degree of hazard given by the horizontal axis, namely the degree of belonging.

To give examples of a knick line, the ambiguity of the definition of concepts is handled quantitatively by expressing sets by means of a membership function showing that "the knick line is very clear" represents High, having a great degree of hazard, "the knick line is clear" represents Medium, with an intermediate degree of hazard, and "there is no knick line" represents Low, having a small degree of hazard.

Also, when investigating information on a natural slope, it seldom occurs that a certain event is judged to be A or B obviously, and it mostly occurs that such event appears to be A, but somewhat has the properties of B as well, and in that case there will also be a difference more or less according to the person who conducts the investigation. In order to incorporate such ambiguity based on the subjective judgment of humans as well, a membership function provides such overlapping areas.

The range of the degree of hazard and overlapping in a membership function are also recognized through discussions by experts of slope investigation.

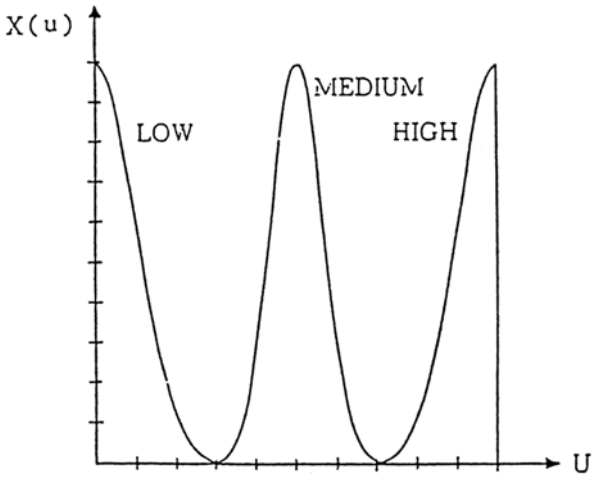



Fig-4 Membership function concerning a knick line

4) Evaluation of the degree of hazardous slope failures

In the procedure of analysis of the evaluation of the degree of hazardous slope failures, an investigator selects applicable language expressions as information on the slope by his/her subjective judgment on the basis of each of the factors shown in Table-2; membership functions representing such expressions are then input into the structurization model shown in Fig-3, and by synthesizing them according to the structurization model, 1 synthesized membership function can be obtained at the top stage as the degree of slope stability at the time of an earthquake (degree of hazard). The membership function shown in Fig-5 represents the final degree of hazard in the said slope. However, if the functions is to be handled as it is, evaluation will be difficult because of its complex form. Therefore, in order to express the degree of hazard as concrete numerical values, a fuzzy distribution function normalized to make the maximum value become 1 has been obtained from the output membership function by using fuzzy integration, and the degree of hazard of the said slope is evaluated by means of the value of its point of intersection with the evaluation function (the value of a fuzzy integral). (Fig-6)

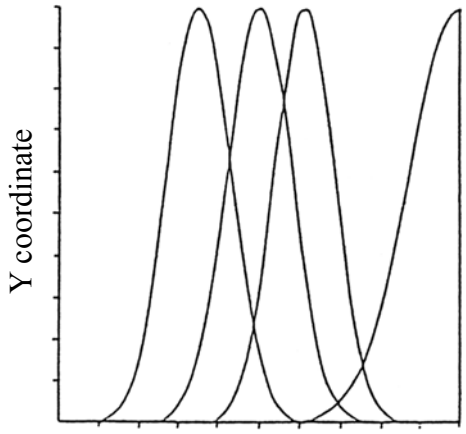



Fig-5 Membership function output at the top stage as the degree of slope stability against failure at the time of an earthquake

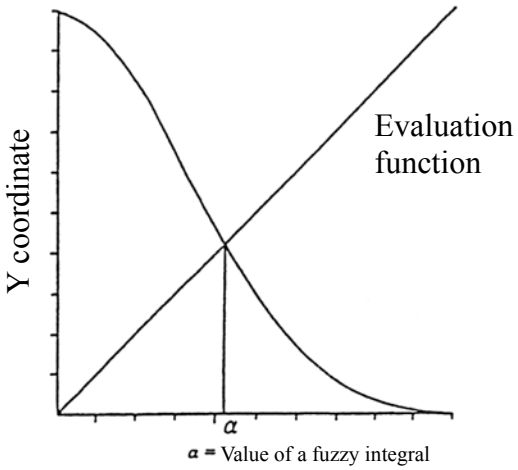



Fig-6 Result of fuzzy integration

Because of the above, the value of a fuzzy integral (degree of hazard) depends on the degree of hazard of a membership function, and as a slope has more language expressions that are close to the great degree of hazard in the membership function, the value of a fuzzy integral increases, and the relative degree of hazard is rated highly.

