

(01)Sabo work(check dam/Erosion control)(Illustration) in Africa(1-244)

(01)Sabo work(check dam/Erosion control)(Illustration) in Africa(1-244)



Only You !

Who teach, who build ?

只野敏夫
TADANO TOSHIO

(01)Sabon Reference

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|---|--|--|
| 1 土木工学ハンドブック
Civil Engineering Handbook | 土木学会編
Edited by Japan Society of Civil Engineers | 技報堂
GIHODO SHUPPAN Co., Ltd. |
| 2 農業土木ハンドブック
Agricultural civil engineering handbook | 農業土木学会編
Japan Society of Agricultural Civil Engineers | 丸善株式会社
Maruzen Co., Ltd. |
| 3 図解テキスト 土木一般 (1-5)
Illustrated Text General civil engineering(1-5) | | 市ヶ谷出版社
ICHIGAYA Publishing Co., Ltd |
| 4 図解 土質・基礎用語集
Illustrated Glossary of Soil Characteristics and Basic Terms | | 東洋書店
Toyo Shoten Co., Ltd. |
| 5 応用地質用語集
Glossary of applied geological terms | | 東洋書店
Toyo Shoten Co., Ltd. |
| 6 実用英和対訳 土木用語辞典
Practical English-Japanese translation Dictionary of civil engineering terms | | 工学出版株式会社
Engineering Publishing Co., Ltd. |
| 7 農業土木用語集
Glossary of agricultural civil engineering terms | | 東洋書店
Toyo Shoten Co., Ltd. |
| 8 土木施工用語集
Glossary of civil engineering construction terms | | 東洋書店
Toyo Shoten Co., Ltd. |
| 9 土木コンクリート用語集
Glossary of civil engineering and concrete terms | | 東洋書店
Toyo Book Book Store |
| 10 土木用語辞典 東京工学研究会編
Dictionary of civil engineering terms Edited by Tokyo Engineering Study Group | | 工学出版株式会社
Engineering Publishing Co., Ltd. |

只野敏夫
Tadano Toshio

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fill-type dam
fill-type dam
spillway
sediment
flow net
flow net
head-fall-drop
lining canal
carrying operation
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211 (S211)avalanche fence	avalanche fence
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179 (S179)carrying operation	carrying operation
189 (S189)catchment well	catchment well
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208 (S208)ridge line	ridge line
200 (S200)rift valley	rift valley
222 (S222)rill erosion	rill erosion
1 (S1)Sabo(Erosion control)	sabo work
2 (S2)Sabo work(check dam/Erosion control)	sabo work
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7 (S7)Sabo work(check dam/Erosion control)	sabo work
8 (S8)Sabo work(check dam/Erosion control)	sabo work
9 (S9)Sabo work(check dam/Erosion control)	sabo work
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97 (S97)Sabo(Erosion control)	Sabo(Erosion control)
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101 (S101)Sabo(Erosion control)	Sabo(Erosion control)
102 (S102)Sabo(Erosion control)	Sabo(Erosion control)
103 (S103)Sabo(Erosion control)	Sabo(Erosion control)
104 (S104)Sabo(Erosion control)-landslide restraining works	Sabo(Erosion control)
105 (S105)Sabo(Erosion control)-landslide restraining works	Sabo(Erosion control)
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161 (S161)sodding(Vegetation potting)	sodding

59 (S59)watercourse
60 (S60)watercourse
61 (S61)watercourse
62 (S62)watercourse
63 (S63)watercourse
217 (S217)wind erosion control

watercourse
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wind erosion control

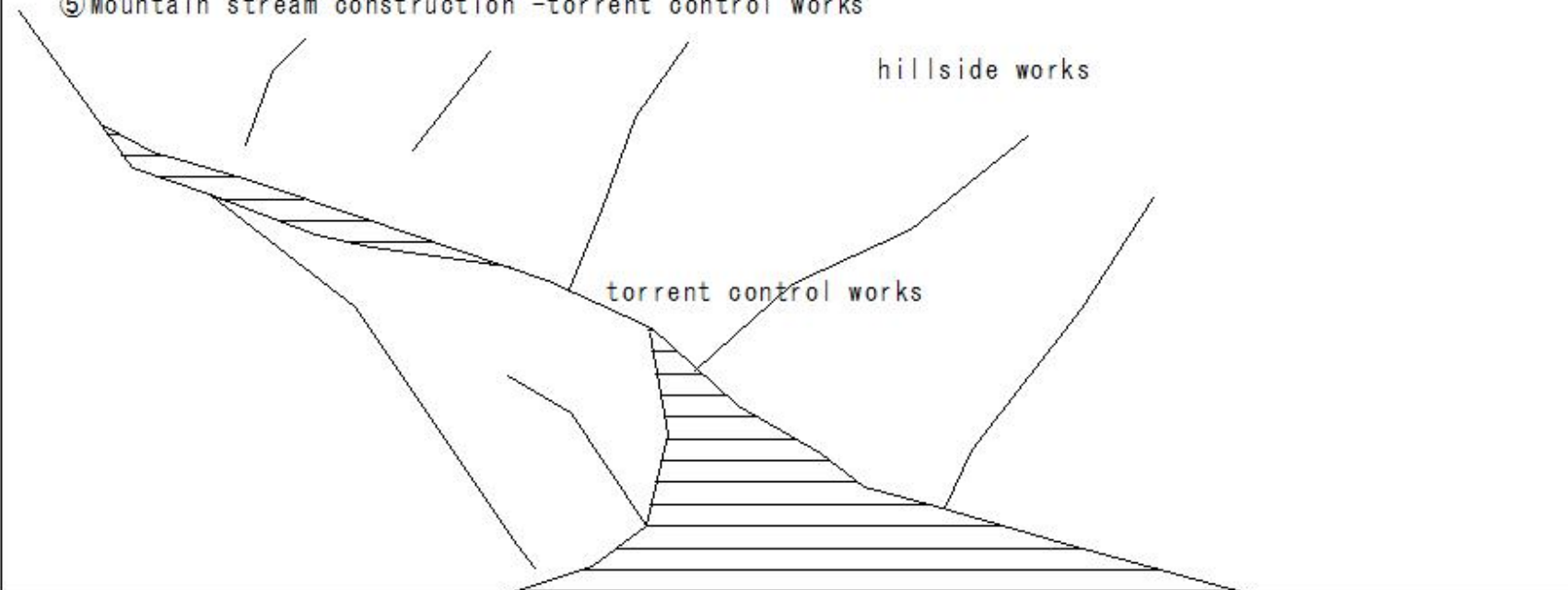
(S1)Sabo(Erosion control)

(S1) Sabo (Erosion control)

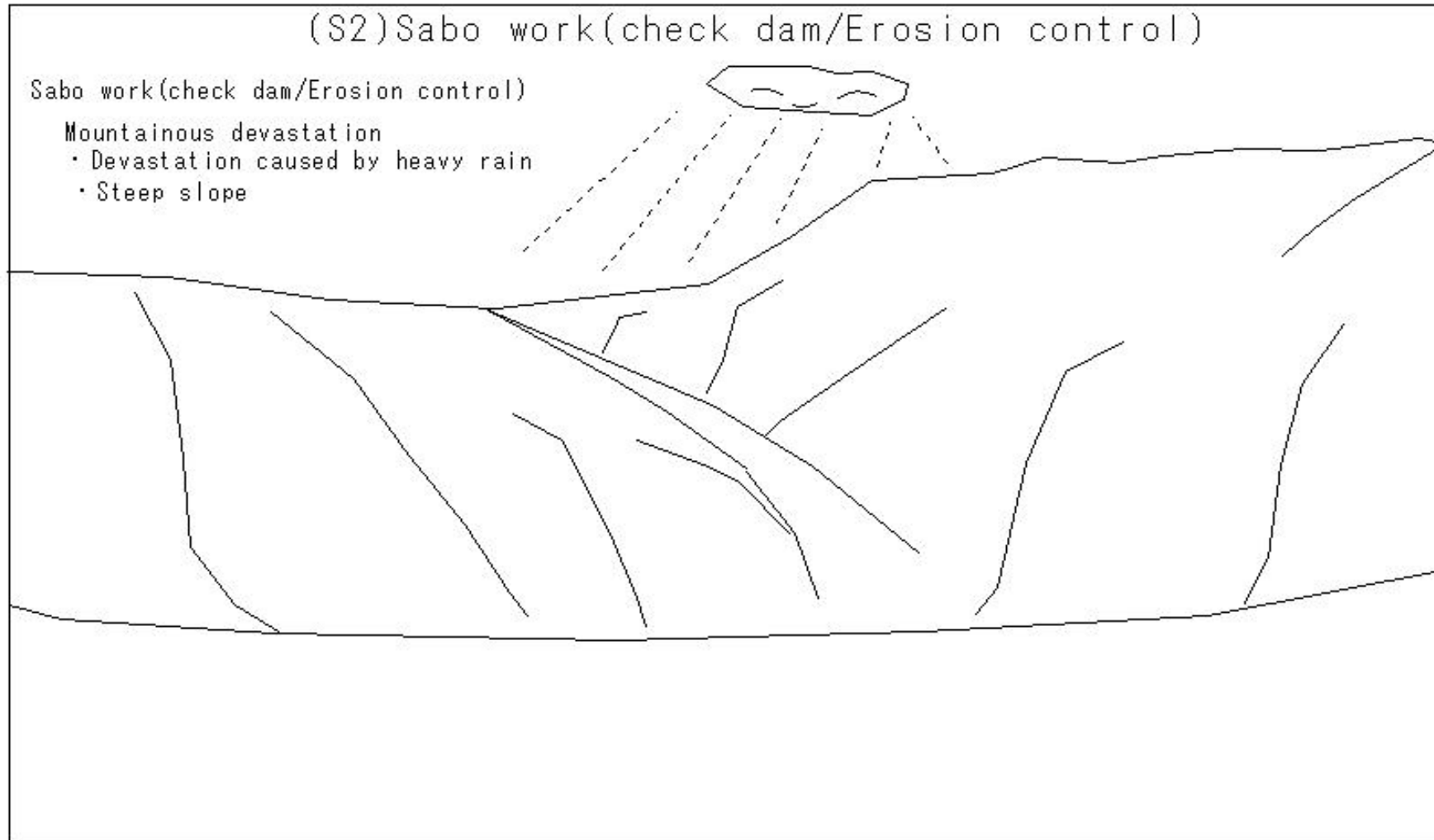
Sabo (Erosion control)

Purpose of erosion control work

- ① Preventing the devastation of mountains
- ② Prevention of gravel production in mountains and mountain streams
- ③ Preventing sand and gravel from flowing down
- ④ Mountain area construction -hillside works
- ⑤ Mountain stream construction -torrent control works



(S2)Sabo work(check dam/Erosion control)



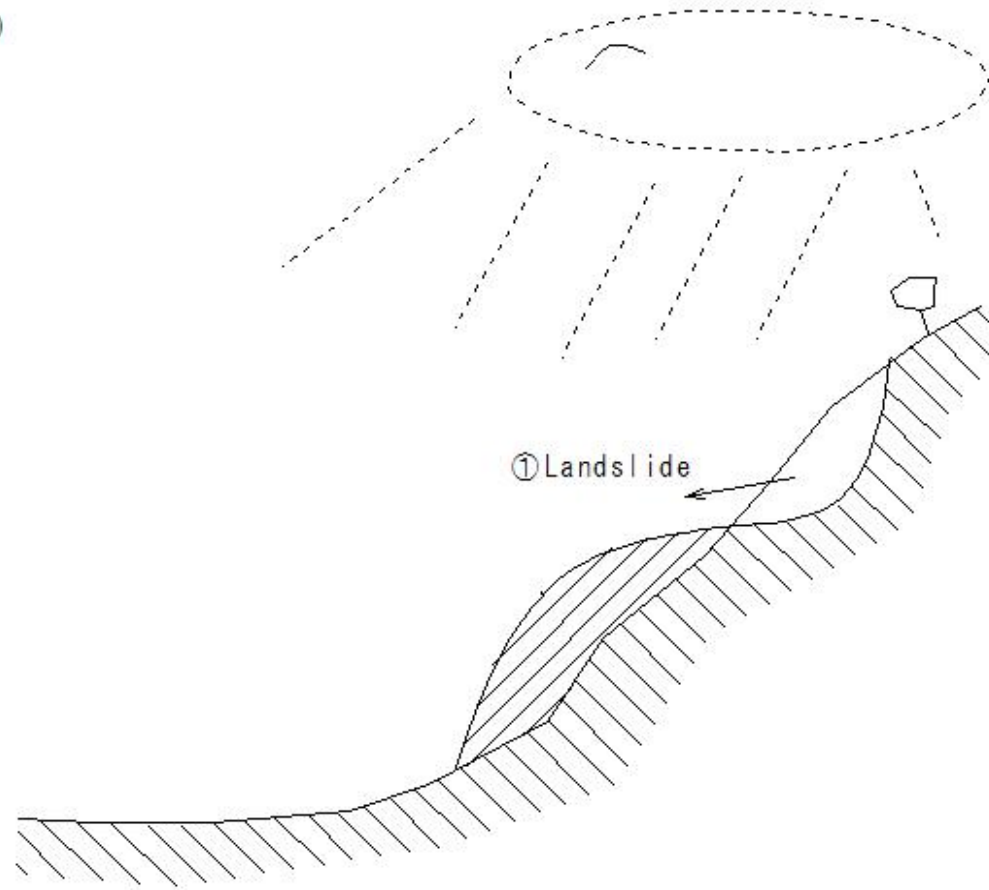
(S3)Sabo work(check dam/Erosion control)

(S3) Sabo work(check dam/Erosion control)

Sabo work(check dam/Erosion control)

Mountainous devastation

①Landslide



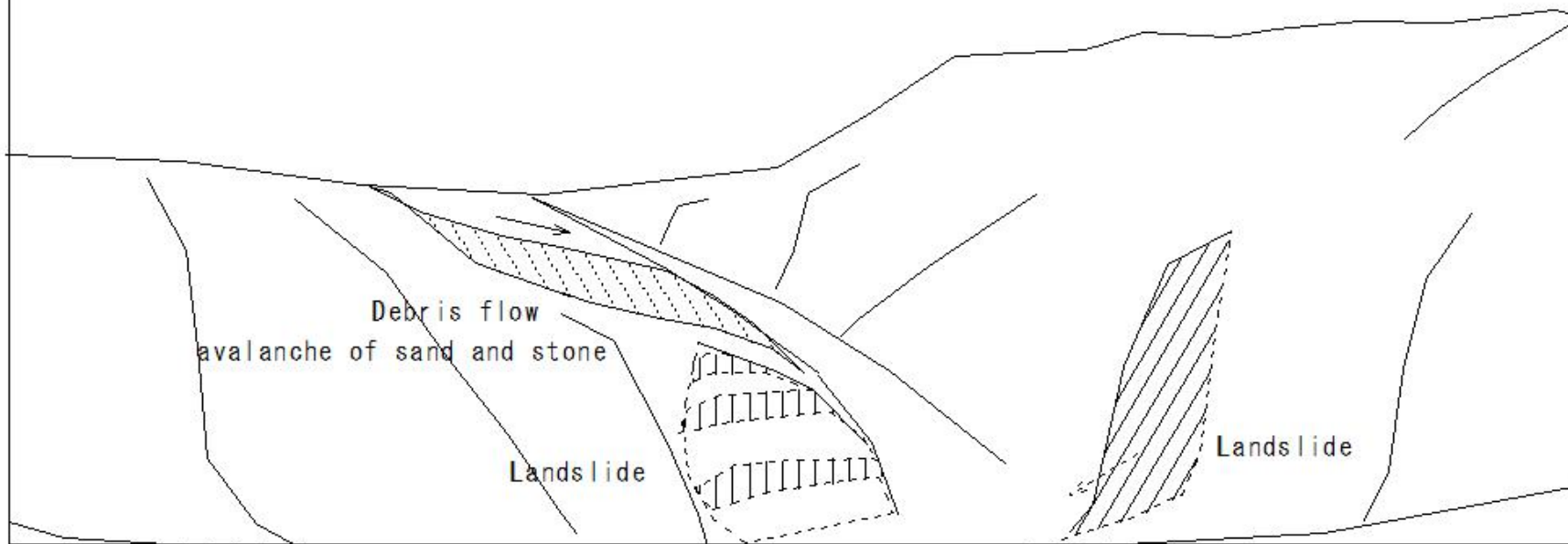
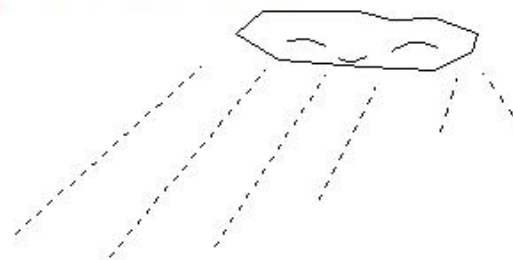
(S4)Sabo work(check dam/Erosion control)

(S4) Sabo work(check dam/Erosion control)

Sabo work(check dam/Erosion control)

Mountainous devastation

②Landslide: Effect of gravity - sliding



(S5)Sabo work(check dam/Erosion control)

(S5) Sabo work (check dam/Erosion control)

Sabo work (check dam/Erosion control)

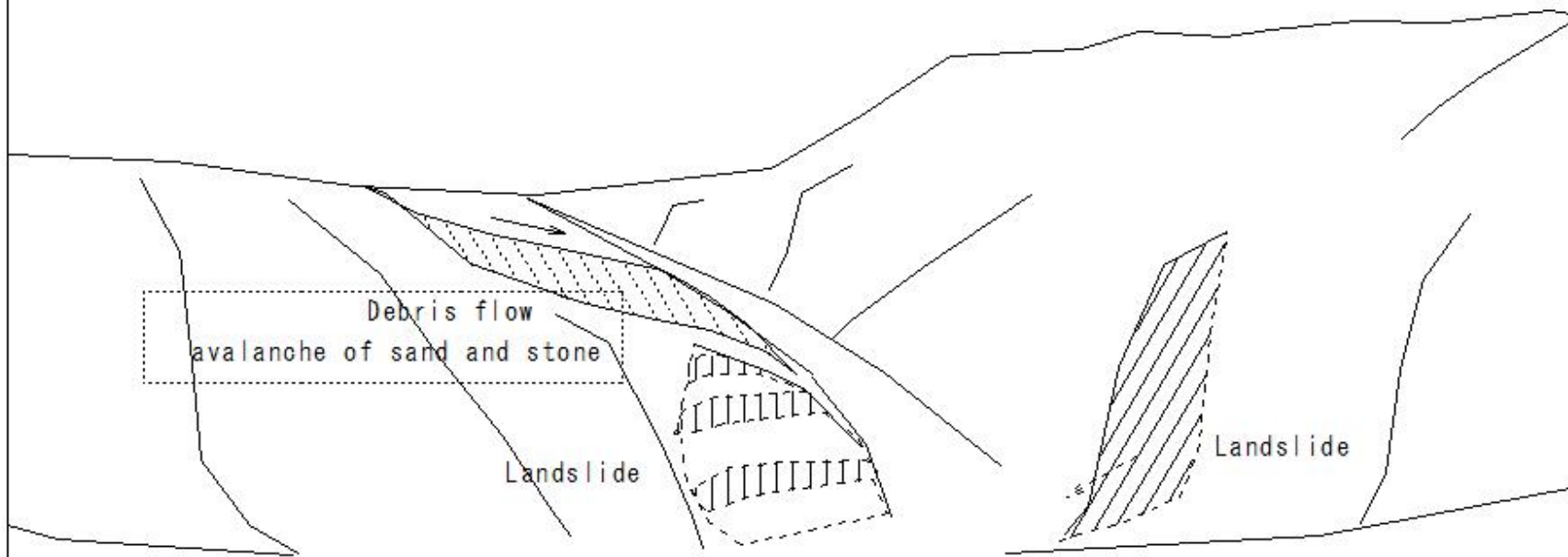
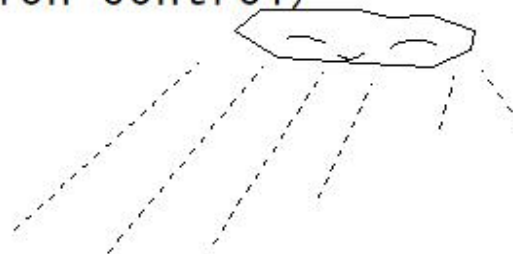
Mountainous devastation

③ avalanche of sand and stone debris flow

Heavy rain

sedimentary soil

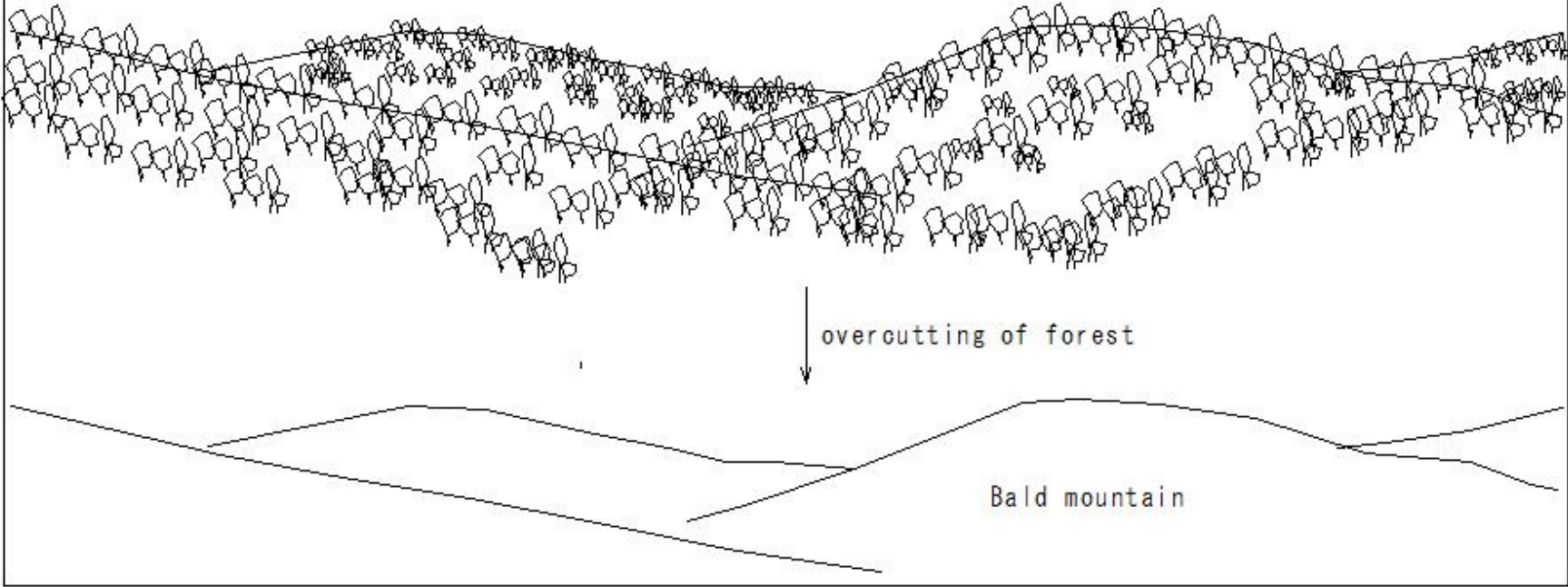
flowing along with huge stones and trees



(S6)Sabo work(check dam/Erosion control)

(S6) Sabo work(check dam/Erosion control)

Sabo work(check dam/Erosion control)
Mountainous devastation
④Bald mountain
overcutting of forest



(S7)Sabo work(check dam/Erosion control)

(S7)Sabo work(check dam/Erosion control)

Sabo work(check dam/Erosion control)

gravel production

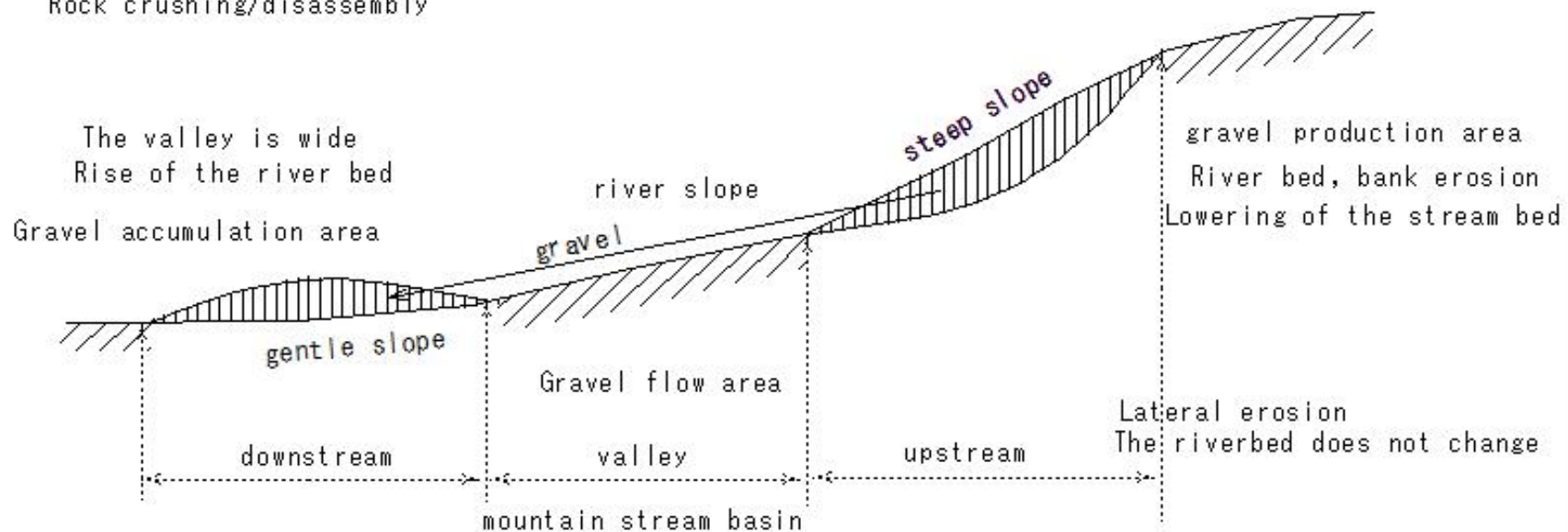
· gravel production by weathering, erosion, and infiltration

①Weathering effect

physical chemical biological

Weathering effect

Rock crushing/disassembly



(S8)Sabo work(check dam/Erosion control)

(S8) Sabo work(check dam/Erosion control)

Sabo work(check dam/Erosion control)

gravel production

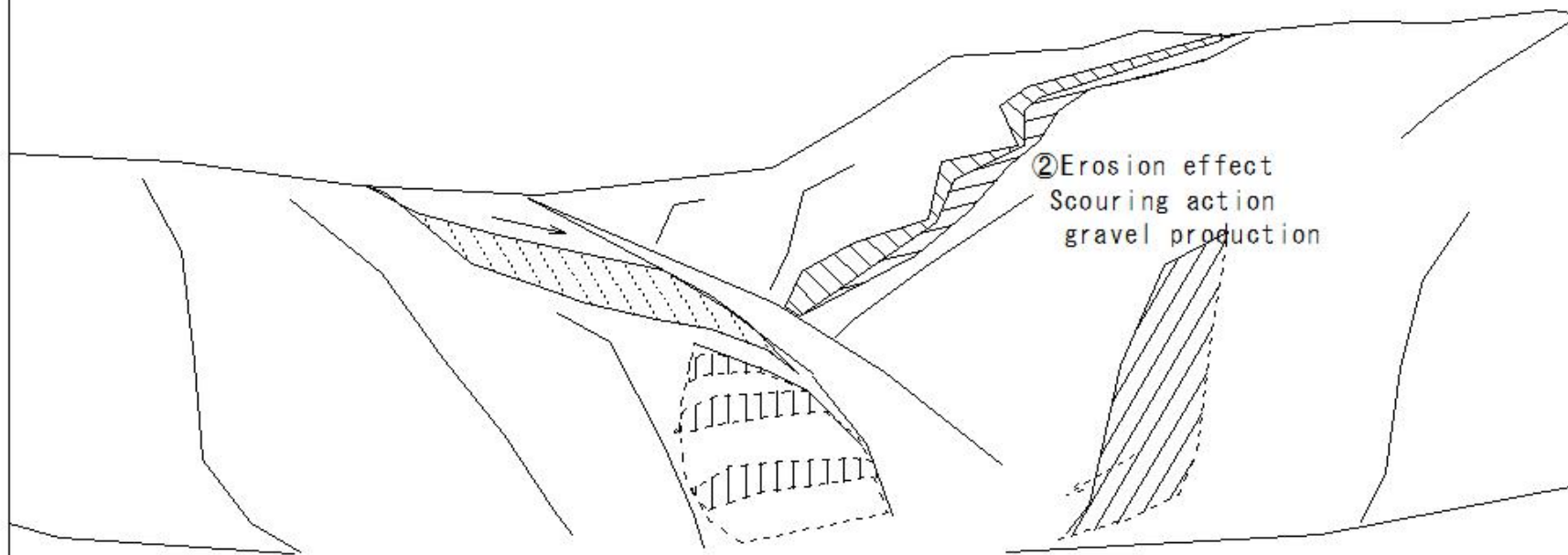
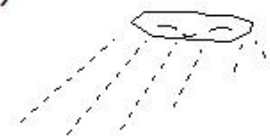
- gravel production by weathering, erosion, and infiltration

②Erosion effect

running water

mountain bed

Scouring action



②Erosion effect
Scouring action
gravel production

(S9)Sabo work(check dam/Erosion control)

(S9) Sabo work (check dam/Erosion control)

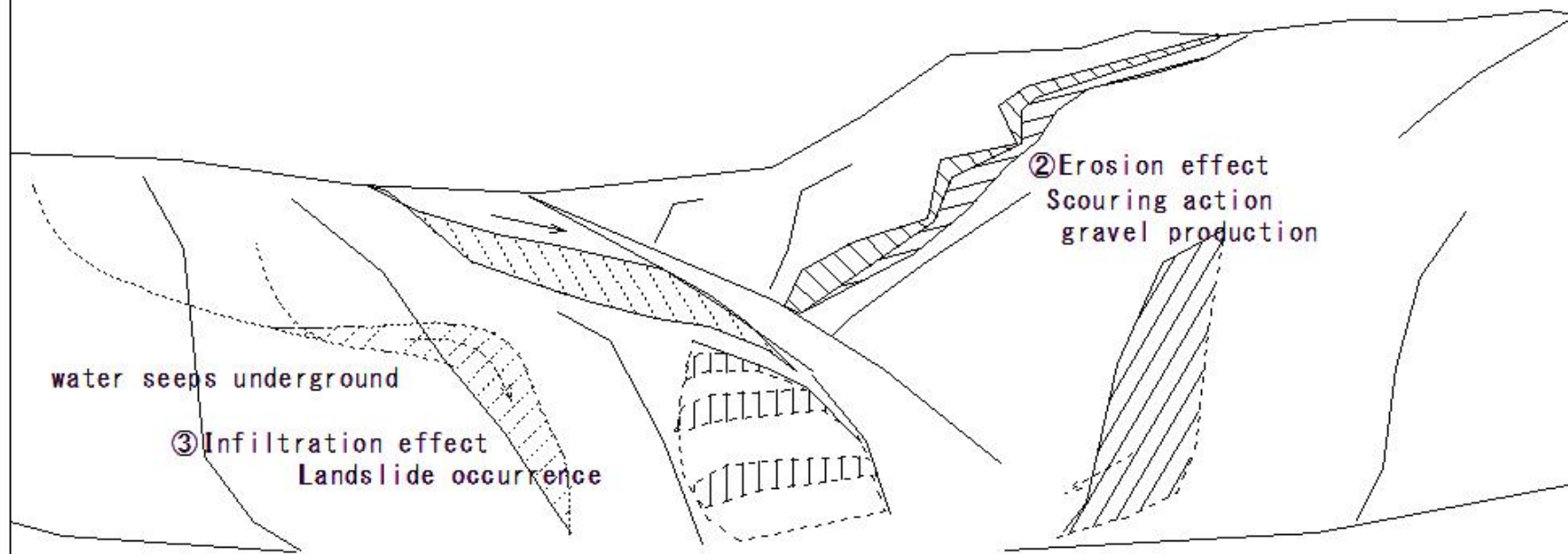
Sabo work(check dam/Erosion control)

- gravel production by weathering, erosion, and infiltration

③ Infiltration effect

water seeps underground

Landslide occurrence



② Erosion effect
Scouring action
gravel production

water seeps underground

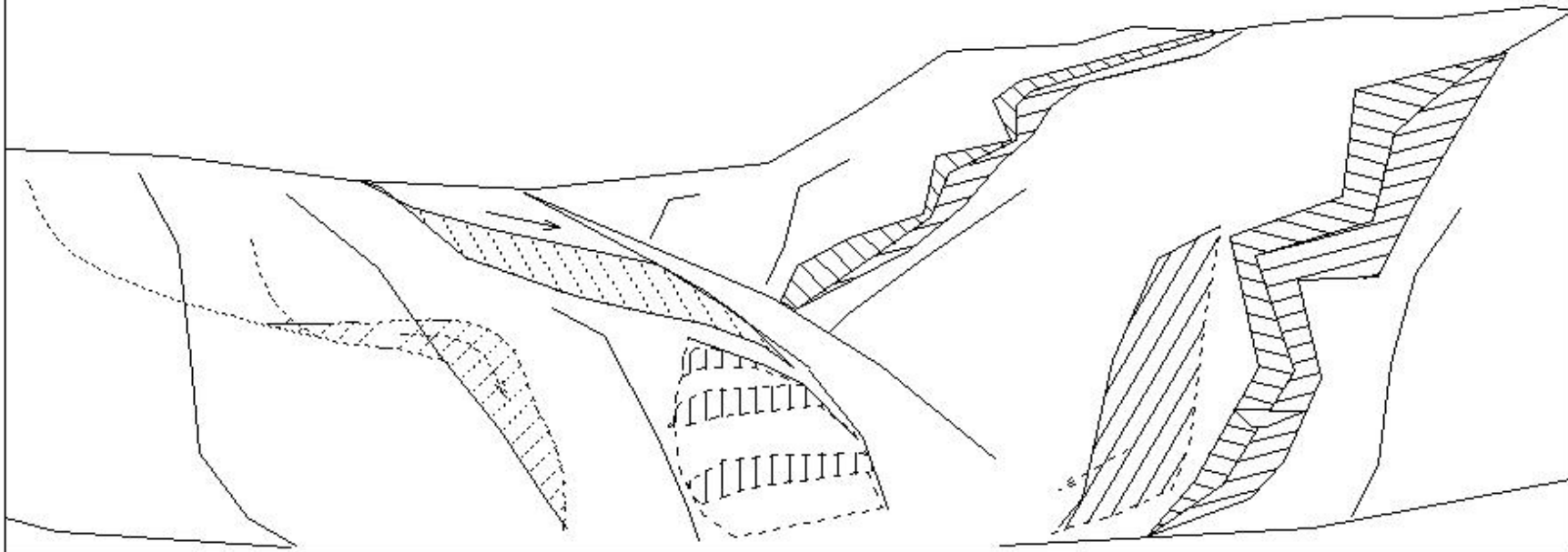
③ Infiltration effect
Landslide occurrence

(S10)Sabo work(check dam/Erosion control)

(S10) Sabo work (check dam/Erosion control)

Construction period of erosion control work

- Work in mountainous areas
- Avoid rain and snow melting periods
- Avoid construction during the severe cold season



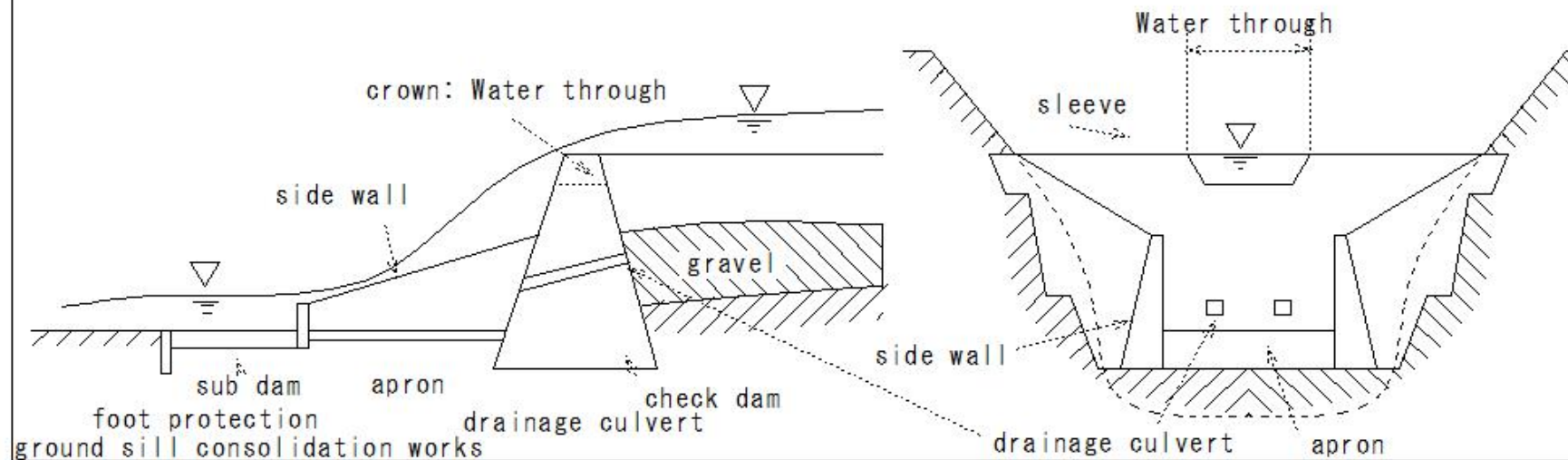
(S11)check dam

(S11)check dam

check dam(erosion control dam)

Purpose of check dam

- ①Prevention of vertical and horizontal erosion of river channels
- ②Storage and regulation of washed-down soil and gravel
- ③Relax the slope of the stream bed and weaken the pushing force of running water
- ④Securing the base and preventing landslides using accumulated earth and sand



(S12)check dam(erosion control dam)

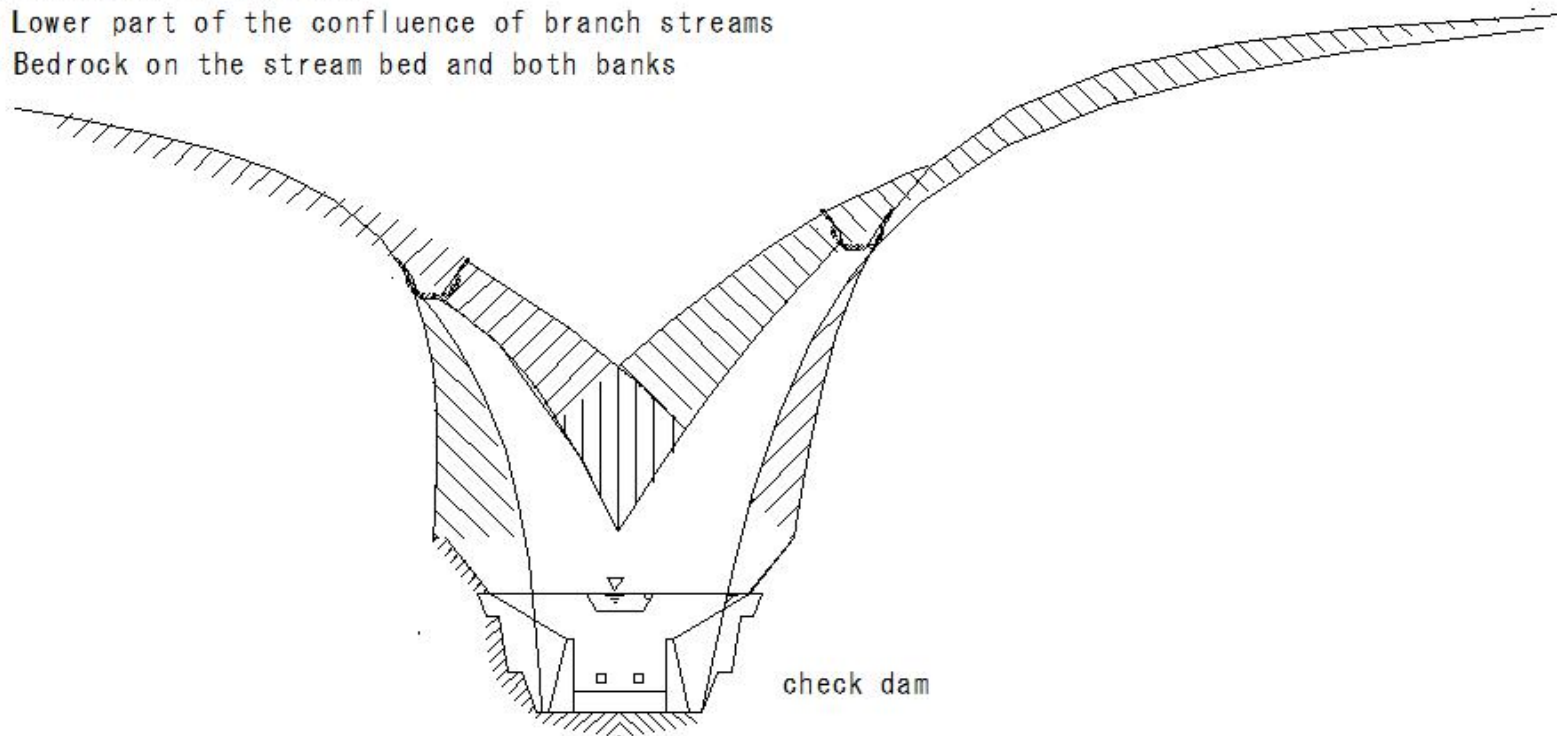
(S12) check dam(erosion control dam)

check dam(erosion control dam)

Installation riverbed of check dam(erosion control dam)

① Selection of location

- Lower part of the confluence of branch streams
- Bedrock on the stream bed and both banks



(S13)check dam(erosion control dam)

(S13) check dam(erosion control dam)

check dam(erosion control dam)

Installation riverbed of check dam

②Foundation ground

- Dam height: Investigation of foundation ground
- Height 15m or more: Rock survey

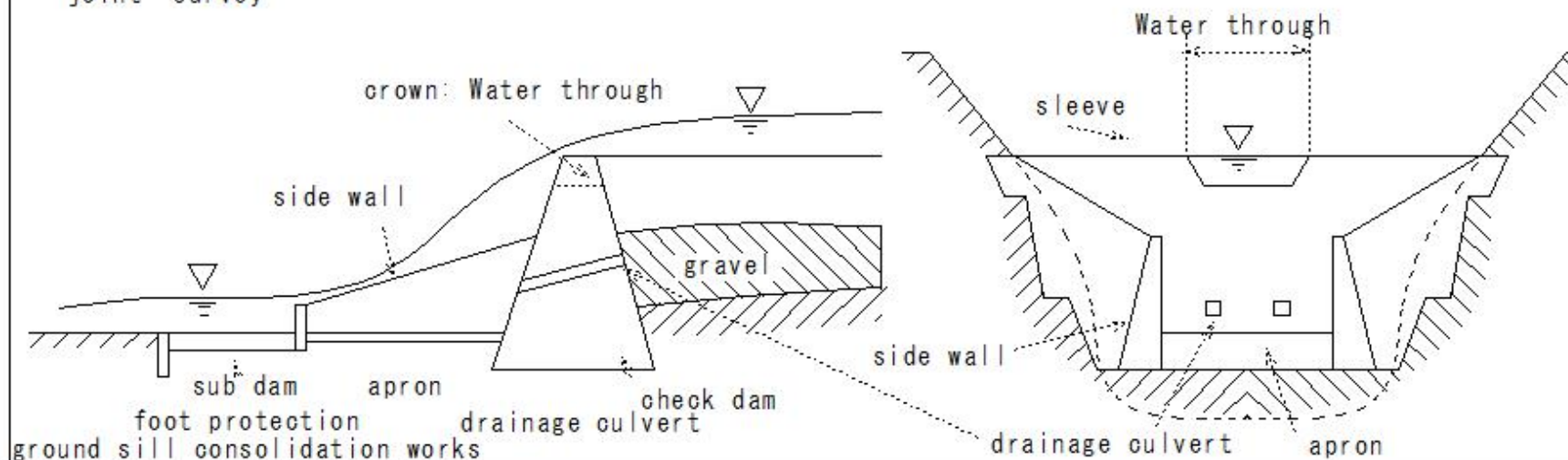
Geological quality

Supporting capacity

water permeability

Presence or absence of fault
joint survey

- River floor: Bedrock - Foundation penetration - Shallow
- Soft rock crack: 2-3m deep footing
- Gravel layer, rolling stones: footing 2m or more
- Downstream protection: apron secondary dam



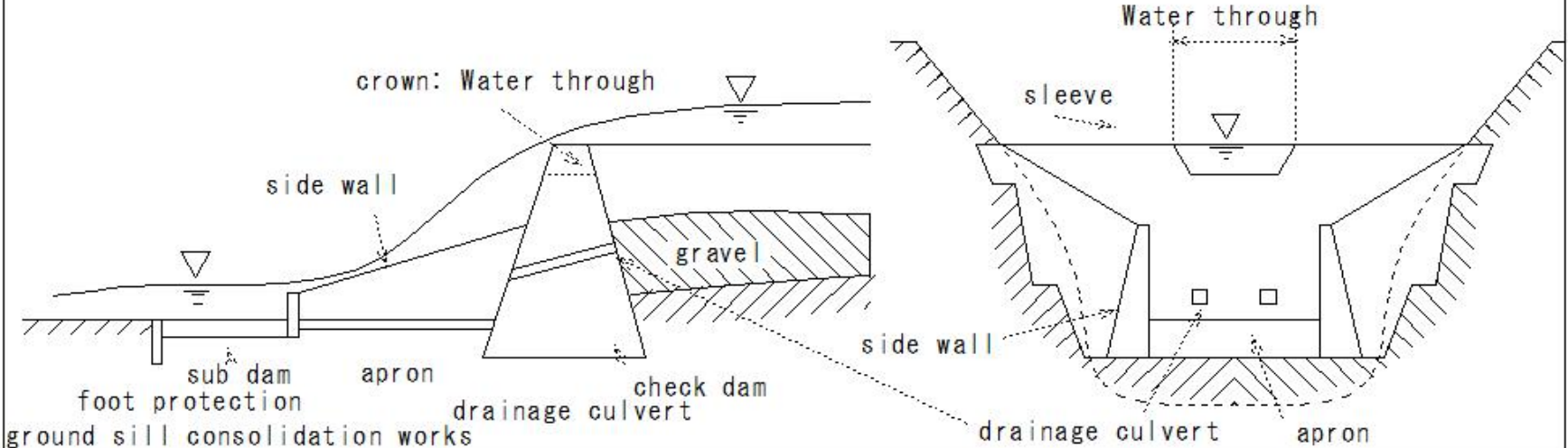
(S14)check dam(erosion control dam)

(S14) check dam(erosion control dam)

check dam(erosion control dam)

Structure of erosion control dam

- crown: Water through
- flow center-fixed
- Water removal - drainage, earth pressure reduction
- apron: Washing and erosion prevention
- apron tip - sub dam foot protection



(S15)check dam(erosion control dam)

(S15) check dam(erosion control dam)

check dam(erosion control dam)