### 1-4 Characteristics of the evaluation of the degree of hazardous slope failures by using fuzzy theory

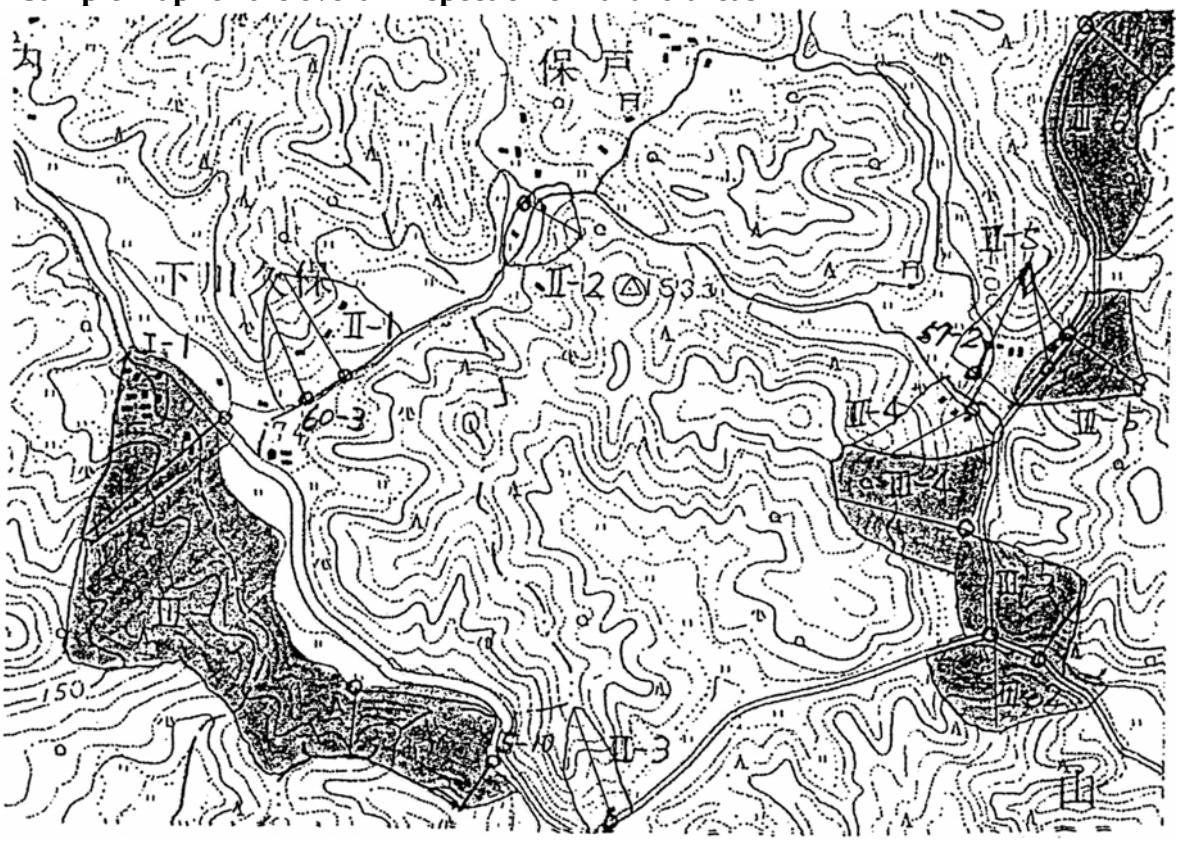
The technique for evaluating the degree of hazardous slope failures by using fuzzy theory are featured by the following.

(i) Humans may make a judgment based on ambiguous information on the basis of subjectivity, such as “the weathering of this slope has advanced considerably” or “this slope failure is considerably quick”, and this technique enables quantitative results (the degree of influence on failures) to be obtained upon inputting such ambiguous information by employing an objective means (fuzzy integration).

(ii) It is an analytical method based on the correlation of factors concerning slope failures and a structural model.

## Attached Sheet - 2

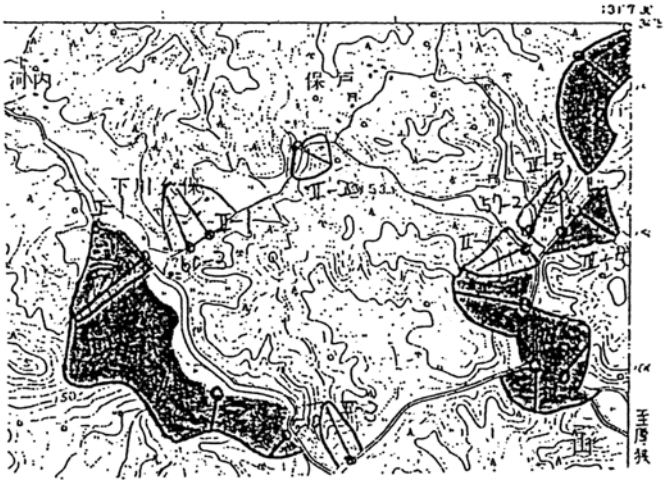
### 1. Sample map for the overall inspection of hazard areas




Sample Map-1 (2/25000)
(If there are 3.5 contour lines within the depth of 4 mm on the map (50 m), the gradient exceeds 30 degrees.)

1. Hazard Area (I): Orange (marker), frame of a black solid line (ball-point pen)
2. Hazard Area (II): Yellow; same as above
3. Quasi-hazard Slope (III): Blue; same as above
4. Slope to be investigated (the most dangerous cross-section) and latitude/longitude: Blue straight line and a small, red circle.
5. Cross-section of the past failure (actual situation of the slope failure disaster) and latitude/longitude: Red straight line and a small, red circle.

30 seconds to the black line




30 seconds to the blue line

2 mm on the map, equivalent to latitude 1.93 seconds
longitude 1.62 seconds

Sample Map-2 (1/25000)
(If there are 3.5 contour lines within the depth of 2 mm on the map (50 m), the gradient exceeds 30 degrees.)

# Procedure of Data Entry

November, 1999

Slope Conservation Division, Sediment Control Department, Ministry of Construction

# Procedure for Preparing Data on Steep Slope Failure Hazard Areas

[Procedure for Preparing Data on Steep Slope Failure Hazard Areas]

This procedure is to describe the coding method when preparing magnetic tape for an input into computers of data on the investigational slip of steep slope failure hazard areas.

(Contents)

1. Item of entry and position of entry
2. Explanation of the item of entry

(Precautions)

1. For 1 hazard area, 1 record (167 bytes) shall be prepared.
2. An entry shall be made in a designated format, based on an investigational slip.
3. Since the accuracy of data is required, they shall be checked against the investigational slip after completion of coding.