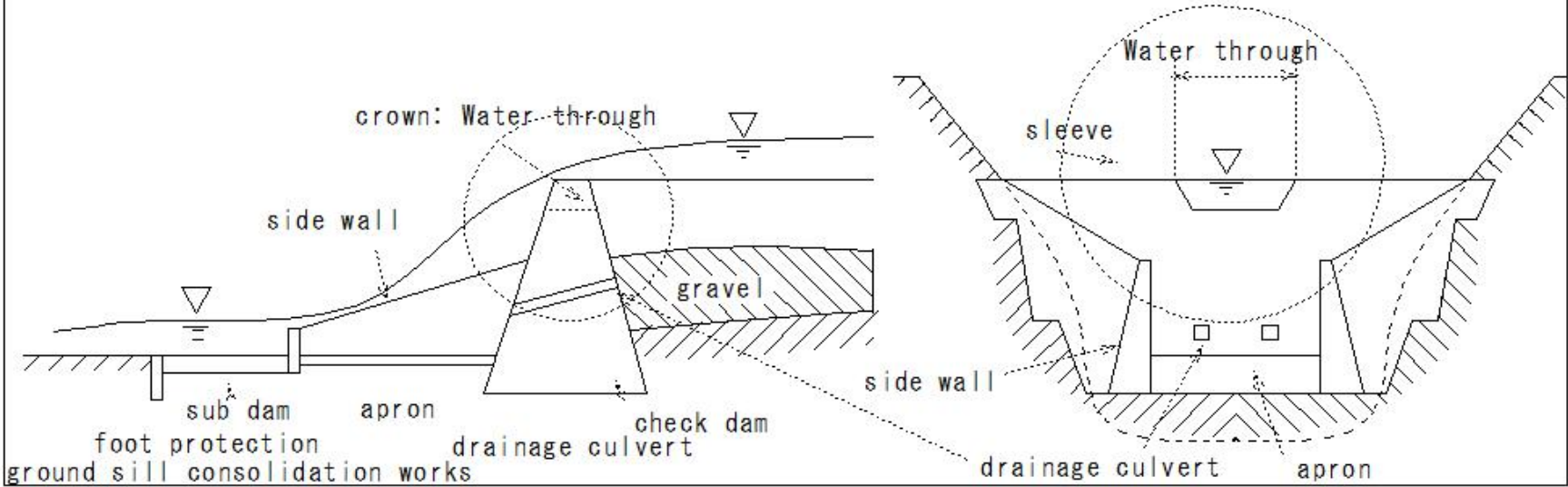
Structure of erosion control dam

①Water through

Target discharge

Water passage width Minimum width 3m

Planned water level + margin height



(S16)check dam(erosion control dam)

(S16) check dam(erosion control dam)

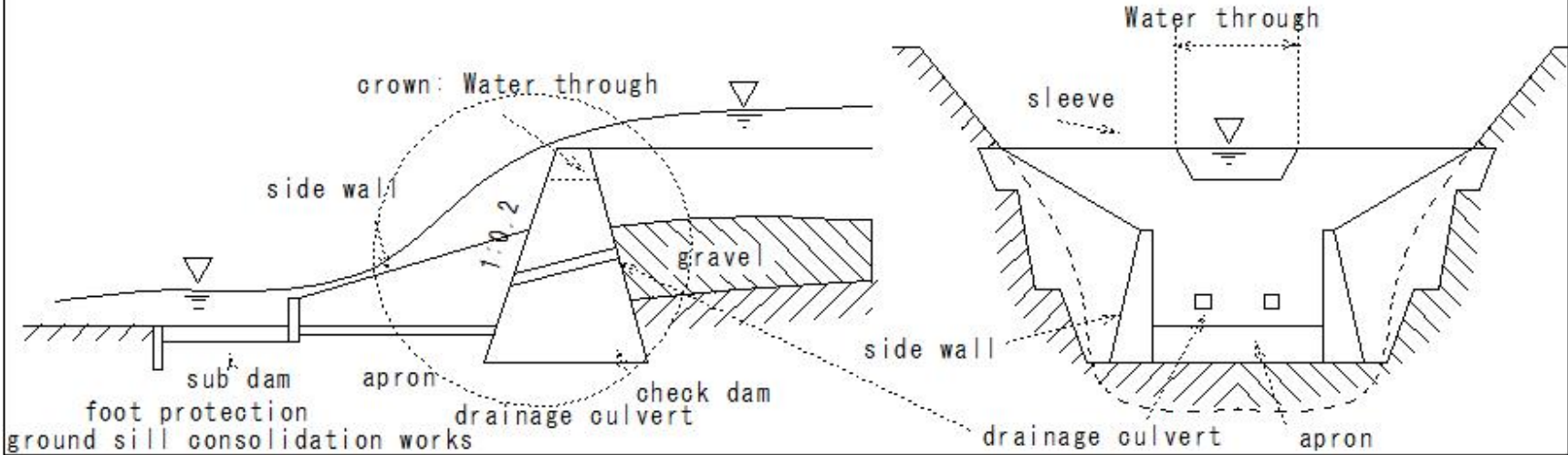
check dam(erosion control dam)

Structure of erosion control dam

② Downstream slope

Slope: Not damaged by overflow sediment

slope gradient 1:0.2



(S17)check dam(erosion control dam)

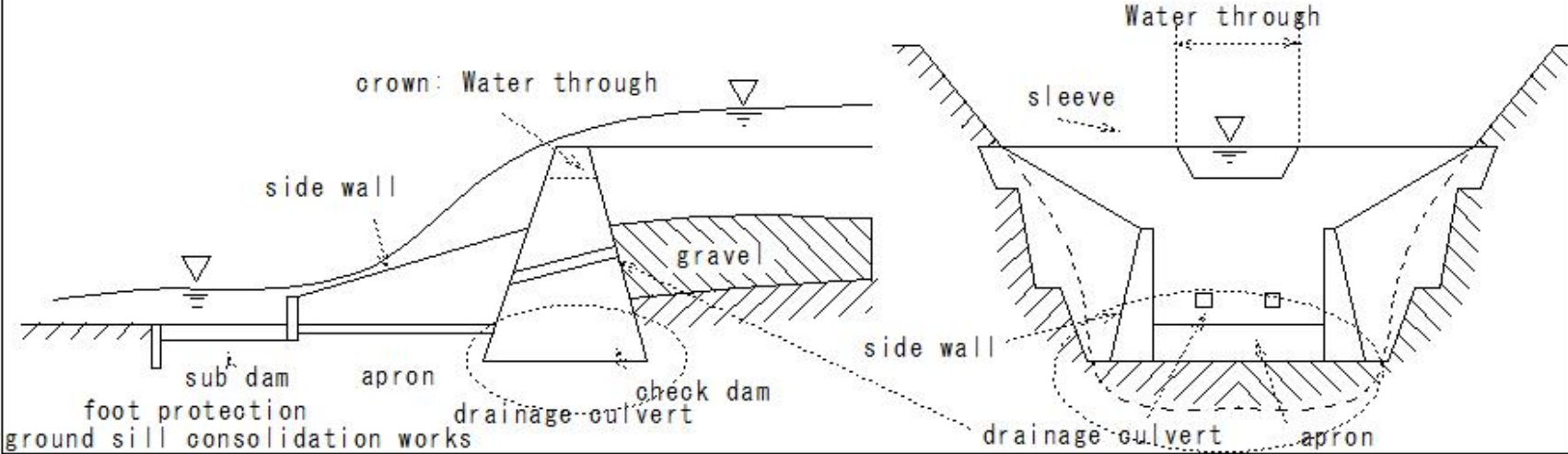
(S17) check dam(erosion control dam)

check dam(erosion control dam)

Structure of erosion control dam

③ foundation

- Required supporting capacity
- Shear resistance friction force
- Not destroyed by penetrating power
- Water-stop wall Reinforced with water-impermeable wall, etc.



(S18)check dam(erosion control dam)

(S18) check dam(erosion control dam)

check dam(erosion control dam)

Structure of erosion control dam

④ Sleeves

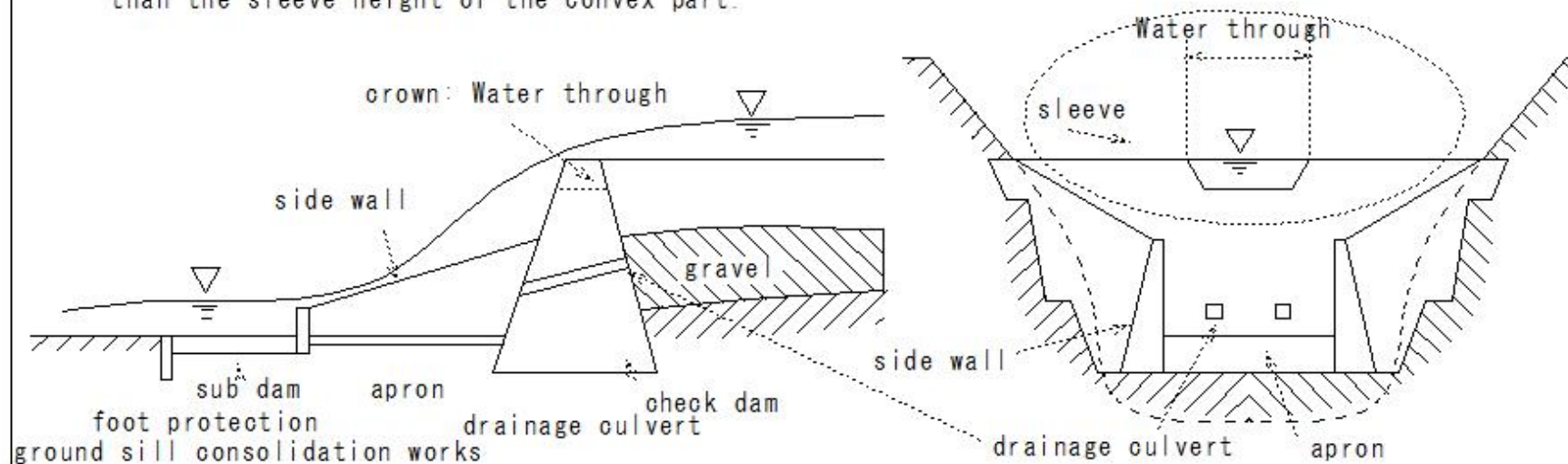
- Do not allow flood water to overflow
- Top of sleeve

Debris flow prevention dam: River bed slope level

Upstream planned sediment gradient

- Bending part

The sleeve height of the concave part should be higher than the sleeve height of the convex part.



(S19)check dam(erosion control dam)

(S19)check dam(erosion control dam)

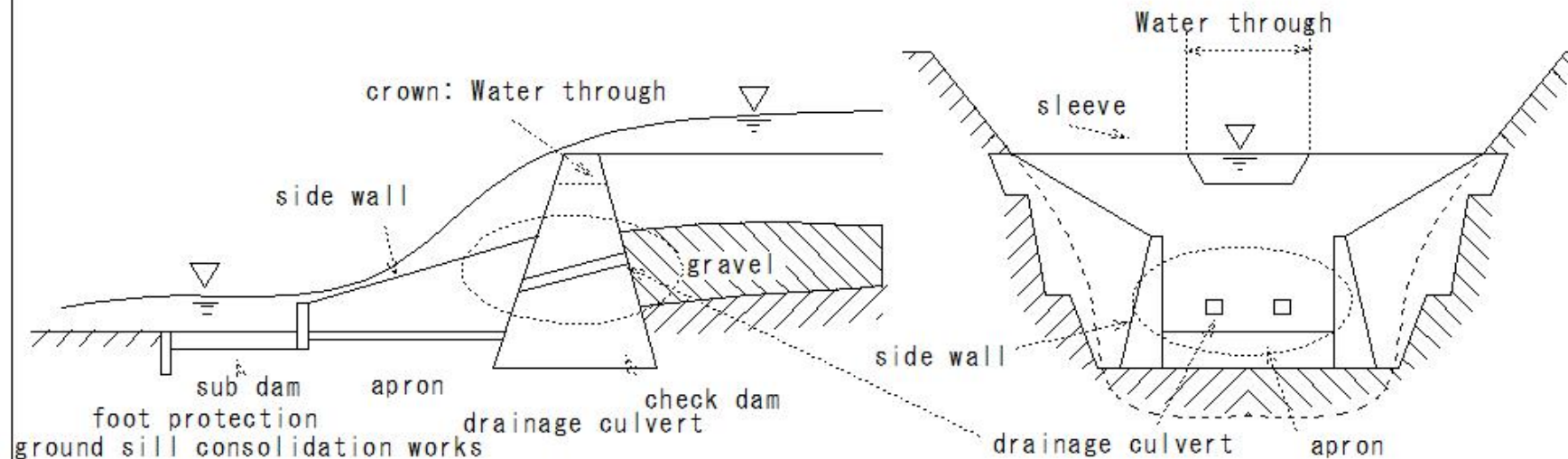
check dam(erosion control dam)

Structure of erosion control dam

⑤ Drainage culvert

- Switch the running water during construction
- After deposition, remove seepage water to reduce soil pressure
- Size, number, shape, and position of drains

Considering flood discharge, quicksand amount, etc.

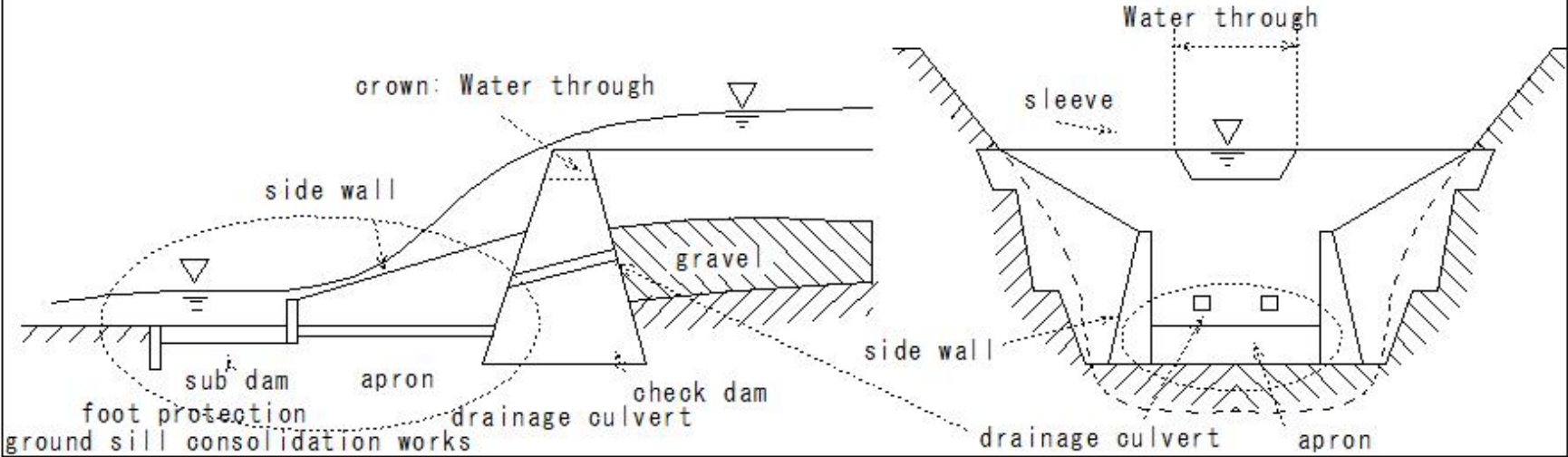


(S20)check dam(erosion control dam)

(S20) check dam(erosion control dam)

check dam(erosion control dam)
 Structure of erosion control dam

- ⑥ Sub-dam apron
 - Falling water -scouring
 - Prevention of scouring



(S21)check dam(erosion control dam)

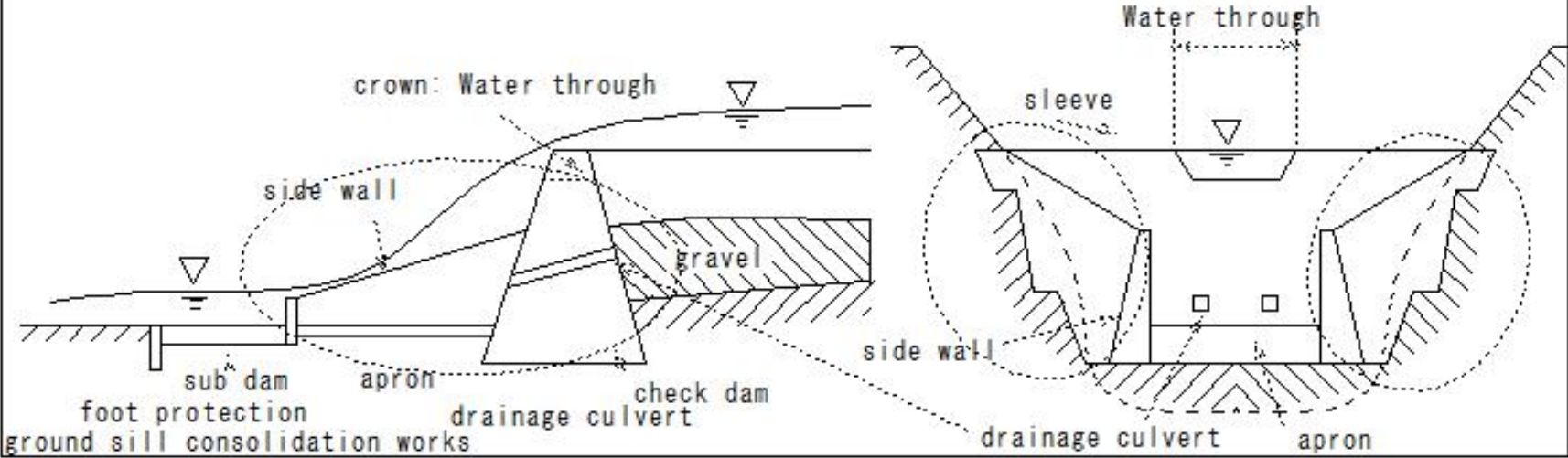
(S21)check dam(erosion control dam)

check dam(erosion control dam)

Structure of erosion control dam

⑦ Filling up space

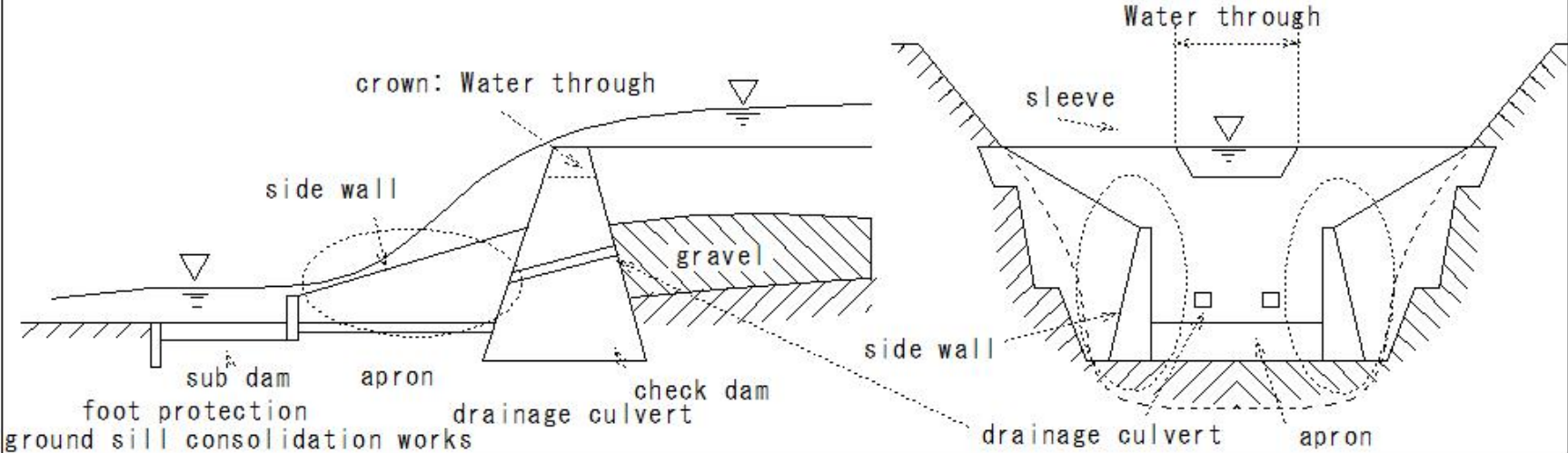
- Excess excavation part - fill-up - protection



(S22)check dam(erosion control dam)

(S22) check dam(erosion control dam)

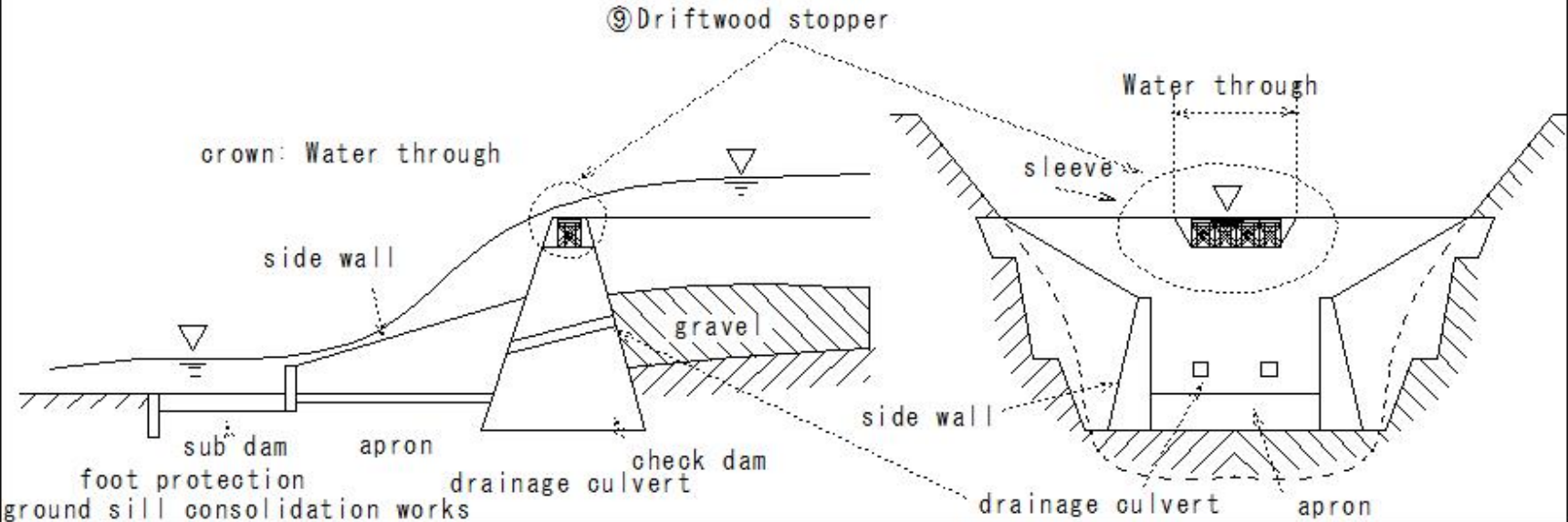
check dam(erosion control dam)
Structure of erosion control dam
⑧Side wall revetment
both sides



(S23)check dam(erosion control dam)

(S23) check dam(erosion control dam)

check dam(erosion control dam)
Structure of erosion control dam
⑨ Driftwood stopper as needed



(S24)check dam(erosion control dam)

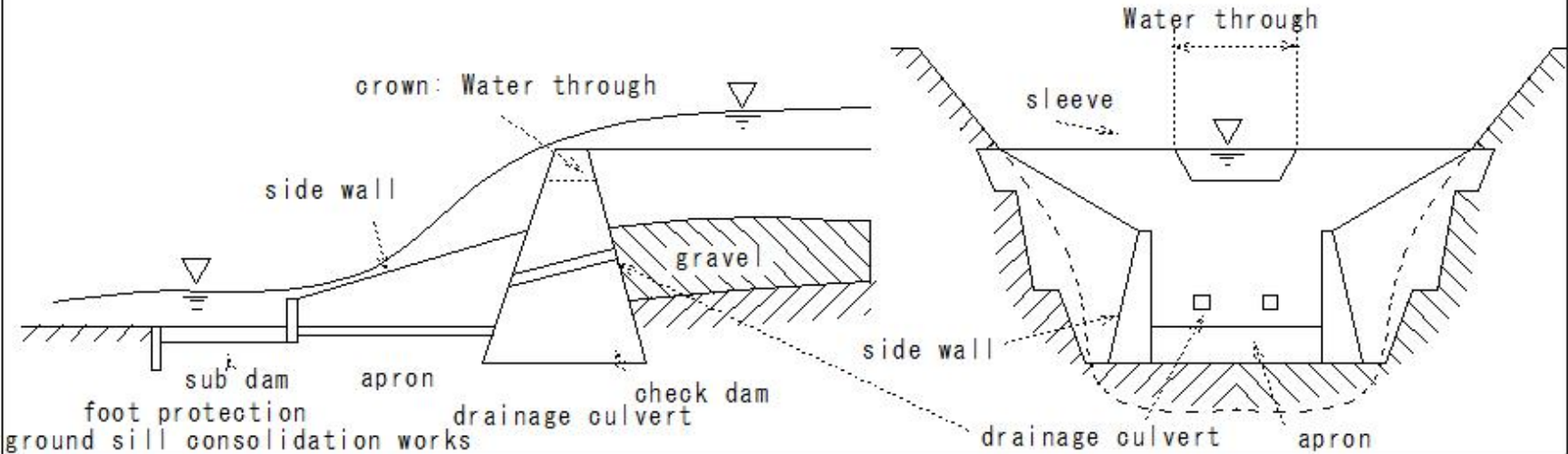
(S24) check dam(erosion control dam)

check dam(erosion control dam)

Sabo dam materials

① Concrete dam

① Concrete dam



(S25)check dam(erosion control dam)

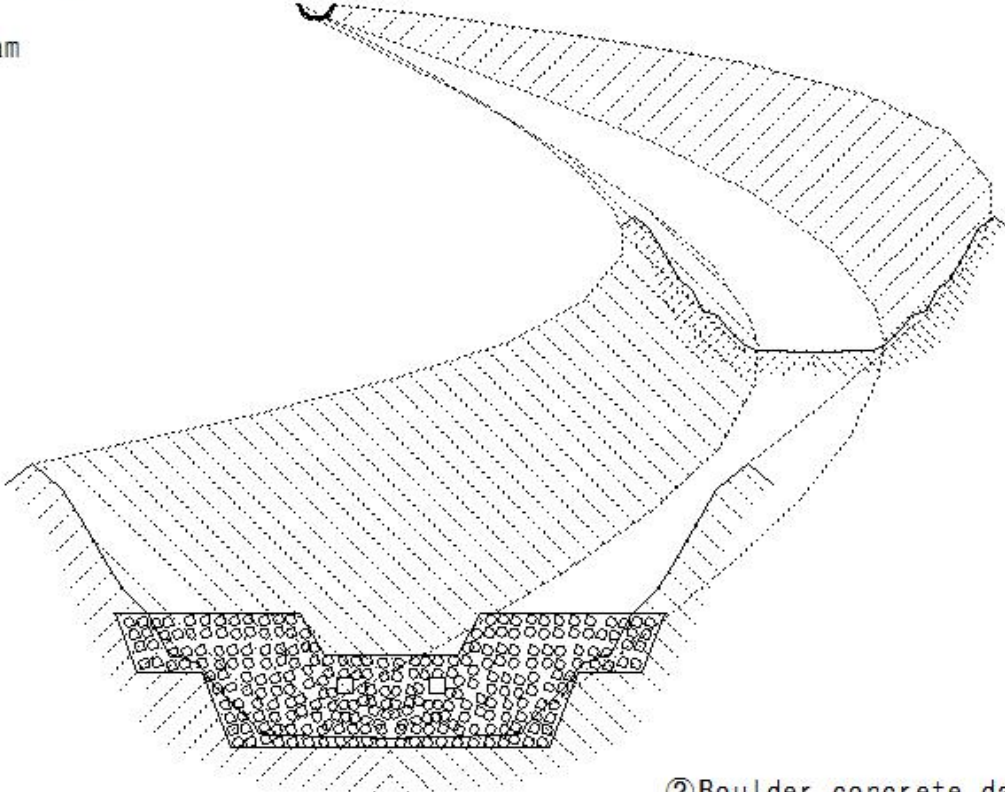
(S25) check dam(erosion control dam)

check dam(erosion control dam)

Sabo dam materials

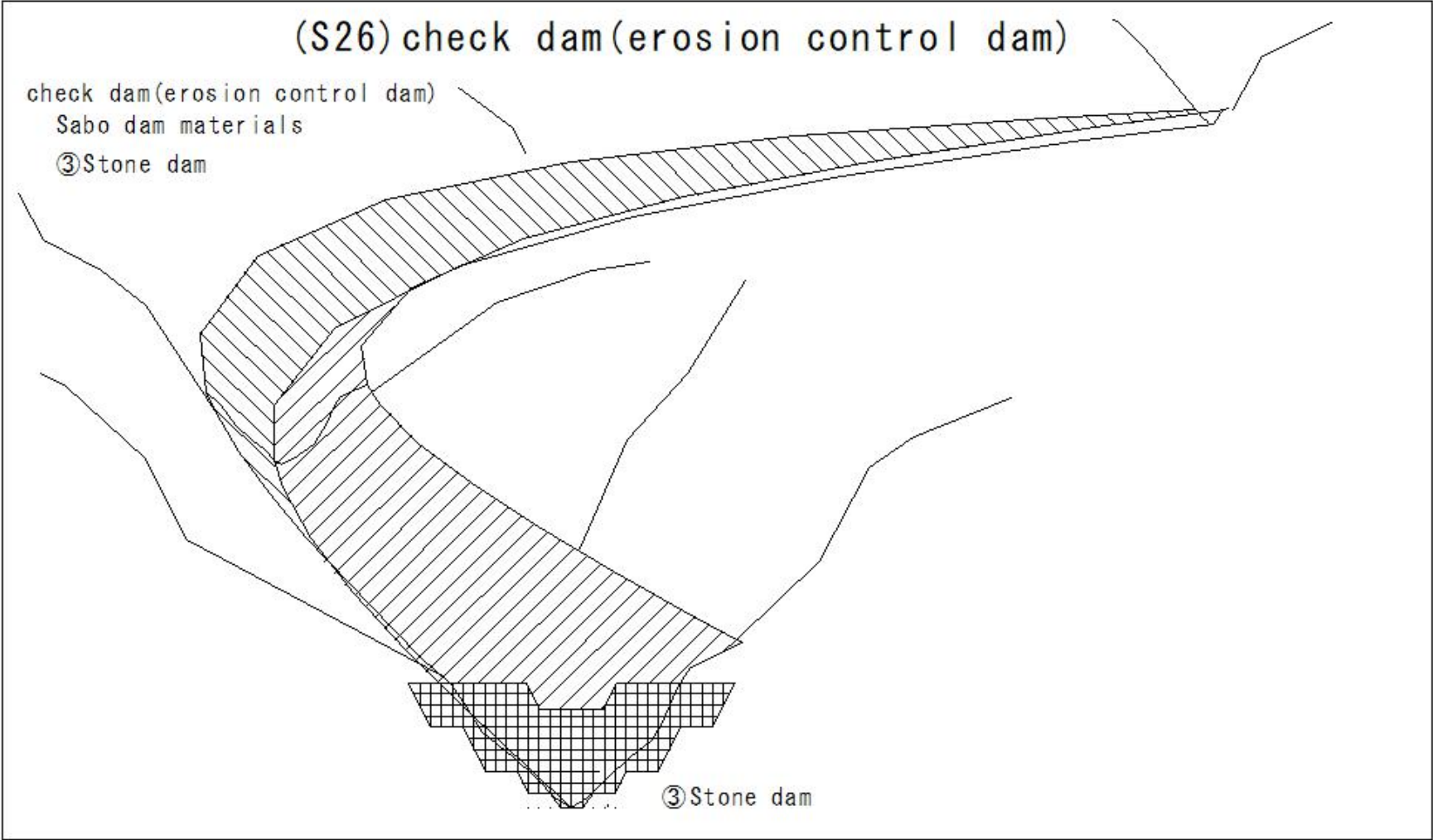
②Boulder concrete dam

Cobblestone 30-45%



②Boulder concrete dam

(S26)check dam(erosion control dam)



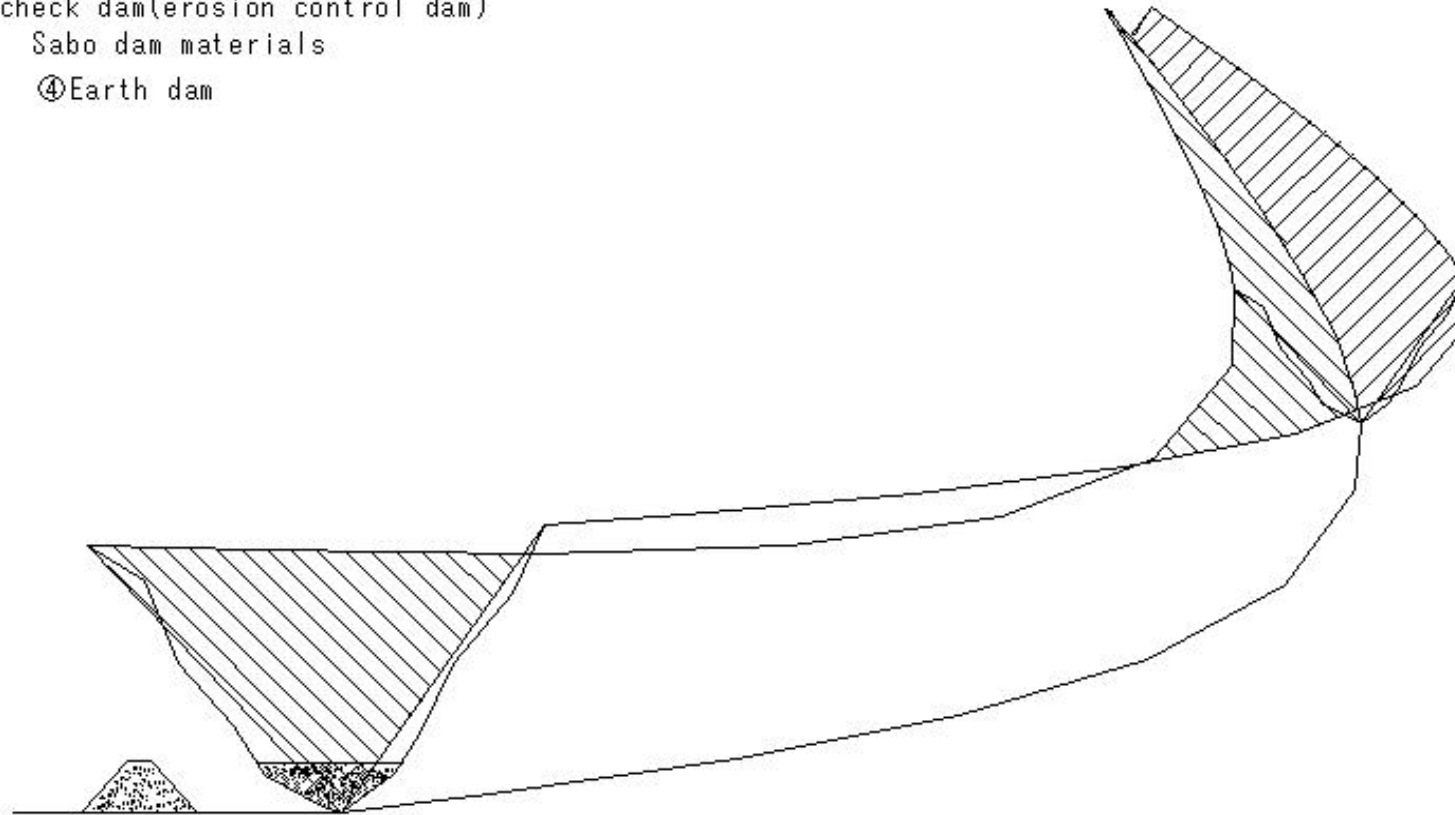
(S27)check dam(erosion control dam)

(S27)check dam(erosion control dam)

check dam(erosion control dam)

Sabo dam materials

④Earth dam



④Earth dam

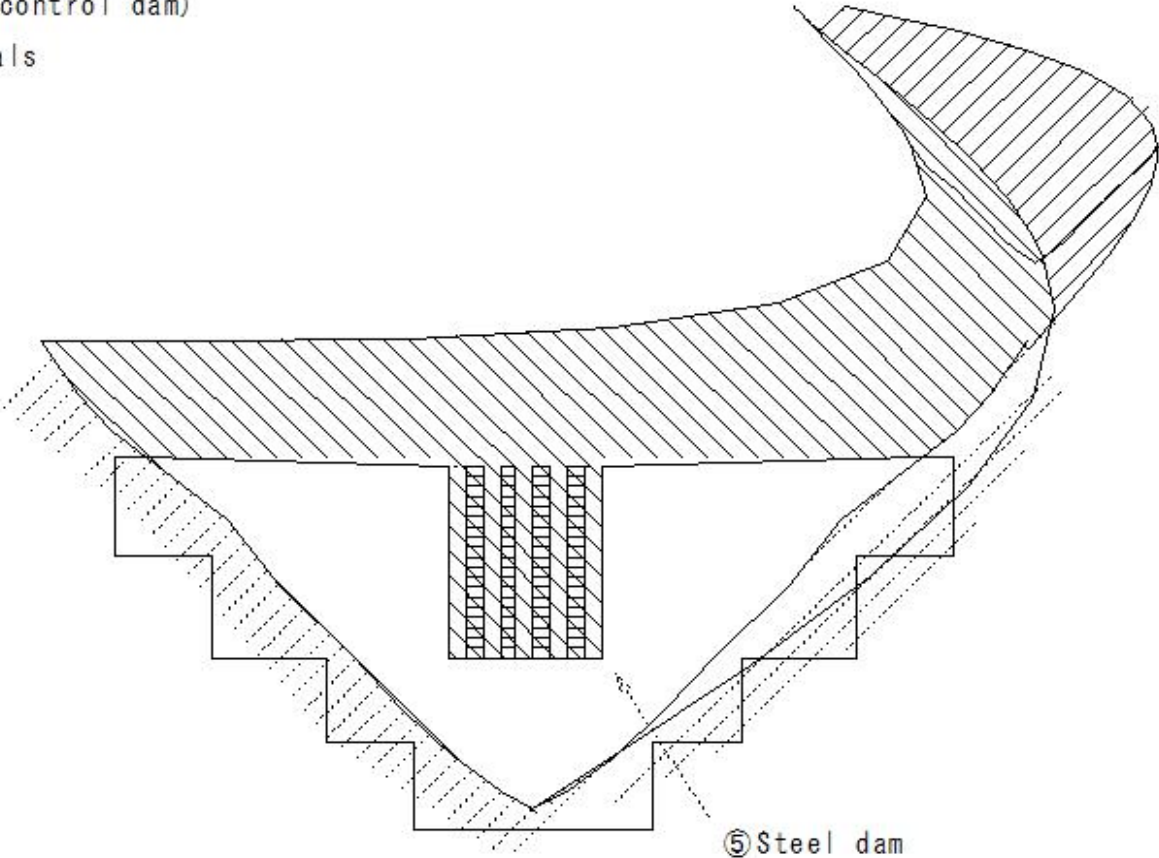
(S28)check dam(erosion control dam)

(S28) check dam(erosion control dam)

check dam(erosion control dam)

Sabo dam materials

⑤ Steel dam



(S29)check dam(erosion control dam)

(S29) check dam(erosion control dam)

check dam(erosion control dam)

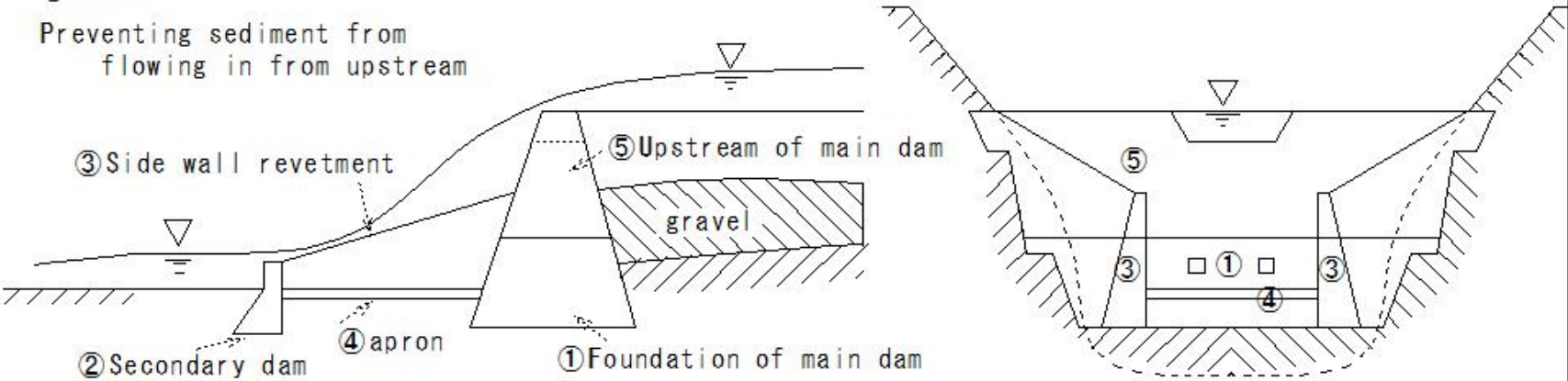
Construction order of check dam

- Desolate mountain stream
- Sand gravel accumulation

Construction order

- ① Foundation of main dam
- ② Secondary dam
- ③ Side wall revetment
- ④ apron
- ⑤ Upstream of main dam gravel

Preventing sediment from flowing in from upstream



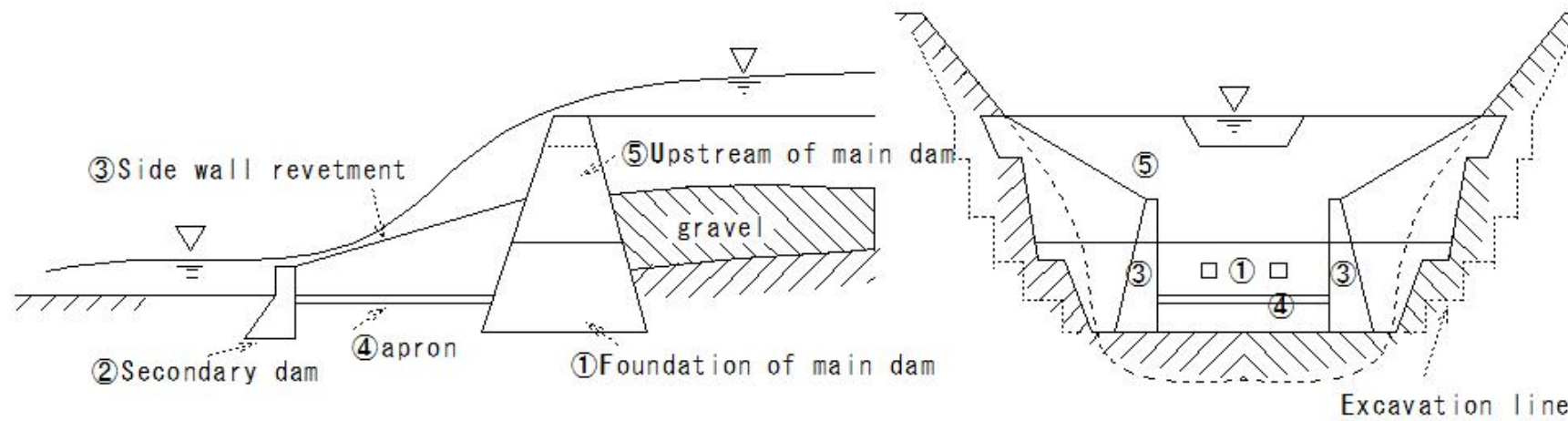
(S30)Construction of check dam

(S30) Construction of check dam

check dam(erosion control dam)

Construction order of check dam

- Excavation foundation treatment work
- ① Foundation excavation
- Construction during dry season
- Excavation on both banks - one stage each
- After concrete placement - next excavation
- Relationship between excavation and process - consideration

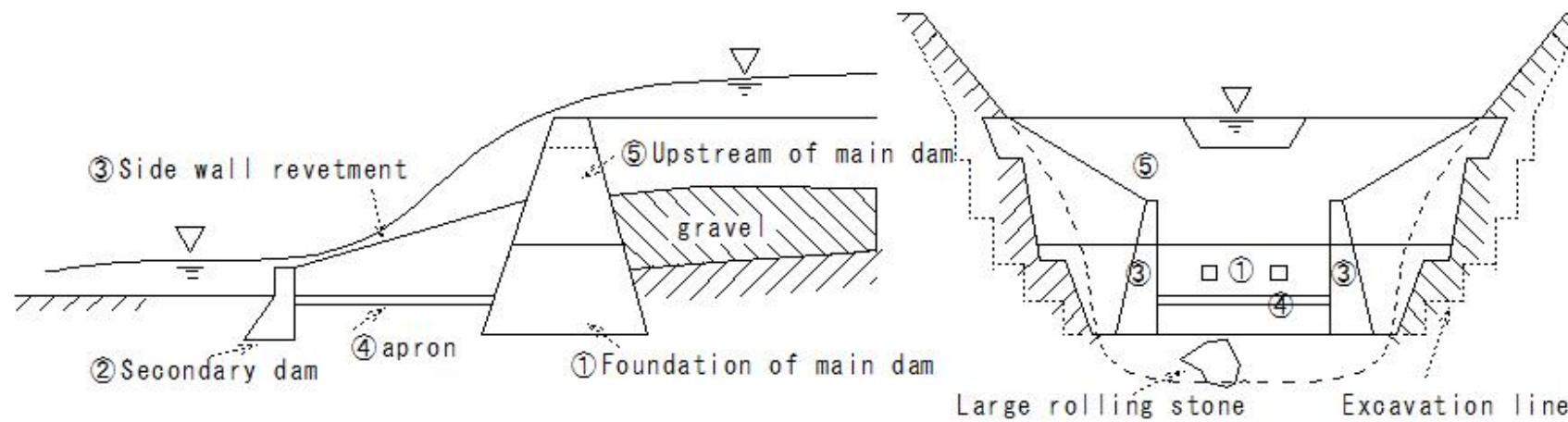


(S31)Construction of check dam

(S31)Construction of check dam

Construction of check dam

- Excavation foundation treatment work
- ②Excavation
 - Below the surface
 - Excavation-rock/ground condition
 - Excavation with safe and minimal limits
 - Changing the design foundation ground height depending on the bedrock
 - Large rolling stones on the foundation ground surface
 - Mostly buried in the ground
 - Difficult to remove - no need to remove

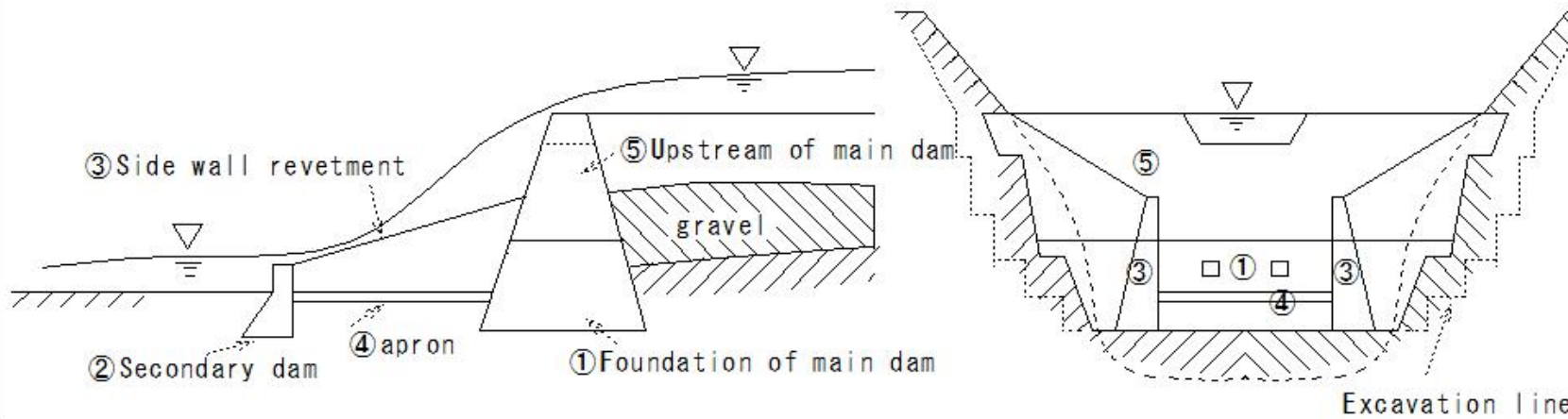


(S32)Construction of check dam

(S32) Construction of check dam

Construction of check dam

- Excavation foundation treatment work
- ③ Excavation
 - case of using gunpowder
 - Do not loosen the foundation ground
 - Near the design foundation height: Do not use explosives
 - Avoid large explosions