## Steep Slope Failure Hazard Area (I), (II)

| | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 1. Prefectural code | 1 - 2 | | Prefectural code of 2 digits (according to JIS standard) shall be entered | |
| 2. Municipal code | 3 - 5 | | Municipal code of 3 digits (according to JIS standard) shall be entered | |
| 3. Classification of slope | 6 | | Natural slope - 1<br>Artificial slope - 2 | |
| 4. Area number | 7 - 10 | Area number | Area number of 4 digits shall be entered (right-aligned) | |
| 5. Whether there has been a slope failure disaster or not | 11 | | Existent -1<br>Nonexistent - 2 | |
| 6 Area number of slope failure disaster investigation | 12 - 21 | | Fiscal year and number shall be entered (in the case of No. 3 in S60 [60th year of the Showa era: 1985]: 60003, right-aligned) | |
| 7. Latitude of a slope failure disaster area | 22 - 33 | | | |
| 8. Longitude of a slope failure disaster area | 34 - 47 | | | |
| 9. Latitude of a hazard area | 48 - 53 | | | |
| 10. Longitude of a hazard area | 54 - 60 | | | |
| 11. Length of the steep slope failure hazard area | 61 - 64 | Length (m) | Length shall be entered as a whole number (unit: m, right-aligned) | |
| 12. Angle of slope | 65 - 66 | Angle of slope (°) | Angle of slope shall be entered as a whole number (unit: °, right-aligned) | |
| 13. Height of slope | 67 - 69 | Height of slope (m) | Height of slope shall be entered as a whole number (unit: m, right-aligned) | |
| 14. Direction of slope | 70 | Direction of slope | Slope facing east - 1<br>Slope facing southeast - 2<br>Slope facing south - 3<br>Slope facing southwest - 4<br>Slope facing west - 5<br>Slope facing northwest - 6<br>Slope facing north - 7<br>Slope facing northeast - 8 | |
| 15. Shape of slope | 71 | Shape of slope | Convex ridge type slope - 1<br>Straight line ridge type slope - 2<br>Concave ridge type slope - 3<br>Convex straight line slope - 4<br>Straight line straight line slope - 5<br>Concave straight line slope - 6<br>Convex valley type slope - 7<br>Straight line valley type slope - 8<br>Concave valley type slope - 9 | |
| 16. Direction of the upper level topography | 72 | Direction of the upper level topography | Slope facing east - 1<br>Slope facing southeast - 2<br>Slope facing south - 3<br>Slope facing southwest - 4<br>Slope facing west - 5<br>Slope facing northwest - 6<br>Slope facing north - 7<br>Slope facing northeast - 8<br>Others - 9 | |
| 17. Transversal shape | 73 | Transversal shape of slope | Having an overhang - 1<br>Having unevenness in the upper part of the slope - 2<br>Having unevenness in the upper part of the slope - 3<br>Having unevenness in the upper part of the slope - 4<br>It is a smooth slope - 5 | |
| 18. Knick line | 74 | Knick line | Very clear knick line - 1<br>Clear knick line - 2<br>Unclear knick line - 3 | |
| 19. Position of the knick line | 75 | Position of the knick line | Upper part - 1<br>Intermediate part - 2<br>Lower part - 3<br>Not applicable - 4 | |

| Item | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 20. Situation of the ground surface | 76 | Situation of the ground surface | Cracks have developed with openings, and boulders and loose rock stud there - 1<br>Consisting of rock that has been weathered and with developed cracks - 2<br>Soil mixed with pebbles, sandy soil - 3<br>Clayey soil - 4<br>Consisting of rock that is unweathered and with undeveloped cracks - 5 | |
| 21. Thickness of the surface soil | 77 - 79 | Thickness of the surface soil | Thickness of the surface soil shall be entered as a whole number (unit: cm, right-aligned) | |
| 22. Situation of the bedrock | 80 | Situation of the bedrock | Collapsed soil - 1<br>Volcanic detritus - 2<br>Strongly weathered rock - 3<br>Terrace deposit - 4<br>Soft rock - 5<br>Hard rock - 6 | |
| 23. Cracks on the bedrock slope | 81 | Space between cracks | The space between cracks is 10 cm or less<br>10 cm - 30 cm - 1<br>30 cm - 50 cm - 2<br>50 cm or more - 3 | |
| | 82 | Scale of open cracks | Open crack<br>Large - 1<br>Small - 2<br>None - 3 | |
| 24. Relationship between a slope and a discontinuous plane | 83 | Relationship between a slope and a discontinuous plane | Type A - 1<br>Type B - 2<br>Type C - 3<br>Type D - 4<br>Type E - 5<br>Type F - 6<br>Type G - 7 | |
| 25. Fault / shattered zone | 84 | Whether there is any fault / shattered zone | Clear fault / shattered zone - existent - 1<br>Clear fault / shattered zone - nonexistent - 2 | |
| 26. Situation of the weathering of slopes | 85 | Situation of weathering | Rock is very hard and has not weathered at all - 1<br>Rock is very hard and unweathered - 2<br>Rock has slightly been altered by weathering - 3<br>Partially changed to clay due to weathering actions - 4<br>Totally weathered and have turned into soil - 5 | |
| 27. Type of vegetation | 86 | Type of vegetation | No vegetation (bare land) - 1<br>Grassland - 2<br>Bamboo forest - 3<br>Conifers - 4<br>Broad-leaved trees - 5<br>Mixture of conifers and broad-leaved trees - 6 | |
| 28. Ages of trees | 87 | Ages of trees | Less than 10 years - 1<br>10 - 20 years - 2<br>20 - 30 years - 3<br>30 - 40 years - 4<br>40 - 50 years - 5<br>50 years or more - 6 | |
| 29. Situation of stumps | 88 | Situation of stumps | Slope with stumps - 1<br>Slope without stumps - 2 | |
| 30. The slope being investigated | 89 | History of failures within the slope being investigated | With an old failure area - 1<br>With a new failure area - 2<br>No failure area can be recognized - 3 | |
| | 90 | Position of an occurrence of failure within the slope being investigated | Failure of the lower part of the slope - 1<br>Failure of the intermediate part of the slope - 2<br>Failure of the upper part of the slope - 3<br>Failure of the whole slope - 4<br>No failure - 5 | |