Avoid large explosions

(S33)Construction of check dam

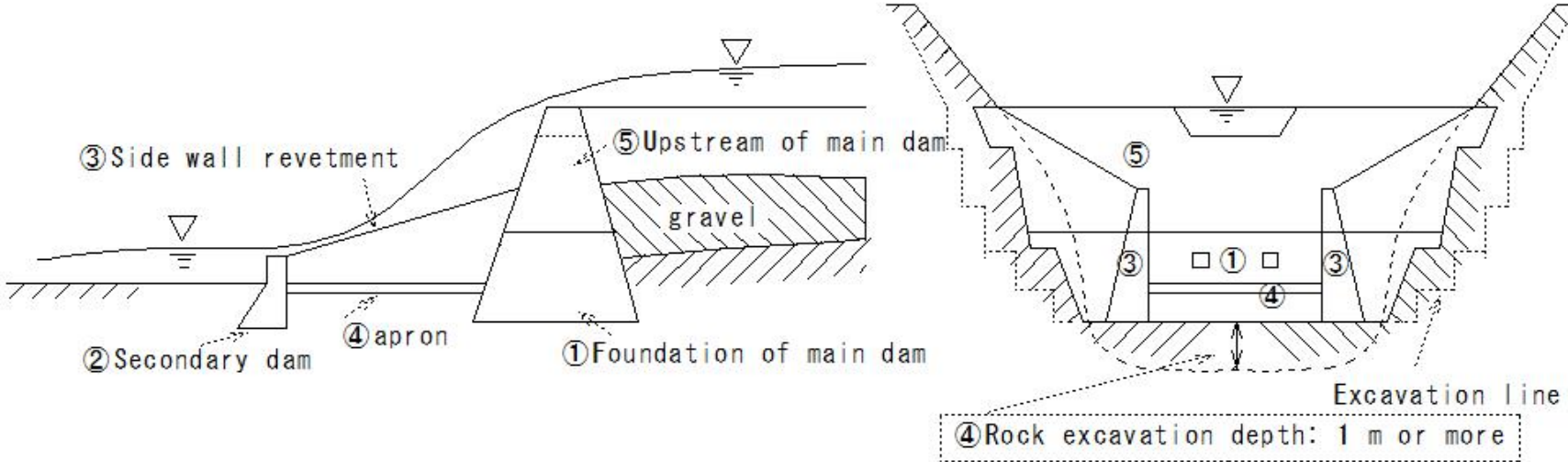
(S33)Construction of check dam

Construction of check dam

- Excavation foundation treatment work

④Rock excavation depth: 1 m or more

- Avoid large explosions

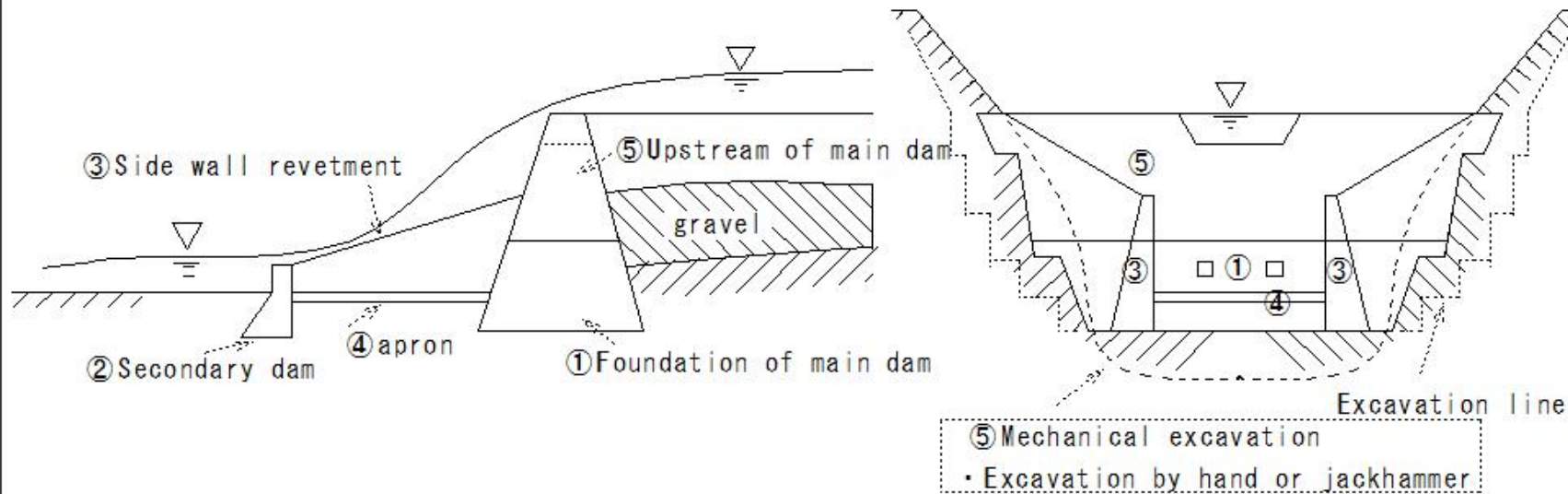


(S34) Construction of check dam

(S34) Construction of check dam

Construction of check dam

- Excavation foundation treatment work
 - ⑤ Mechanical excavation
 - Proceeding to near the design foundation ground
 - Excavation by hand or jackhammer
- Deep trenches do not require backfilling

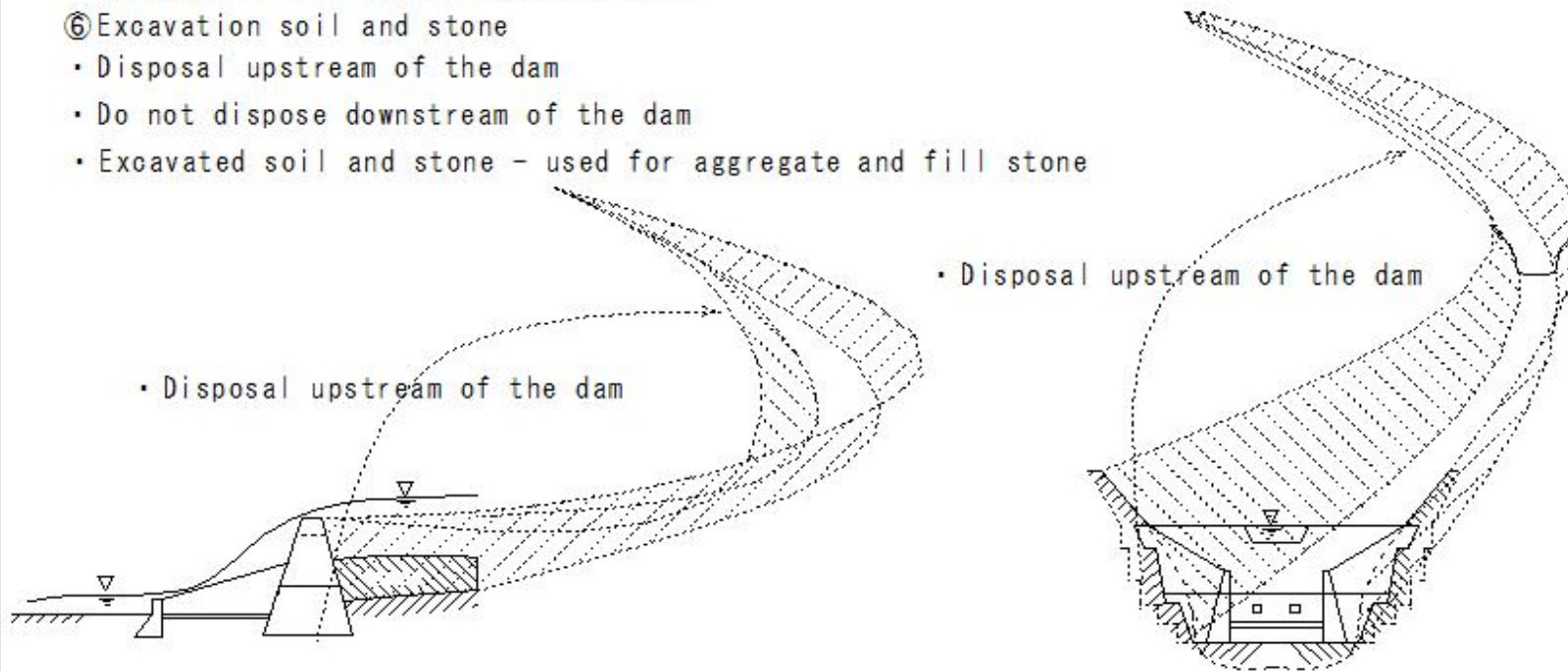


(S35)Construction of check dam

(S35) Construction of check dam

Construction of check dam

- Excavation foundation treatment work
- ⑥ Excavation soil and stone
 - Disposal upstream of the dam
 - Do not dispose downstream of the dam
 - Excavated soil and stone - used for aggregate and fill stone



(S36)Construction of check dam

(S36) Construction of check dam

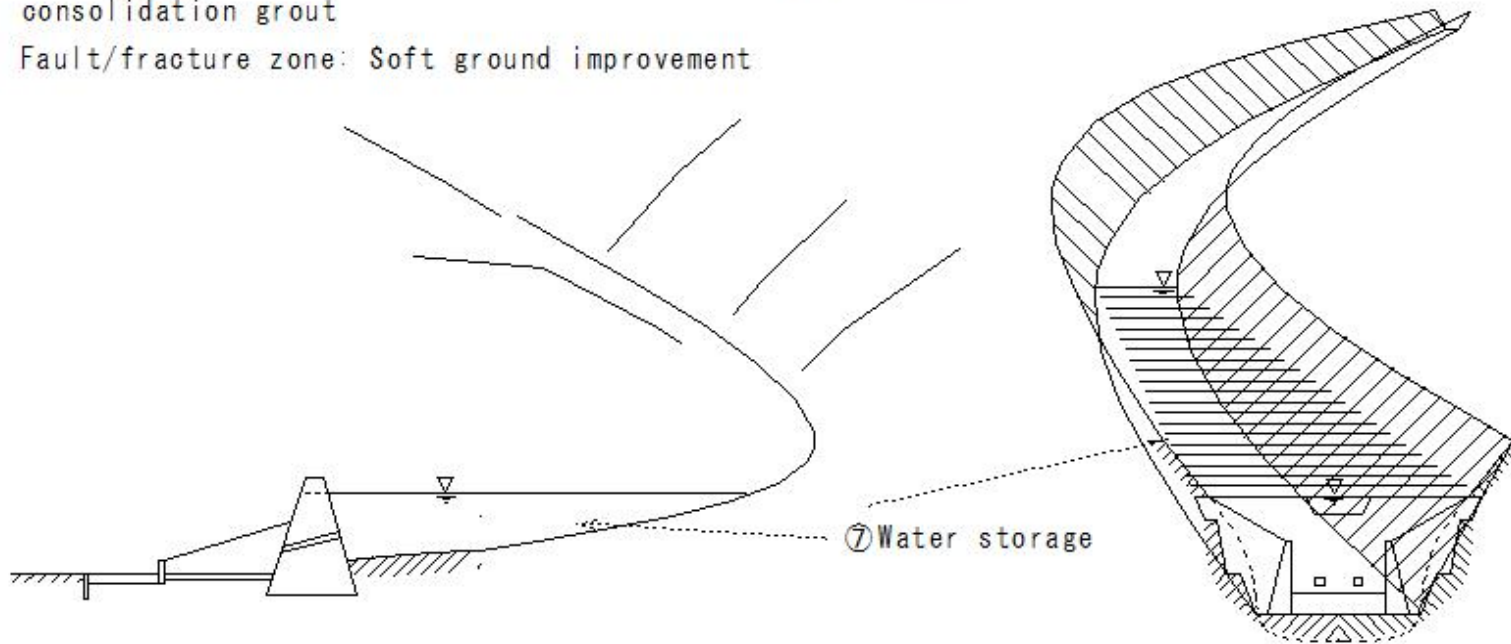
Construction of check dam

- Excavation foundation treatment work

⑦ Water storage

- Not intended for water storage
- Increasing the size - for the purpose of water storage consolidation grout

Fault/fracture zone: Soft ground improvement



(S37)Construction of check dam

(S37)Construction of check dam

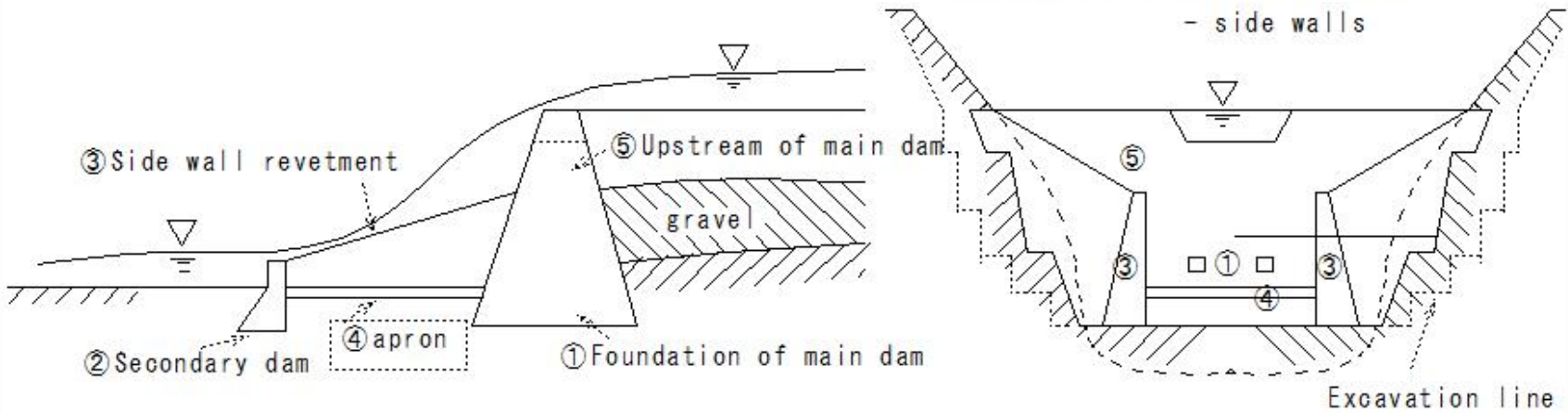
Construction of check dam

apron

- Prevention of scouring at downstream destination
- After concrete placement - next excavation
- rubble mound construction
- concrete block construction
- Length of apron

- Direct height of dam: h
- h=5m L=0.7-1.0m
- h=10m L=1.5m
- h=20m L=3m

- apron . downstream tip. scouring
- prevention vertical wall (sub-dam)
- footing depth: not scoured
- Both banks - easy to collapse



(S38)Construction of check dam

(S38)Construction of check dam

Construction of check dam

①concrete placement

Transport vehicle

cable crane

chute: Not good.

(check dam)erosion control dam

launch height

downstream

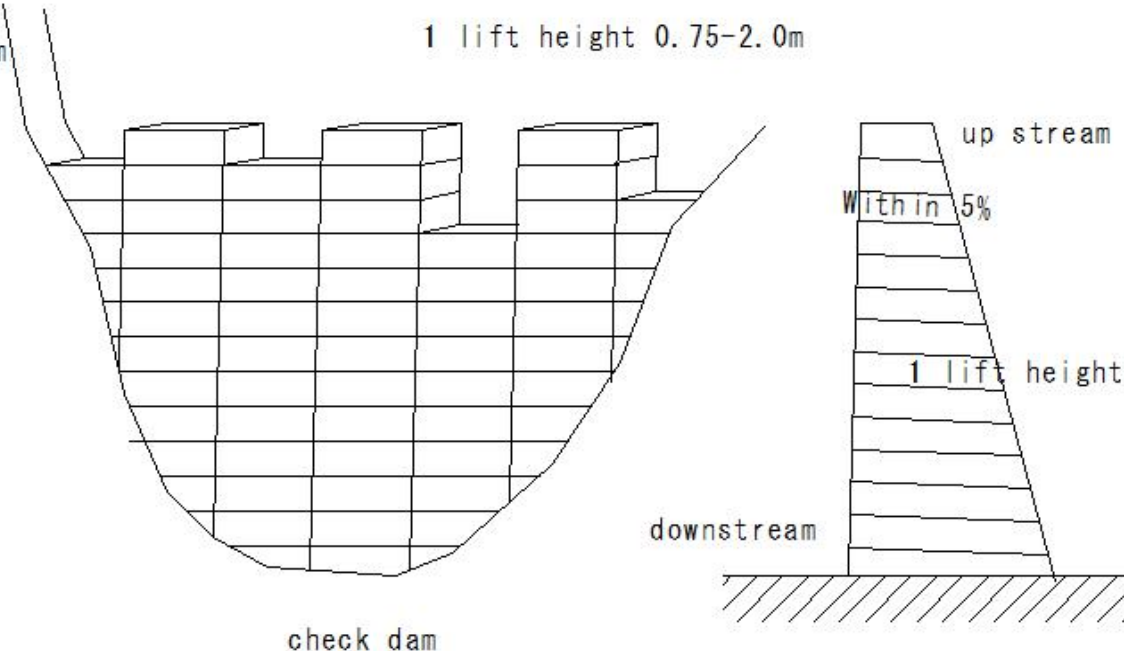
Preventing sediment from
flowing in from upstream

Within 5%

1 lift height

placing surface slope

1 lift height 0.75-2.0m



check dam

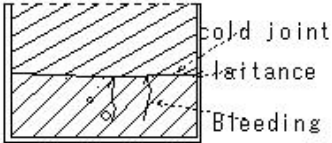
(S39)Construction of check dam

(S39)Construction of check dam

Construction of check dam

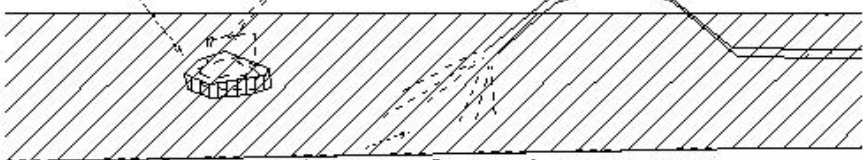
concrete placement

- ② Before placing, thoroughly clean the new and old rock bed joints.
 - washing mortar using pressure water, etc.
 - Exposing the surface of coarse aggregate
 - Lay mortar about 2cm thick
 - The standard thickness for new and old concrete casting surfaces is 1.5 cm.

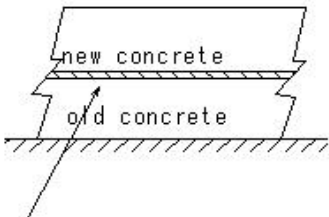
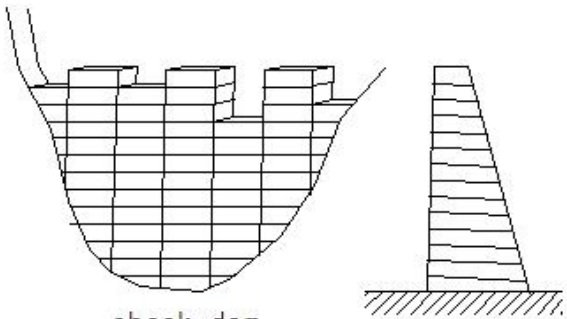


Measures to prevent cold joints Temporary suspension of construction does not integrate with concrete

① Laitance removal



C880



① Horizontal joint

C1410

(S40)Construction of check dam

(S40)Construction of check dam

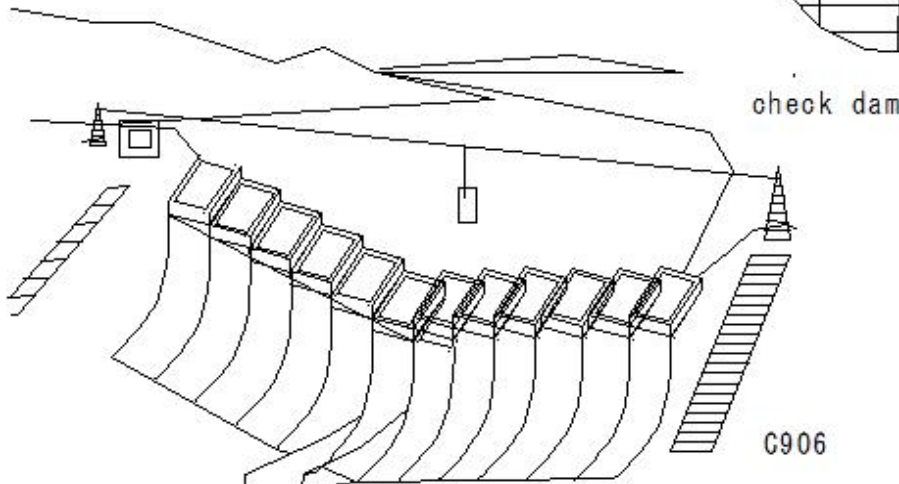
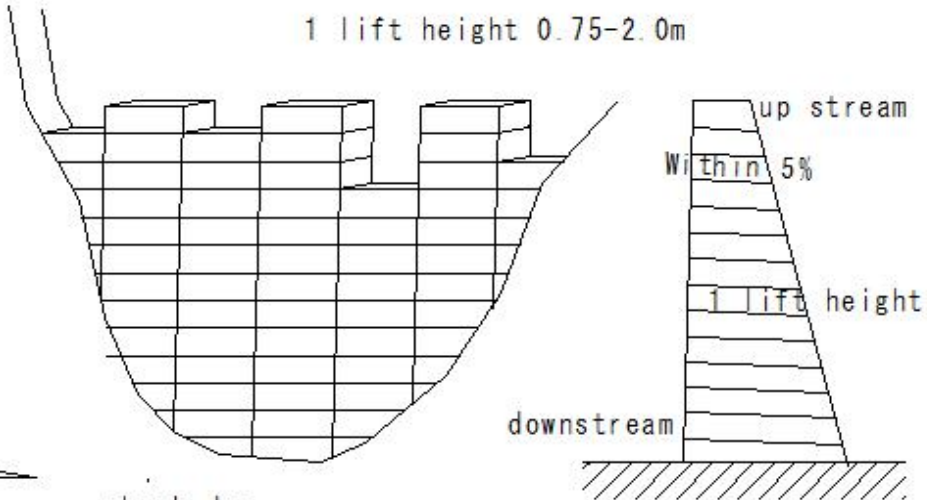
Construction of check dam

concrete placement

③Height of one concrete placing

1 lift height

- 0.75m-2.0m
- Dissipation of curing heat
- Consider cracks



(S41)watercourse

(S41) watercourse

watercourse

ground sill consolidation works

sediment accumulation

watercourse

3-sided revetment

apron , downstream tip, scouring prevention

vertical wall (sub-dam)

Water passage width Minimum width 3m

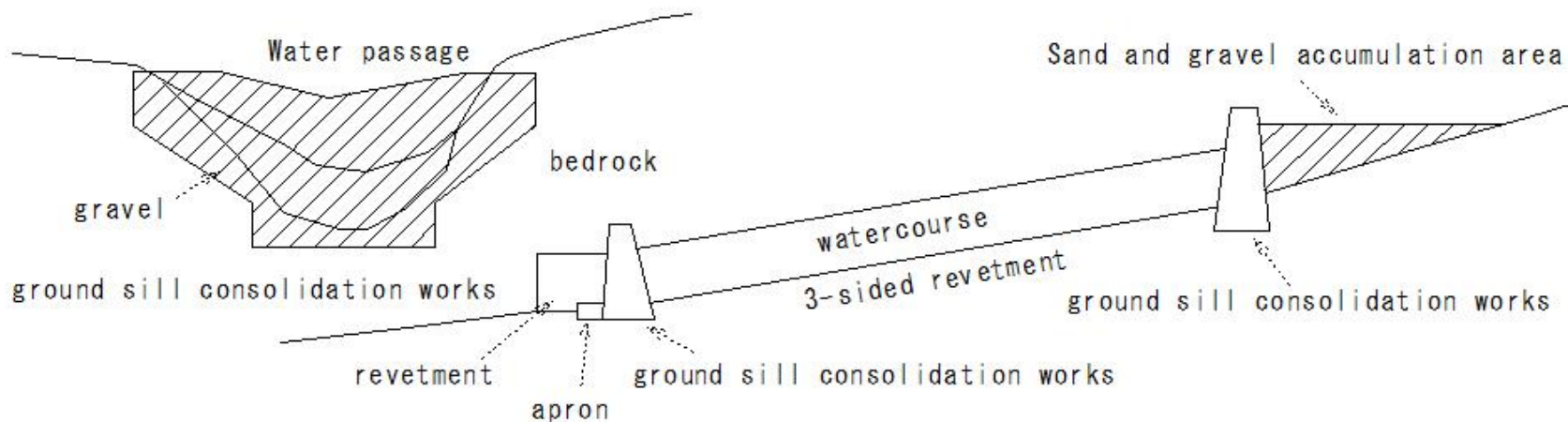
ground sill consolidation works

- Sand and gravel accumulation area
- Vertical and horizontal erosion of running water
- Sediment production

①Vertical regulation of watercourse

②watercourse flatness regulation

③Prevention of collapse revetment on both banks



(S42)watercourse

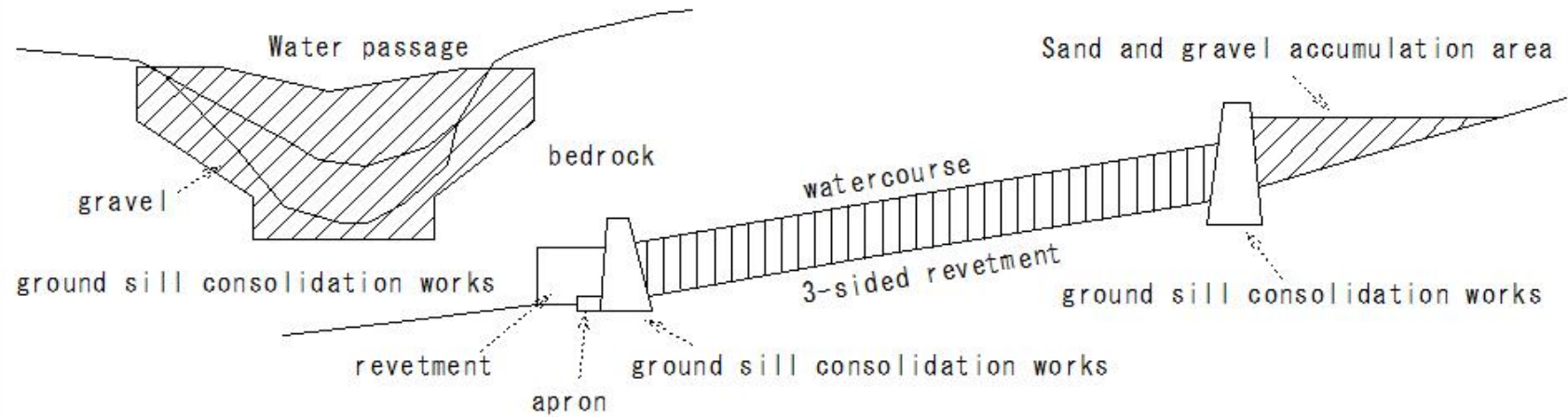
(S42) watercourse

watercourse

structure

① check dam and watercourse

familiarly installed downstream from the secondary dam



(S43)watercourse

(S43) watercourse

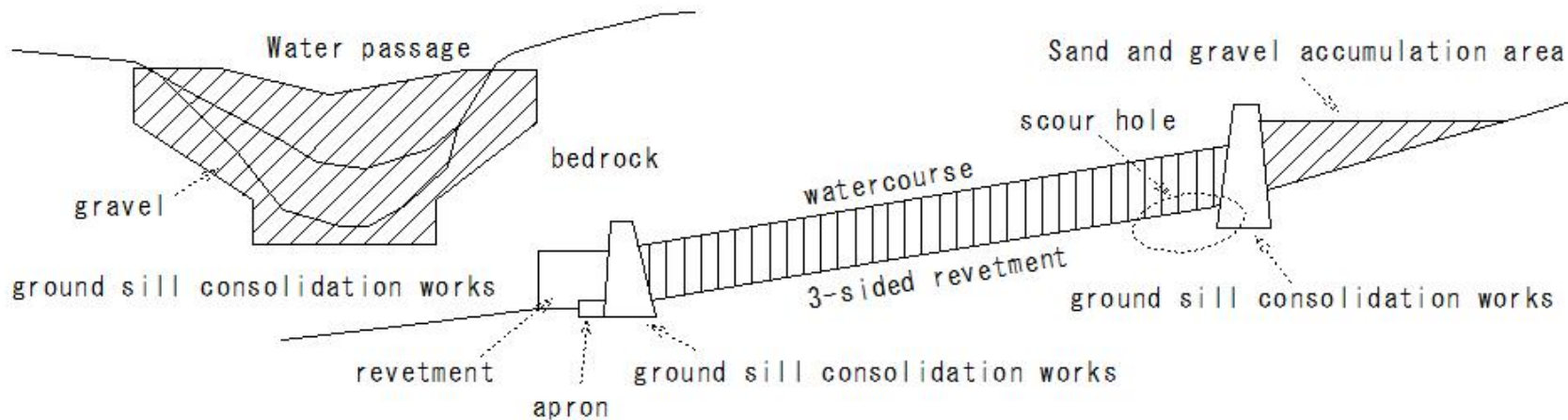
watercourse

structure

②End treatment of the stretched part

3-sided watercourse construction - 2-sided watercourse construction

- Difference in current velocity - near upstream area, foundation part of revetment - scour hole
- Bed protection work - Consider energy reduction work



(S44)watercourse

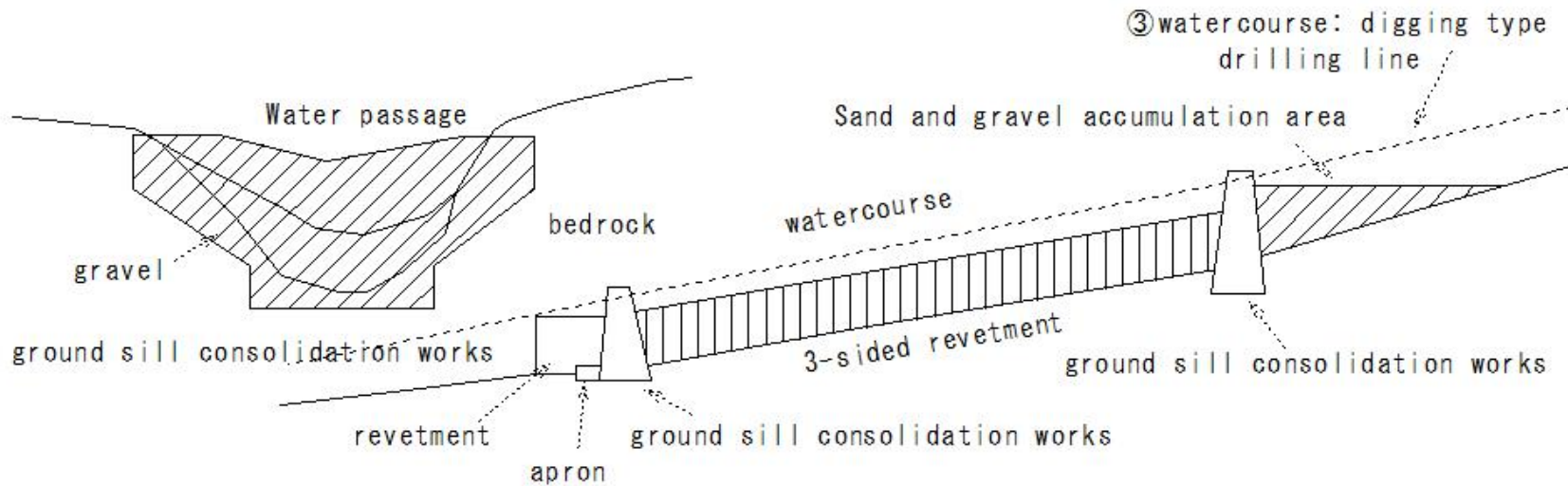
(S44) water course

watercourse

structure

③watercourse: digging type

- Avoid embankment construction



(S45)watercourse

(S45) watercourse

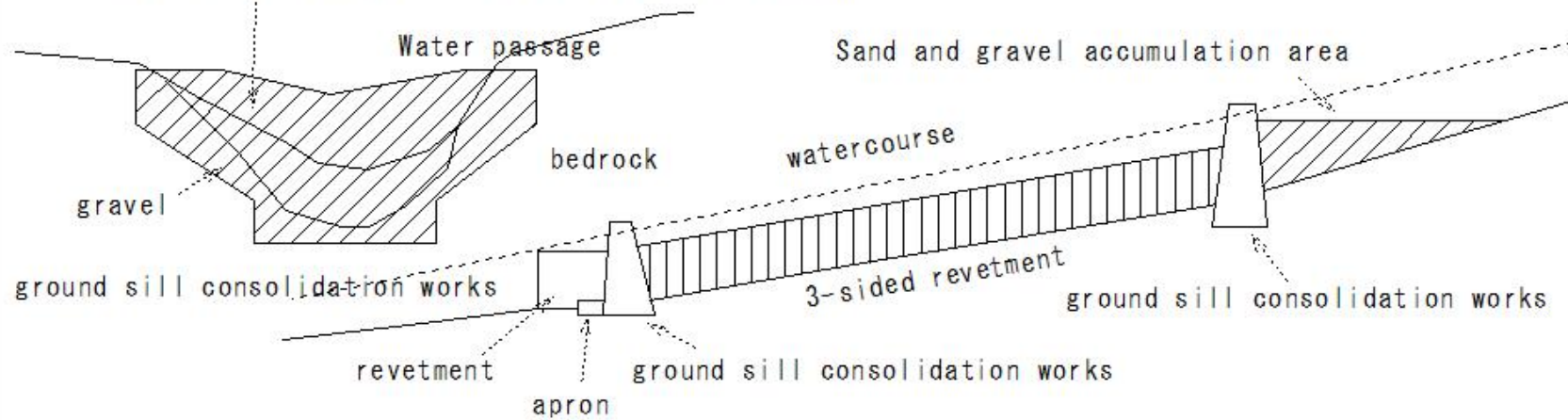
watercourse
structure

④Planned cross section

④Planned cross section

• Current river channel width

Prevent the river width from becoming smaller than it is now.



(S46)watercourse

(S46) watercourse

watercourse

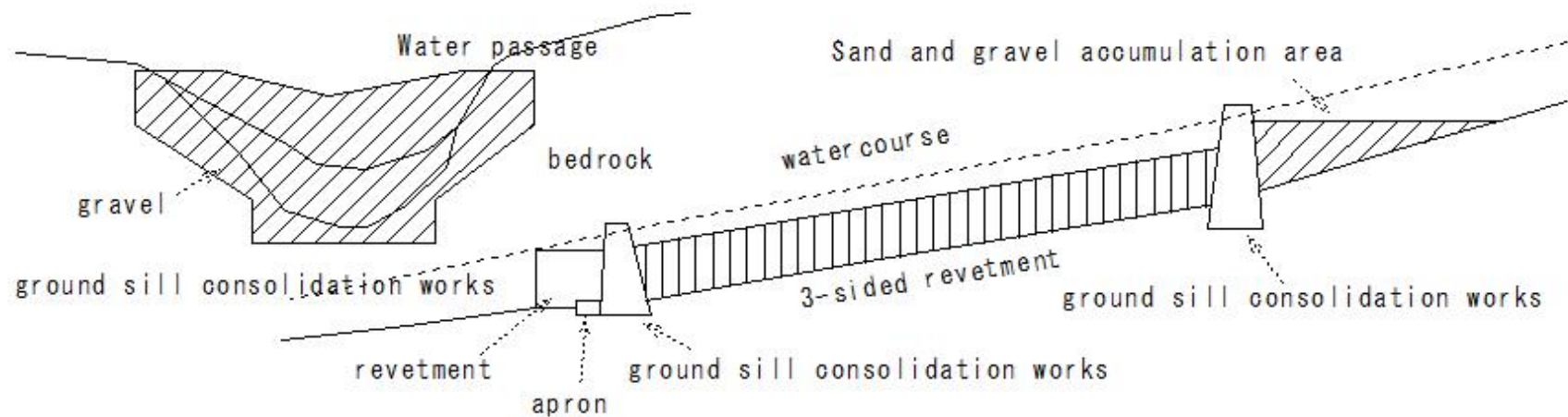
Construction start date

Examining the condition of devastation
in the upper reaches of mountain streams

①Upstream area is in ruins

- check dam work has been completed -
watercourse can be carried out

①Upstream area is in ruins



(S47)watercourse

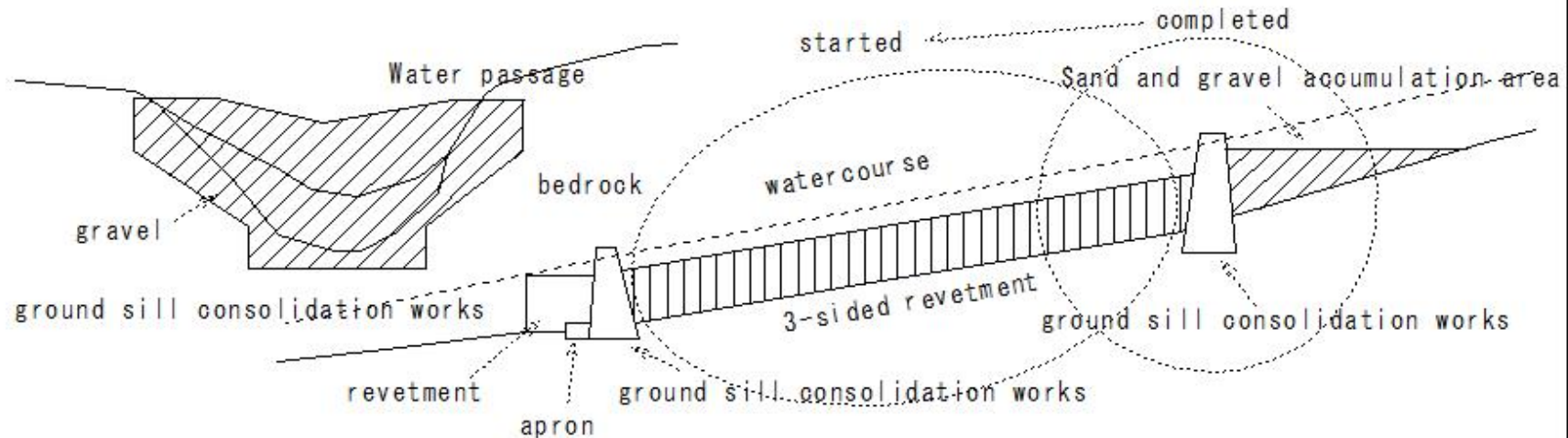
(S47) watercourse

watercourse

Construction start date

② case of relatively little devastation upstream

- watercourse construction - Can be started as soon as equipment to prevent earth and sand from upstream is completed.

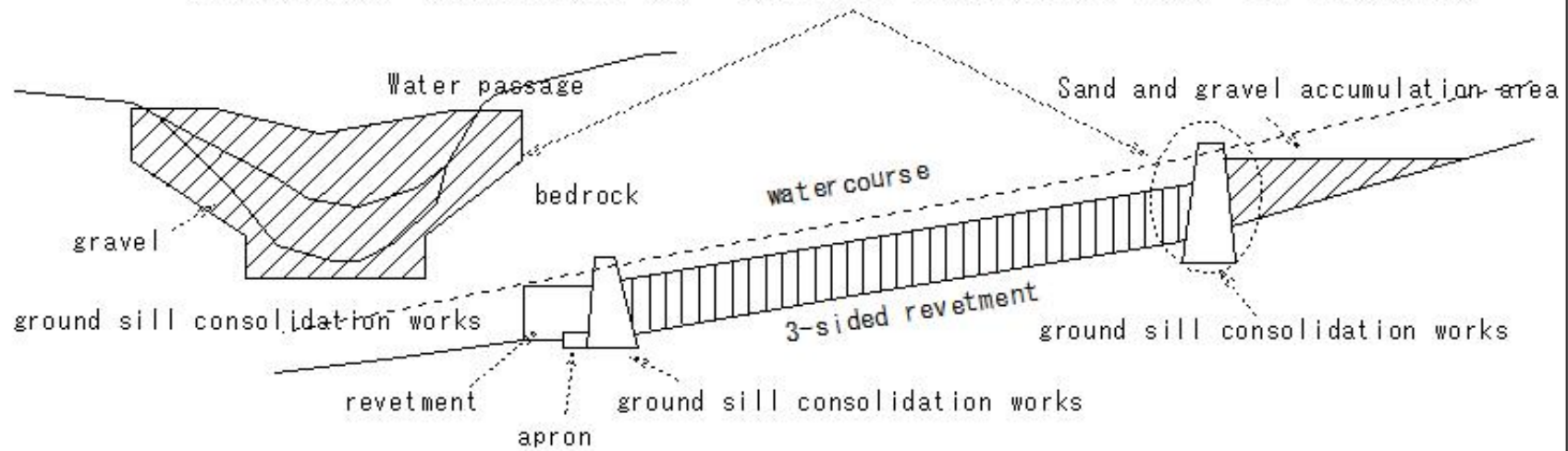


(S48)watercourse

(S48)watercourse

watercourse
Construction

①watercourse - Most upstream end - ground sill consolidation works -fit into bedrock