| Item | Column | Item of entry | | Procedure of entry | Remarks |
|---|---|---|---|---|---|
| 31. Adjoining slope | 91 | History of failures within the adjoining slope | | With an old failure area - 1<br>With a new failure area - 2<br>No failure area can be recognized - 3 | |
| | 92 | Position of an occurrence of failure within the slope being investigated | | Failure of the lower part of the slope - 1<br>Failure of the intermediate part of the slope - 2<br>Failure of the upper part of the slope - 3<br>Failure of the whole slope - 4<br>No failure - 5 | |
| 32. Spring water | 93 | Whether there is any spring water | | Existent - 1<br>Nonexistent - 2 | |
| | 94 | Situation of the spring water | | Always with spring water - 1<br>With spring water at the time of rainfall - 2<br>The slope is always damp - 3<br>The slope is dry - 4 | |
| 33. Preventive works | 95 | Whether there is any abnormality in the preventive works | | With abnormality in the preventive works - 1<br>Without abnormality in the preventive works - 2 | |
| 34. Situation of the upper part of the preventive works | 96 | Situation of the upper part of the preventive works | | With a slope that has been left as it is after a length of 10 m or more has been excavated - 1<br>With a slope that has been left as it is after a length of 5 m or more has been excavated - 2<br>With a slope that has been left as it is after a length of less than 5 m has been excavated - 3<br>Without any slope that has been left as it is after excavation - 4 | |
| 35. Situation of land use in the upper part of the slope | 97 | Situation of land use in the upper part of the slope (ridge type) | | Ridge type<br>Road - 1<br>Waterway - 2<br>Pond or swamp - 3<br>House - 4<br>Farmland - 5<br>Mountain forest - 6<br>Others - 7 | The column of unapplicable classification shall be left blank. |
| | 98 | Situation of land use in the upper part of the slope (plateau type) | | Plateau type<br>Road - 1<br>Waterway - 2<br>Pond or swamp - 3<br>House - 4<br>Farmland - 5<br>Mountain forest - 6<br>Others - 7 | |
| 36. Population of municipality | 99 | Population of municipality | | Government ordinance designated city - 1<br>City of which population is 300,000 or more (exclusive of government ordinance designated city) - 2<br>City of which population is 200,000 or more and less than 300,000 - 3<br>City of which population is 100,000 or more and less than 200,000 - 4<br>City of which population is less than 100,000 - 5<br>Town - 6<br>Village - 7 | |
| 37. Number of houses | 100 - 102 | Number of houses | | Number of houses shall be entered (unit: house, right-aligned) | The column of unapplicable classification shall be left blank.<br>The "number of houses" shall mean the number of houses excluding the number of facilities related to people vulnerable to disasters.<br>The "converted number of houses" shall mean the converted number of houses including the number of facilities related to people vulnerable to disasters. |
| | 103 - 105 | Converted number of houses | | Aforesaid number + number of facilities related to people vulnerable to disasters (maximum number of people / 3) (unit: house, right-aligned) | |
| 38. The number of houses within 10 m of a steep slope | 106 - 107 | Situation of the upper part of the slope | Wooden | Number of houses shall be entered (unit: house, right-aligned) | |
| | 108 - 109 | | | Converted number of houses (unit: house, right-aligned) | |
| | 110 - 111 | | Non-wooden | Number of houses shall be entered (unit: house, right-aligned) | |
| | 112 - 113 | | | Converted number of houses (unit: house, right-aligned) | |
| | 114 - 115 | Situation of the lower part of the slope | Wooden | Number of houses (unit: house, right-aligned) | |
| | 116 - 117 | | | Converted number of houses (unit: house, right-aligned) | |
| | 118 - 119 | | Non-wooden | Number of houses (unit: house, right-aligned) | |
| | 120 - 121 | | | Converted number of houses (unit: house, right-aligned) | |

| Item | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 39. Buildings of a public nature | 122 | Classification A | The number of buildings shall be entered in the column of each applicable classification. (right-aligned) (If the number is 10 or more, it shall be substituted by an alphabetical letter, like: A=10, B=11, C=12, ……)<br><br>Classification A: Police stations, police boxes<br>Classification B: Fire departments<br>Classification C: Prefectural government offices, and municipal offices<br>Classification D: Government and municipal agencies such as post offices<br>Classification E: Schools<br>Classification F: Kindergartens<br>Classification G: Children's welfare facilities<br>Classification H: Medical facilities<br>Classification I: Community centers<br>Classification J: Lodging houses<br>Classification K: Railroad stations<br>Classification L: Power stations, substations<br>Classification M: Water purification facilities<br>Classification N: Welfare facilities for the aged<br>Classification O: Facilities for rehabilitation and aid for the handicapped<br>Classification P: Facilities for aid for the mentally handicapped<br>Classification Q: Others | The column of unapplicable classification shall be left blank. |
| | 123 | Classification B | | |
| | 124 | Classification C | | |
| | 125 | Classification D | | |
| | 126 | Classification E | | |
| | 127 | Classification F | | |
| | 128 | Classification G | | |
| | 129 | Classification H | | |
| | 130 | Classification I | | |
| | 131 | Classification J | | |
| | 132 | Classification K | | |
| | 133 | Classification L | | |
| | 134 | Classification M | | |
| | 135 | Classification N | | |
| | 136 | Classification O | | |
| | 137 | Classification P | | |
| | 138 | Classification Q | | |
| 40. Description in the regional disaster prevention plan | 139 | Whether there is any description in the regional disaster prevention plan | Existent - 1<br>Nonexistent - 2 | |
| 41. Related evacuation area | 140 | Whether there is any related evacuation area | Existent - 1<br>Nonexistent - 2 | |
| 42. Related evacuation route | 141 | Whether there is any related evacuation route | Existent - 1<br>Nonexistent - 2 | |
| 43. Public facilities | 142 - 145 | JR | The number of facilities shall be entered in the column of each applicable classification. (For Bridge and Others, B, the number shall be entered, and for others the length (m) shall be entered; right-aligned)<br>Others, A: Other public facilities represented by the length (m)<br>Others, B: Other public facilities represented by the number | The column of unapplicable classification shall be left blank. |
| | 146 - 149 | Private railroad | | |
| | 150 - 153 | Highway / national road | | |
| | 154 - 157 | Prefectural road | | |
| | 158 - 161 | Municipal road | | |
| | 162 - 165 | Other roads | | |
| | 166 - 169 | River | | |
| | 170 | Bridge | | |
| | 171 - 174 | Others, A | | |
| | 175 | Others, B | | |
| 44. Designation of areas for other projects | 176 | Sabo designated area | The following number shall be entered in the column of the designation of areas<br>• Sabo designated area<br>Sabo (Entire) - 1<br>Sabo (Partial) - 2<br>• Landslide prevention area<br>Land (Entire) - 1<br>Land (Partial) - 2<br>• Dump failure prevention area<br>Dump (Entire) - 1<br>Dump (Partial) - 2<br>• Protection forest<br>Protection (Entire) - 1<br>Protection (Partial) - 2<br>• Protection facility district<br>Protection Facility (Entire) - 1<br>Protection Facility (Partial) - 2 | |
| | 177 | Landslide prevention area | | |
| | 178 | Dump failure prevention area | | |
| | 179 | Protection forest | | |
| | 180 | Protection facility district | | |

| Item | Column | Item of entry | | Procedure of entry | Remarks |
|---|---|---|---|---|---|
| 45. Designation of a steep slope failure hazard area | 181 - 182 | Steep slope failure hazard area | Year | No designation - blank<br>With designation - If there is designation, enter the date<br>Year - to be entered as the year of Showa or Heisei of the Japanese era<br>Month - to be right-aligned in the case of 1 digit<br>Day - to be right-aligned in the case of 1 digit | |
| | 183 - 184 | | Month | | |
| | 185 - 186 | | Day | | |
| | 187 - 188 | Disaster hazard area | Year | | |
| | 189 - 190 | | Month | | |
| | 191 - 192 | | Day | | |
| 46. Whether or not an investigation was conducted last time | 193 | Whether or not an investigation was conducted last time | | Investigation conducted last time - nonexistent - 0<br>Investigation conducted last time - existent<br>Rank A - 1<br>Rank B - 2<br>Rank C - 3 | |
| 47. Areas requiring construction work | 194 | Nation | | Not required - 0<br>Required - 1 | 'Nation' and 'Independent' may overlap each other. |
| | 195 | Independent | | | |
| | 196 | Others | | | |
| 48. Situation of construction work | 197 | Nation | Situation | If an area requiring construction work has been designated as 'Nation' or 'Independent' (including the overlapping of 'Nation' and 'Independent'), the situation of construction work and the fiscal year (the fiscal year of the start of work or the fiscal year of having roughly been completed) shall be entered in each of the applicable columns.<br>Situation of construction work<br>Not started yet: Not Yet - 0<br>Under construction: Under Construction - 1<br>Roughly completed: Roughly - 2<br>Fiscal year<br>Not started yet<br>- Blank<br>Under construction<br>- Fiscal year of the start of work (Showa)<br>Roughly completed<br>- Fiscal year of having been roughly completed (Showa) | |
| | 198 - 199 | | Fiscal year | | |
| | 200 | Independent | Situation | | |
| | 201 - 202 | | Fiscal year | | |
| 49. Situation of construction work of other projects | 203 | Sabo | | Enter the applicable situation of construction work.<br>Not started yet: Not Yet - 0<br>Under construction: Under Construction - 1<br>Roughly completed: Roughly - 2 | It shall be entered when 'Others' was selected in 47. Areas requiring construction work. (Not to be entered when 'Nation' or 'Independent' was selected.) |
| | 204 | Landslide | | | |
| | 205 | Protection forest | | | |
| | 206 | Others | | | |
| 50. Raing of the degree of hazard (Rainfall) | 207 | Degree of hazard resulting from rainfall | | Rank A - A<br>Rank B - B<br>Rank C - C | Entry not required in this investigation. |
| 51. Raing of the degree of hazard (Earthquake) | 208 | Degree of hazard resulting from an earthquake | | Rank A - A<br>Rank B - B<br>Rank C - C | Entry not required in this investigation. |

* In 47. Areas requiring construction work and 48. Situation of construction work, (Nation) shall be selected in the case of complying with the Standards for the Adoption of Public Works.

| Item | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 52. Those related to special legislation, and others | 209 | Heavy snowfall area | The following number shall be entered in the column of the designation of areas, and if not applicable, leave it blank.<br>• Heavy snowfall area<br>Heavy snowfall area — Heavy - 1<br>Specially heavy snowfall area — Special - 2<br>• Earthquake disaster prevention area with strengthened measures<br>Applicable - 1<br>Not applicable - 0<br>• Peninsula advancement district / isolated island advancement district<br>Peninsula advancement district — Peninsula - 1<br>Isolated island advancement district — Isolated - 2<br>• Typhoon prone area<br>Applicable - 0<br>Not applicable - 1<br>• Special soil area<br>Shirasu are — Shirasu - 1<br>Others — Others - 2<br>• Underpopulated area / technopolis area<br>Applicable - 0<br>Not applicable - 1<br>• Resort area<br>Specified area — Resort - 1<br>Prioritized improvement district — Prioritized - 2<br>• Restricted residential land development area / DID district<br>Applicable - 0<br>Not applicable - 1<br>• City planning area<br>Area designated for urbanization — City - 1<br>Controlled urbanization area — Controlled - 2<br>Undemarcated area — Undemarcated -3 | |
| | 210 | Earthquake disaster prevention area with strengthened measures | | |
| | 211 | Peninsula advancement district / isolated island advancement district | | |
| | 212 | Typhoon prone area | | |
| | 213 | Special soil area | | |
| | 214 | Underpopulated area | | |
| | 215 | Technopolis area | | |
| | 216 | Resort area | | |
| | 217 | Restricted residential land development area | | |
| | 218 | DID district | | |
| | 219 | City planning area | | |
| 53. Designation of areas subject to environmental measures | 220 | National park | The following number shall be entered in the column of the designation of areas, and if not applicable, leave it blank.<br>• National park, quasi-national park, prefectural natural park<br>Within a special area — Special - 1<br>Area other than the foregoing — Ordinary - 2<br>• Scenic district<br>No designation of areas - 0<br>With designation of areas - 1<br>• Green space conservation district and suburban green space conservation district<br>Suburban green space district — Suburban - 1<br>Green space conservation district — Green - 2<br>• Historical landscape preservation area<br>Within the historical landscape preservation area — Historical - 0<br>Within Special preservation district — Special - 1 | National park, Quasi-national park, Prefectural natural park<br>… Natural Park Law<br>Scenic district<br>… City Planning Law<br>Green space conservation district<br>… Law for the Conservation of Urban Green Space<br>Suburban green space conservation district<br>… Law for the Conservation of Suburban Green Space in the Metropolitan Area<br>Historical landscape preservation zone<br>… Law for Special Measures Concerning the Preservation of Historical Landscape in Ancient Capitals |
| | 221 | Quasi-national park | | |
| | 222 | Prefectural natural park | | |
| | 223 | Scenic district | | |
| | 224 | Green space conservation district and suburban green space conservation district | | |
| | 225 | Historical landscape preservation area | | |