(S49)watercourse

(S49) watercourse

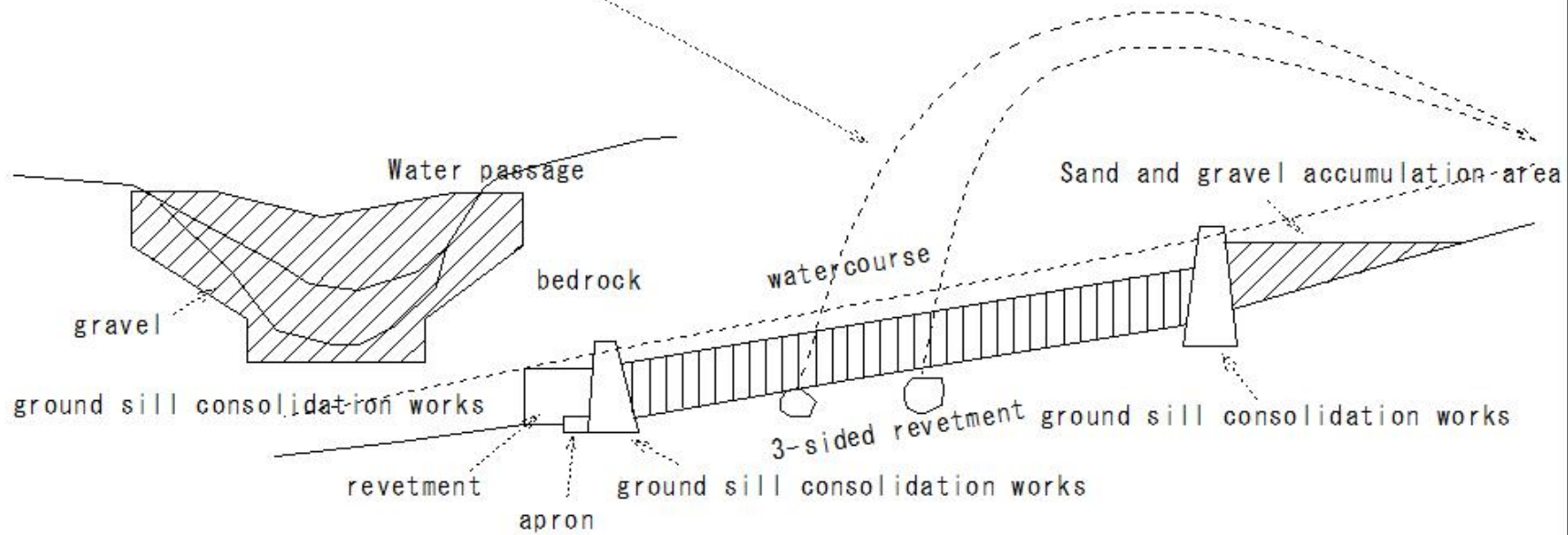
watercourse

Construction

②After the watercourse construction is completed

Collecting rolling stones and cobblestones from the riverbed

Causes of channel damage



(S50)watercourse

(S50) watercourse

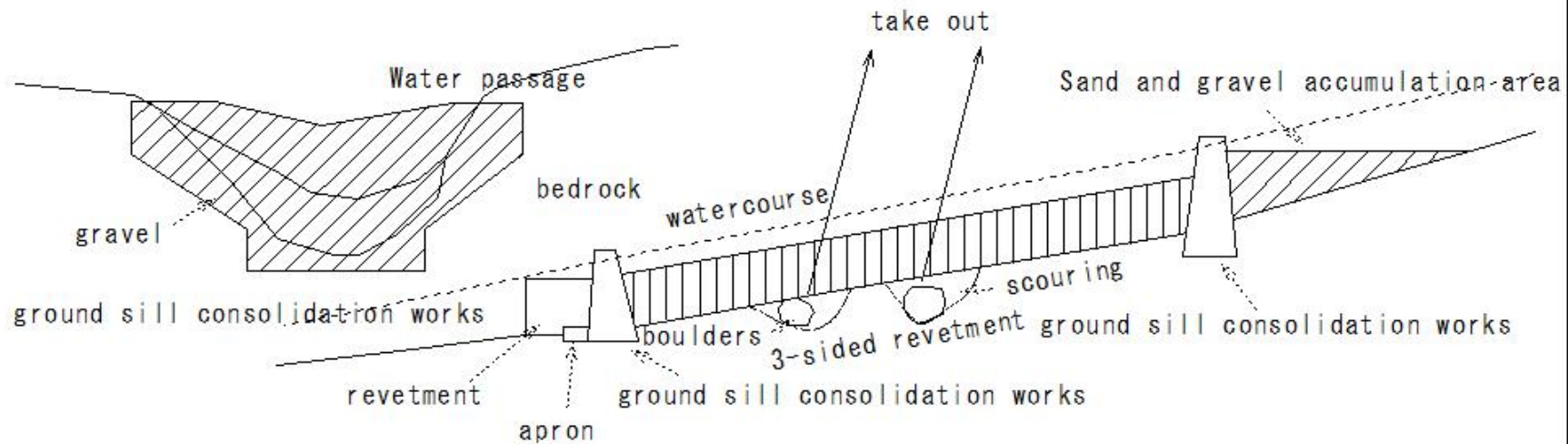
watercourse

Construction

③ case of there are boulders in the watercourse work
scouring is carried out

Destruction of revetment

• take out before watercourse construction

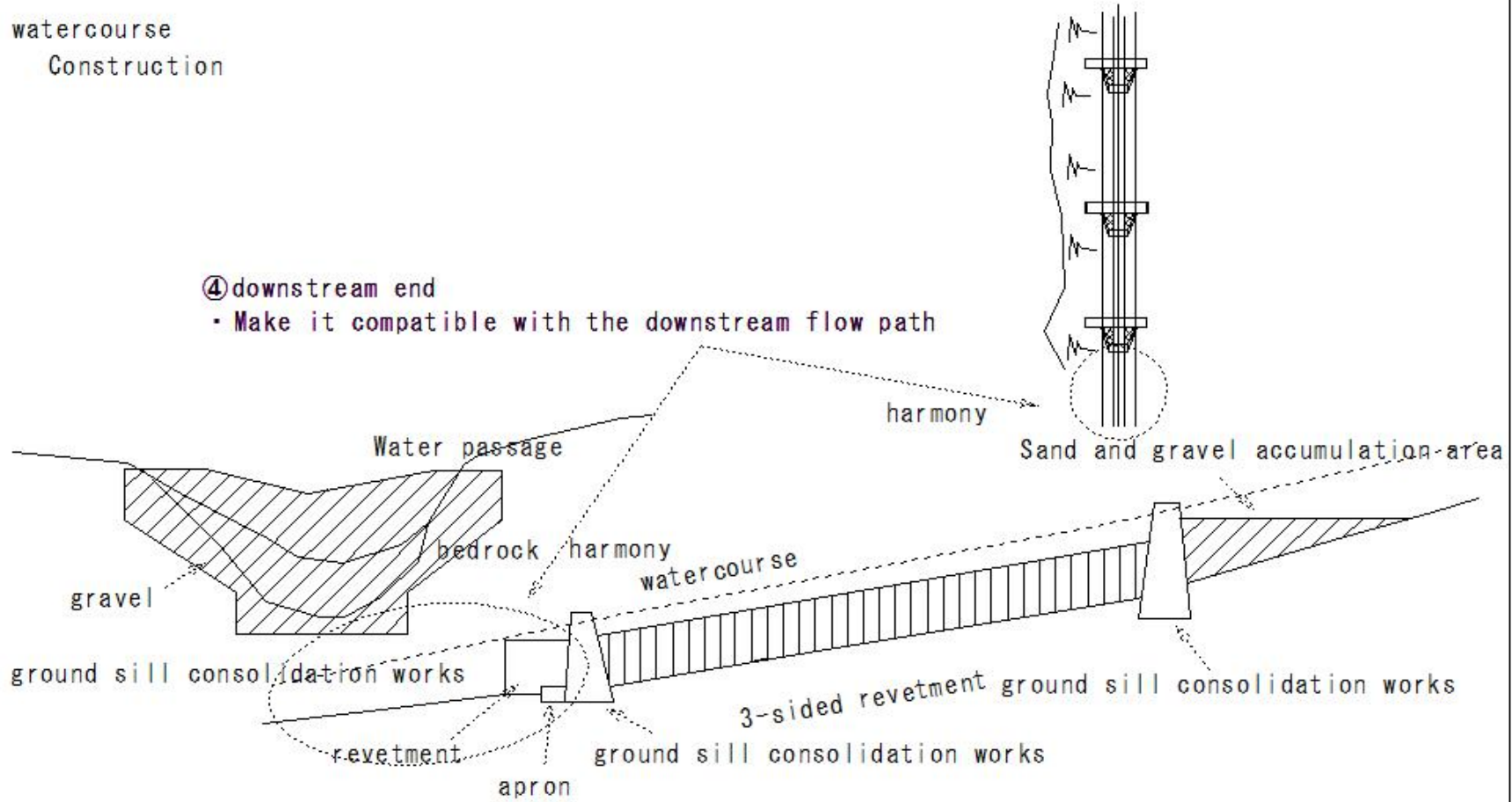


(S51)watercourse

(S51) water course

watercourse
Construction

- ④ downstream end
- Make it compatible with the downstream flow path

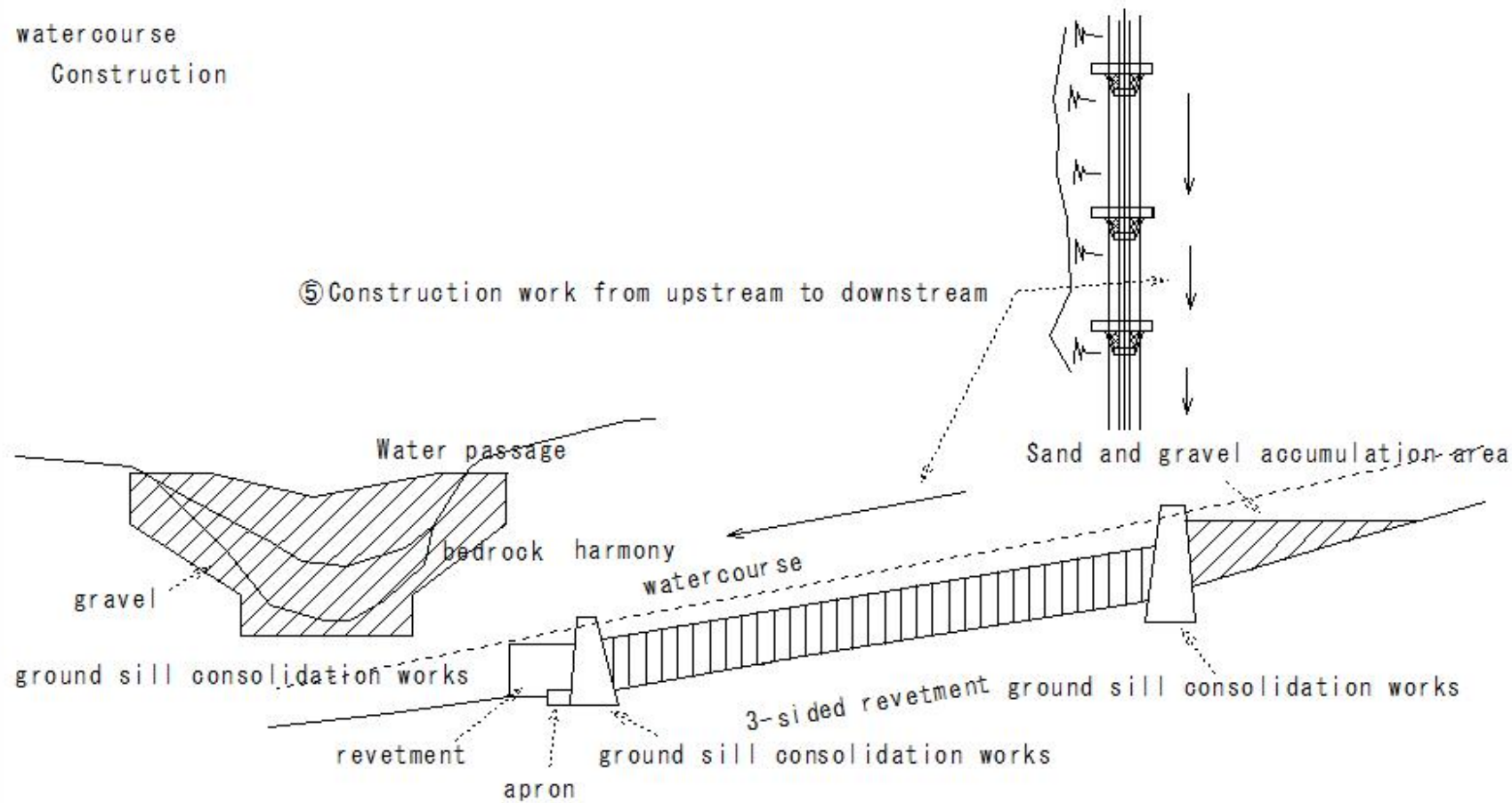


(S52)watercourse

(S52) watercourse

watercourse
Construction

⑤ Construction work from upstream to downstream



(S53)watercourse

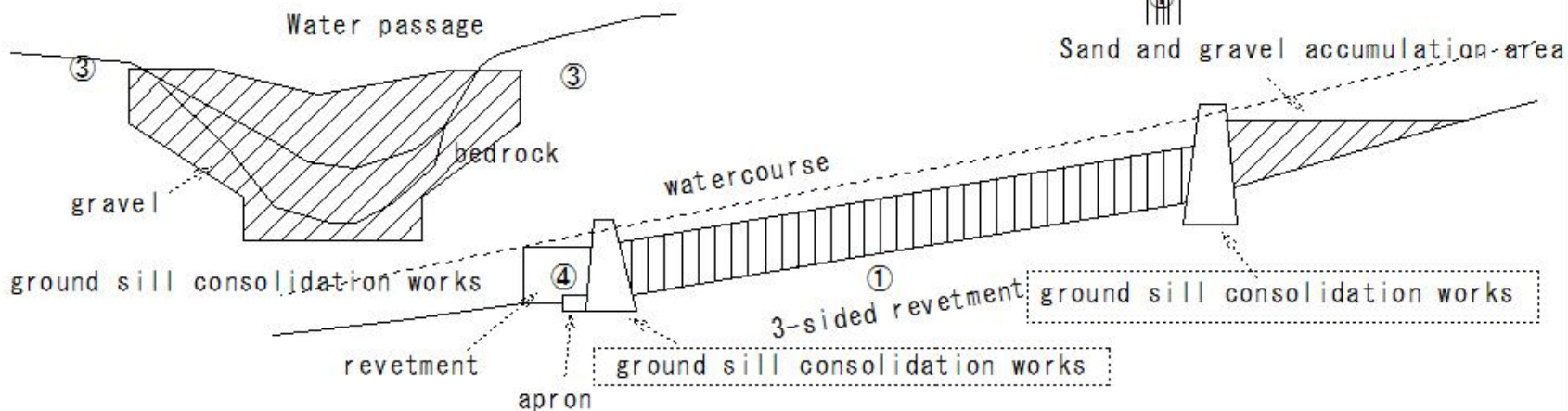
(S53) watercourse

watercourse

ground sill consolidation works

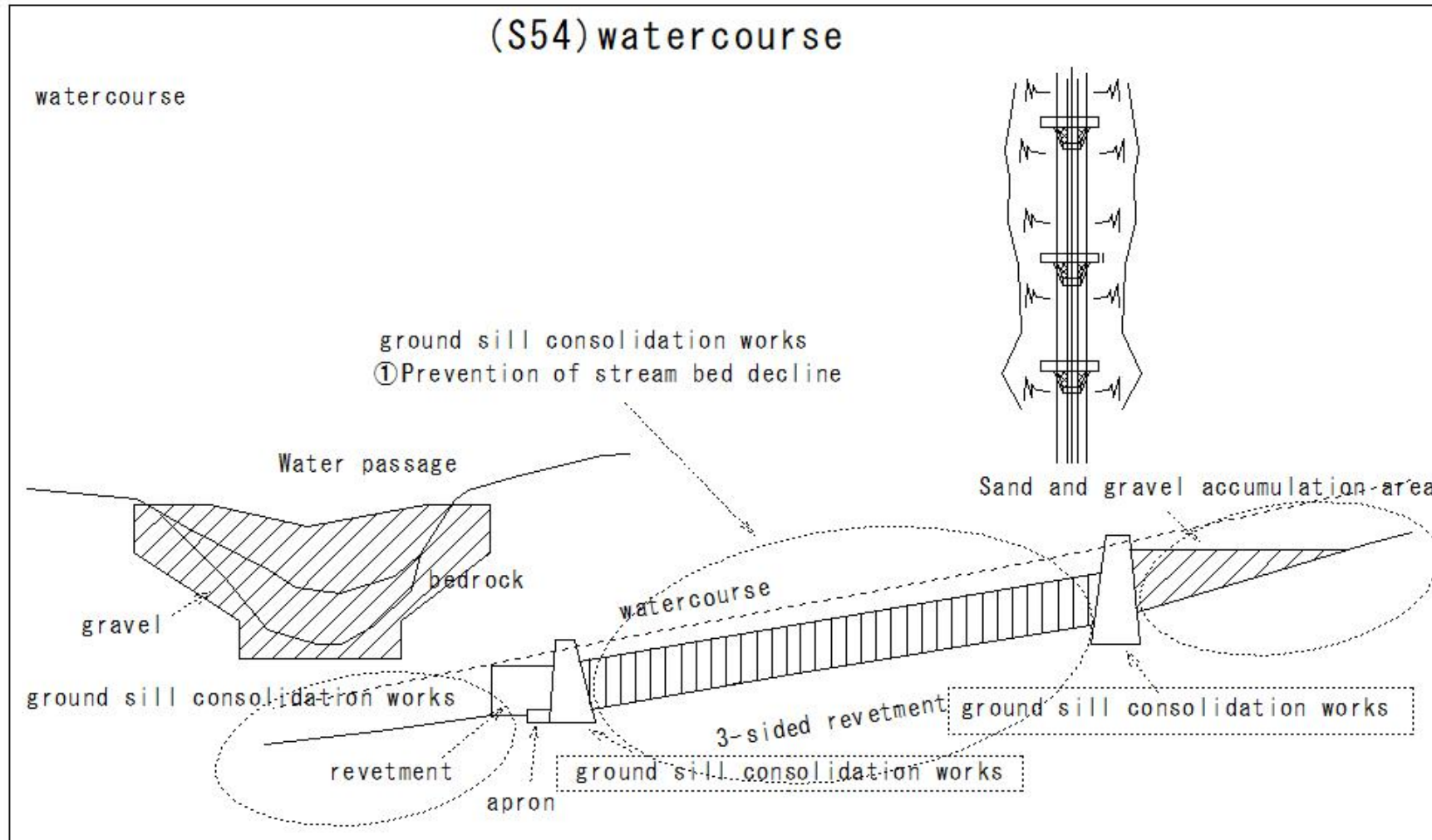
purpose

- ① Preventing vertical erosion and stabilizing the stream bed
- ② Prevention of re-migration of streambed sediments
- ③ Prevention of bank failure/collapse
- ④ Foundation protection of structures such as revetment



(S54)watercourse

(S54) watercourse

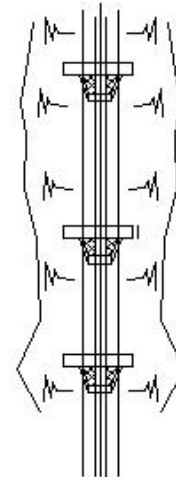


(S55)watercourse

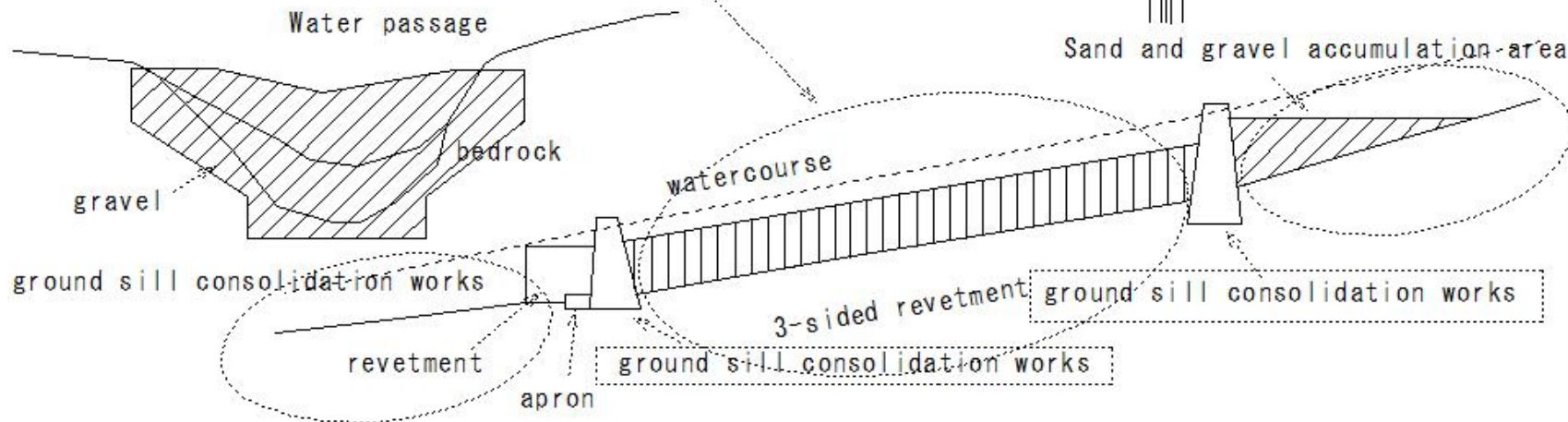
(S55) watercourse

watercourse

ground sill consolidation works
②Mountain stream width - wide
Prevention of turbulence



Sand and gravel accumulation-area



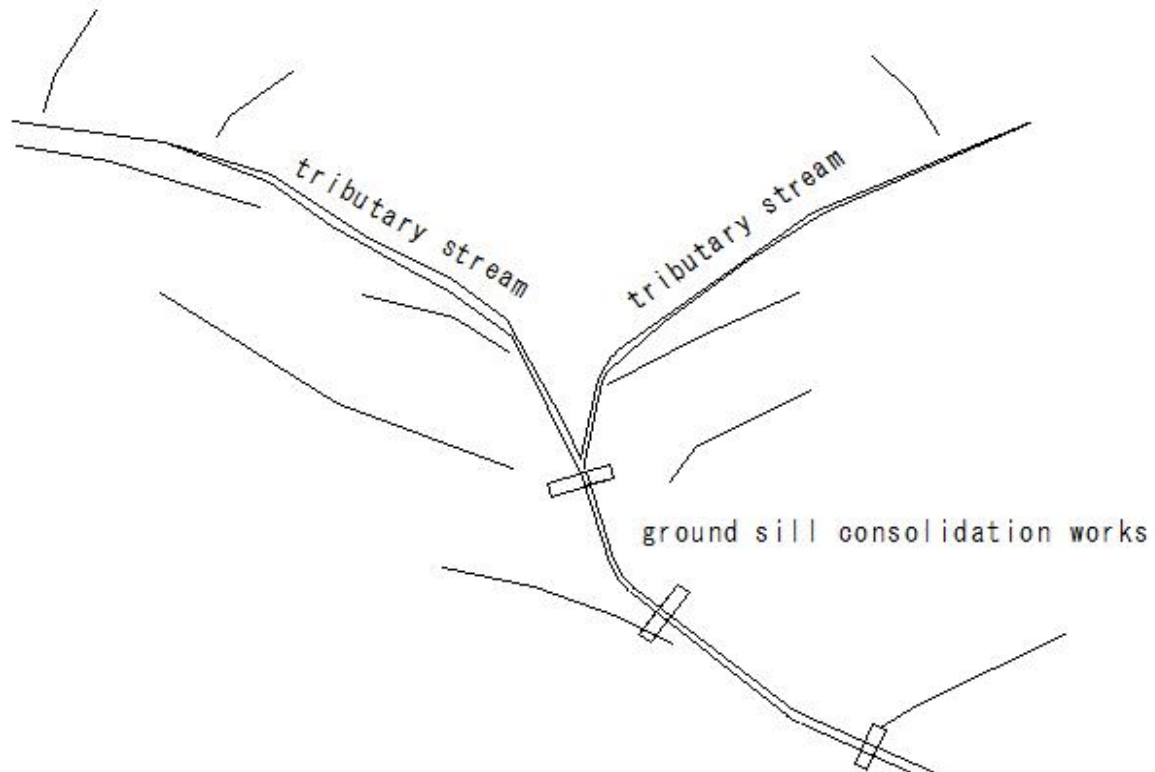
(S56)watercourse

(S56) water course

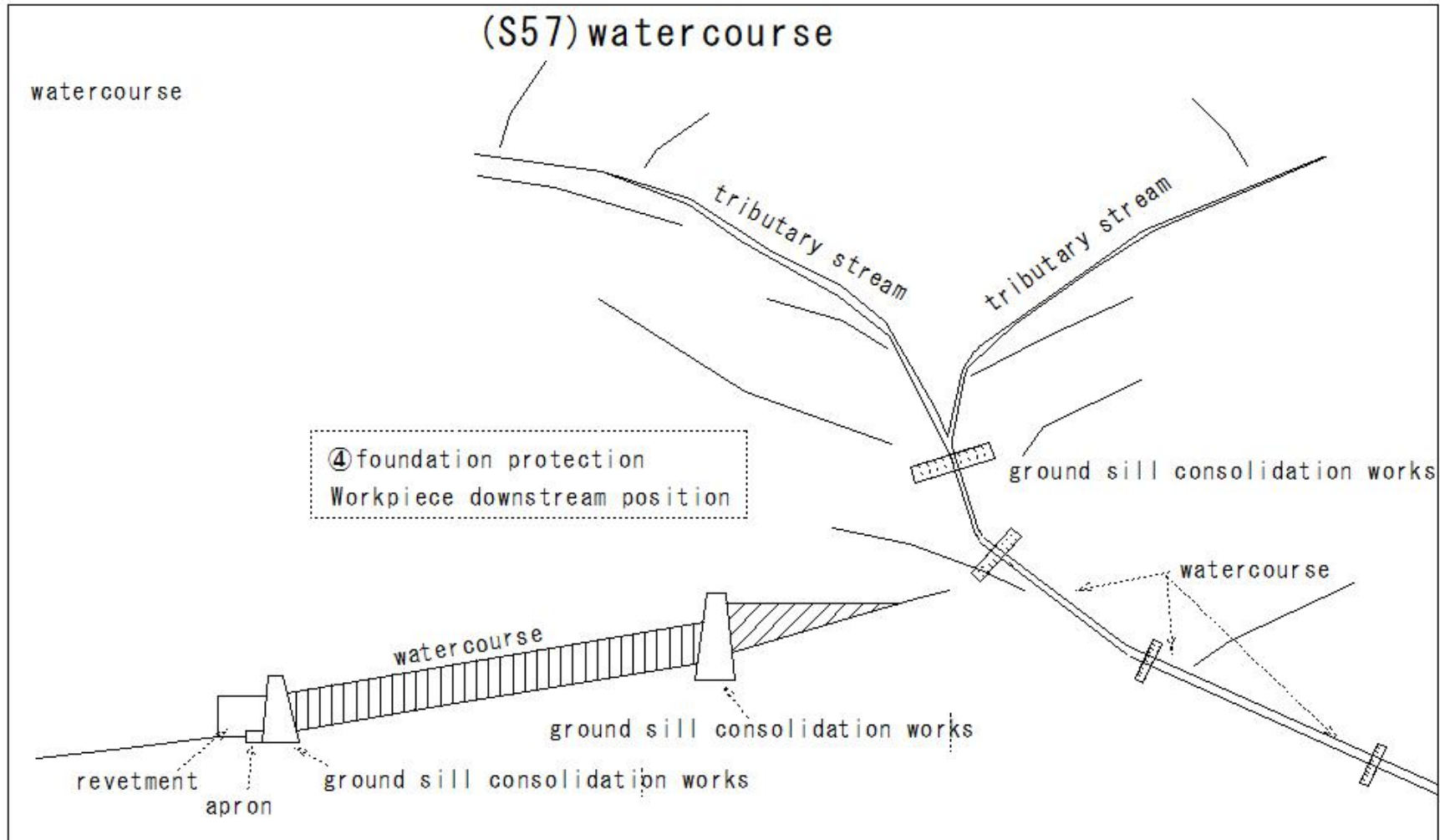
watercourse

ground sill consolidation works

③ Downstream location of tributary stream confluence



(S57)watercourse



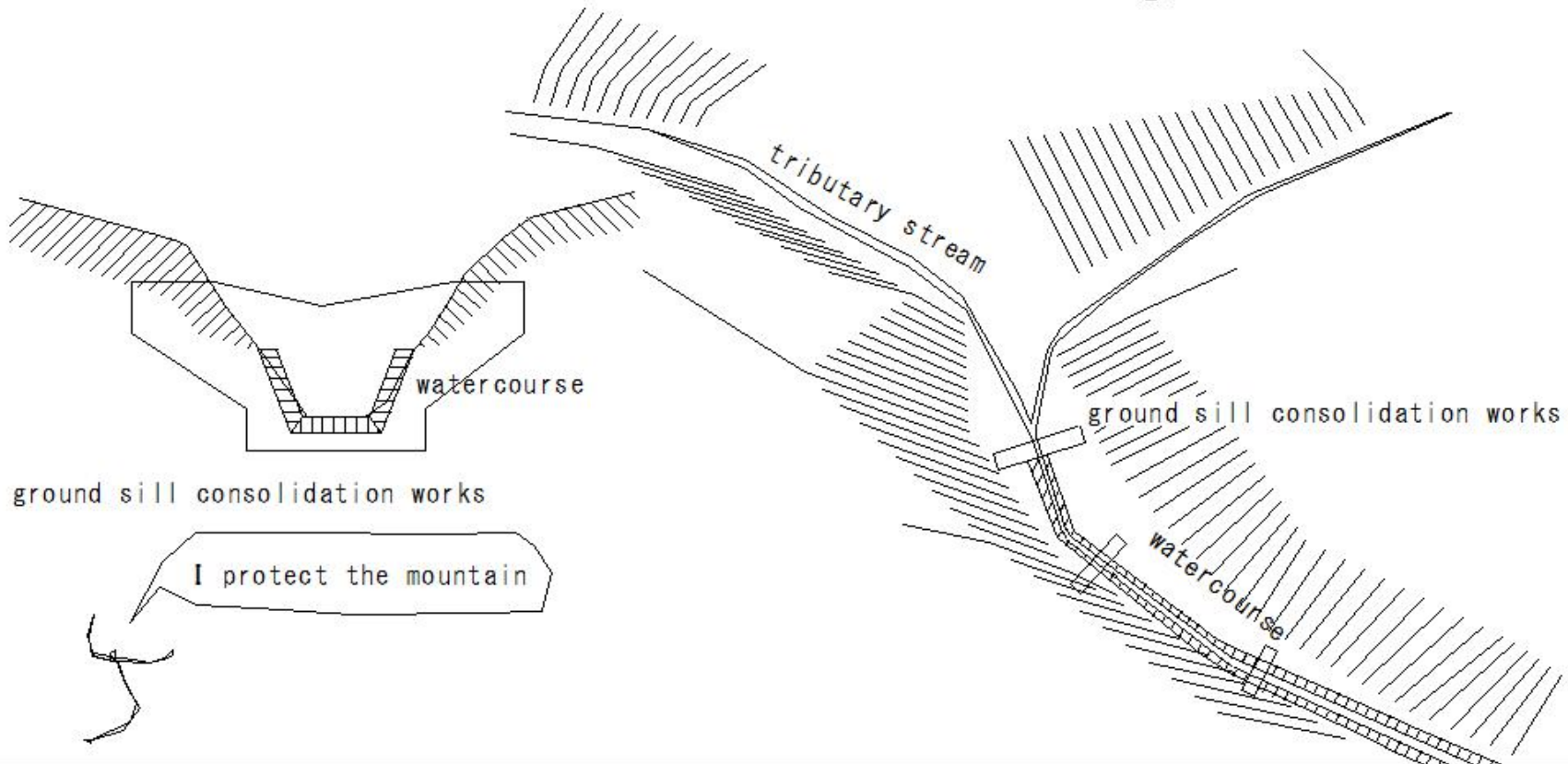
(S58)watercourse

(S58) watercourse

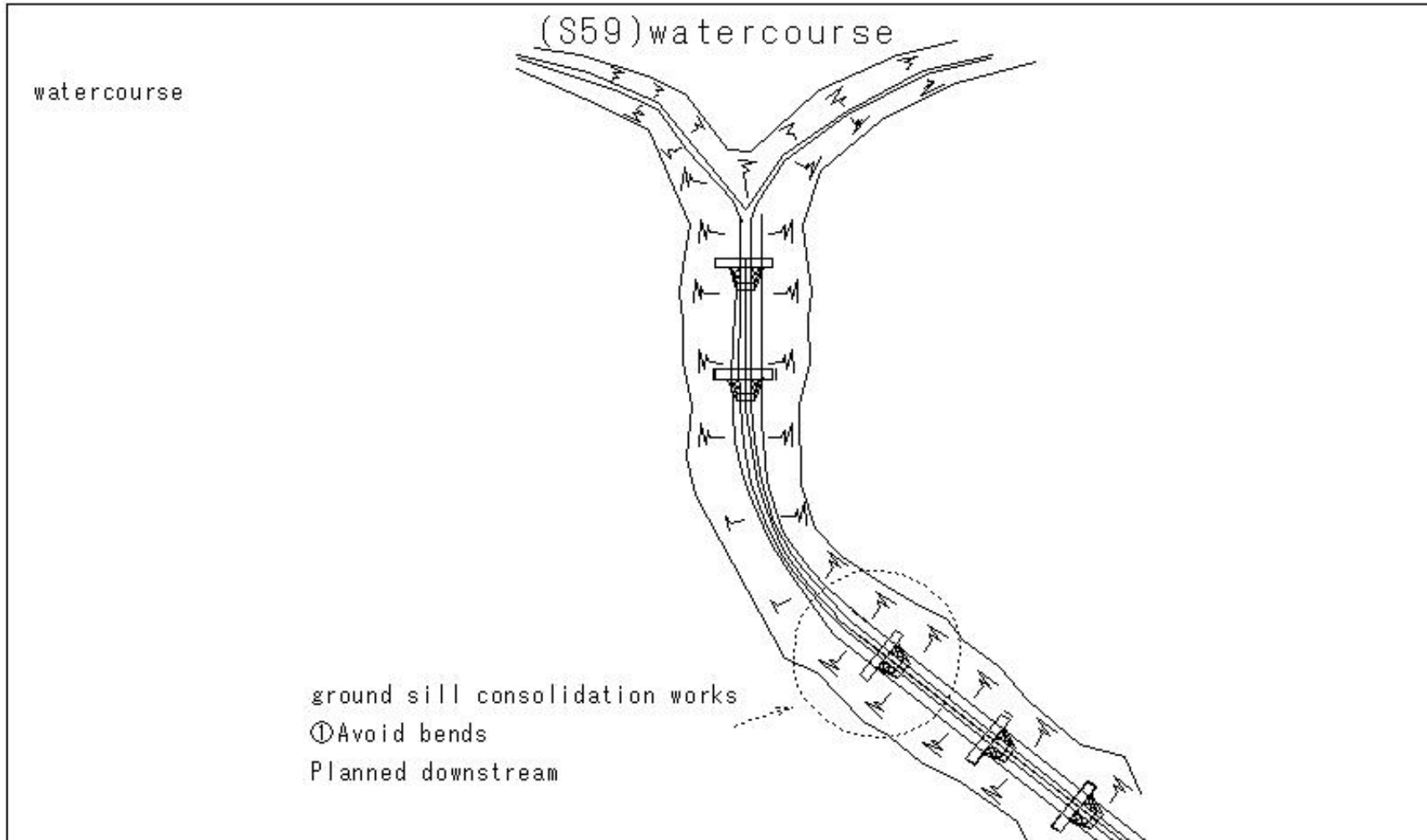
watercourse

⑤Prevention of riverbank bursts, collapses, and landslides

God bless !



(S59)watercourse



(S60)watercourse

(S60)watercourse

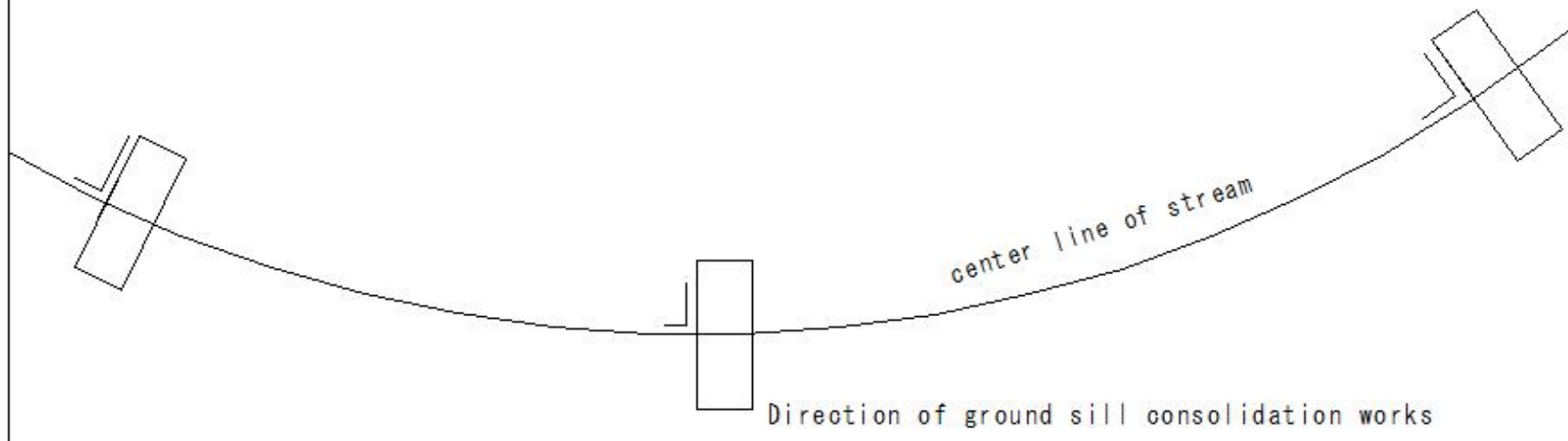
watercourse

ground sill consolidation works

②ground sill consolidation works direction

Perpendicular to the flow center line downstream of the planned location

Center point of water passage: Set on the flow center line of
ground sill consolidation works water passage



(S61)watercourse

(S61) water course

watercourse

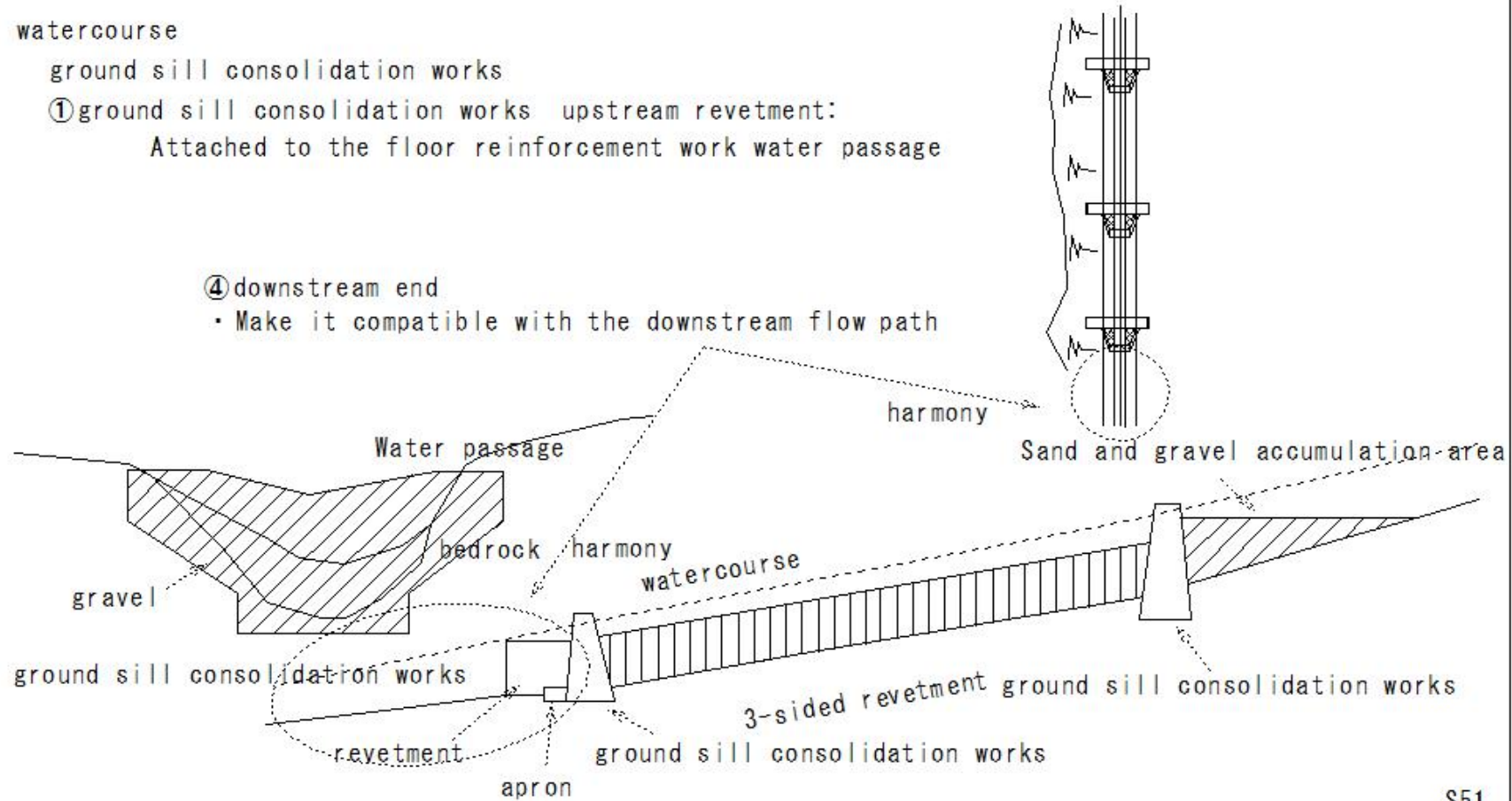
ground sill consolidation works

①ground sill consolidation works upstream revetment:

Attached to the floor reinforcement work water passage

④downstream end

• Make it compatible with the downstream flow path



(S62)watercourse

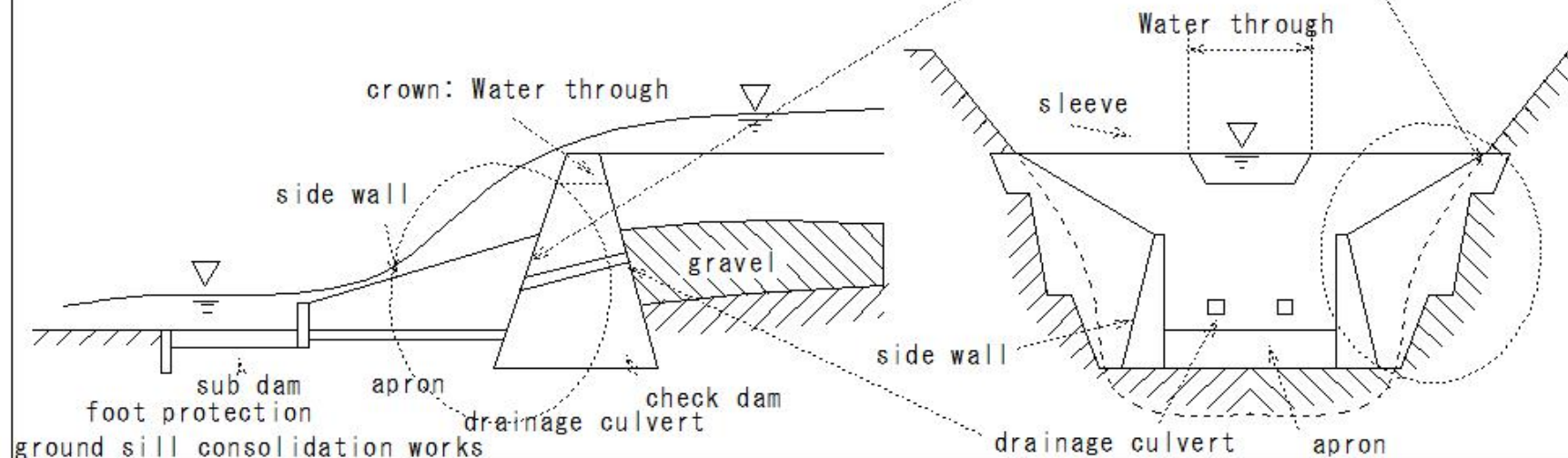
(S62) watercourse

watercourse

ground sill consolidation works

Construction

- ② Sleeves of ground sill consolidation
- Put sleeves into the ground
- Insulated from the revetment



(S63)watercourse

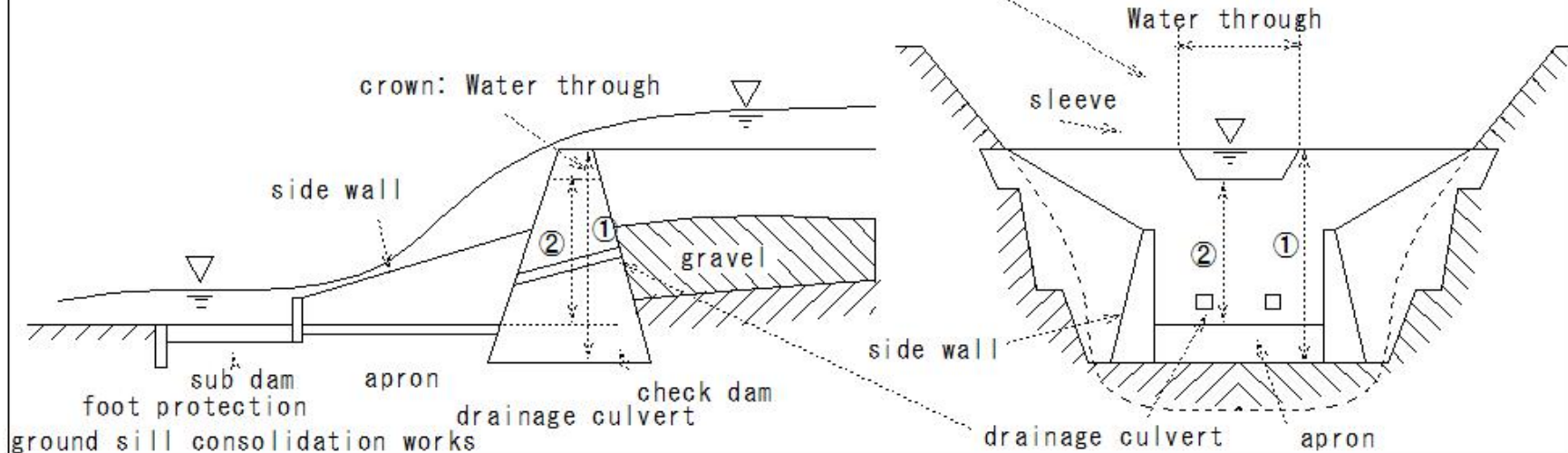
(S63) watercourse

watercourse

ground sill consolidation works

Construction

- ③ Height of the ground sill consolidation works
- ① Less than about 5m
- ② Head 3.5-4.5m
- More than 5m - Planned in a stairway



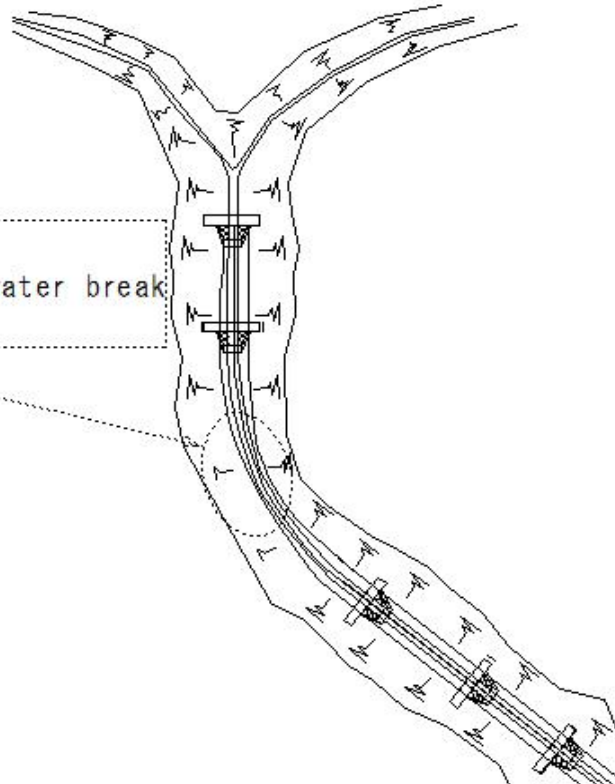
(S64)revetment:bank protection

(S64)revetment:bank protection

revetment:bank protection

revetment(bank protection works) for watercourse

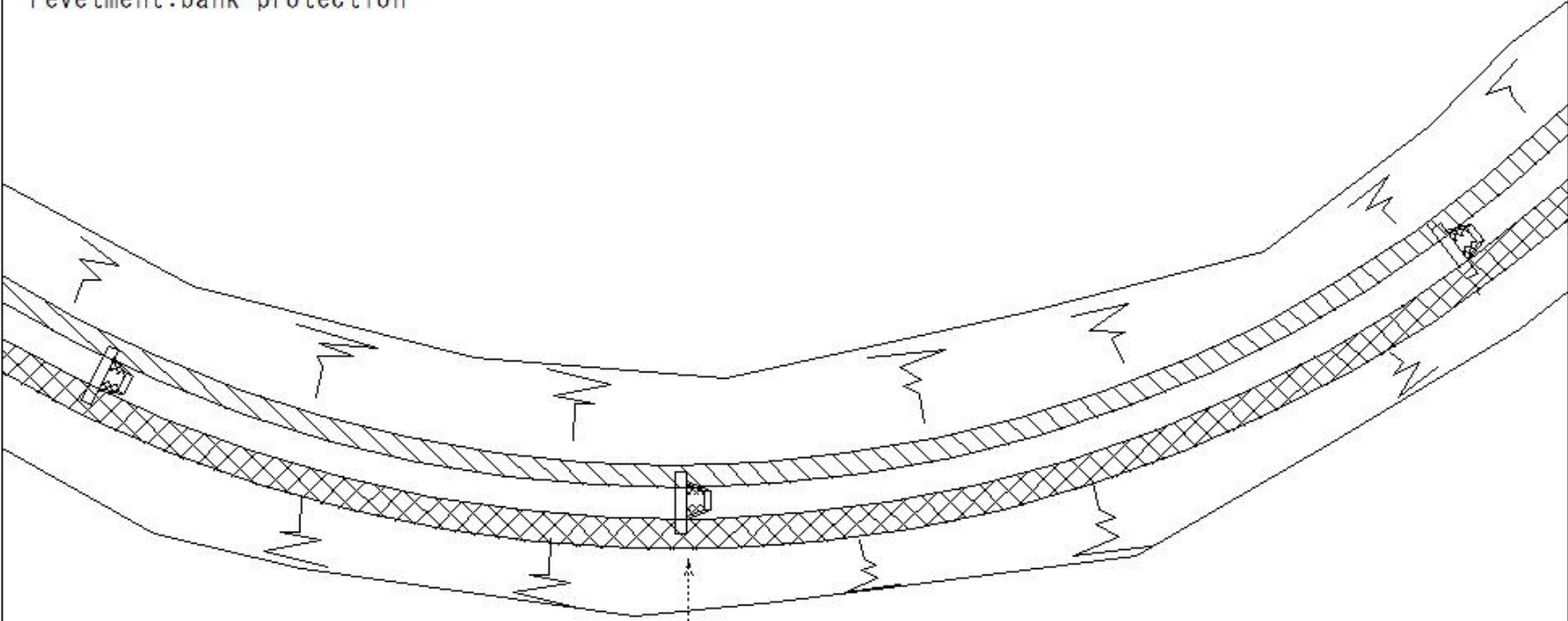
① Mountain stream, water flow, channel, curve - water break
Expected collapse location



(S65)revetment:bank protection

(S65)revetment:bank protection

revetment:bank protection



revetment:bank protection
②Downstream mountain stream, sedimentary area, residential area collapse location

(S66)revetment:bank protection

(S66)revetment:bank protection

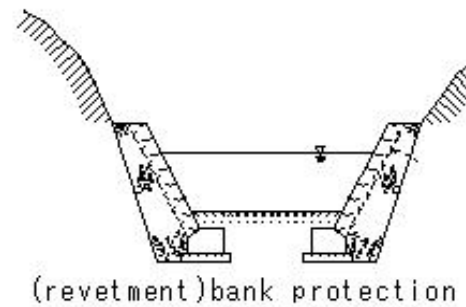
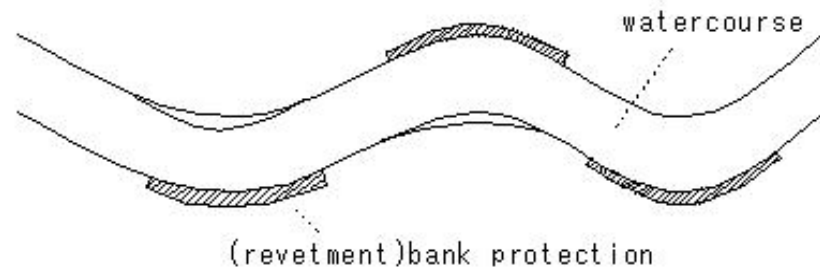
(revetment)bank protection