## Slope of a Quasi Steep Slope Failure Hazard Area (III)

| | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 1. Prefectural code | 1 - 2 | | Prefectural code of 2 digits (according to JIS standard) shall be entered | |
| 2. Municipal code | 3 - 5 | | Municipal code of 3 digits (according to JIS standard) shall be entered | |
| 3. Classification of slope | 6 | | Natural slope - 1<br>Artificial slope - 2 | |
| 4. Area number | 7 - 10 | Area number | Area number of 4 digits shall be entered (right-aligned) | |
| 5. Whether there has been a slope failure disaster or not | 11 | | Existent -1<br>Nonexistent - 2 | |
| 6 Area number of slope failure disaster investigation | 12 - 21 | | Fiscal year and number shall be entered (in the case of No. 3 in S60 [60th year of the Showa era: 1985]: 60003, right-aligned) | |
| 7. Latitude of a slope failure disaster area | 22 - 33 | | | |
| 8. Longitude of a slope failure disaster area | 34 - 47 | | | |
| 9. Latitude of the quasi-hazard slope | 48 - 53 | | | |
| 10. Longitude of the quasi-hazard slope | 54 - 60 | | | |
| 11. Length of the quasi-hazard slope | 61 - 64 | Length (m) | Length shall be entered as a whole number (unit: m, right-aligned) | |
| 12. Angle of slope | 65 - 66 | Angle of slope (°) | Angle of slope shall be entered as a whole number (unit: °, right-aligned) | |
| 13. Height of slope | 67 - 69 | Height of slope (m) | Height of slope shall be entered as a whole number (unit: m, right-aligned) | |
| 14. Knick line | 70 | Knick line | Very clear knick line - 1<br>Clear knick line - 2<br>Unclear knick line - 3 | |
| 15. Position of the knick line | 71 | Situation of the knick line | Upper part - 1<br>Intermediate part - 2<br>Lower part - 3<br>Not applicable - 4 | |
| 16. Situation of the bedrock | 72 | Situation of the bedrock | Collapsed soil - 1<br>Volcanic detritus - 2<br>Strongly weathered rock - 3<br>Terrace deposit - 4<br>Soft rock - 5<br>Hard rock - 6 | |
| 17. Fault / shattered zone | 73 | Whether there is any fault / shattered zone | Fault / shattered zone - existent - 1<br>Fault / shattered zone - nonexistent - 2 | |
| 18. Type of vegetation | 74 | Type of vegetation | No vegetation (bare land) - 1<br>Grassland - 2<br>Bamboo forest - 3<br>Conifers - 4<br>Broad-leaved trees - 5<br>Mixture of conifers and broad-leaved trees - 6 | |
| 19. Situation of land use in the upper part of the slope | 75 | Situation of land use in the upper part of the slope (ridge type) | Ridge type<br>Road - 1<br>Waterway - 2<br>Pond or swamp - 3<br>House - 4<br>Farmland - 5<br>Mountain forest - 6<br>Others - 7 | |
| | 76 | Situation of land use in the upper part of the slope (plateau type) | Plateau type<br>Road - 1<br>Waterway - 2<br>Pond or swamp - 3<br>House - 4<br>Farmland - 5<br>Mountain forest - 6<br>Others - 7 | |

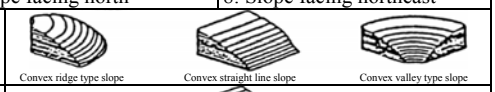
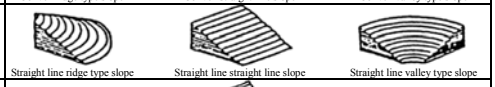
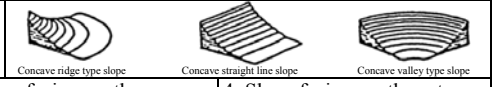
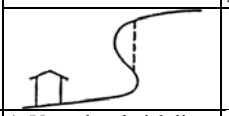
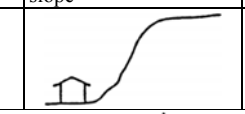
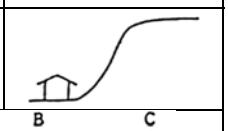
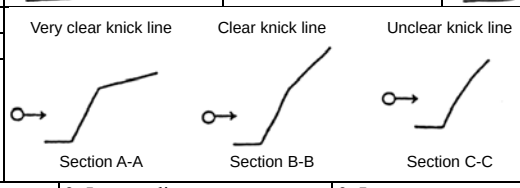
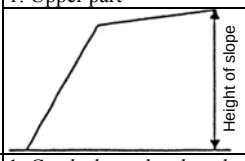
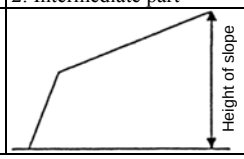
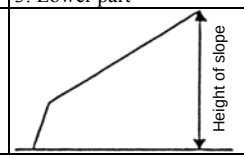
| Item | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 20. Population of municipality | 77 | Population of municipality | Government ordinance designated city - 1<br>City of which population is 300,000 or more (exclusive of government ordinance designated city) - 2<br>City of which population is 200,000 or more and less than 300,000 - 3<br>City of which population is 100,000 or more and less than 200,000 - 4<br>City of which population is less than 100,000 - 5<br>Town - 6<br>Village - 7 | |
| 21. Public facilities | 78 - 81 | Japan Railway | The number of facilities shall be entered in the column of each applicable classification. (For Bridge and Others, B, the number shall be entered, and for others the length (m) shall be entered; right-aligned)<br>Others, A: Other public facilities represented by the length (m)<br>Others, B: Other public facilities represented by the number | The column of unapplicable classification shall be left blank. |
| | 82 - 85 | Private railroad | | |
| | 86 - 89 | Freeway | | |
| | 90 - 93 | Prefectural road | | |
| | 94 - 97 | Municipal road | | |
| | 98 - 101 | Other roads | | |
| | 102 - 105 | River | | |
| | 106 | Bridge | | |
| | 107 - 110 | Others, A | | |
| | 111 | Others, B | | |
| 22. Designation of areas for other projects | 112 | Sabo designated area | The following number shall be entered in the column of the designation of areas<br>• Sabo designated area<br>Sabo (Entire) - 1<br>Sabo (Partial) - 2<br>• Landslide prevention area<br>Land (Entire) - 1<br>Land (Partial) - 2<br>• Dump failure prevention area<br>Dump (Entire) - 1<br>Dump (Partial) - 2<br>• Protection forest<br>Protection (Entire) - 1<br>Protection (Partial) - 2<br>• Protection facility district<br>Protection Facility (Entire) - 1<br>Protection Facility (Partial) - 2 | |
| | 113 | Landslide prevention area | | |
| | 114 | Dump failure prevention area | | |
| | 115 | Protection forest | | |
| | 116 | Protection facility district | | |