Bank protection works for watercourse

③River bank collapse-collapse prevention

ground sill consolidation works/dam work

foot protection - revetment work



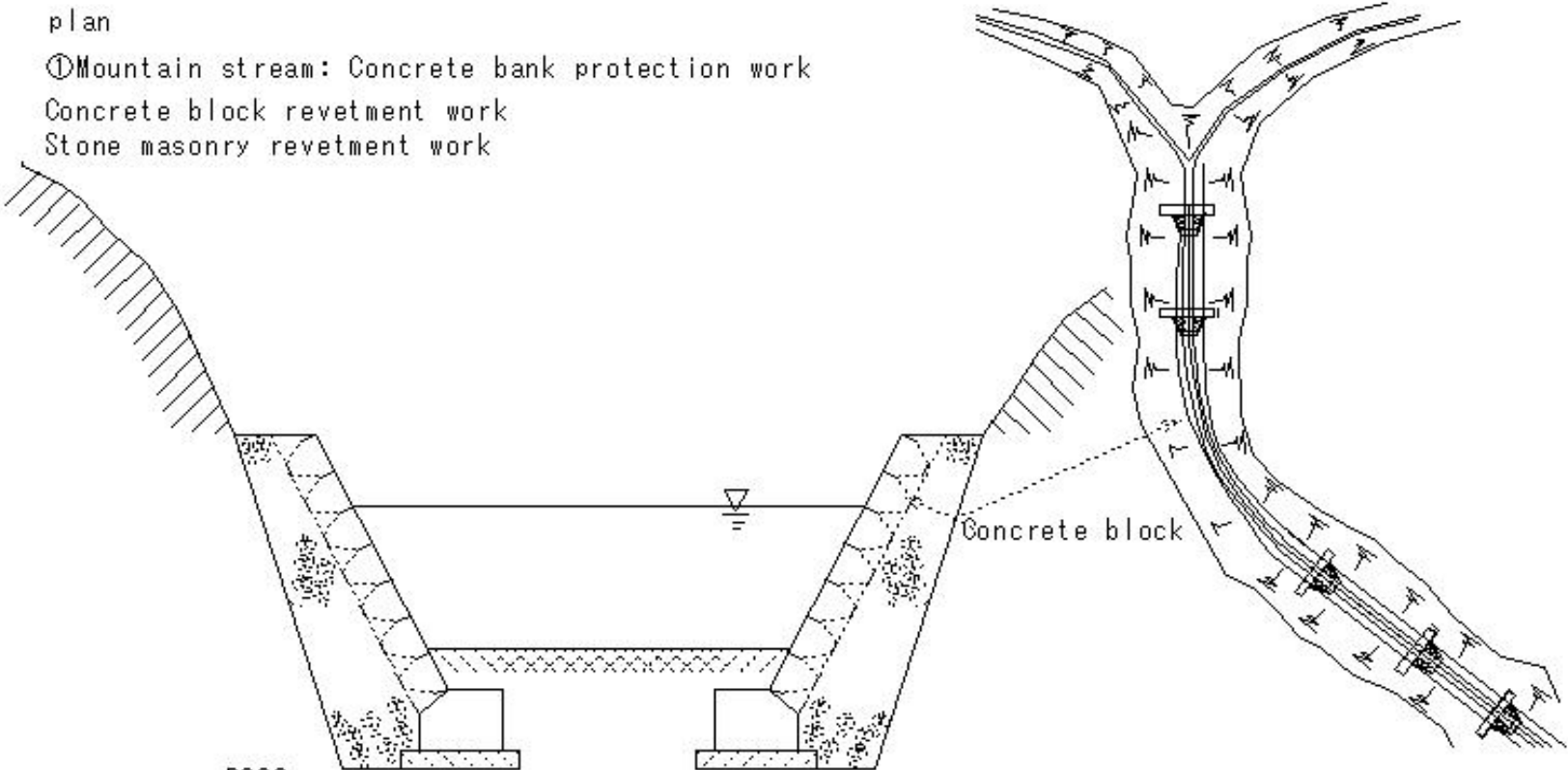
(S67)revetment:bank protection

(S67)revetment:bank protection

(revetment)bank protection

Bank protection works for watercourse
plan

- ① Mountain stream: Concrete bank protection work
- Concrete block revetment work
- Stone masonry revetment work



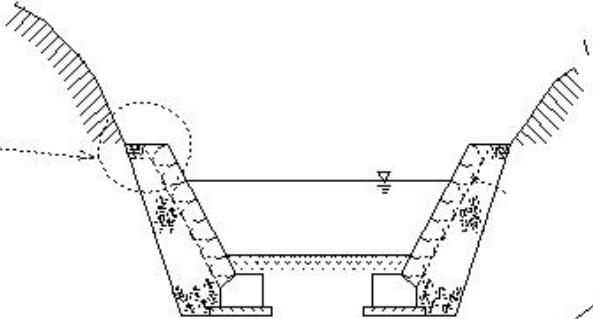
(S68)revetment:bank protection

(S68)revetment:bank protection

(revetment)bank protection
Bank protection works for watercourse
plan

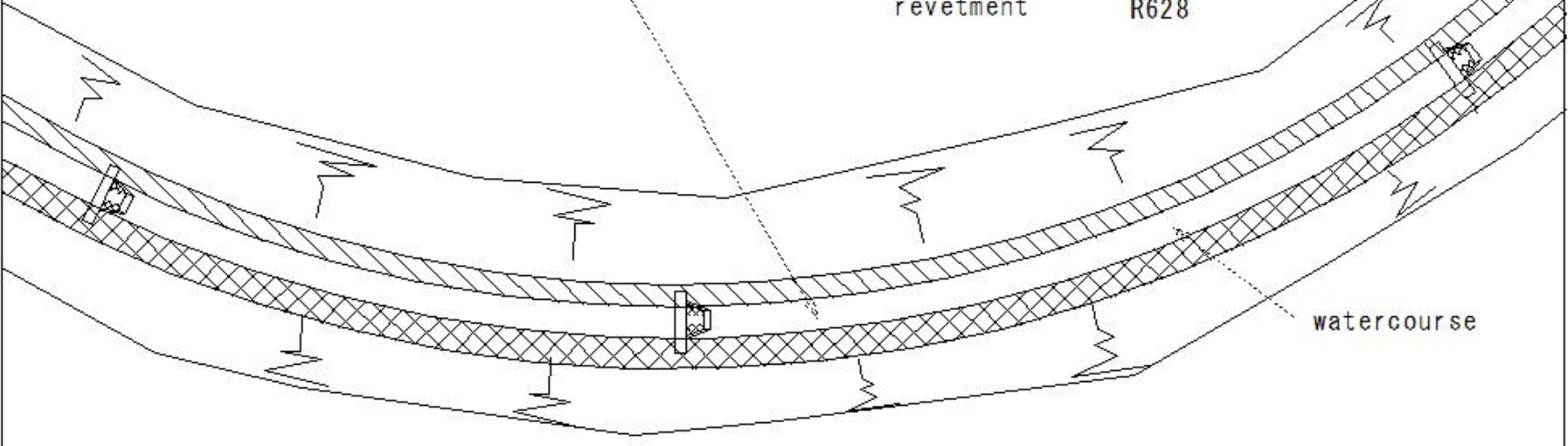
- ② Revetment work crown height
- Planned high water level + margin height
 - ▣ Water bump: Strong
 - Bending part outer curve: Increase the top height

Stone masonry revetment work



revetment R628

watercourse

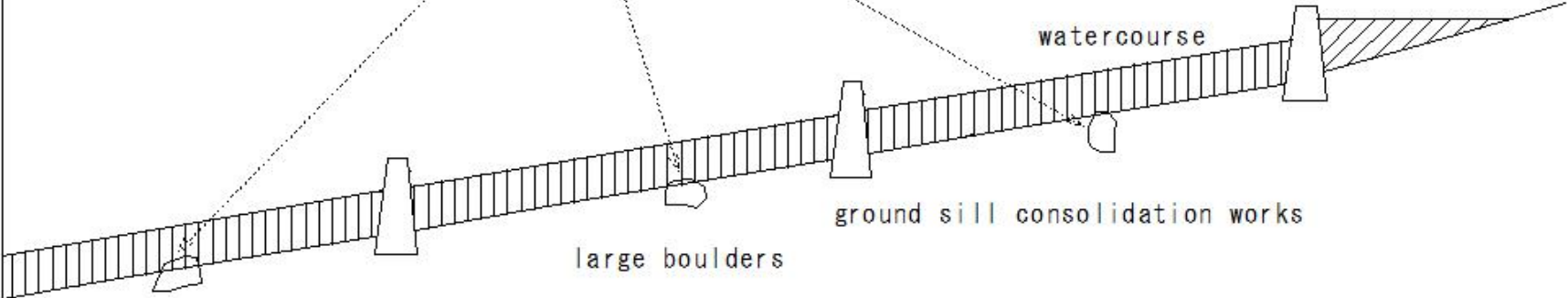


(S69)revetment:bank protection

(S69)revetment:bank protection

revetment:bank protection

Bank protection works for watercourse
Construction
①During the excavation of the bank revetment floor, large boulders - removed and destroyed



(S70)revetment:bank protection

(S70)revetment:bank protection

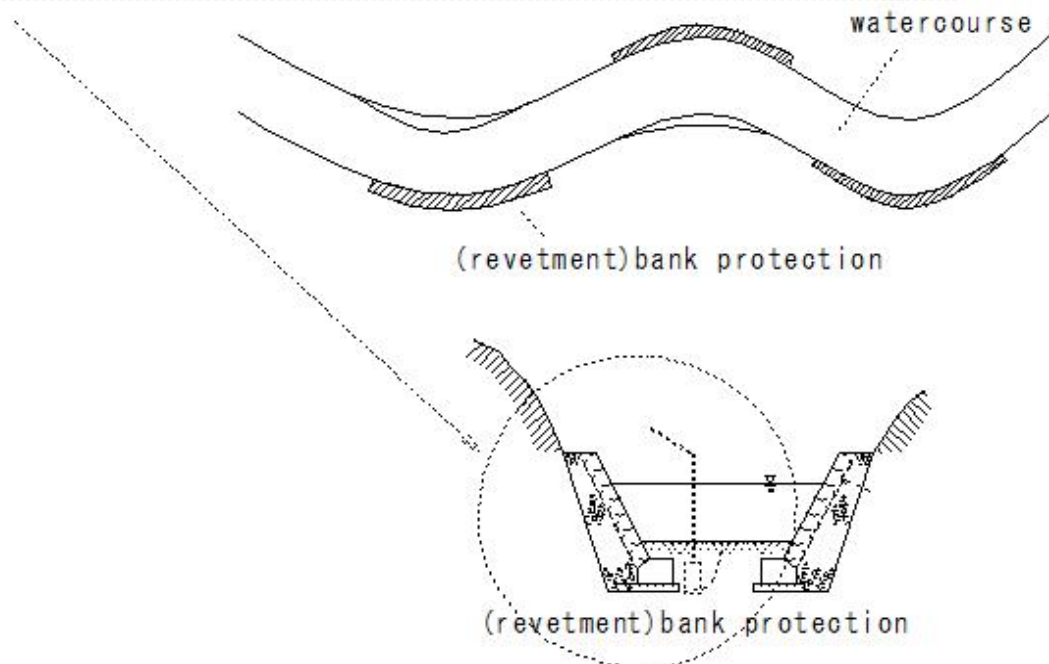
(revetment)bank protection

Bank protection works for watercourse

Construction

②case of spring water during the excavation of the revetment bed

- Direct spring water
- Increased amount of backfilling for revetment



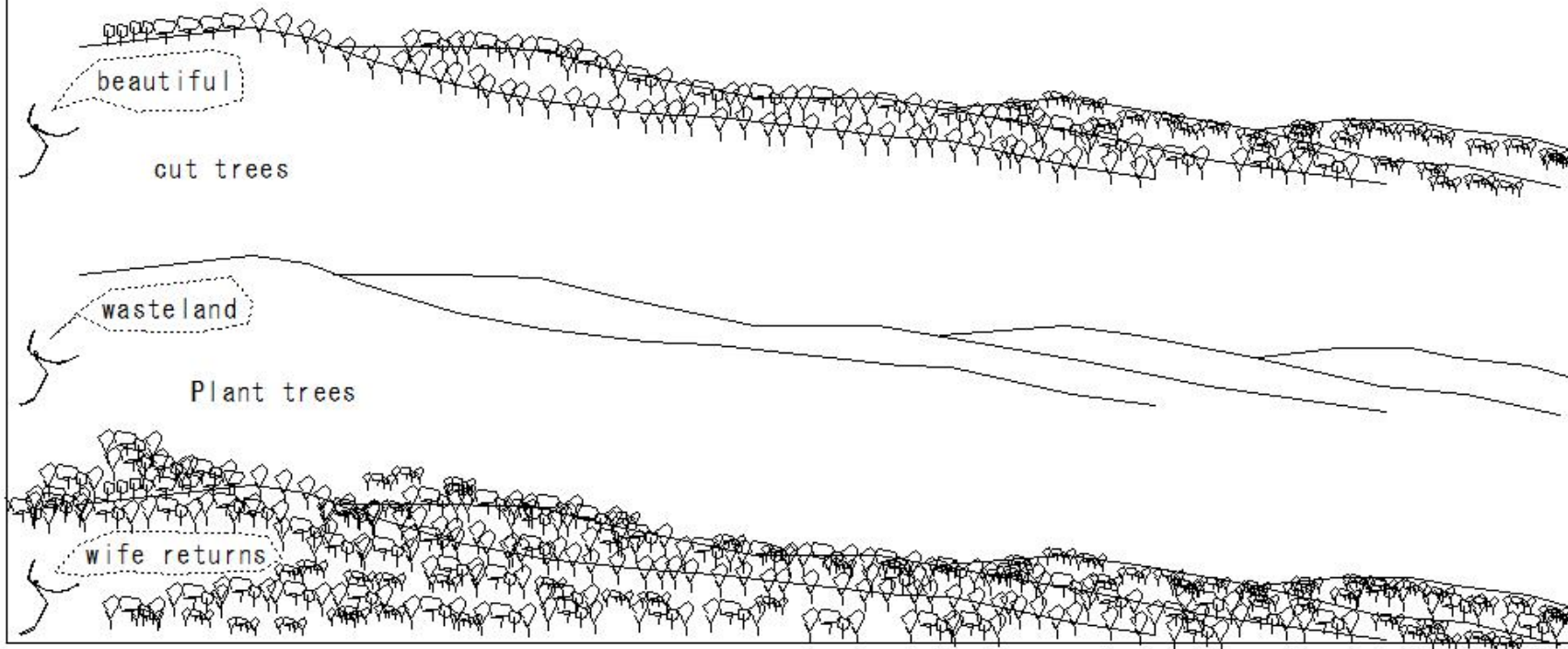
(S71)hillside works

(S71)hillside works

hillside works

Constructing simple civil engineering work on mountainous wasteland

- Vegetation
- Prevention of sediment production



(S72)hillside works

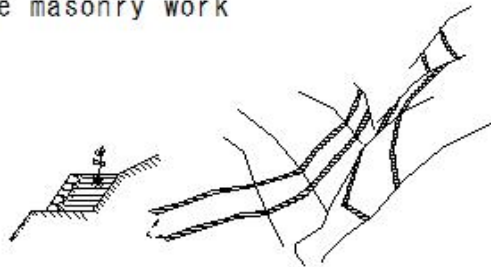
(S72)hillside works

hillside works

①Valley work

- Erosion valley within the collapsed area
- Directly downstream of the mountainside security
- stone masonry work
- sodding work
- fence work
- wire cylinder masonry work(gabion)

• stone masonry work



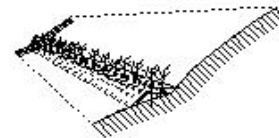
• sodding work



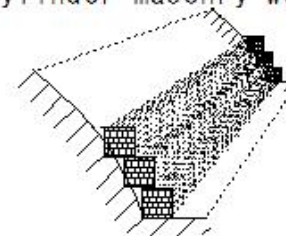
S183

S157

• fence work



• wire cylinder masonry work(gabion)



S77

(S73)hillside works

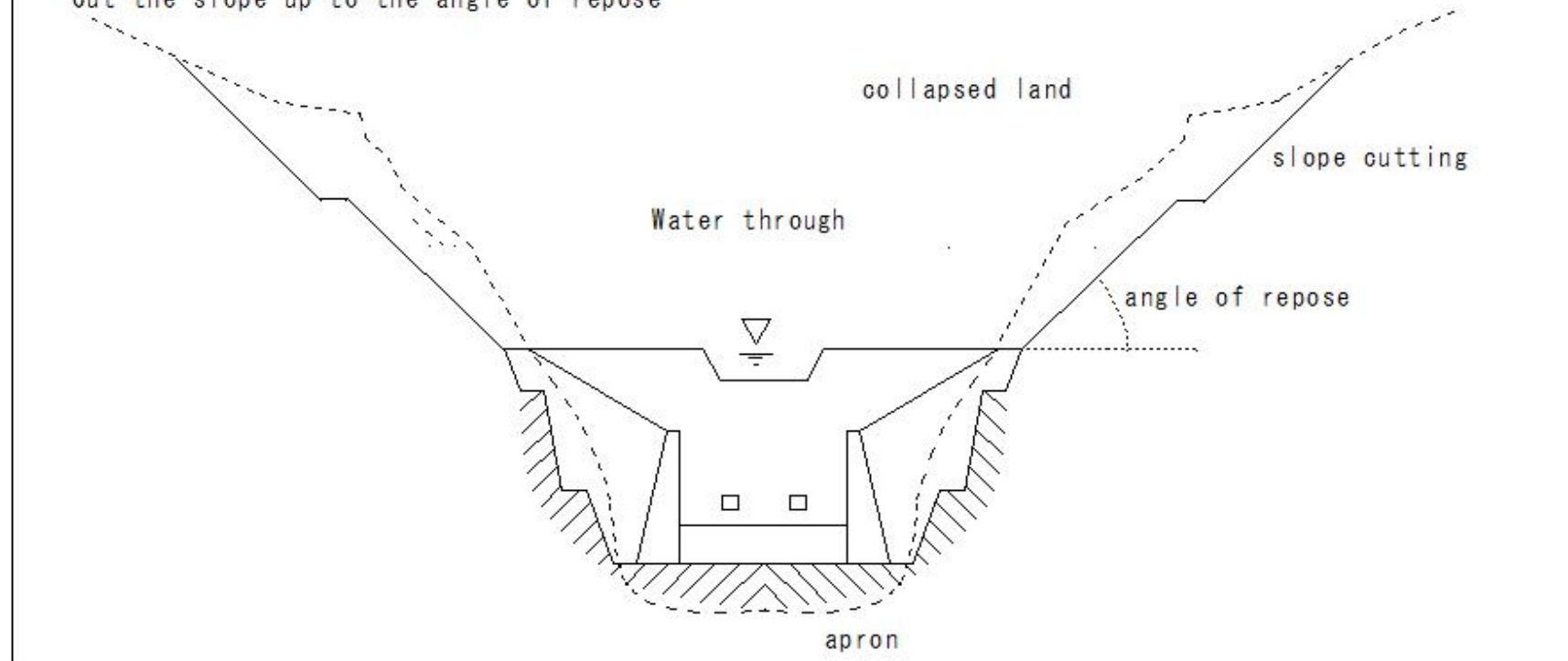
(S73)hillside works

hillside works

② slope cutting

- Steep part of the slope of the collapsed land
- Rough slope

Cut the slope up to the angle of repose

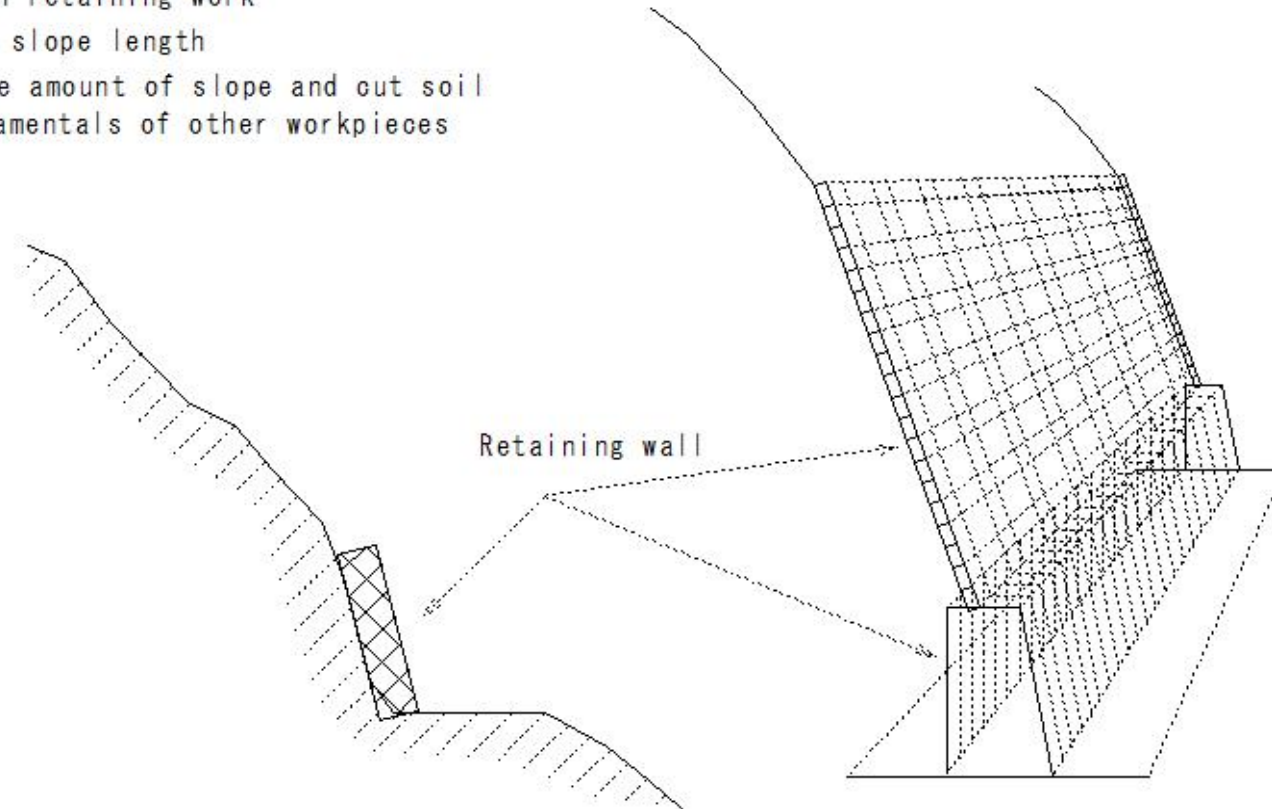


(S74)hillside works

(S74)hillside works

hillside works

- ③ Earth retaining work
- ① Long slope length
- ② Large amount of slope and cut soil
- ③ Fundamentals of other workpieces



(S75)hillside works

(S75)hillside works

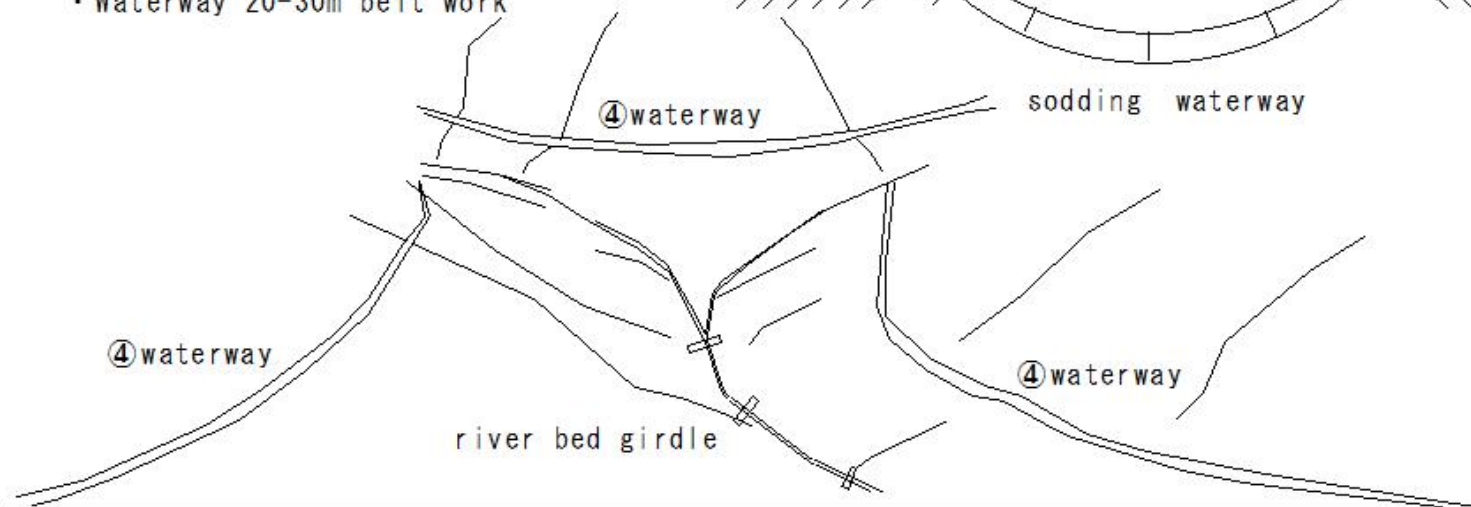
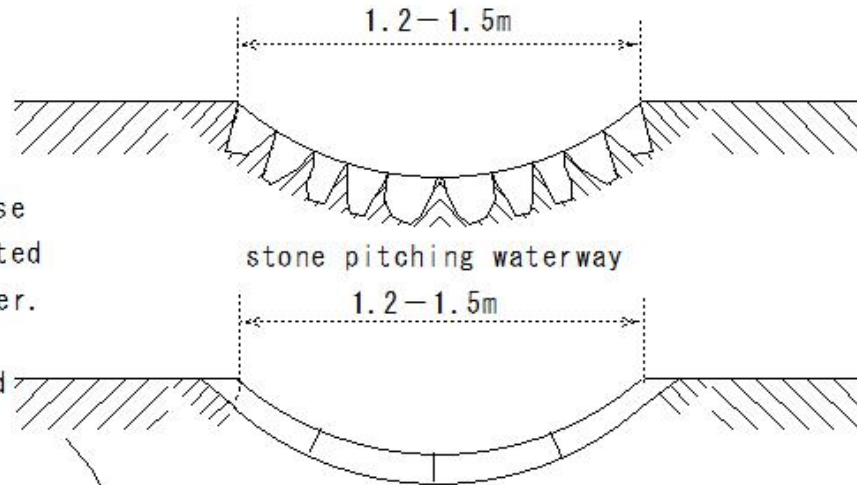
hillside works

- ④waterway
- ①slope length is long
- ②Ups and downs on the slope
- ③Water collects from around the collapse
- ④Water collected by culverts is converted into surface water.

• Position: ▣ part of slope

• Places where drainage can be collected

• Waterway 20-30m belt work



(S76)hillside works

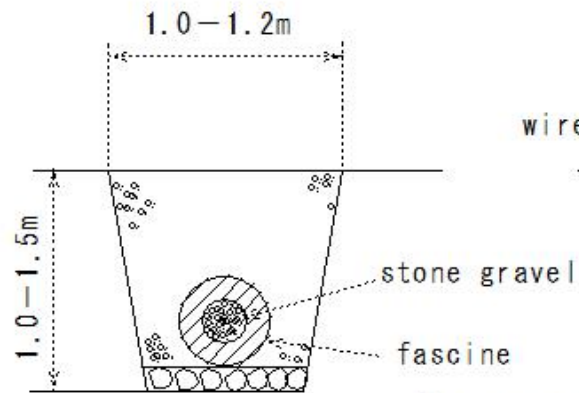
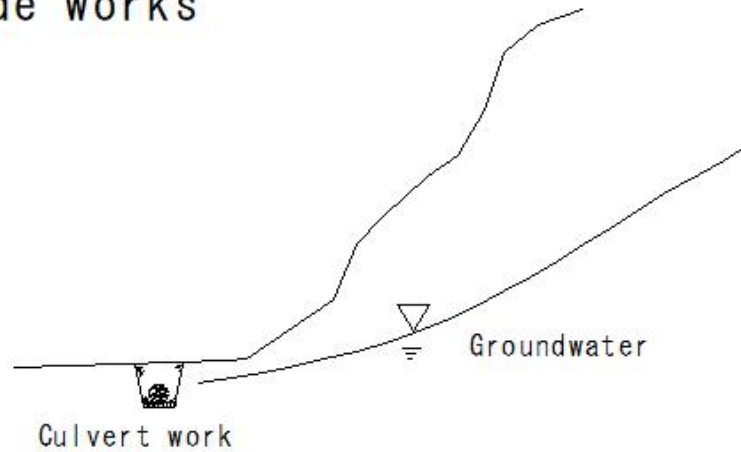
(S76)hillside works

hillside works

⑤ Culvert work

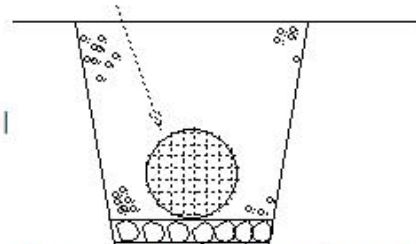
- Groundwater - a lot
- Re-collapse - many places
- Large amounts of sand and sand deposited
- Location: Location where groundwater can be easily collected and drained

① fascine culvert work

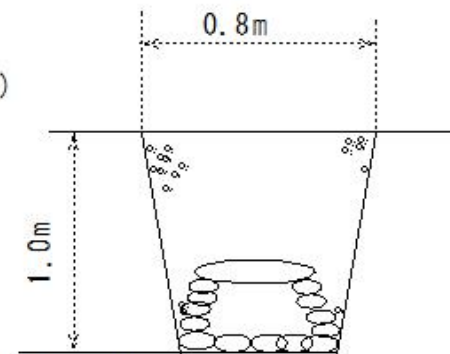


① fascine culvert work

wire cylinder masonry work(gabion)



② wire cylinder masonry work(gabion) culvert work



③ Stone gravel culvert work

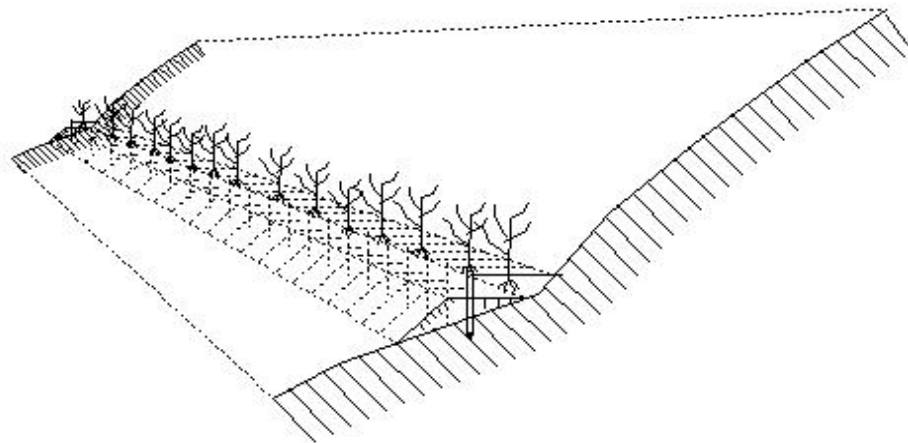
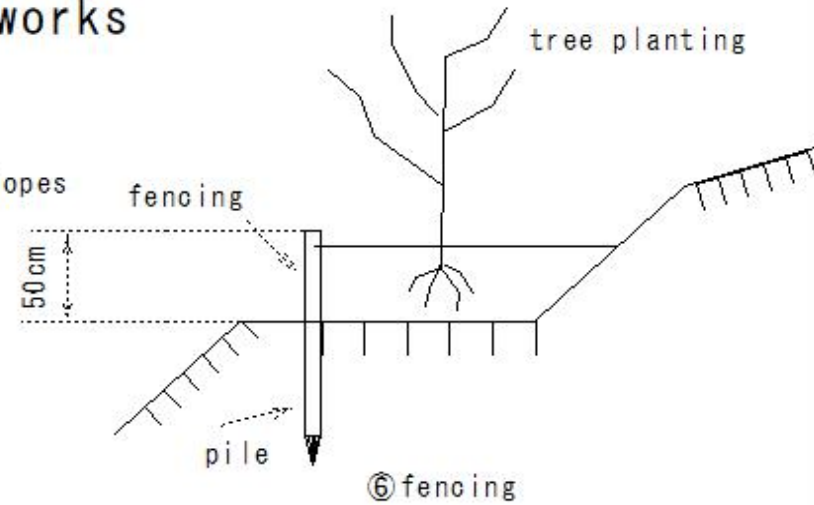
(S77)hillside works

(S77)hillside works

hillside works

⑥ fencing

- Points where topsoil flows out on mountainside slopes
 - Positions where vegetation can be introduced
- Height of pilework: approximately 50cm



(S78)hillside works

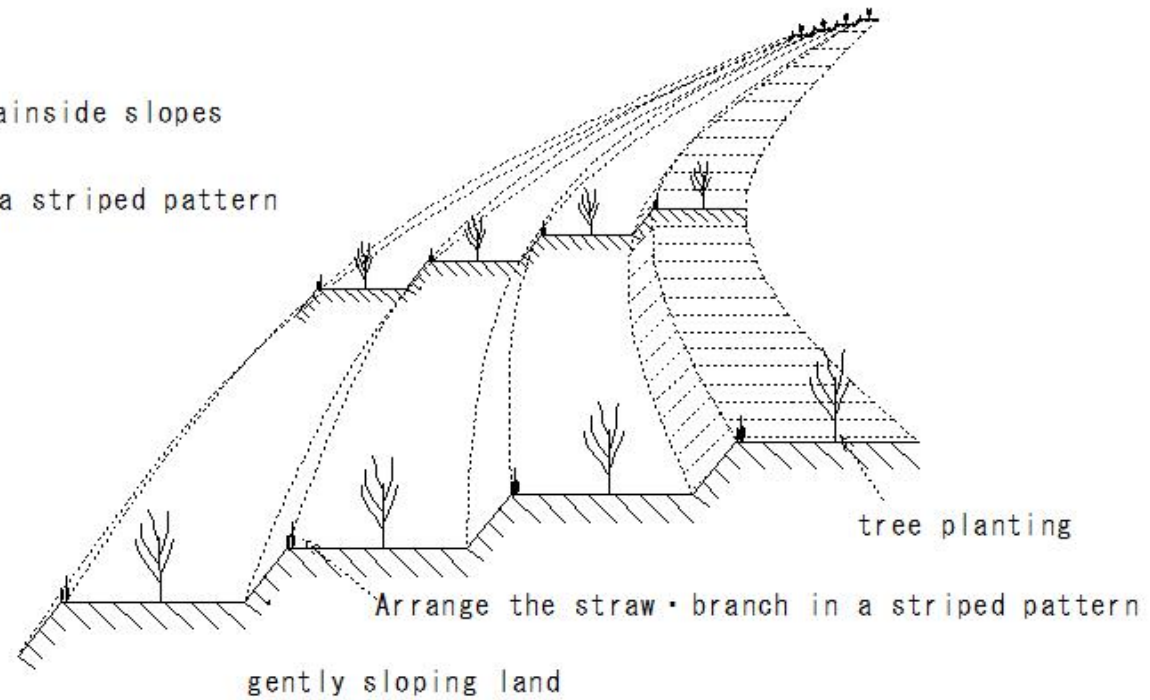
(S78)hillside works

hillside works

⑧ tree planting works

- Top soil - deep
- Rainwater distribution
- Preventing erosion of mountainside slopes
- Vegetation-early planting

Arrange the straw • branch in a striped pattern



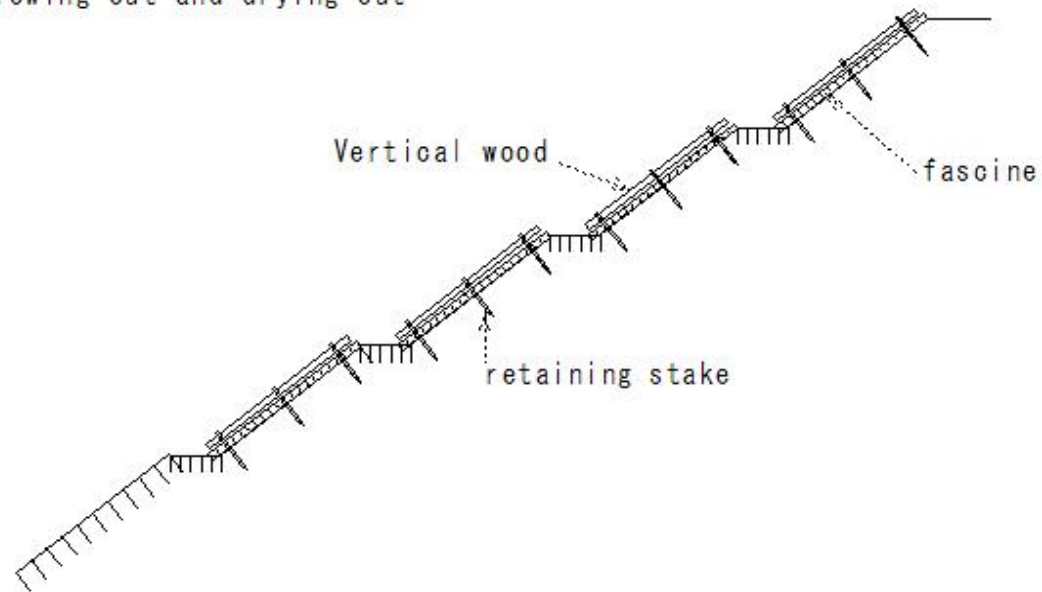
(S79)hillside works

(S79)hillside works

hillside works

⑨ fascine work

- Erosion caused by rain, frozen soil, frost pillars, wind, etc.
- Vegetation on the slope
- Sowing seeds
- Prevent seeds from flowing out and drying out



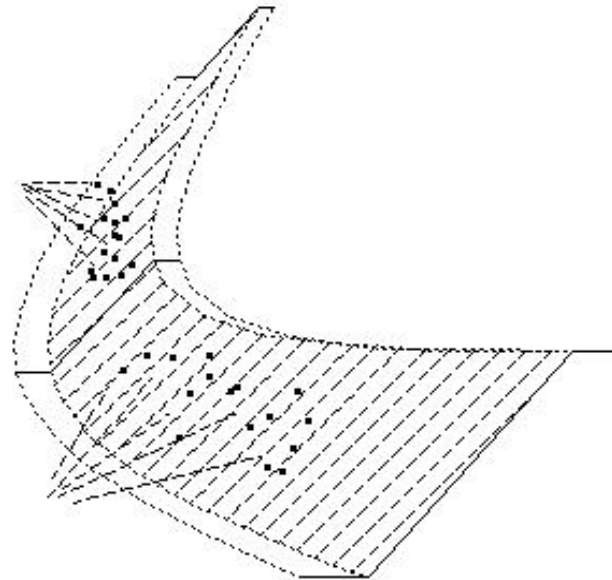
(S80)hillside works

(S80)hillside works

hillside works

- ⑩Seed sowing
 - Slope - short
 - Good land conditions
 - Early greening

⑩Seed sowing



(S81)hillside works

(S81)hillside works

hillside works

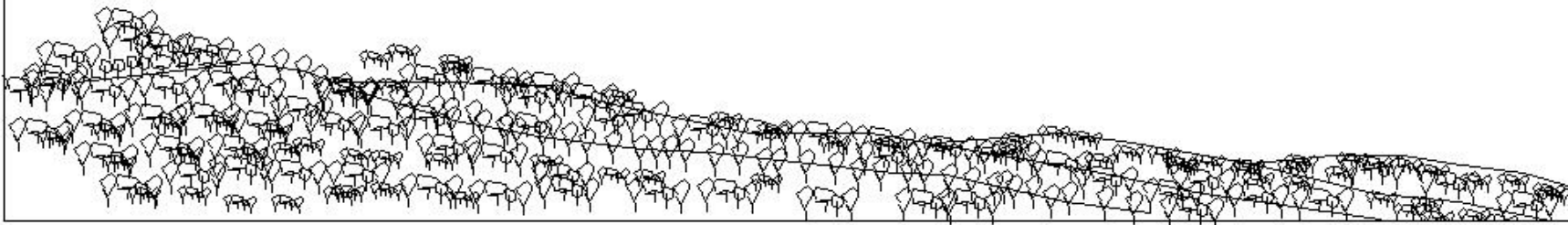
⑩ Planting

- ruined soil
- Collapsed land - urgent greening
- Selection of tree species

- ① Growth potential -strong
 - ② Roots are good
 - ③ ruined soil, dry soil, frozen soil, insects - great adaptability and resistance
 - ④ Soil greening effect - great
- Number of plants: 3000-5000/1ha
 - Exposed ground area 8000-12000 trees/1ha
 - Fertilization

Collapsed land

Plant trees



(S82)Landslide prevention work

(S82)Landslide prevention work

Landslide prevention work
construction method

① landslide control works

② Surface water drainage works

③ waterway Penetration prevention work

④ Underground drainage works

⑤ Shallow layer

⑥ open channel • culvert bowling groundwater cutoff

⑦ Deep layer

⑧ Bowling . water collection well . tunnel

⑨ Earth removal work

⑩ Loading embankment method

⑪ River structures ⑫ Dam, ground sill consolidation works, bank protection

⑬ landslide restraining works

⑭ Pile driver

⑮ Shaft work

⑯ Anchor work

⑰ Retaining wall work

(S83)Landslide prevention work

(S83)Landslide prevention work

Landslide prevention work

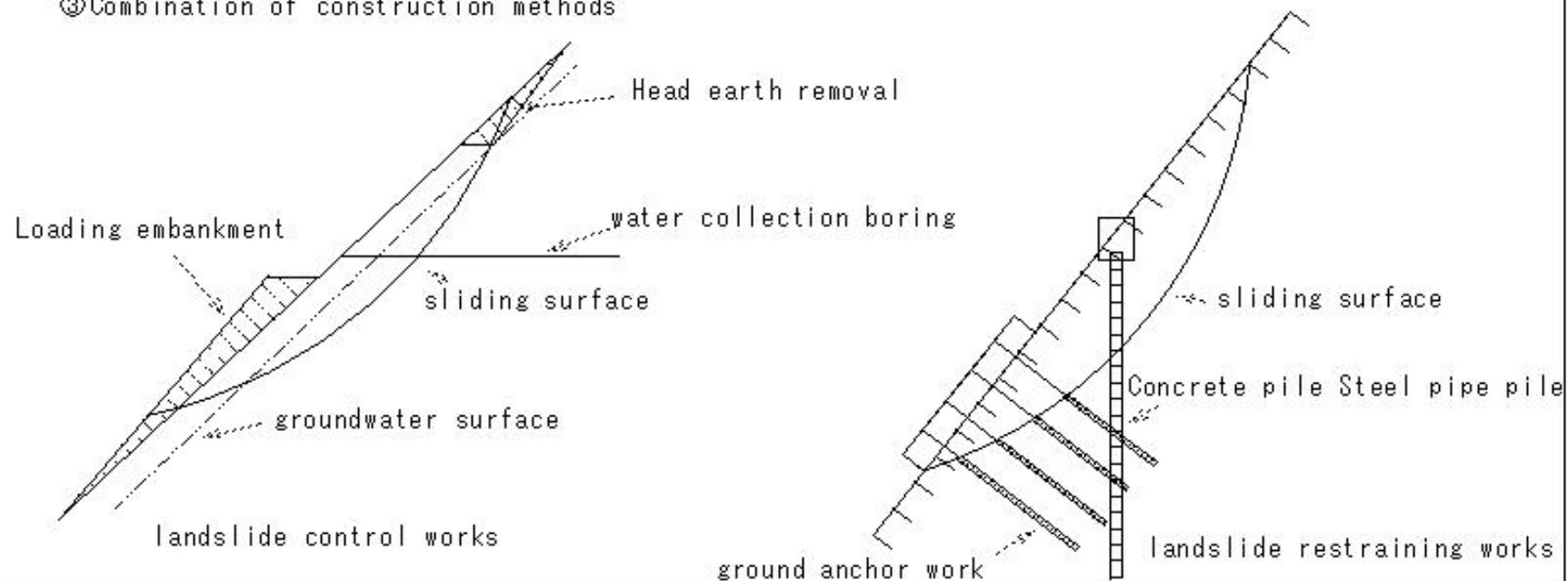
Construction method selection

① landslide control works - main

landslide restraining works - artificial houses/facilities -
stabilization of small landslide movement blocks

② landslide control works - Mitigation, landslide restraining works - Practical

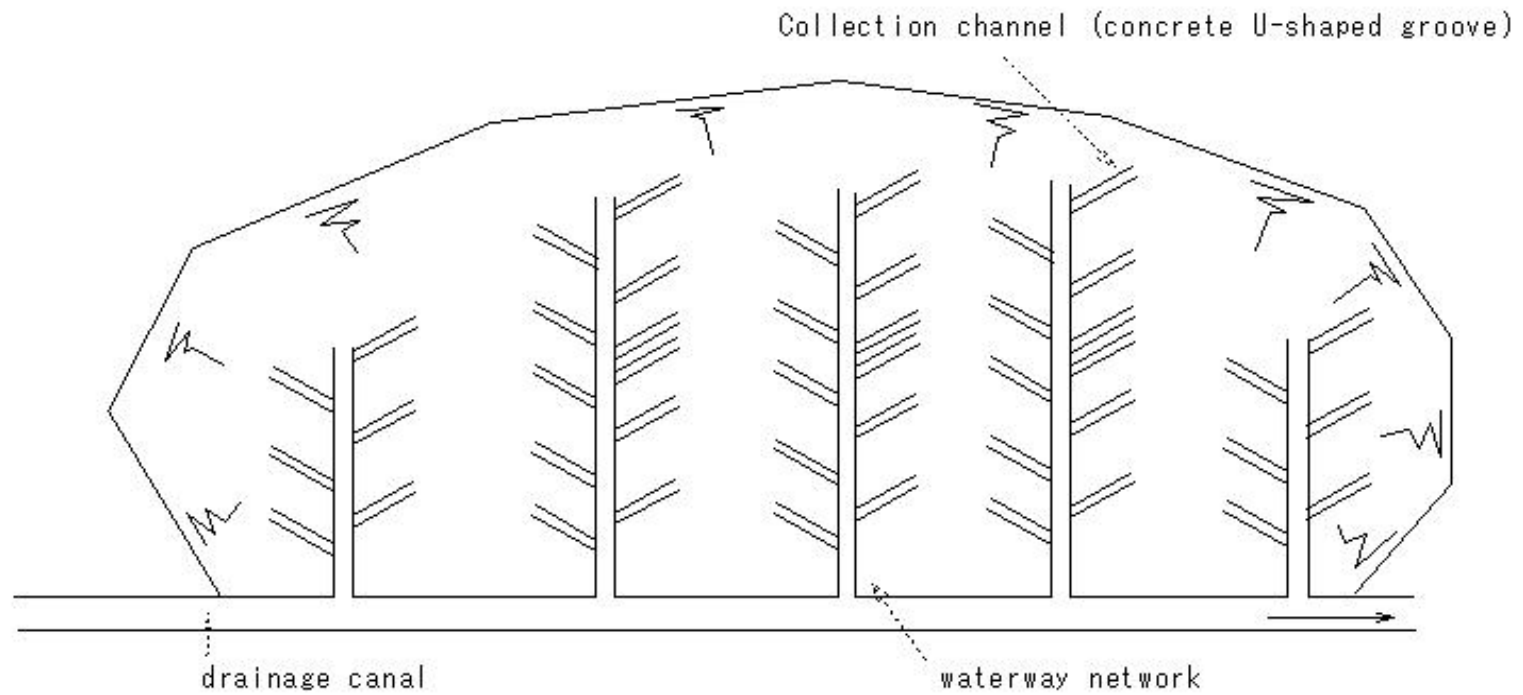
③ Combination of construction methods



(S84)Landslide prevention work

(S84)Landslide prevention work

Landslide prevention work
surface water drainage



(S85)Landslide prevention work

(S85)Landslide prevention work

Landslide prevention work

surface water drainage

Penetration prevention work

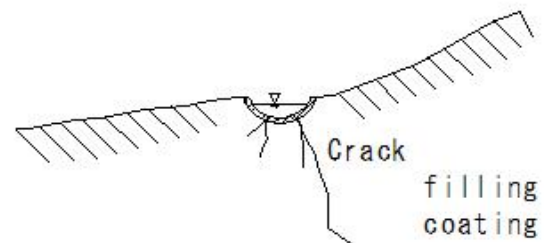
Crack occurrence location

:Clay cement filling

vinyl coating

Leakage prevention work for swamp waterways

Improvements such as covering, excavating swamps,
replacing waterways, etc.