| Item | Column | Item of entry | Procedure of entry | Remarks |
|---|---|---|---|---|
| 23. Those related to special legislation, and others | 117 | Heavy snowfall area | The following number shall be entered in the column of the designation of areas, and if not applicable, leave it blank.<br>• Heavy snowfall area<br>Heavy snowfall area — Heavy - 1<br>Specially heavy snowfall area — Special - 2<br>• Earthquake disaster prevention area with strengthened measures<br>Applicable — - 1<br>Not applicable — - 0<br>• Peninsula advancement district / isolated island advancement district<br>Peninsula advancement district — Peninsula - 1<br>Isolated island advancement district — Isolated - 2<br>• Typhoon prone area<br>Applicable — - 0<br>Not applicable — - 1<br>• Special soil area<br>Shirasu are — Shirasu - 1<br>Others — Others - 2<br>• Underpopulated area / technopolis area<br>Applicable — - 0<br>Not applicable — - 1<br>• Resort area<br>Specified area — Resort - 1<br>Prioritized improvement district — Prioritized - 2<br>• Restricted residential land development area / DID district<br>Applicable — - 0<br>Not applicable — - 1<br>• City planning area<br>Area designated for urbanization — City - 1<br>Controlled urbanization area — Controlled - 2<br>Undemarcated area — Undemarcated -3 | |
| | 118 | Earthquake disaster prevention area with strengthened measures | | |
| | 119 | Peninsula advancement district / isolated island advancement district | | |
| | 120 | Typhoon prone area | | |
| | 121 | Special soil area | | |
| | 122 | Underpopulated area | | |
| | 123 | Technopolis area | | |
| | 124 | Resort area | | |
| | 125 | Restricted residential land development area | | |
| | 126 | DID district | | |
| | 127 | City planning area | | |
| 24. Designation of areas subject to environmental measures | 128 | National park | The following number shall be entered in the column of the designation of areas, and if not applicable, leave it blank.<br>• National park, quasi-national park, prefectural natural park<br>Within a special area — Special - 1<br>Area other than the foregoing — Ordinary - 2<br>• Scenic district<br>No designation of areas — - 0<br>With designation of areas — - 1<br>• Green space conservation district and suburban green space conservation district<br>Suburban green space district — Suburban - 1<br>Green space conservation district — Green - 2<br>• Historical landscape preservation area<br>Within the historical landscape preservation zone — Historical - 0<br>Within Special preservation district — Special - 1 | National park, Quasi-national park, Prefectural natural park<br>… Natural Park Law<br>Scenic district<br>… City Planning Law<br>Green space conservation district<br>… Law for the Conservation of Urban Green Space<br>Suburban green space conservation district<br>… Law for the Conservation of Suburban Green Space in the Metropolitan Area<br>Historical landscape preservation area<br>… Law for Special Measures Concerning the Preservation of Historical Landscape in Ancient Capitals |
| | 129 | Quasi-national park | | |
| | 130 | Prefectural natural park | | |
| | 131 | Scenic district | | |
| | 132 | Green space conservation district and suburban green space conservation district | | |
| | 133 | Historical landscape preservation area | | |

Table of site investigation for steep slope failure hazard areas (1/2)

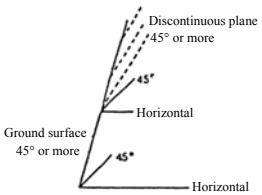
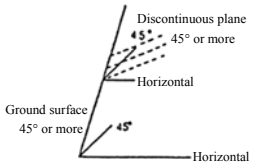
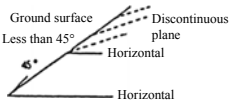
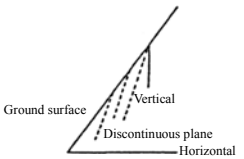
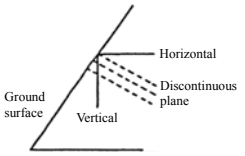
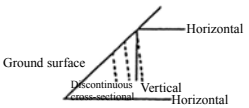
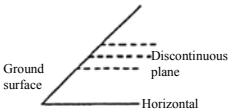
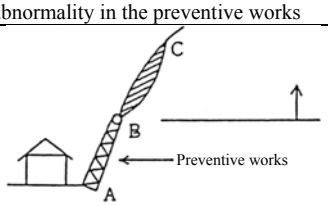
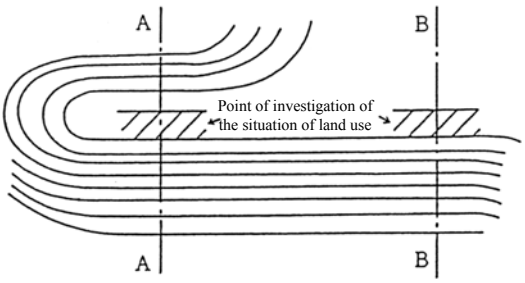
_____ Prefecture

(Steep Slope Failure Hazard Area (I), Steep Slope Failure Hazard Area (II))

| | | | | | | |
|---|---|---|---|---|---|---|
| Area number | | Classification of slope | Natural slope / artificial slope | Area name | | |
| Position | County / city | Town / village | Section of village | Subsection of village | | |
| Area number of the investigation of a slope failure disaster | | | | | | |
| Latitude and longitude of the steep slope failure hazard area, etc. | | | Latitude | Longitude | | |
| Length of the steep slope failure hazard area | | m | | | | |
| Topographical factor | Angle of slope | ° | | | | |
| | Height of slope | m | | | | |
| | Direction of slope | 1: Slope facing east | 2: Slope facing southeast | 3: Slope facing south | 4: Slope facing southwest | |
| | | 5: Slope facing west | 6: Slope facing northwest | 7: Slope facing north | 8: Slope facing northeast | |
| | Shape of slope | 1: Convex ridge type slope | 4: Convex straight line slope | 7: Convex valley type slope |   | |
| | | 2: Straight line ridge type slope | 5: Straight line straight line slope | 8: Straight line valley type slope |   | |
| | | 3: Concave ridge type slope | 6: Concave straight line slope | 9: Concave valley type slope |   | |
| | Direction of the upper level topography | 1: Slope facing east | 2: Slope facing southeast | 3: Slope facing south | 4: Slope facing southwest | |
| | | 5: Slope facing west | 6: Slope facing northwest | 7: Slope facing north | 8: Slope facing northeast | |
| | | 9: Others | | | | |
| | Transversal shape | 1: Having an overhang | 2: Having unevenness in the upper part of the slope | 3: Having unevenness in the whole slope | 4: Having unevenness in the lower part of the slope | 5: It is a smooth slope |
| | |  |  |  |  |  |
| | Knick line | 1: Very clear knick line |   | | | |
| | | 2: Clear knick line | | | | |
| | | 3: Unclear knick line | | | | |
| | Position of the knick line | 1: Upper part | 2: Intermediate part | 3: Lower part | 4: Not applicable | |
| | |   |   |   | | |
| Geological / soil factors | Situation of the ground surface | 1: Cracks have developed with openings, and boulders and loose rock stud there | | | | |
| | | 2: Consisting of rock that has been weathered and with developed cracks | | | | |
| | | 3: Soil mixed with pebbles, sandy soil | | | | |
| | | 4: Clayey soil | | | | |
| | | 5: Consisting of rock that is unweathered and with undeveloped cracks | | | | |
| | Thickness of the surface soil | cm | | | | |
| | Situation of the bedrock | 1: Collapsed soil | 2: Volcanic detritus | 3: Strongly weathered rock | 4: Soft rock | 5: Hard rock |
| | Cracks on the bedrock slope | 1: The space between cracks is 10 cm or less | 2: The space between cracks is 10 cm - 30 cm | 3: The space between cracks is 30 cm - 50 cm | 4: The space between cracks is 50 cm or more | |
| | Scale of open cracks | 1: Large 2: Small 3: None | | | | |