(S86)Landslide prevention work

(S86)Landslide prevention work

Landslide prevention work

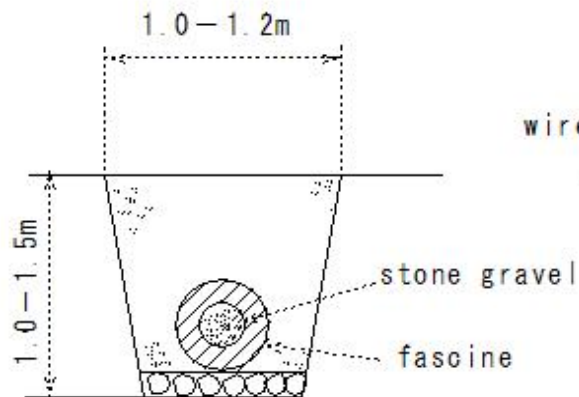
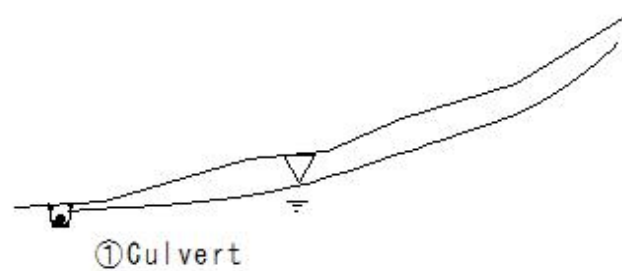
Groundwater drainage works

- Inside landslide area

Groundwater drainage works

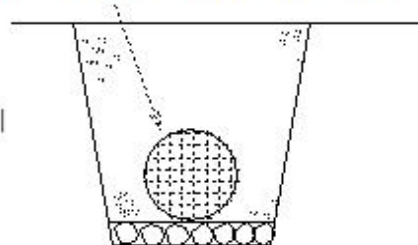
① Culvert

3m groundwater removal from the ground surface

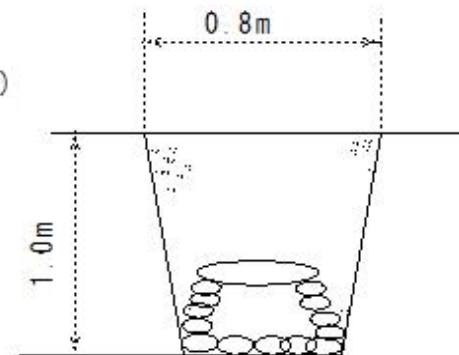


① fascine culvert work

wire cylinder masonry work(gabion)



② wire cylinder masonry work(gabion) culvert work



③ Stone gravel culvert work

(S87)Landslide prevention work

(S87)Landslide prevention work

Landslide prevention work

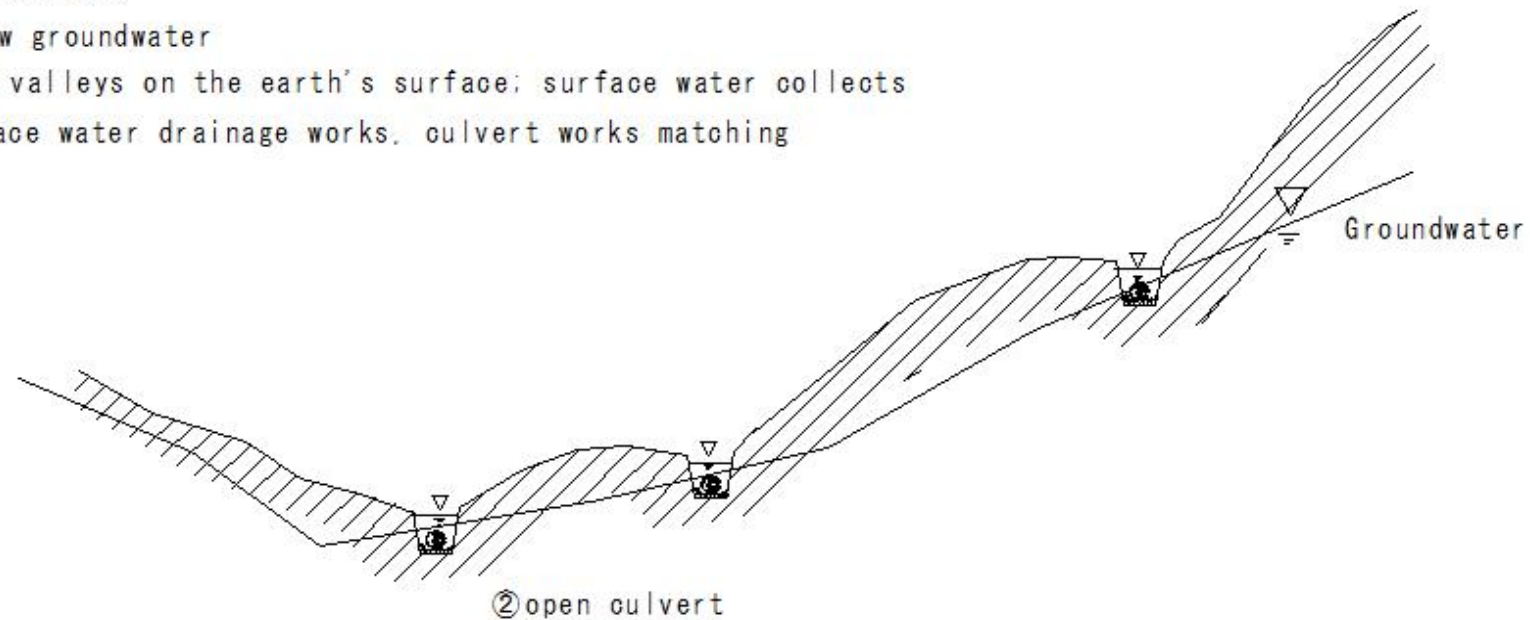
Groundwater drainage works

② open culvert

shallow groundwater

▣ and valleys on the earth's surface; surface water collects

• Surface water drainage works, culvert works matching



Groundwater drainage works

(S88)Landslide prevention work

(S88)Landslide prevention work

Landslide prevention work

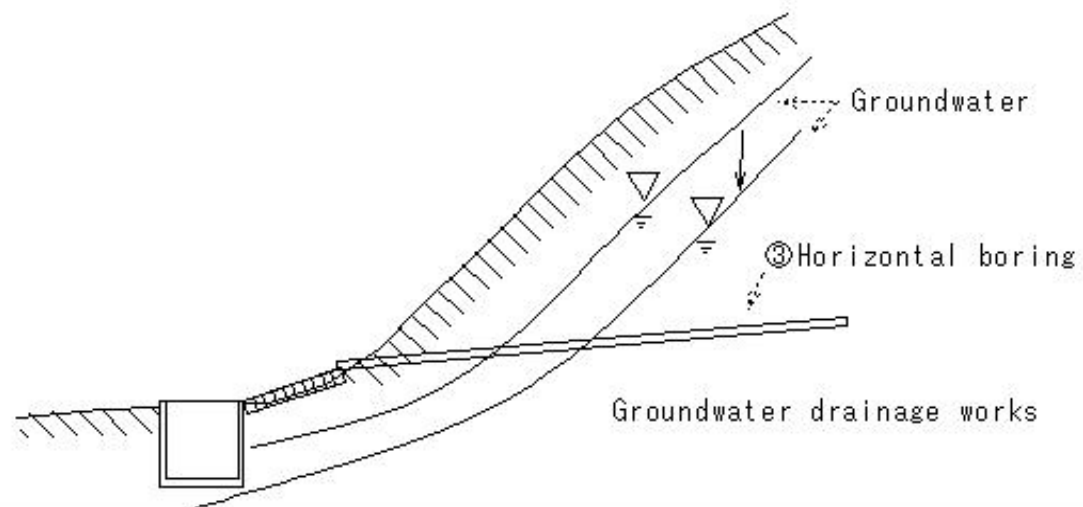
Groundwater drainage works

③Horizontal boring

Extension 20-50m

Horizontal boring

Boring machine - digging a horizontal hole
bring out groundwater



(S89)Landslide prevention work

(S89)Landslide prevention work

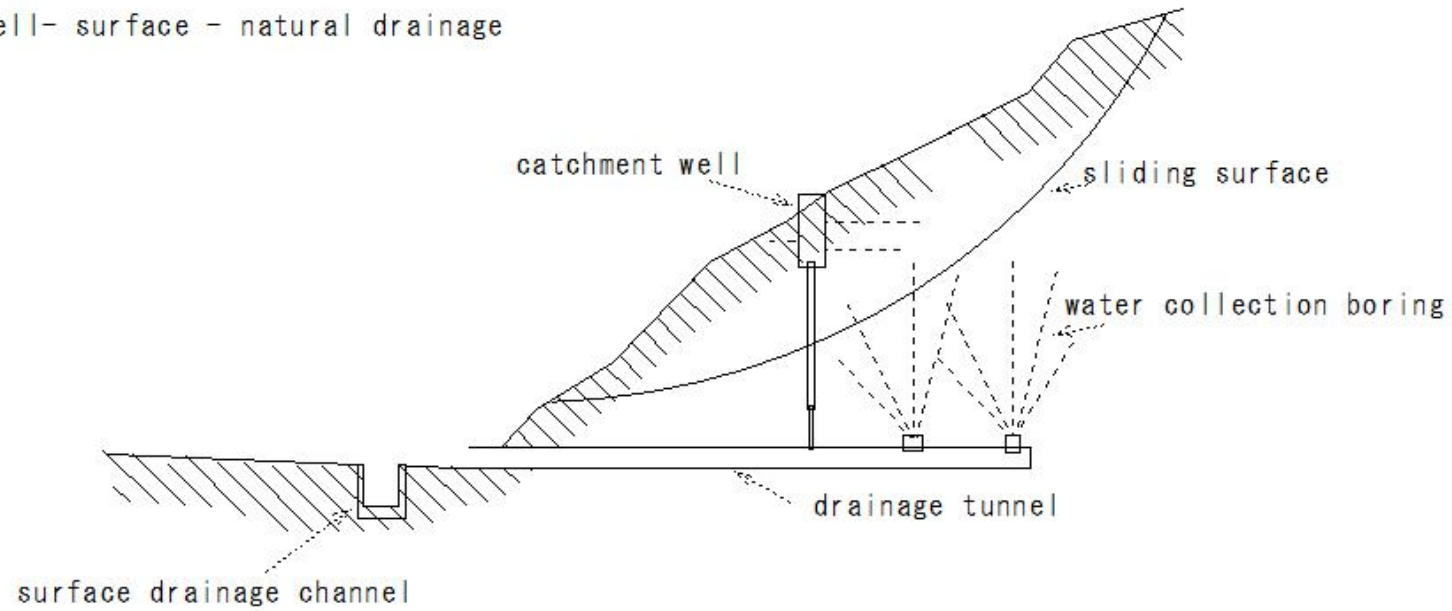
Landslide prevention work

Groundwater drainage works

④ catchment well

depth 30m

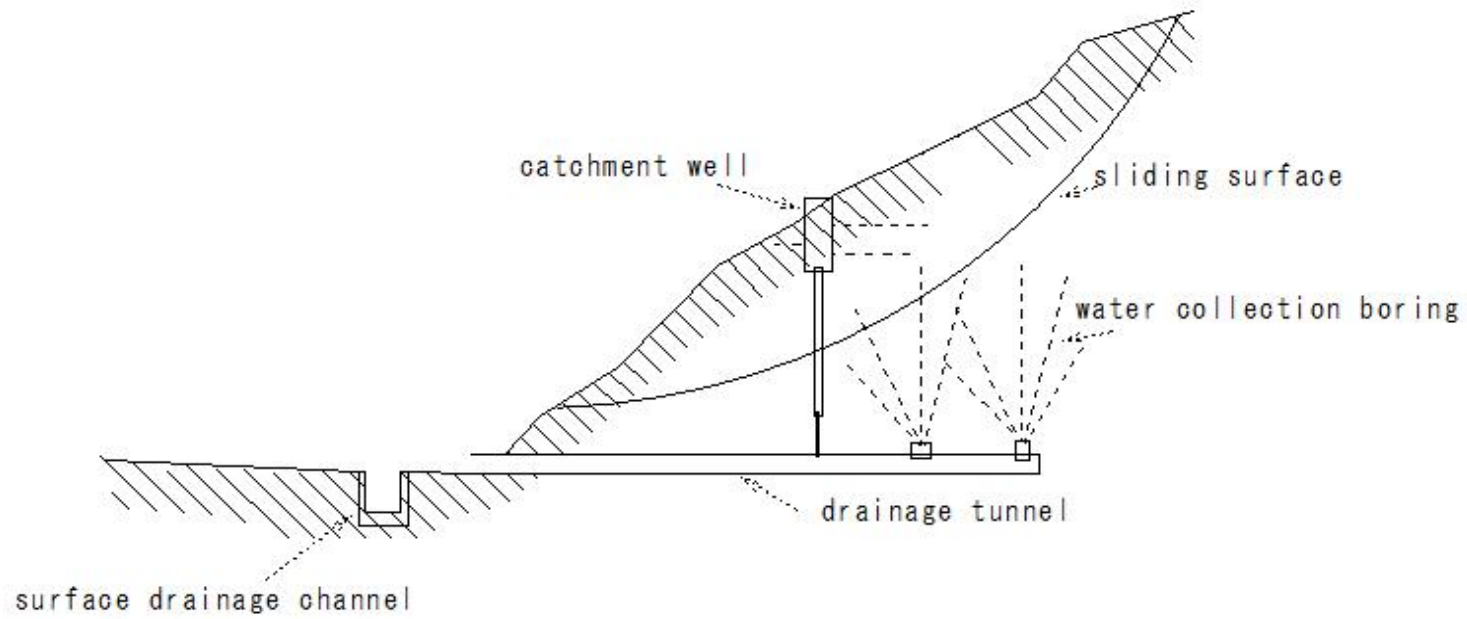
catchment well- surface - natural drainage



(S90)Landslide prevention work

(S90)Landslide prevention work

Landslide prevention work
Groundwater drainage works
⑤ Drainage tunnel



(S91)Landslide prevention work

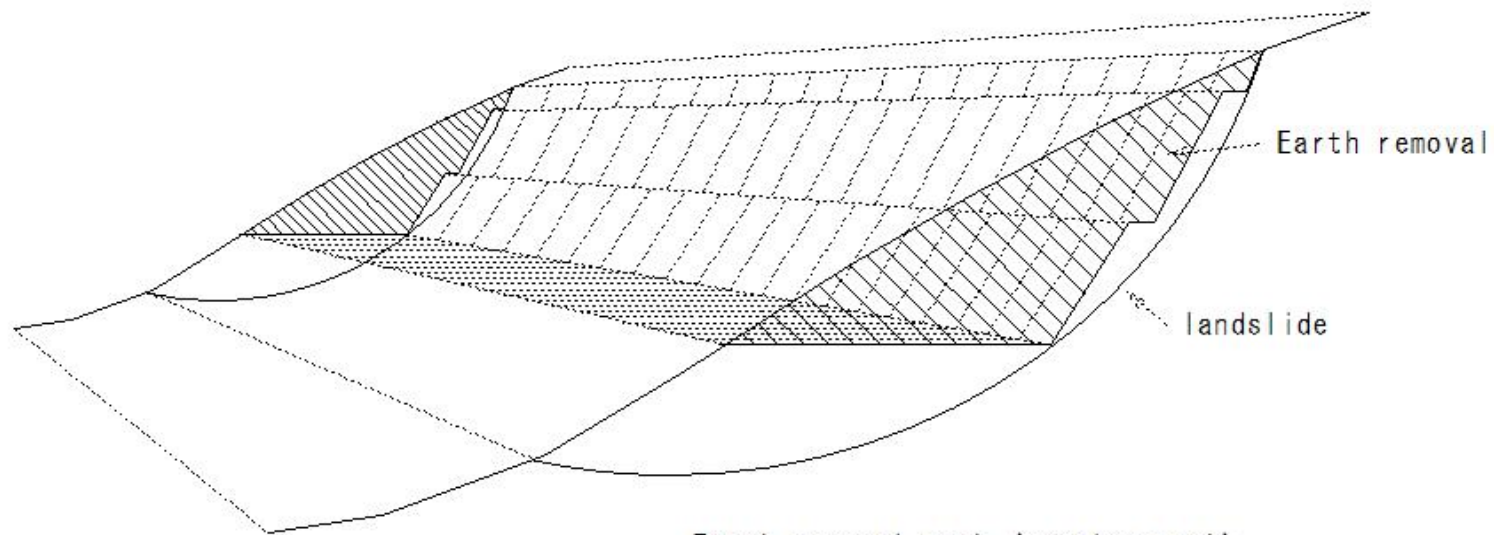
(S91)Landslide prevention work

Landslide prevention work

Earth removal work (cutting work)

- Landslide head -earth removal plan
- Multiple landslide blocks are linked in
- Top block plan
- Eliminate landslide earth and sand

Earth removal from the upper part of the slope



Earth removal work (cutting work)

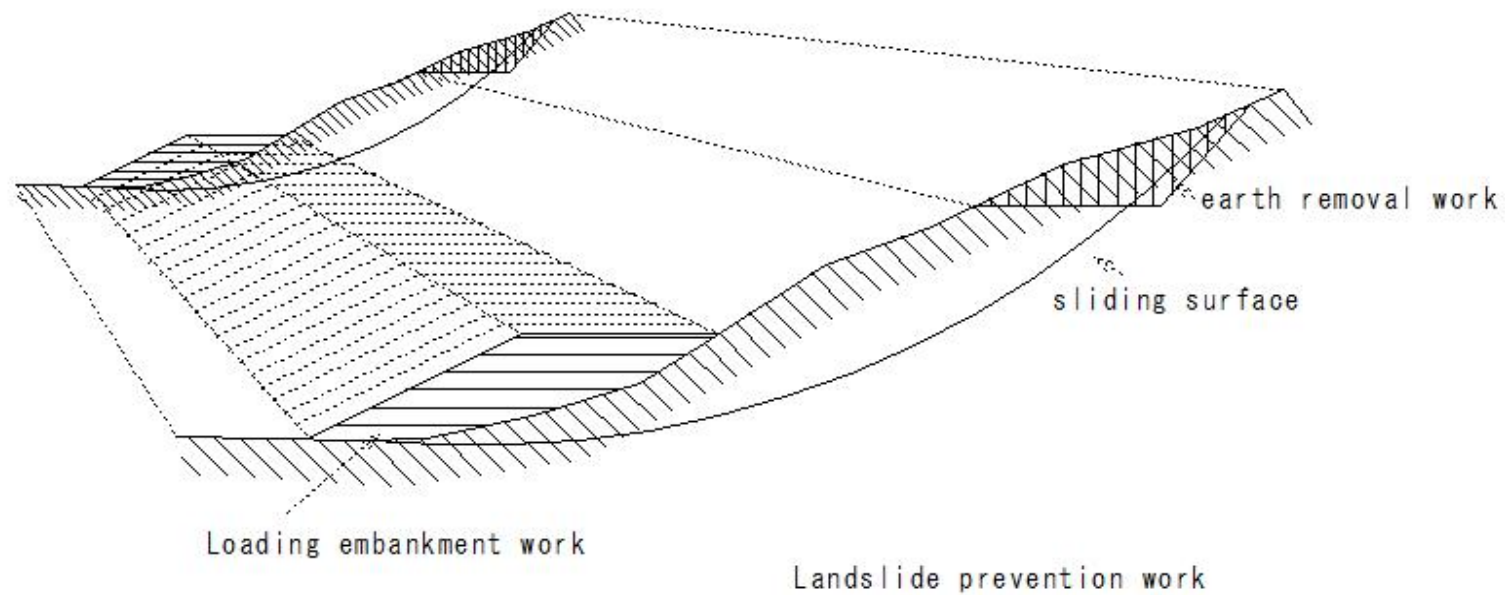
(S92)Landslide prevention work

(S92)Landslide prevention work

Landslide prevention work

Loading embankment work

- Landslide control works
- Planned on vacant land at the end of the landslide
- Used in conjunction with earth removal work



(S93)Landslide prevention work

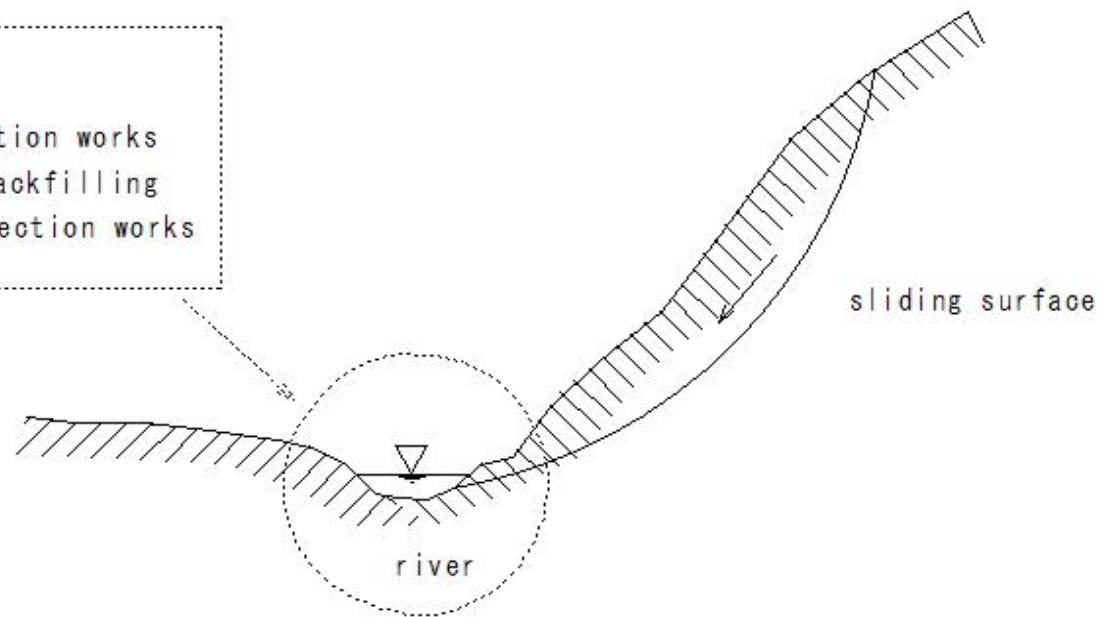
(S93)Landslide prevention work

Landslide prevention work

river structure

- Riverbed decline and bank erosion due to running water erosion
 - Protection of riverbeds and riverbanks
- Stabilize the end of the landslide

- Replacement of rivers
- Erosion control dam
- ground sill consolidation works
- Increased amount of backfilling
for bank protection works
- groin



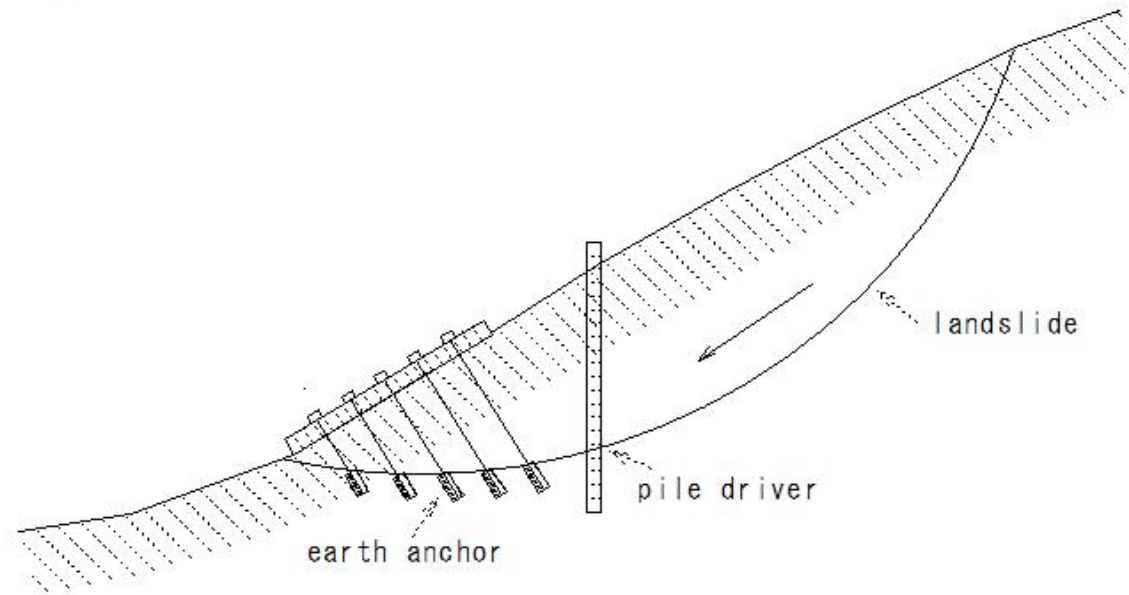
(S94)Landslide prevention work

(S94)Landslide prevention work

Landslide prevention work

pile driver

- Landslide movement 1mm/day Pile driving construction - impossible
- Position of pile driver: location where the sliding surface is about to become horizontal
- Sliding thickness - thick
- Pile length - up to 30m



Landslide prevention work

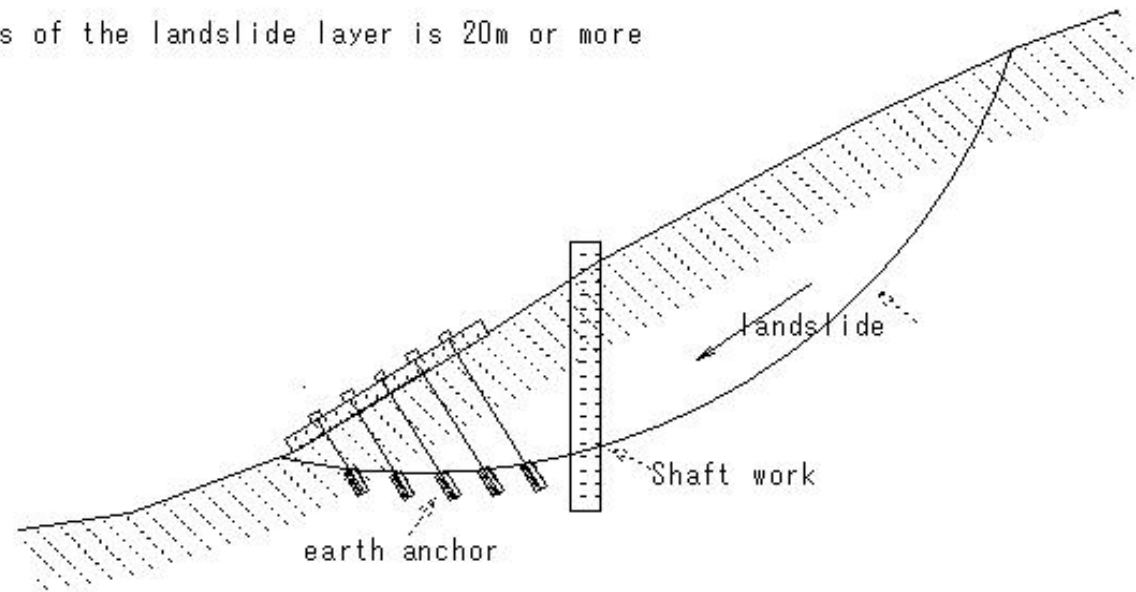
(S95)Landslide prevention work

(S95)Landslide prevention work

Landslide prevention work

Shaft work

- Diameter 1.5-2.5m Well
- Reinforced concrete placing in shaft
- same time construction possible
- Foundation ground - good
- Plan-case of the thickness of the landslide layer is 20m or more



Landslide prevention work

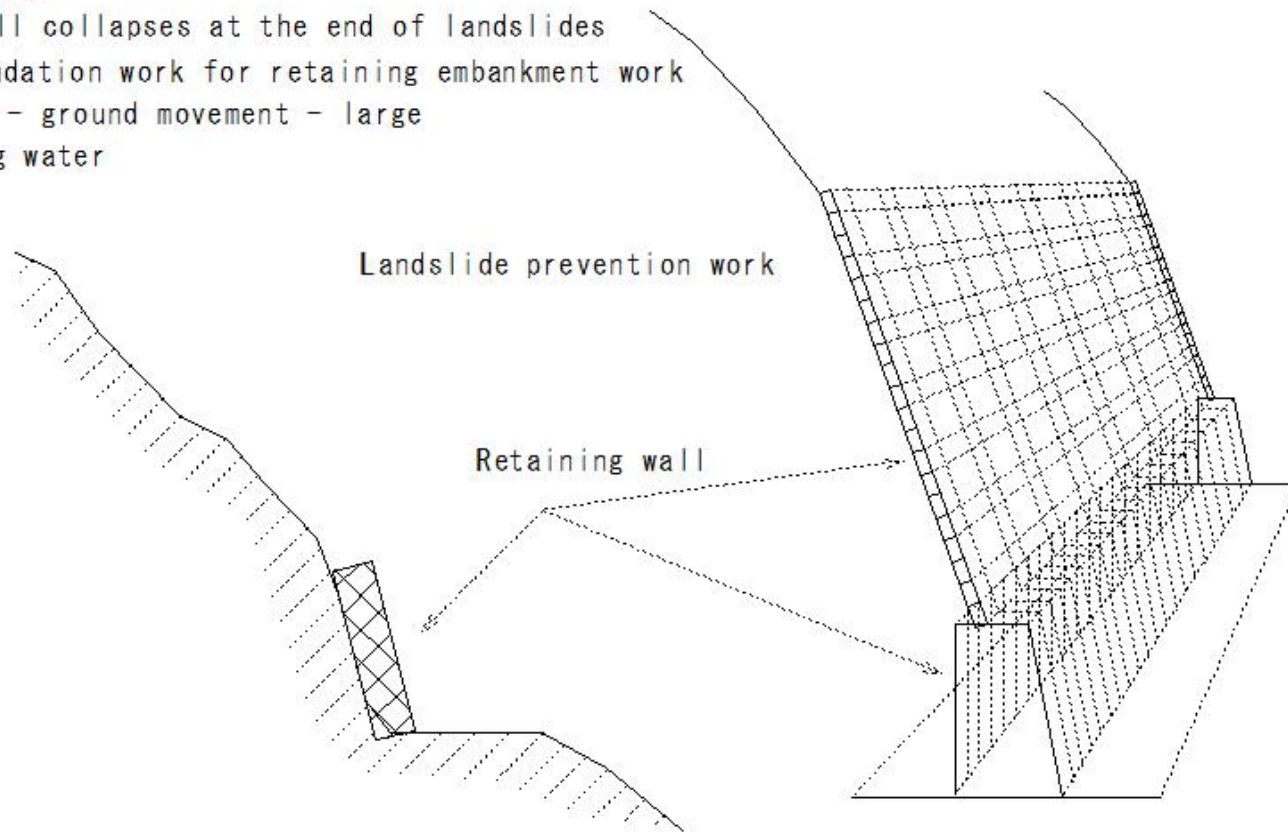
(S96)Landslide prevention work

(S96)Landslide prevention work

Landslide prevention work

Retaining wall work

- Preventing small collapses at the end of landslides
- Planned as foundation work for retaining embankment work
- Landslide area - ground movement - large
- A lot of spring water
- Drainage plan



(S97)Sabo(Erosion control)

(S97) Sabo(Erosion control)

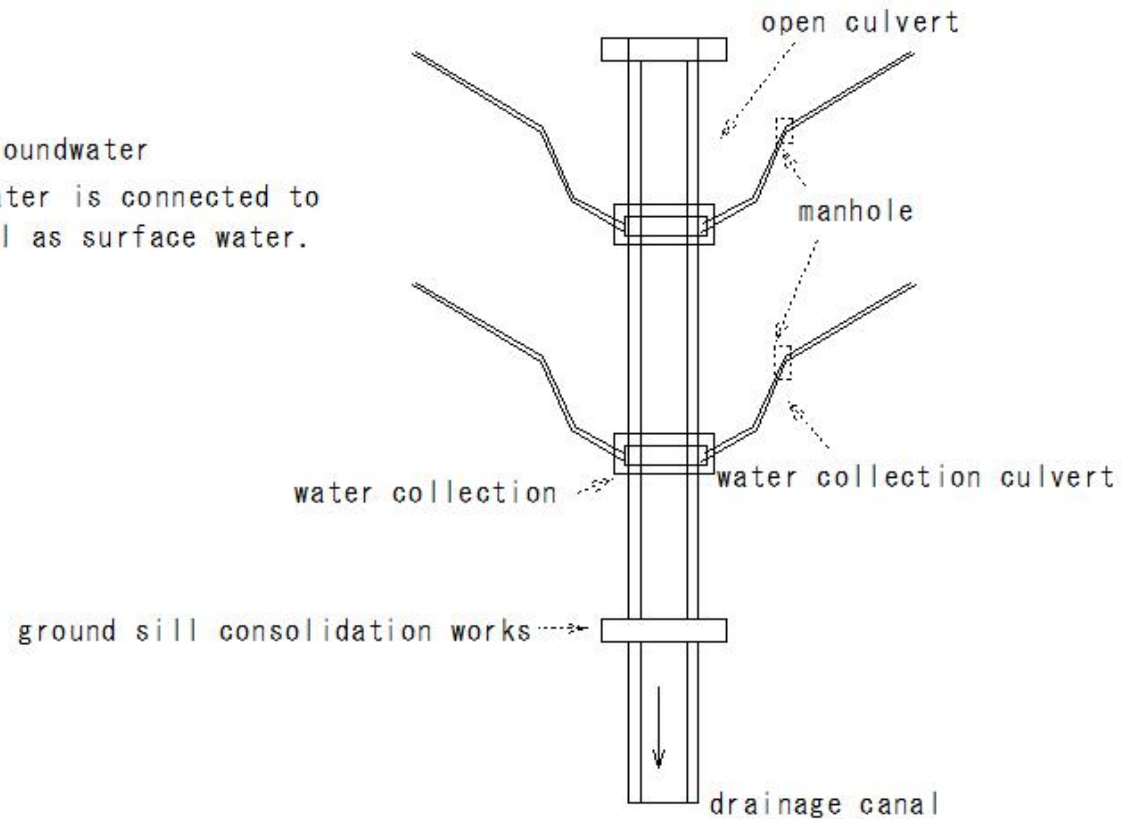
culvert work

- Landslide prevention works

Groundwater drainage works

- Eliminate shallow groundwater
- Landslide stability
- Water culvert that collects groundwater
- Drainage culvert: Collected water is connected to the drainage channel as surface water.

Drainage culvert network

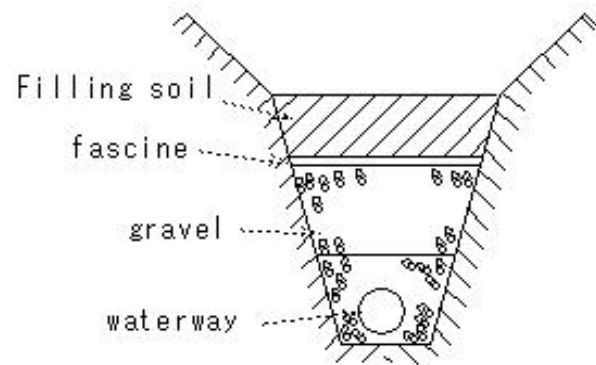


(S98)Sabo(Erosion control)

(S98)Sabo(Erosion control)

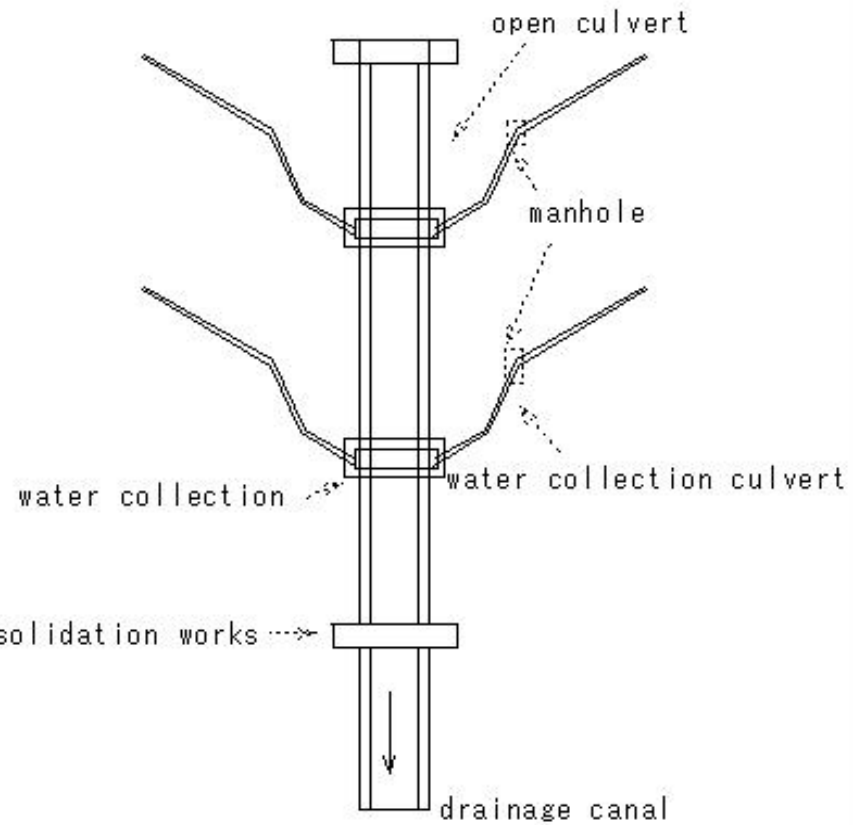
Sabo(Erosion control)

- culvert work
- water collection culvert
- ①Culvert work



①Culvert work

Drainage culvert network



(S99)Sabo(Erosion control)

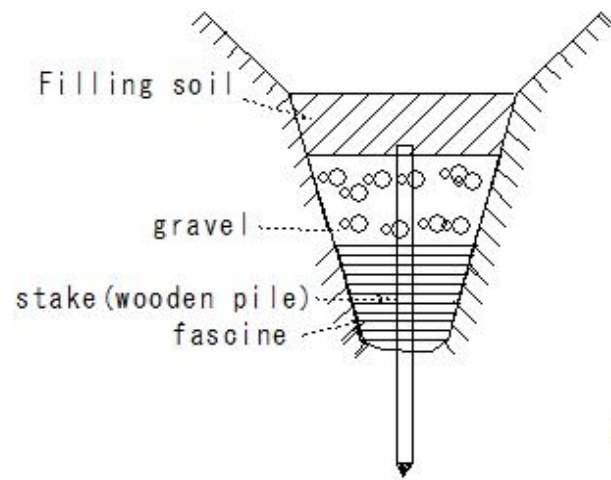
(S99) Sabo (Erosion control)

Sabo(Erosion control)

culvert work

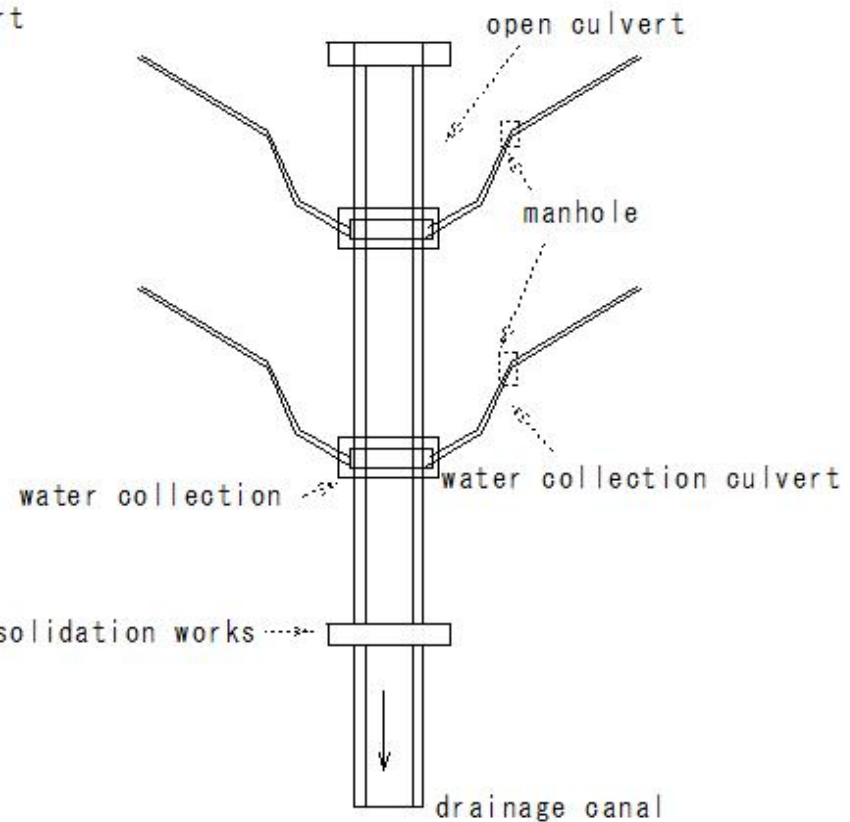
• Cross-sectional view of water collection culvert

② fascine-filled culvert



② fascine-filled culvert

Drainage culvert network

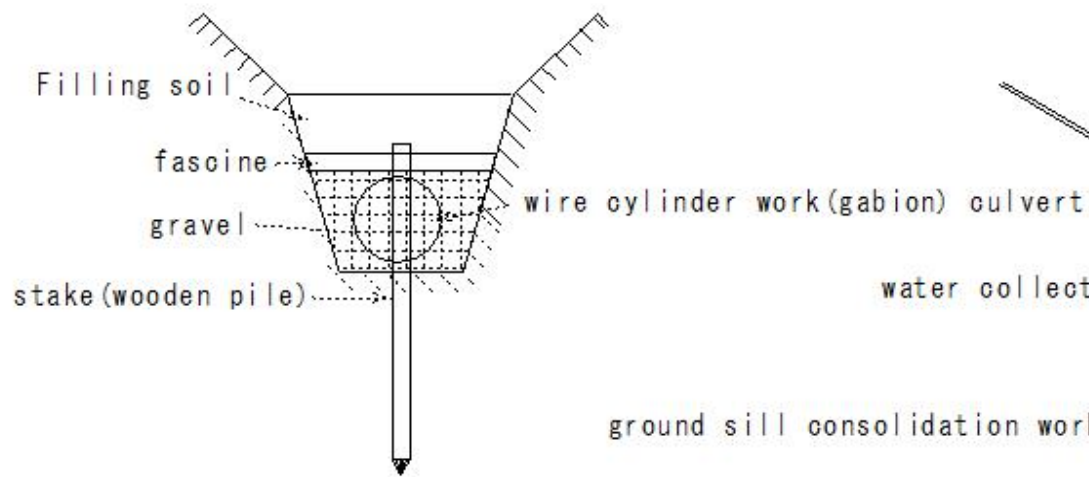


(S100)Sabo(Erosion control)

(S100) Sabo (Erosion control)

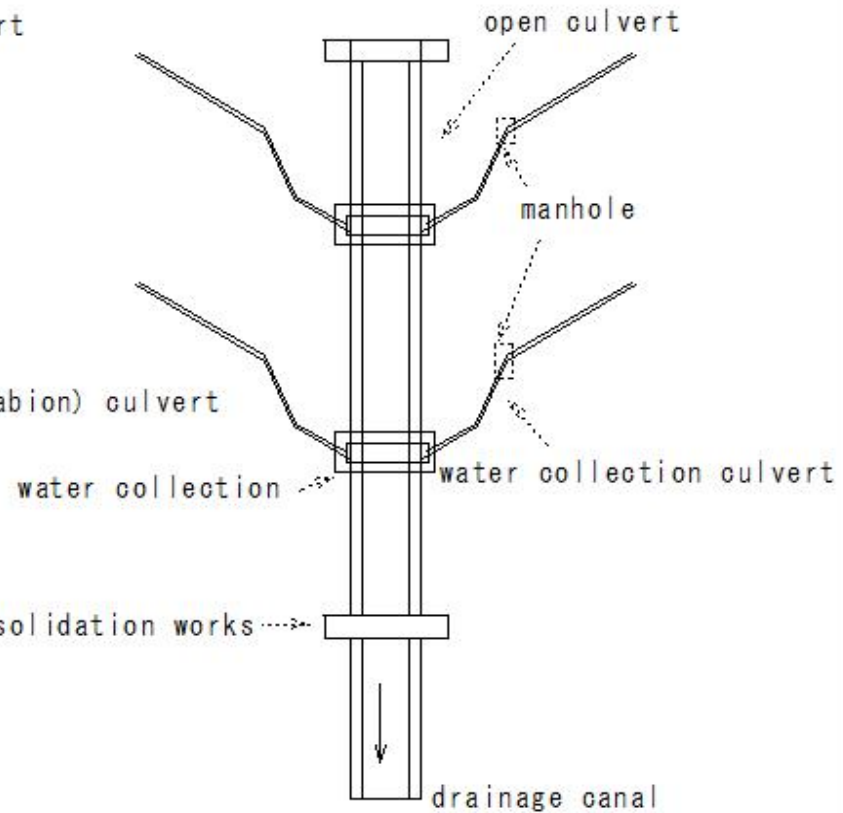
Sabo(Erosion control)
culvert work

- Cross-sectional view of water collection culvert
- ③ wire cylinder work(gabion) culvert



③ wire cylinder work (gabion) culvert

Drainage culvert network



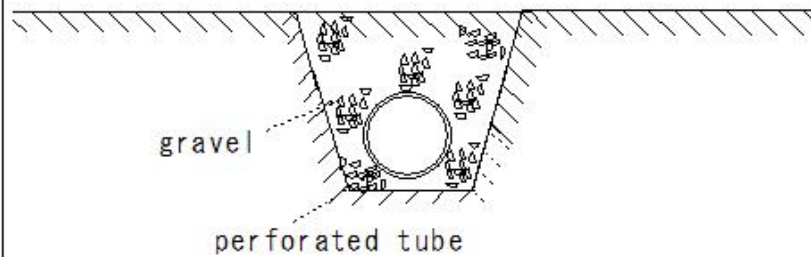
(S101)Sabo(Erosion control)

(S101) Sabo (Erosion control)

Sabo(Erosion control)

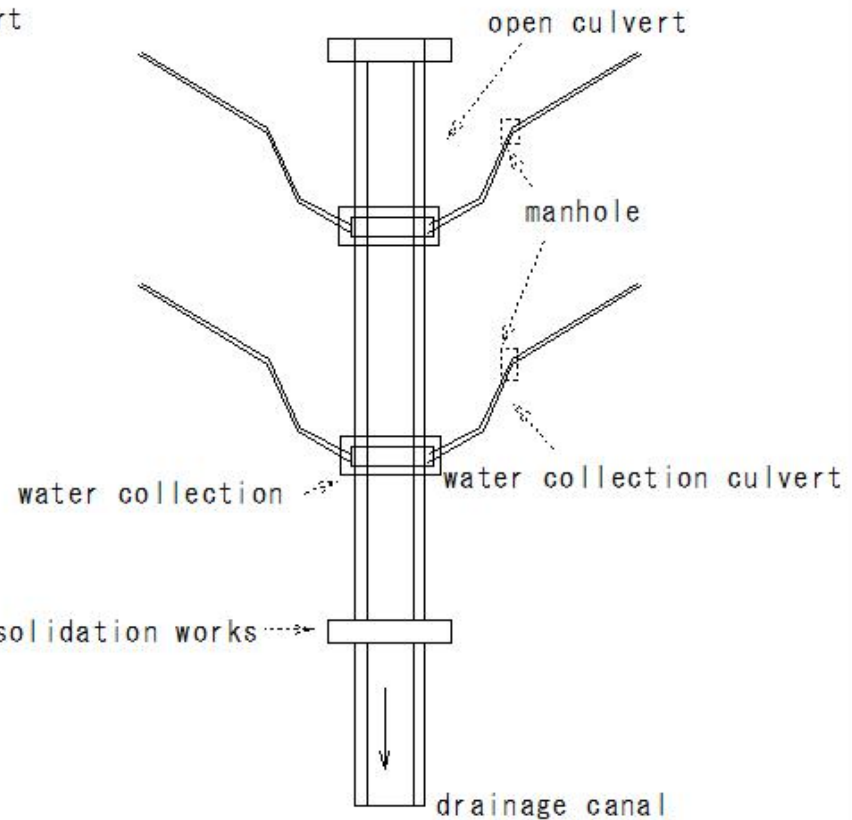
culvert work

- Cross-sectional view of water collection culvert



④ Drainage culvert

Drainage culvert network



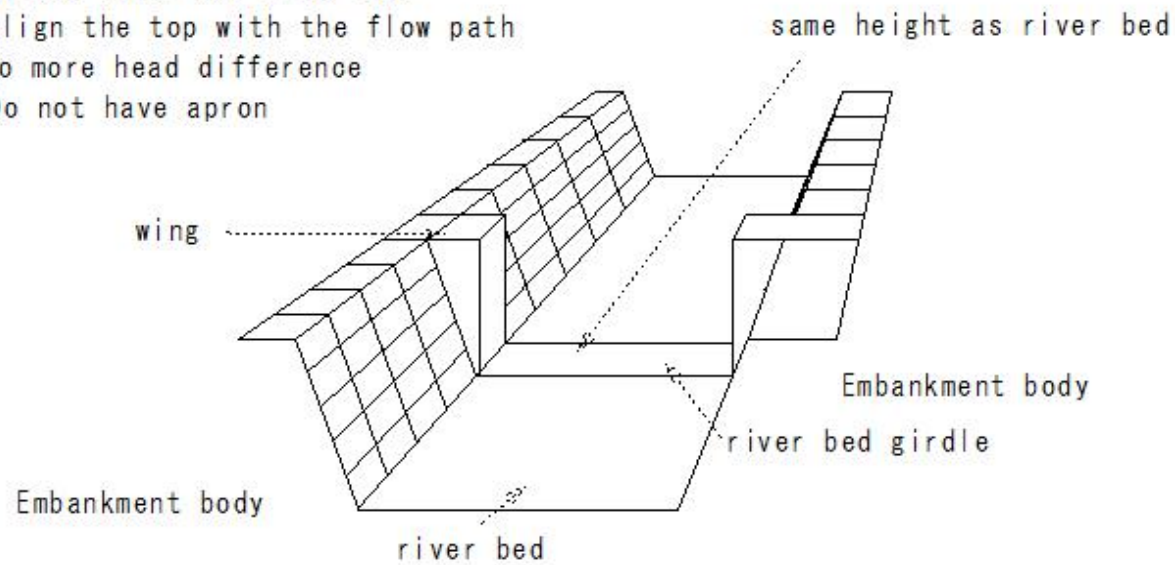
(S102)Sabo(Erosion control)

(S102) Sabo (Erosion control)

Sabo(Erosion control)

river bed girdle

- A type of ground sill consolidation works
- Preventing riverbed scouring
- Stabilize the slope of the river channel
- Do not lower the river bed
- Align the top with the flow path
- No more head difference
- Do not have apron



(S103)Sabo(Erosion control)

(S103) Sabo (Erosion control)

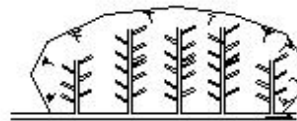
Sabo(Erosion control)

Steep slope collapse prevention work

- Landslide prevention works
- landslide control works

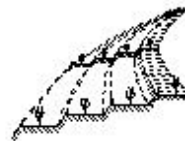
- ① Surface water drainage works
- ② Groundwater drainage works
- ③ Vegetation work
- ④ Spraying
- ⑤ stone pitching
- ⑥ crib work
- ⑦ Cutting work
- ⑧ Loading embankment work

① Surface water drainage works ② Groundwater drainage works



③ Vegetation work

④ Spraying



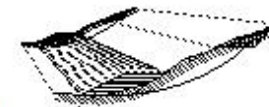
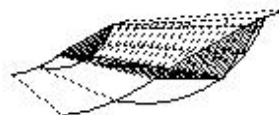
⑤ stone pitching

⑥ crib work



⑦ Cutting work

⑧ Loading embankment work



S84

S90

S78

S80

S75

S96

S91

S92

(S104)Sabo(Erosion control)-landslide restraining works

(S104)Sabo(Erosion control)-landslide restraining works

Sabo(Erosion control)

Steep slope collapse prevention work

landslide restraining works

① Retaining wall work

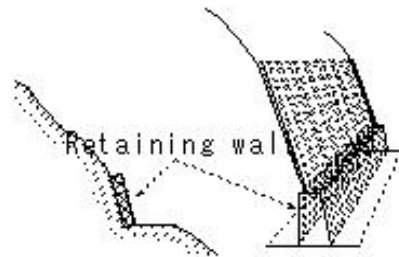
② Anchor work

③ Pilework

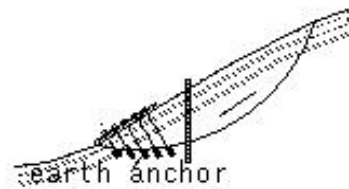
① Retaining wall work

② Anchor work

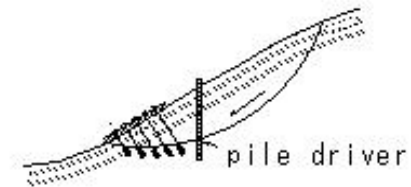
③ Pilework



S96



S94



S94

(S105)Sabo(Erosion control)-landslide restraining works

(S105) Sabo (Erosion control) – landslide restraining works

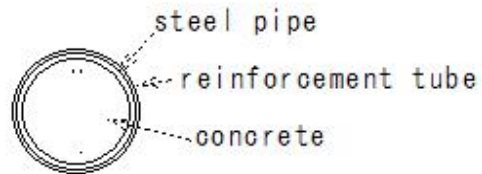
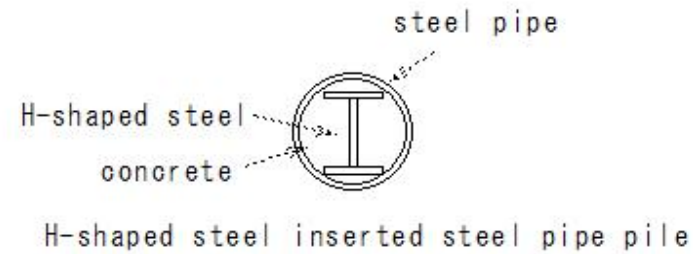
Sabo (Erosion control)

Steep slope collapse prevention work

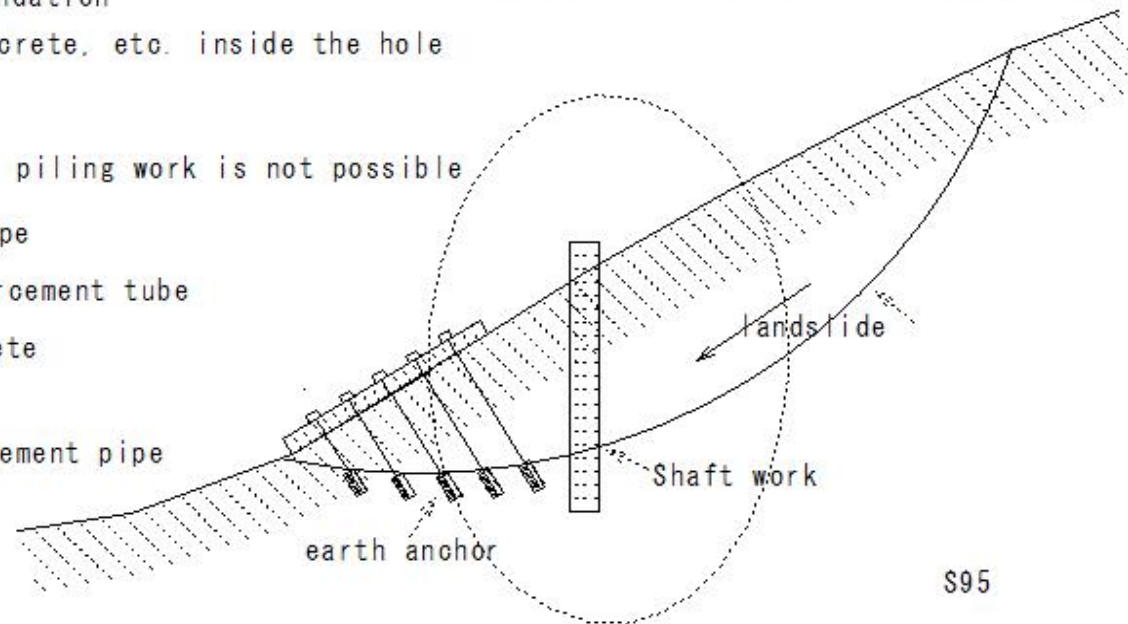
- Landslide prevention works
- landslide restraining works

Pilework

- Large diameter boring (30-50cm diameter)
- Excavation inside the foundation
- Made with steel pipe, concrete, etc. inside the hole
- Landslide slope stability
- Pile length up to 30m
- Landslide of 1mm per day, piling work is not possible



Steel pipe pile with reinforcement pipe



(S106)check dam(erosion control dam)

(S106)check dam(erosion control dam)

check dam(erosion control dam)

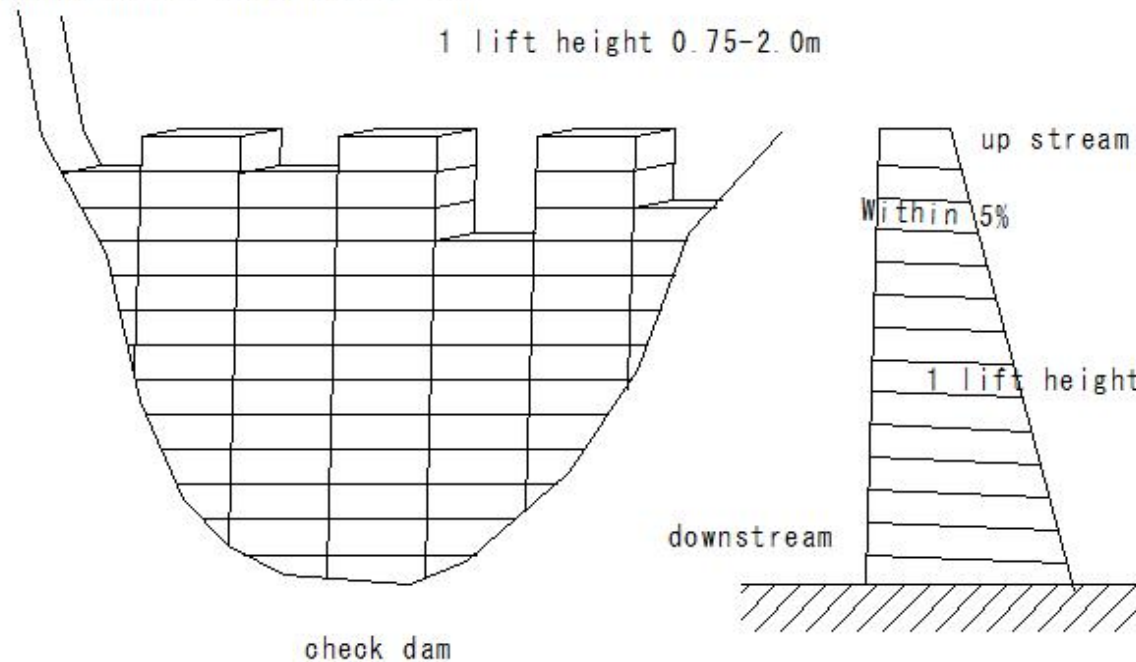
• Concrete placement

① Adhesion to bedrock

② Bedrock cleaning

③ 2.0cm thick mortar

④ New and old concrete pouring joint 1.5cm mortar bed



1 lift height 0.75-2.0m

up stream

Within 5%

1 lift height

downstream

check dam

S38

(S107)check dam(erosion control dam)

(S107)check dam(erosion control dam)

check dam(erosion control dam)

- Concrete placement
 - Placing order
- Block division (dam axis direction 15m standard)
- Placing from a low point
 - From the upstream side to the downstream side

Slope within 5%

- Prevention of cracks

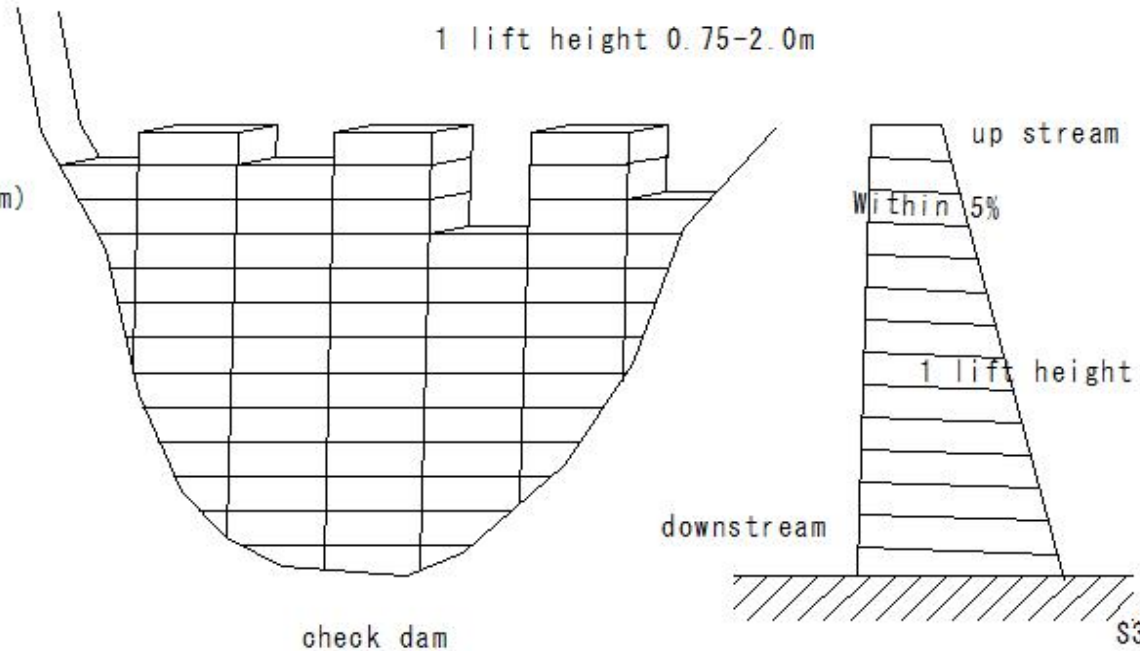
1 lift: 0.75-1.5m standard
lift height

check dam(erosion control dam)

1 lift height 0.75-1.5m

placing surface slope

Within 5%



check dam

(S108)check dam(erosion control dam)

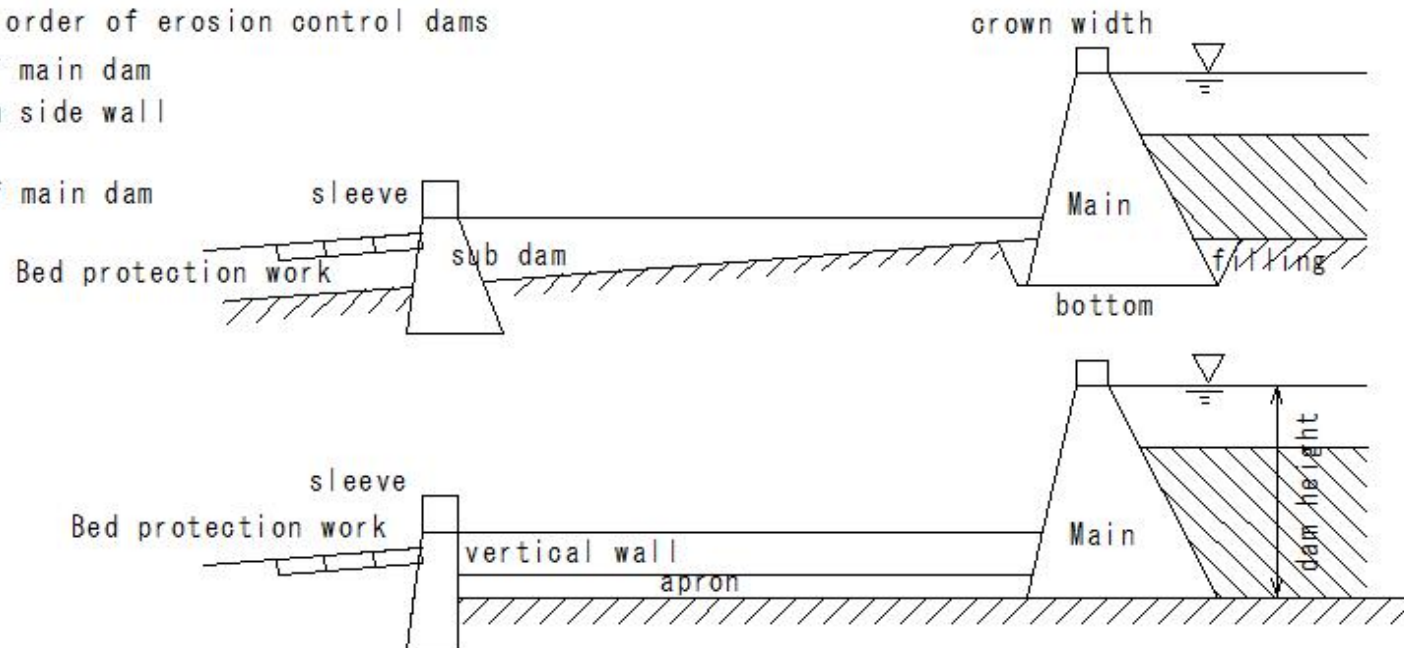
(S108) check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- Main body of mountain stream construction

① Construction order of erosion control dams

- ① Lower part of main dam
- ② Secondary dam side wall
- ③ apron
- ④ Upper part of main dam



(S109)check dam(erosion control dam)

(S109)check dam(erosion control dam)

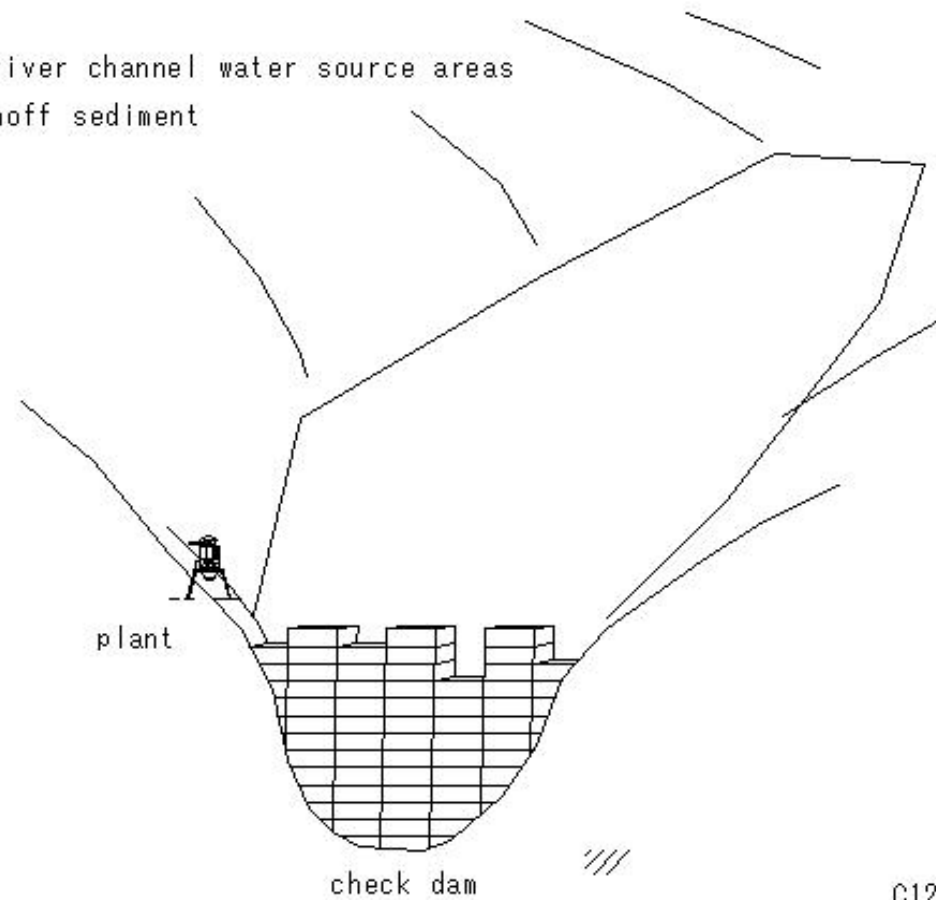
check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works

②Concrete aggregate storage area

Plant installation location

- Drop method
- Use high spots on slopes



C1226

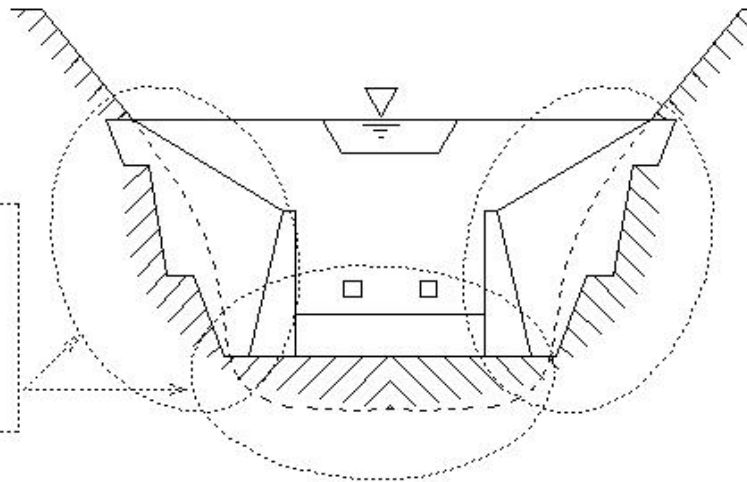
(S110)check dam(erosion control dam)

(S110) check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works

③ After completion of excavation
Prior to concrete placing
mud on bedrock
dust
remove standing water



check dam(erosion control dam)

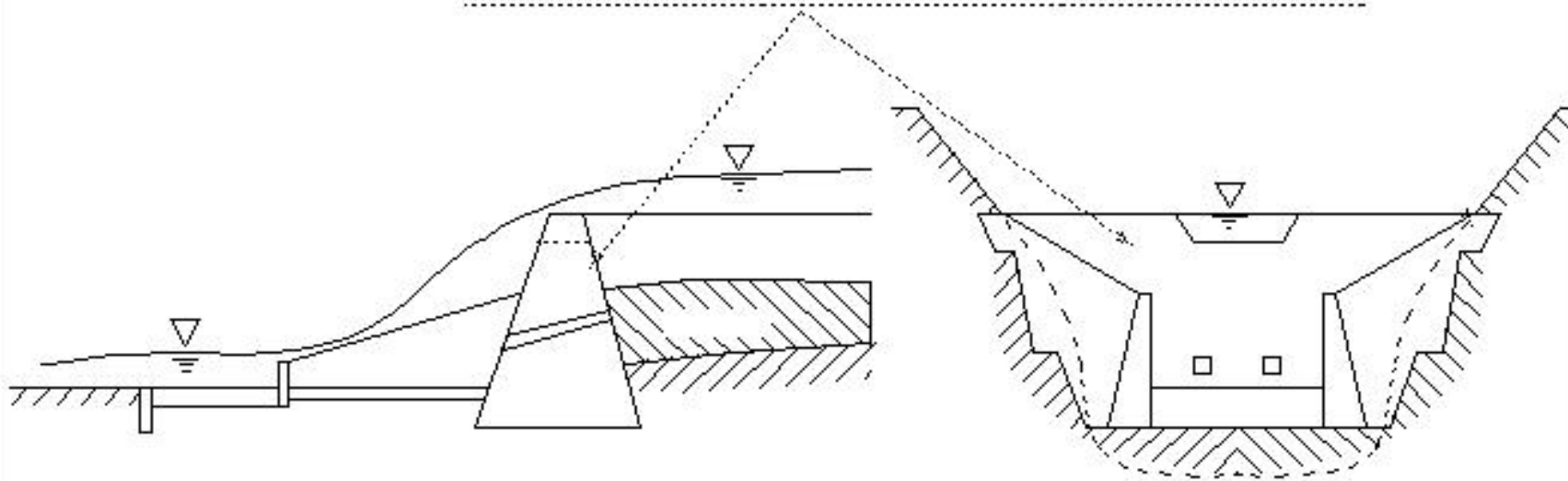
(S111)check dam(erosion control dam)

(S111)check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works

④Main concrete
Low neutralization heat
Uses blast furnace cement with excellent wear resistance



check dam

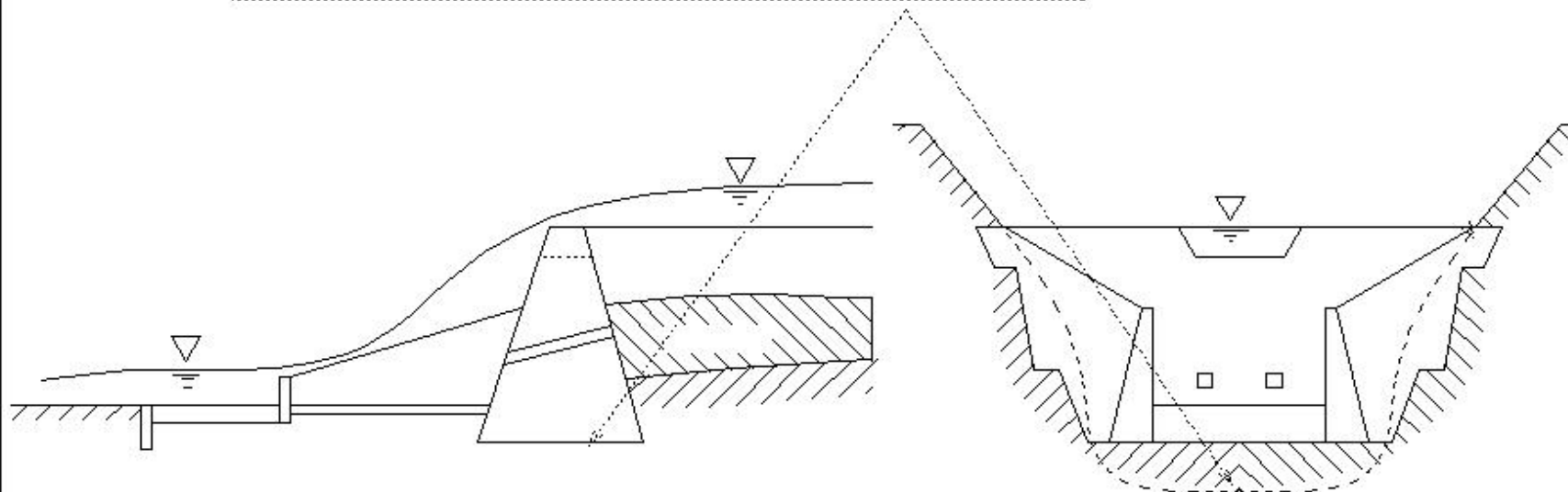
(S112)check dam(erosion control dam)

(S112) check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works

⑤ Bedrock foundation surface before concrete pouring
wet condition



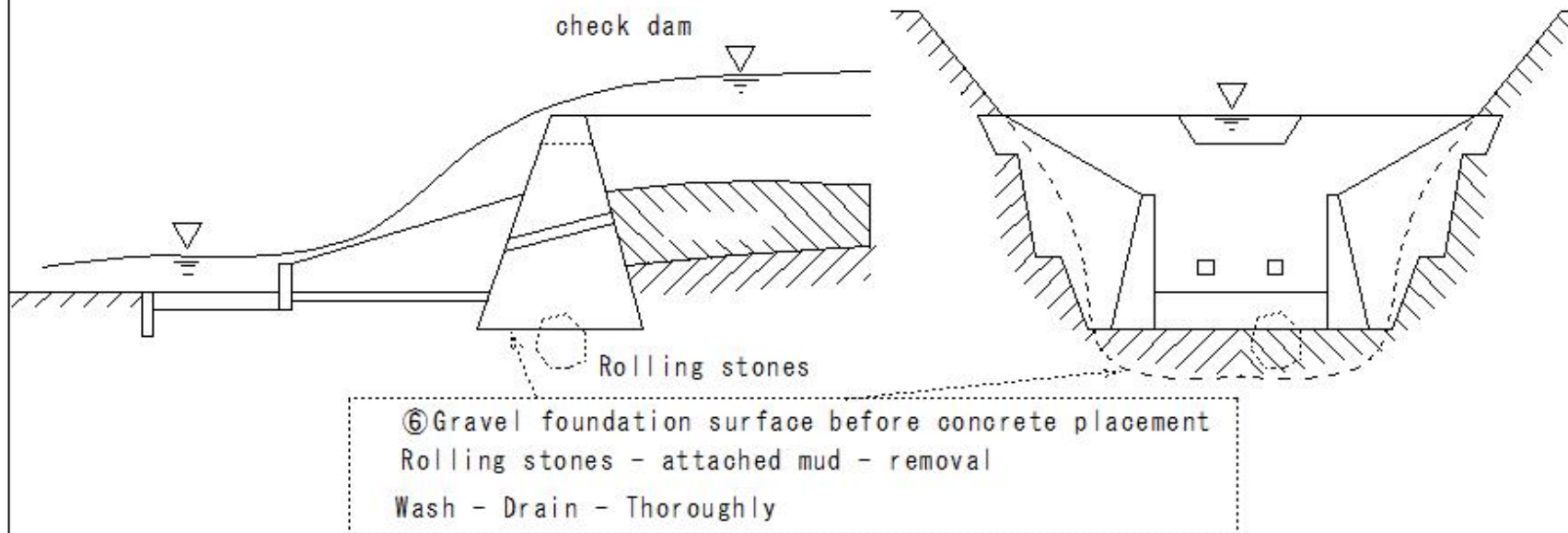
check dam

(S113)check dam(erosion control dam)

(S113) check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works

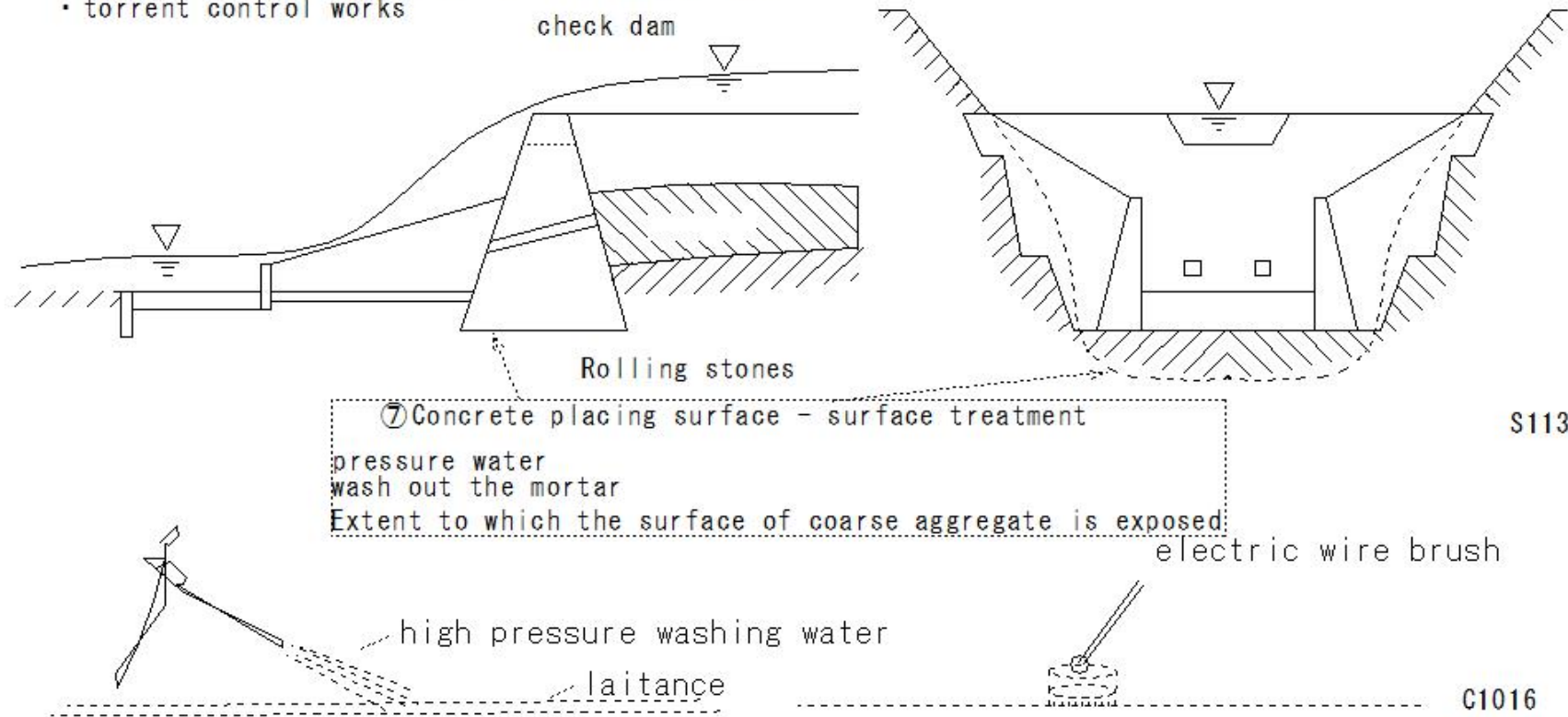


(S114)check dam(erosion control dam)

(S114) check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works



S113

C1016

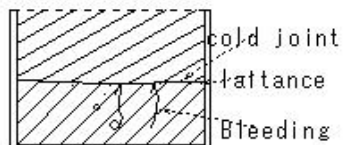
(S115)check dam(erosion control dam)

(S115)check dam(erosion control dam)

check dam(erosion control dam)

- Prevention of sediment production in river channel water source areas
- Purpose of storing and controlling runoff sediment
- torrent control works

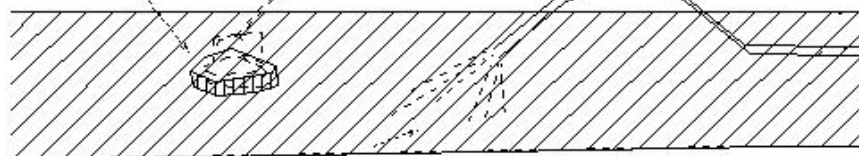
⑧Horizontal placing joint of dam concrete
Mortar-water cement ratio in concrete



Measures to prevent cold joints

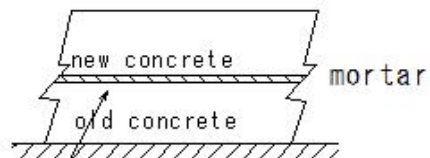
Temporary suspension of construction does not integrate with concrete

①Laitance removal



② Pressurized water - Rise - Green cut

C880



①Horizontal joint

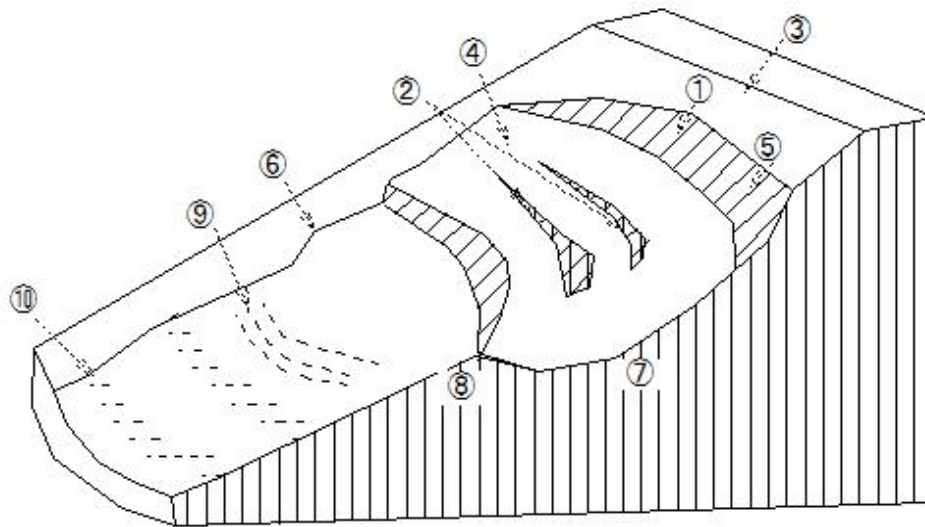
C1410

(S116)Landslide

(S116) Landslide

Landslide

- ① Sliding cliff (crack)
- ② Secondary sliding cliff
- ③ Top of crown
- ④ Head
- ⑤ Vertex
- ⑥ Side
- ⑦ Slip surface
- ⑧ Legs
- ⑨ Tongue
- ⑩ Lower end



(S117)Landslide prevention method

(S117)Landslide prevention method

Landslide prevention method

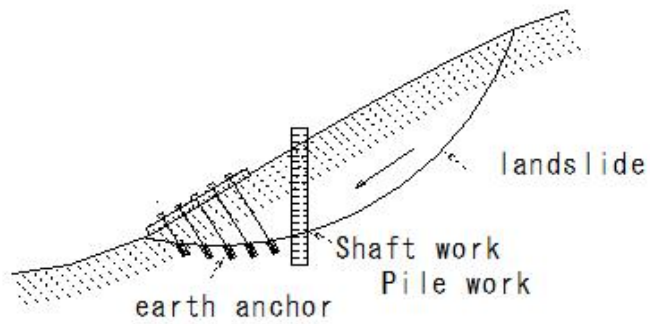
- ① landslide control works- main
 - ② Surface water drainage works-waterway-Penetration prevention work
 - ③ Groundwater drainage works
 - ④ Shallow groundwater drainage works
 - ⑤ open culvert-culvert work-Horizontal boring
 - ⑥ Groundwater isolation work
 - ⑦ Deep groundwater drainage works-horizontal boring-catchment well-drainage tunnel construction
 - ⑧ Earth removal work
 - ⑨ Loading embankment work
 - ⑩ River structures-Weir work-ground sill consolidation works-groin-revetment

(S118)Landslide prevention method

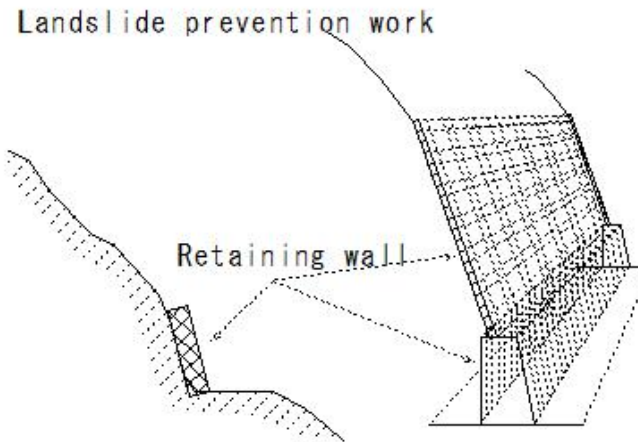
(S118)Landslide prevention method

Landslide prevention method

- ① landslide restraining works
- ② Pile work
- ③ Shaft work
- ④ Anchor work
- ⑤ Retaining wall work



S95



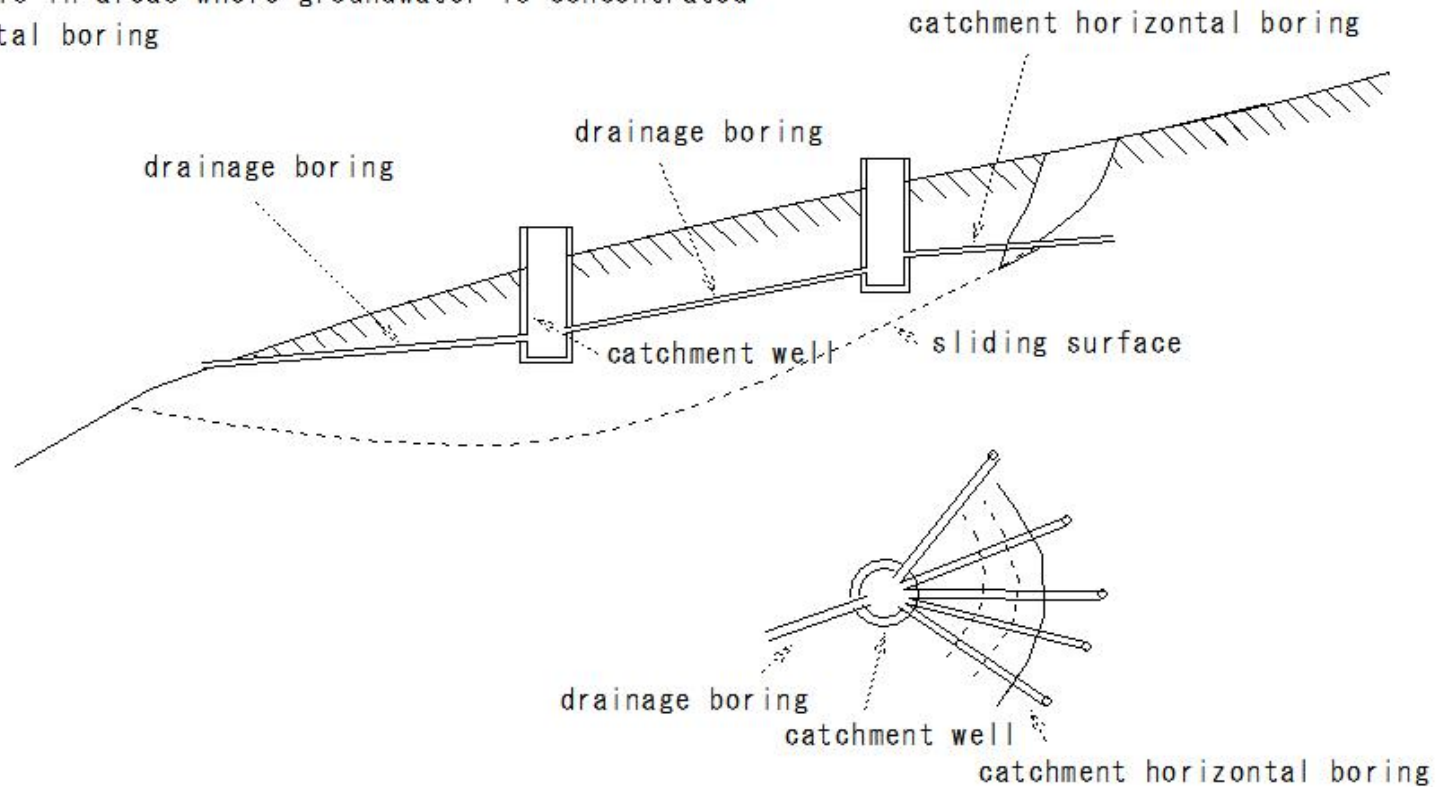
S96

(S119)Landslide prevention method

(S119)Landslide prevention method

catchment well

- Eliminate deep groundwater
- Dig wells in areas where groundwater is concentrated
- Horizontal boring