# Table of site investigation for steep slope failure hazard areas (2/2)

_____ Prefecture

<table>
<tr><td rowspan="10">Geological / soil factors</td><td rowspan="2">Relationship of gradient between a slope and a discontinuous plane</td><td>1: Type A</td><td>2: Type B</td><td>3: Type C</td><td>4: Type D</td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td><td> 
</td></tr>
<tr><td>5: Type E</td><td>6: Type F</td><td>7: Type G</td><td></td></tr>
<tr><td> 
</td><td> 
</td><td> 
</td><td></td></tr>
<tr><td>Fault / shattered zone</td><td colspan="2">1: Clear fault / shattered zone - existent</td><td colspan="2">2: Clear fault / shattered zone - nonexistent</td></tr>
<tr><td rowspan="5">Situation of weathering</td><td colspan="4">1: Rock is very hard and has not weathered at all</td></tr>
<tr><td colspan="4">2: Rock is very hard and unweathered</td></tr>
<tr><td colspan="4">3: Rock has slightly been altered by weathering</td></tr>
<tr><td colspan="4">4: Partially changed to clay due to weathering actions</td></tr>
<tr><td colspan="4">5: Totally weathered and have turned into soil</td></tr>
<tr><td rowspan="11">Environmental factor</td><td>Type of vegetation</td><td>1: No vegetation (bare land)</td><td>2: Grassland</td><td>3: Bamboo forest</td><td>4: Conifers</td><td>5: Broad-leaved trees</td><td>6: Mixture of conifers and broad-leaved trees</td></tr>
<tr><td>Age of trees</td><td>1: Less than 10 years</td><td>2: 10 - 20 years</td><td>3: 20 - 30 years</td><td>4: 30 - 40 years</td><td>5: 40 - 50 years</td><td>6: 50 years or more</td></tr>
<tr><td>Situation of stumps</td><td colspan="3">1: Slope with stumps</td><td colspan="3">2: Slope without stumps</td></tr>
<tr><td rowspan="2">The slope being investigated</td><td>The history of failures</td><td colspan="2">1: With an old failure area</td><td colspan="2">2: With a new failure area</td><td>3: No failure area can be recognized</td></tr>
<tr><td>Situation</td><td>1: Failure of the lower part of the slope</td><td>2: Failure of the intermediate part of the slope</td><td>3: Failure of the upper part of the slope</td><td>4: Failure of the whole slope</td><td>5: No failure</td></tr>
<tr><td rowspan="2">Adjoining slope</td><td>The history of failures</td><td colspan="2">1: With an old failure area</td><td colspan="2">2: With a new failure area</td><td>3: No failure area can be recognized</td></tr>
<tr><td>Situation</td><td>1: Failure of the lower part of the slope</td><td>2: Failure of the intermediate part of the slope</td><td>3: Failure of the upper part of the slope</td><td>4: Failure of the whole slope</td><td>5: No failure</td></tr>
<tr><td>Spring water</td><td colspan="2">1: Always with spring water</td><td colspan="2">2: With spring water at the time of rainfall</td><td>3: The slope is always damp</td><td>4: The slope is dry</td></tr>
<tr><td>Preventive works</td><td colspan="3">1: With abnormality in the preventive works</td><td colspan="3">2: Without abnormality in the preventive works</td></tr>
<tr><td>Situation of the upper part of the preventive works</td><td colspan="3">1: With a slope that has been left as it is after a length of 10 m or more has been excavated<br>2: With a slope that has been left as it is after a length of 5 m or more has been excavated<br>3: With a slope that has been left as it is after a length of less than 5 m has been excavated<br>4: Without any slope that has been left as it is after excavation</td><td colspan="3"> 
</td></tr>
<tr><td>Situation of land use in the upper part of the slope</td><td colspan="6"> 
</td></tr>
<tr><td rowspan="4">Areas to be protected</td><td>Number of houses</td><td colspan="6"></td></tr>
<tr><td>Buildings of a public nature</td><td colspan="3"></td><td>Public facilities</td><td colspan="2"></td></tr>
<tr><td>Number of houses in the lower part of the slope</td><td colspan="6"></td></tr>
<tr><td>Number of houses in the upper part of the slope (within 10 m)<br>Number of houses in the lower part of the slope (within 10 m)</td><td colspan="6">Wooden<br>Non-wooden<br>Wooden<br>Non-wooden</td></tr>
</table>

| Situation of land use in the upper part of the slope | | | | | |
|---|---|---|---|---|---|
| Ridge type | 1 | Road | 2 | Waterway | |
| | 3 | Pond or swamp | 4 | House | |
| | 5 | Farmland | 6 | Mountain forest | |
| | 6 | Others | | | |
| Plateau type | 1 | Road | 2 | Waterway | |
| | 3 | Pond or swamp | 4 | House | |
| | 5 | Farmland | 5 | Mountain forest | |
| | 7 | Others | | | |