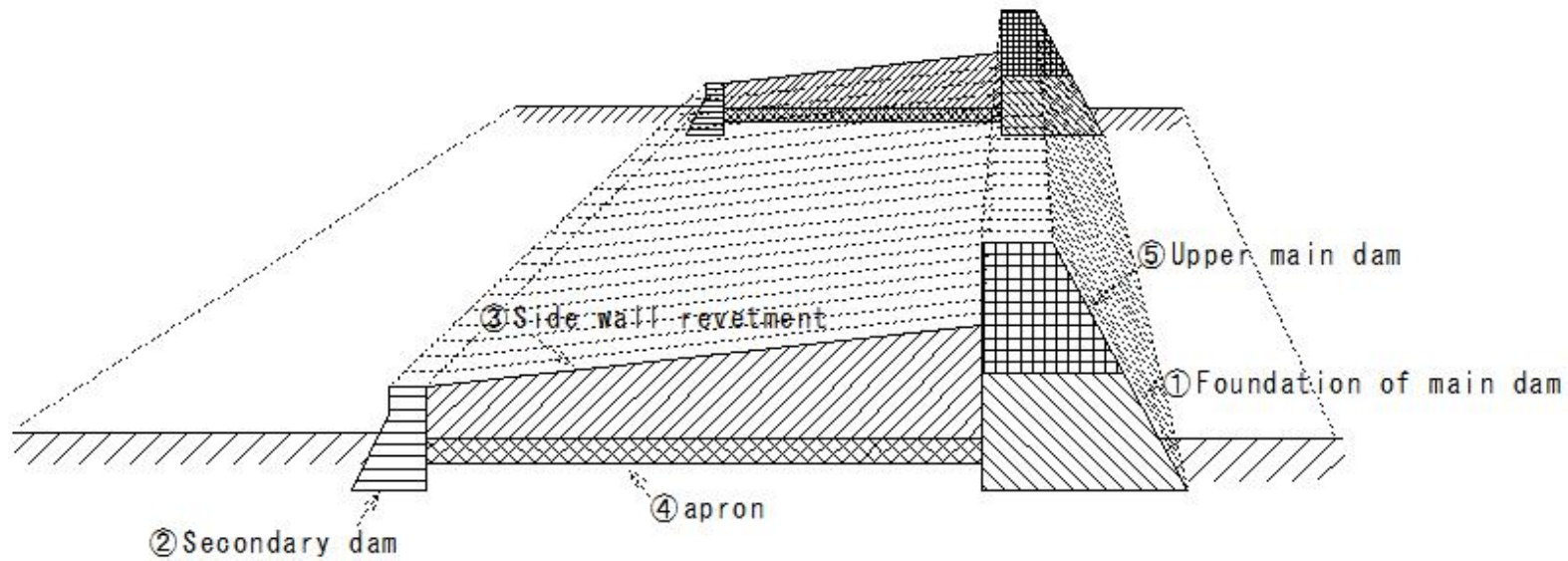


(S120) Dam construction order

(S120) Dam construction order

Dam construction order

- Eliminate deep groundwater



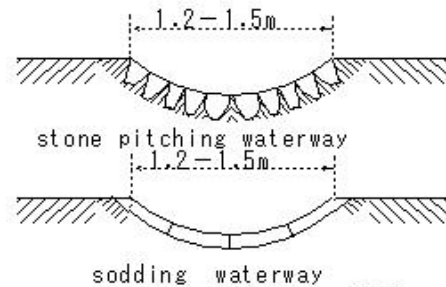
(S121)Surface water drainage works

(S121)Surface water drainage works

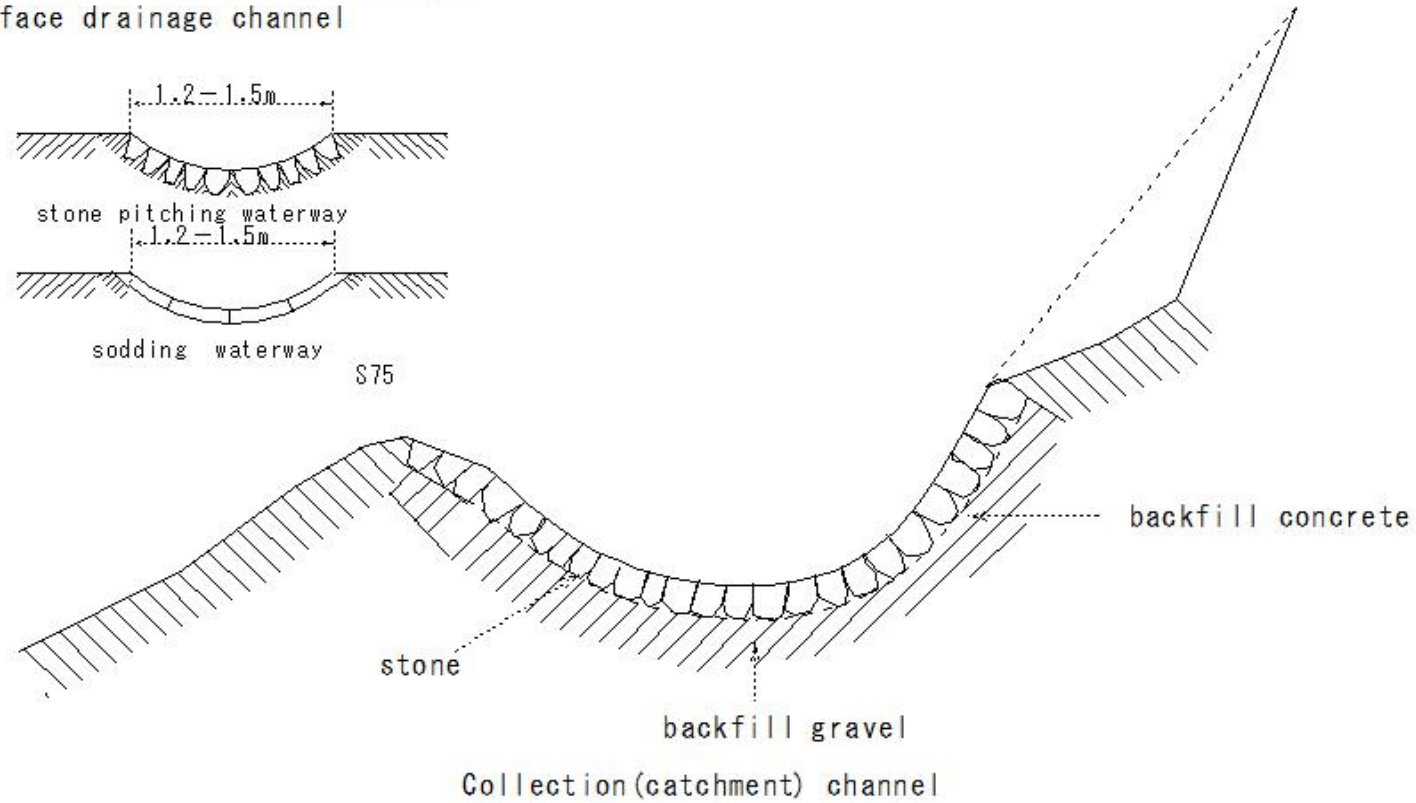
Surface water drainage works

- waterway seepage prevention work

① Surface drainage channel



S75



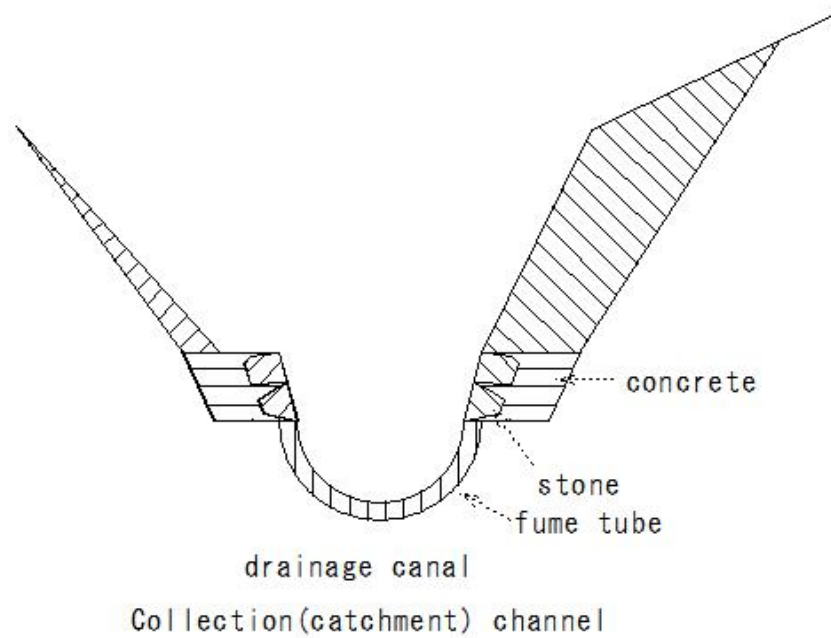
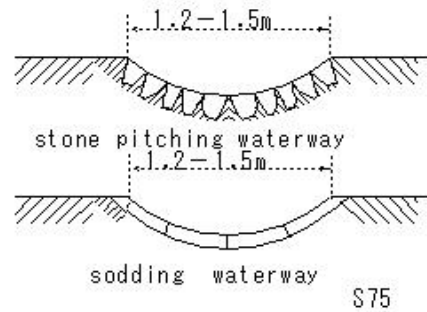
(S122)Surface water drainage works

(S122) Surface water drainage works

Surface water drainage works

- waterway seepage prevention work

②Surface drainage channel

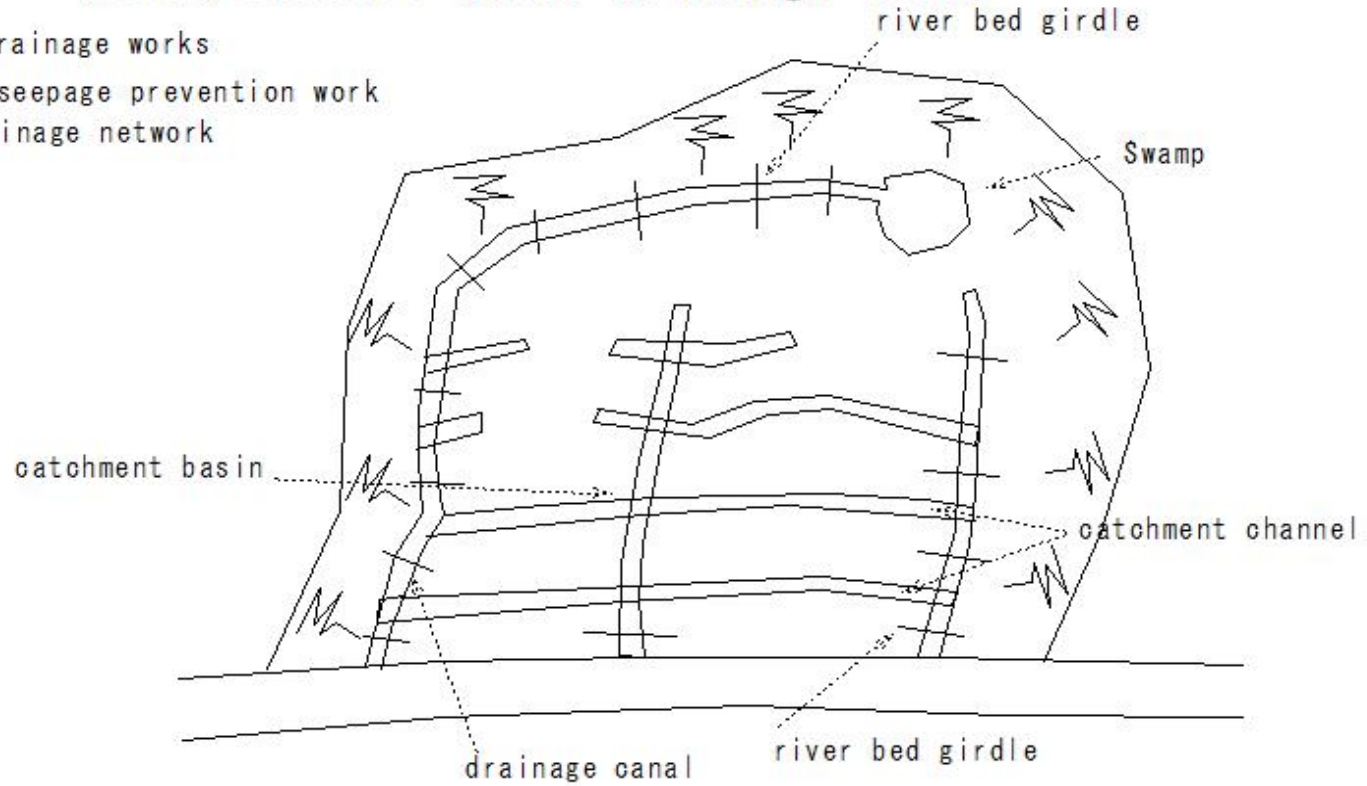


(S123)Surface water drainage works

(S123) Surface water drainage works

Surface water drainage works

- Waterworks seepage prevention work
- ③ Surface drainage network

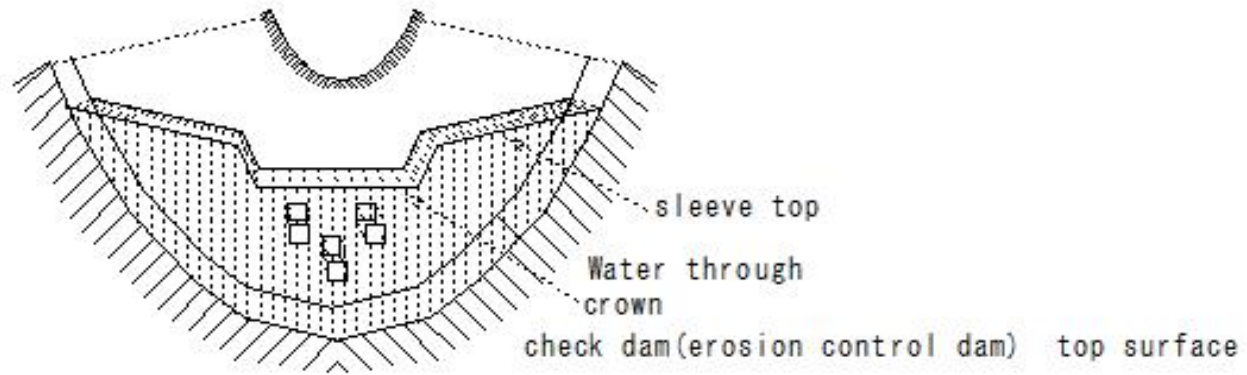


③ Surface drainage network

(S124)check dam(erosion control dam)

(S124)check dam(erosion control dam)

check dam(erosion control dam)



(S125)ground sill consolidation works

(S125)ground sill consolidation works

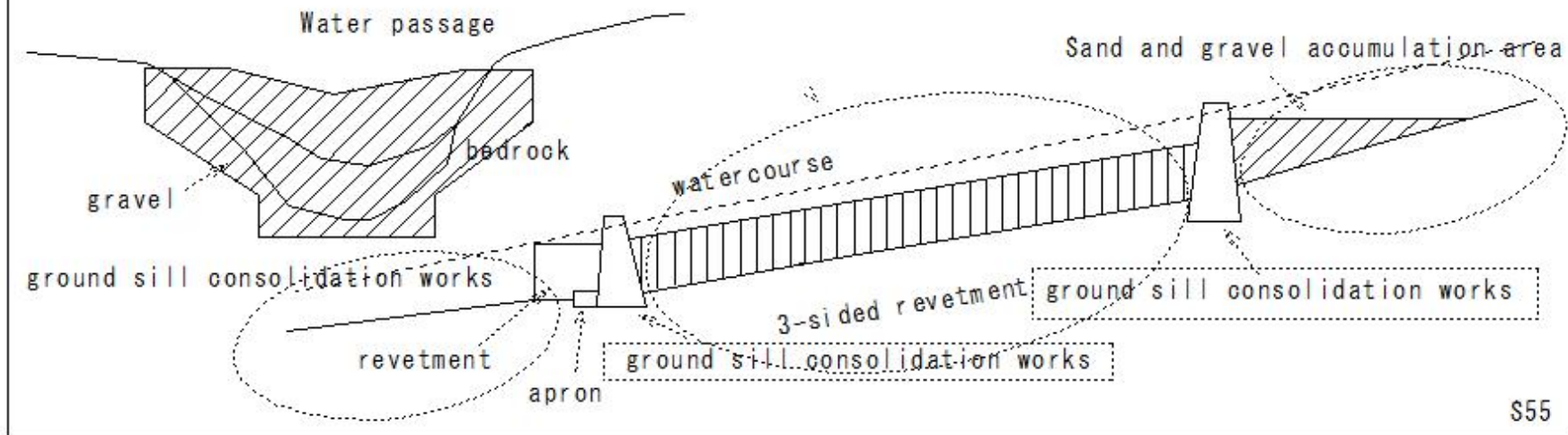
ground sill consolidation works

- Main structure of mountain stream construction

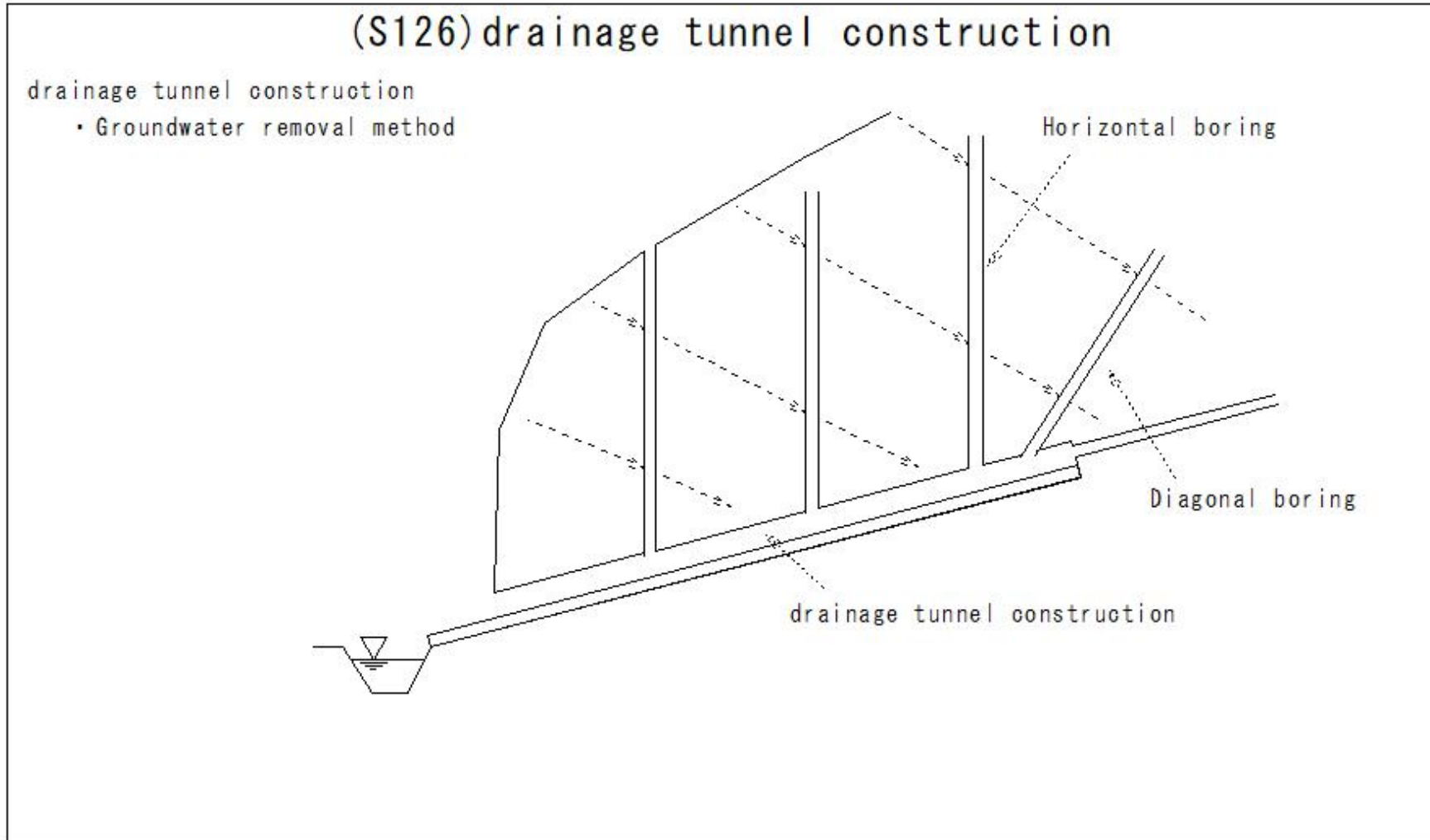
River bed/bank protection maintenance

Horizontal structure (horizontal structure)

- Prevention of re-migration of streambed sediments
- Prevention of re-migration of streambed sediments



(S126)drainage tunnel construction



(S127)check dam(erosion control dam)-sub dam

(S127)check dam(erosion control dam)-sub dam

check dam(erosion control dam)-sub dam

water cushion

main dam

$$L = (1.5 - 2.0) (H_1 + h_o)$$

$$H_2 = H/3 - H/4$$

H_1 : Main dam height from the top of the water tap

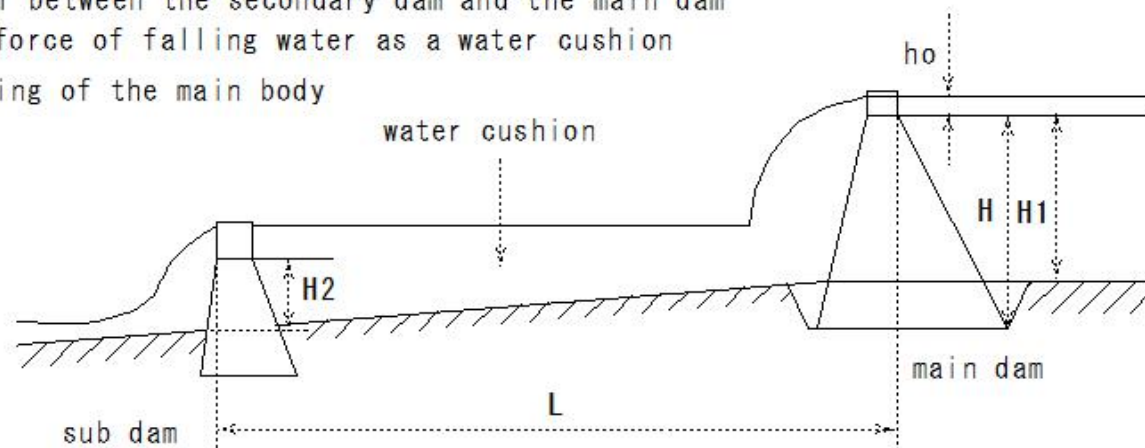
h_o : Water depth overflow from this dam

H : Height of dam

sub dam

Prevention of scouring downstream of this dam

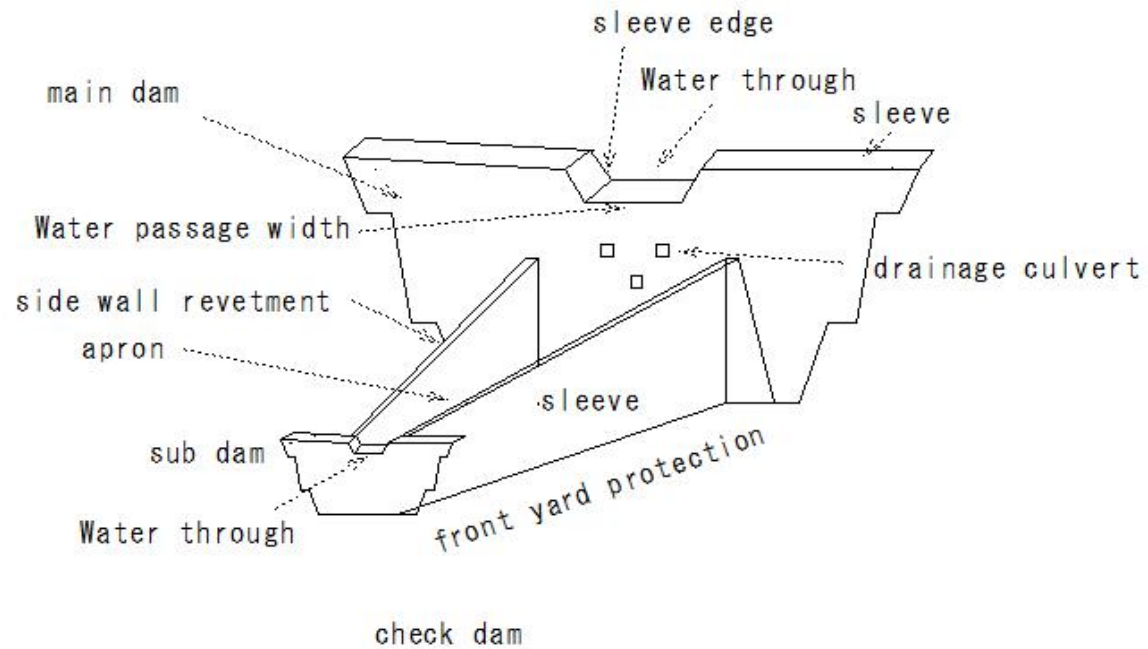
- Deposition of gravel between the secondary dam and the main dam
- Reduces the impact force of falling water as a water cushion
- Prevention of scouring of the main body



(S128)check dam(erosion control dam)-main dam

(S128) check dam(erosion control dam)-main dam

check dam(erosion control dam)-main dam



(S129)check dam(erosion control dam)-main dam

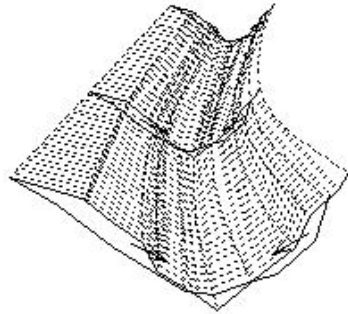
(S129)check dam(erosion control dam)-main dam

check dam(erosion control dam)

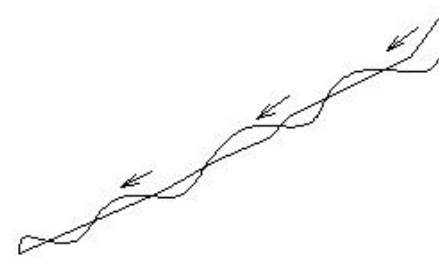
purpose

①Reducing mountain stream slope

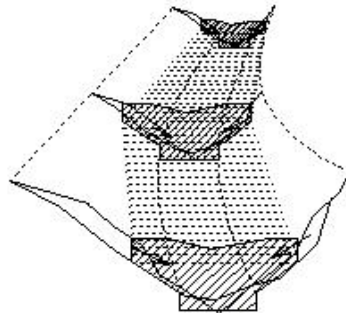
Vertical and horizontal erosion prevention



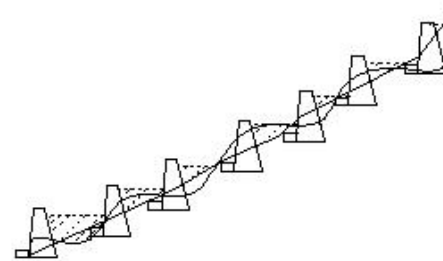
horizontal erosion



Vertical erosion



erosion prevention

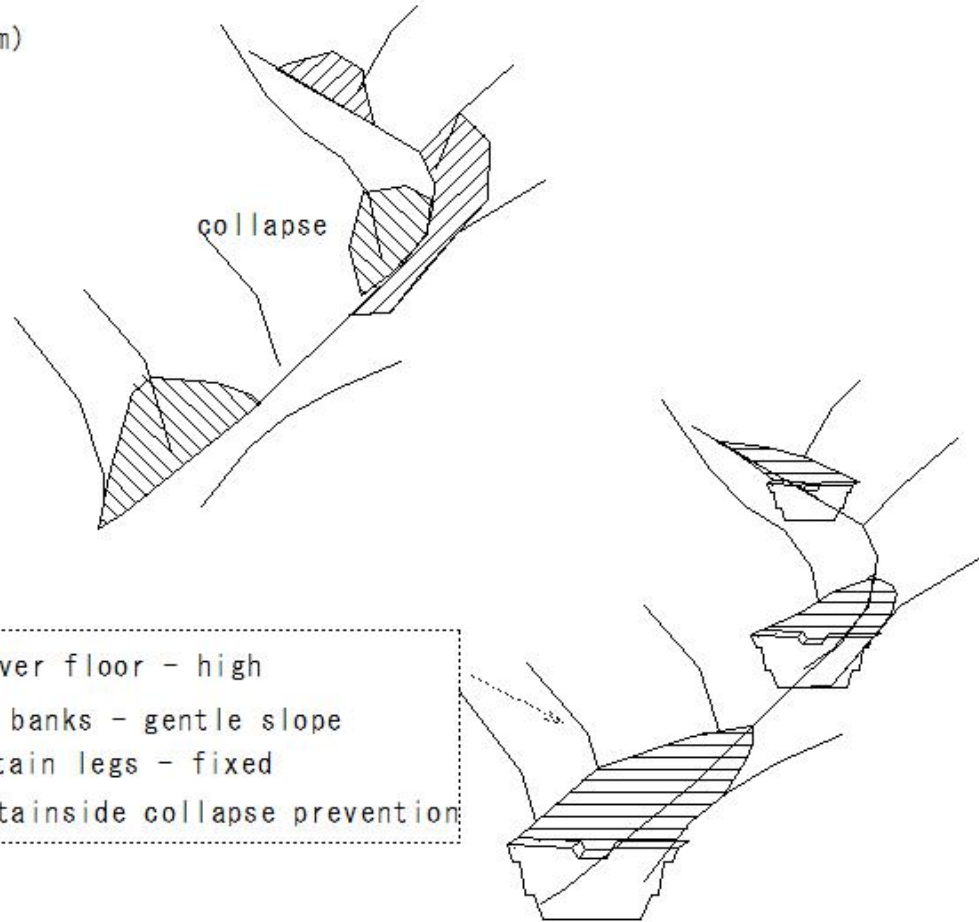


erosion prevention

(S130)check dam(erosion control dam)-main dam

(S130) check dam(erosion control dam)-main dam

check dam(erosion control dam)

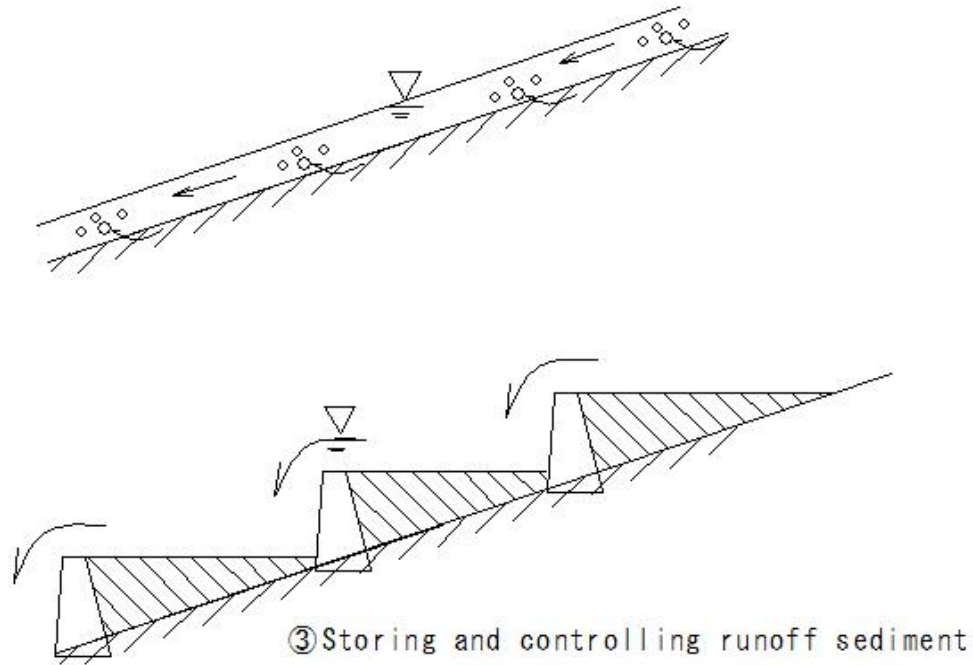


②River floor - high
Both banks - gentle slope
Mountain legs - fixed
Mountainside collapse prevention

(S131)check dam(erosion control dam)-main dam

(S131) check dam(erosion control dam) -main dam

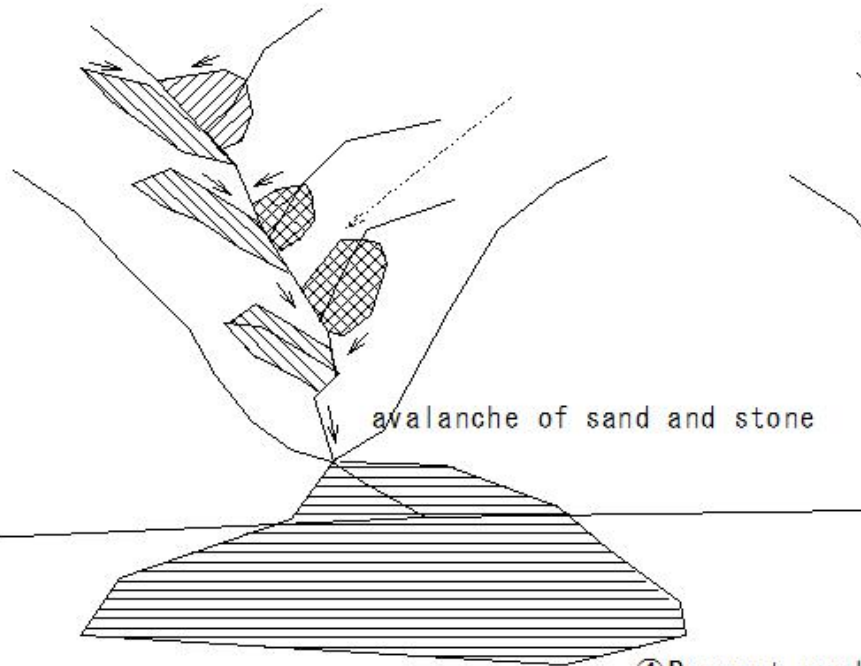
check dam(erosion control dam)



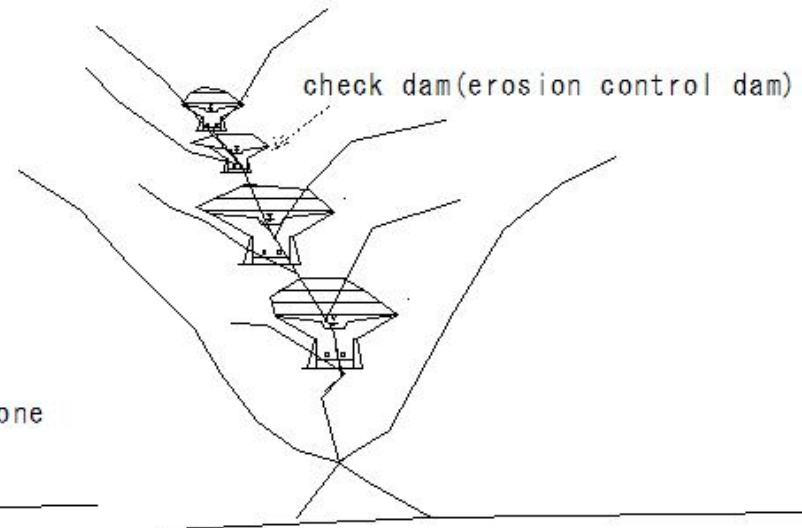
(S132)check dam(erosion control dam)-main dam

(S132) check dam(erosion control dam)-main dam

check dam(erosion control dam)



④ Prevent avalanche of sand and stone

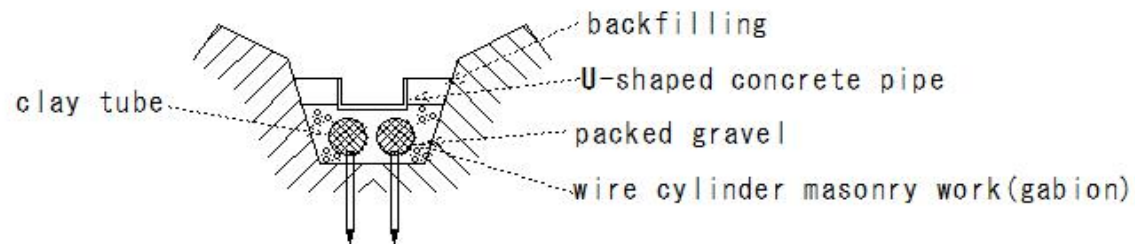
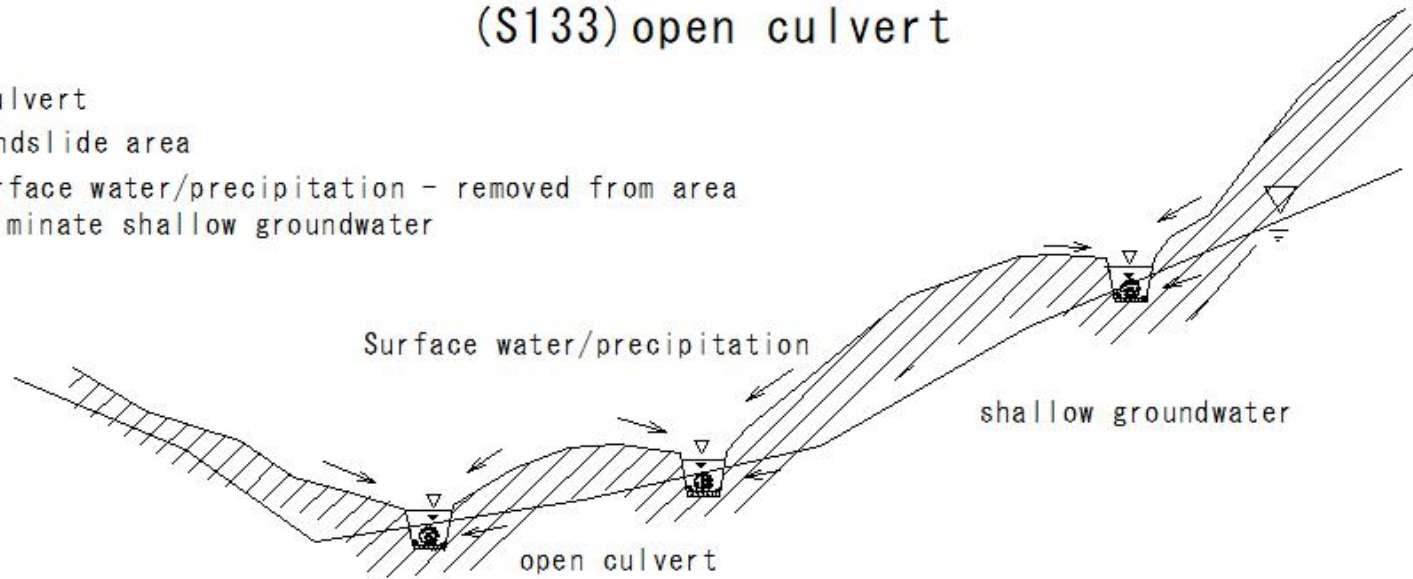


(S133)open culvert

(S133) open culvert

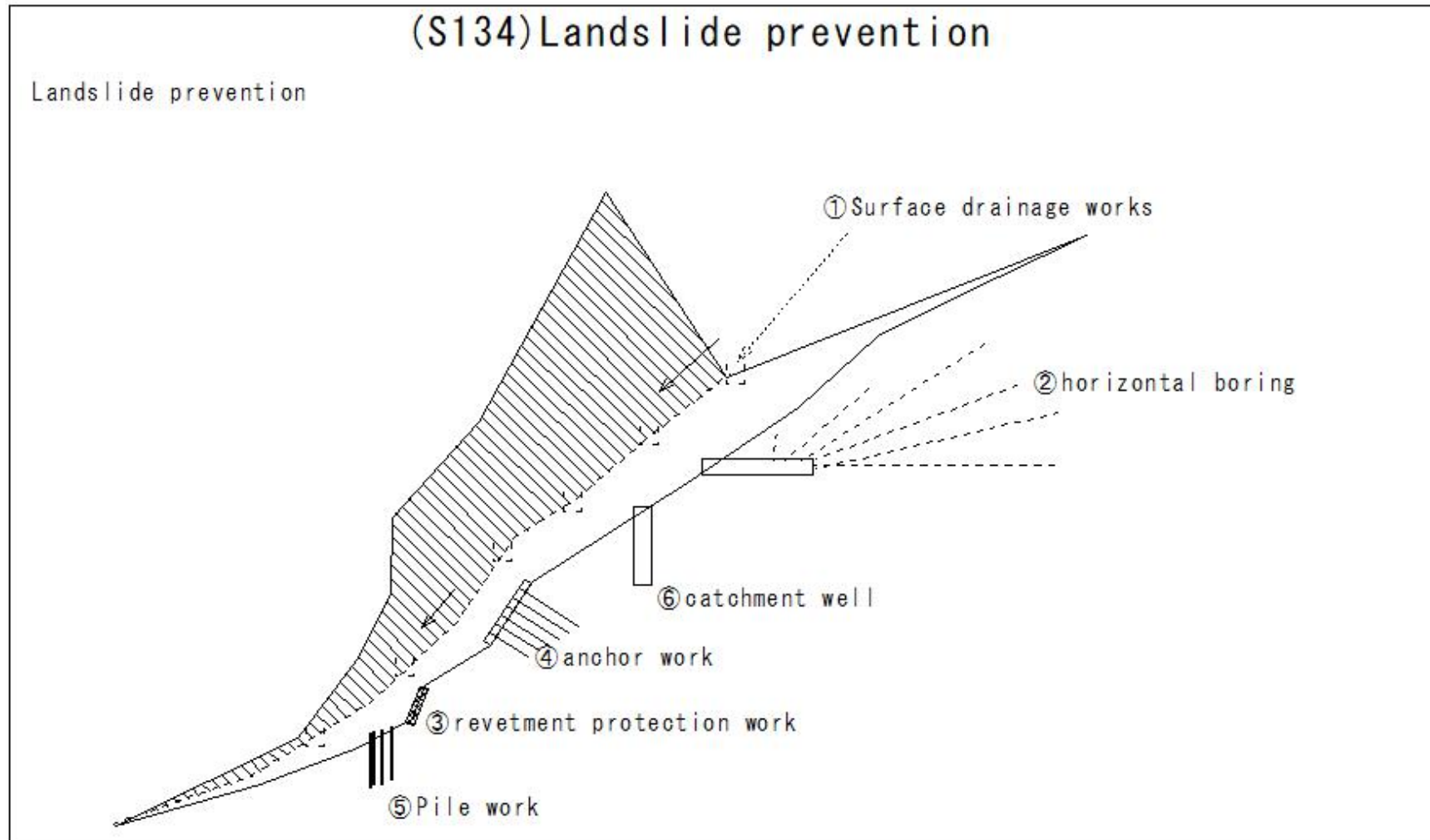
open culvert

- Landslide area
- Surface water/precipitation - removed from area
- Eliminate shallow groundwater



wire cylinder masonry work (gabion) culvert

(S134)Landslide prevention

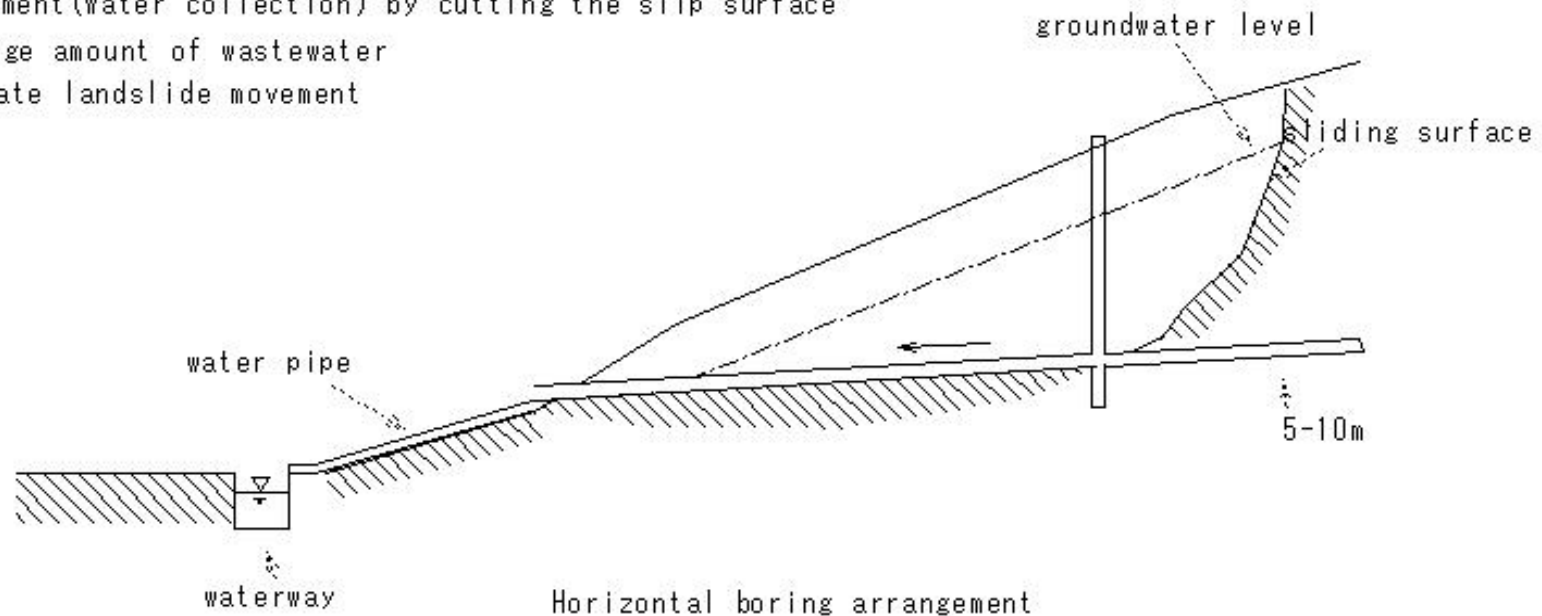


(S135)Landslide prevention(horizontal boring)

(S135)Landslide prevention(horizontal boring)

horizontal boring

- Shallow groundwater 3 m or more below the ground surface
- Elimination of crack water
- Length 80-100m long boring
- catchment(Water collection) by cutting the slip surface
- A large amount of wastewater
- Mitigate landslide movement

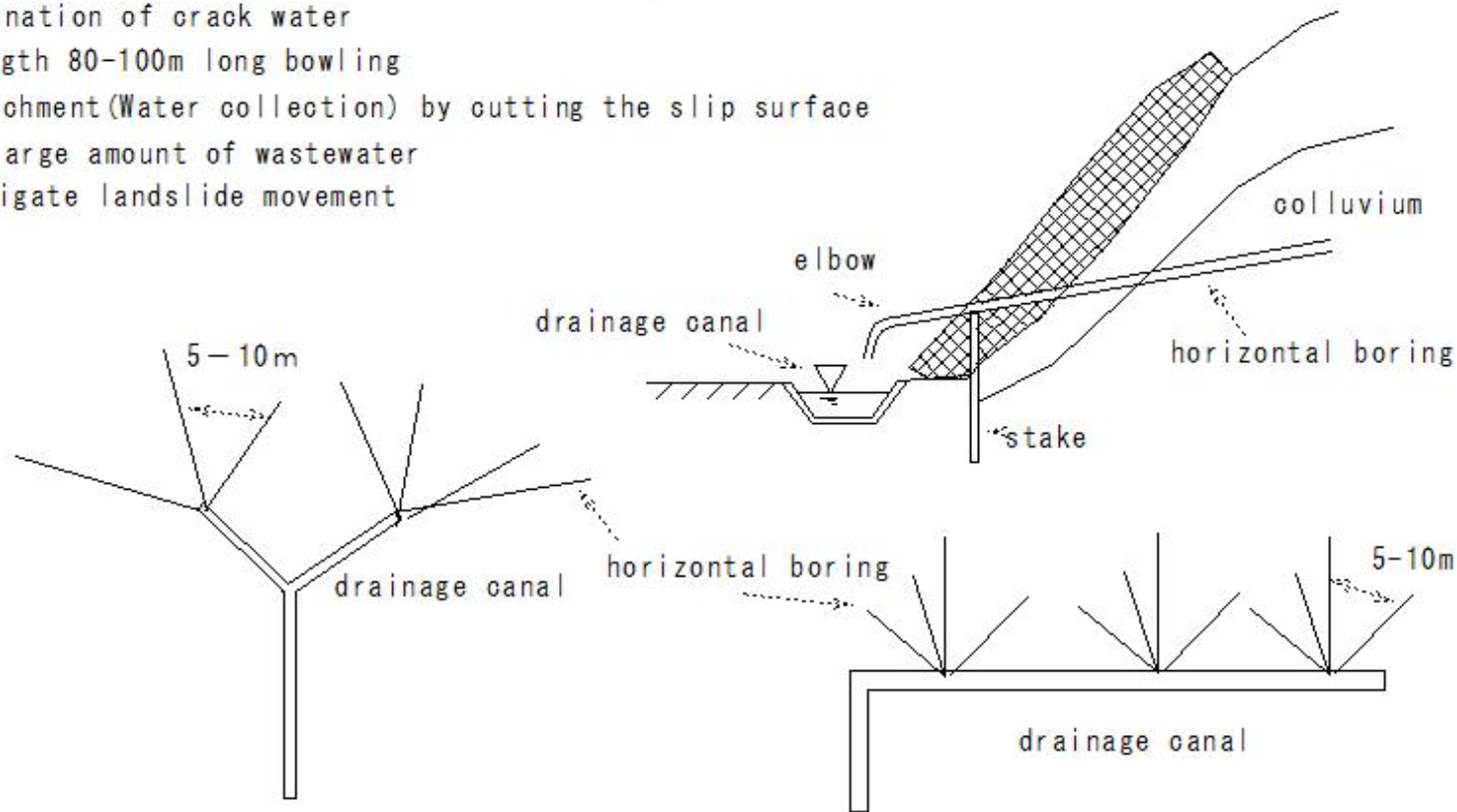


(S136)Landslide prevention(horizontal boring)

(S136) Landslide prevention(horizontal boring)

horizontal boring

- Shallow groundwater 3 m or more below the ground surface
- Elimination of crack water
- Length 80-100m long bowling
- catchment(Water collection) by cutting the slip surface
- A large amount of wastewater
- Mitigate landslide movement

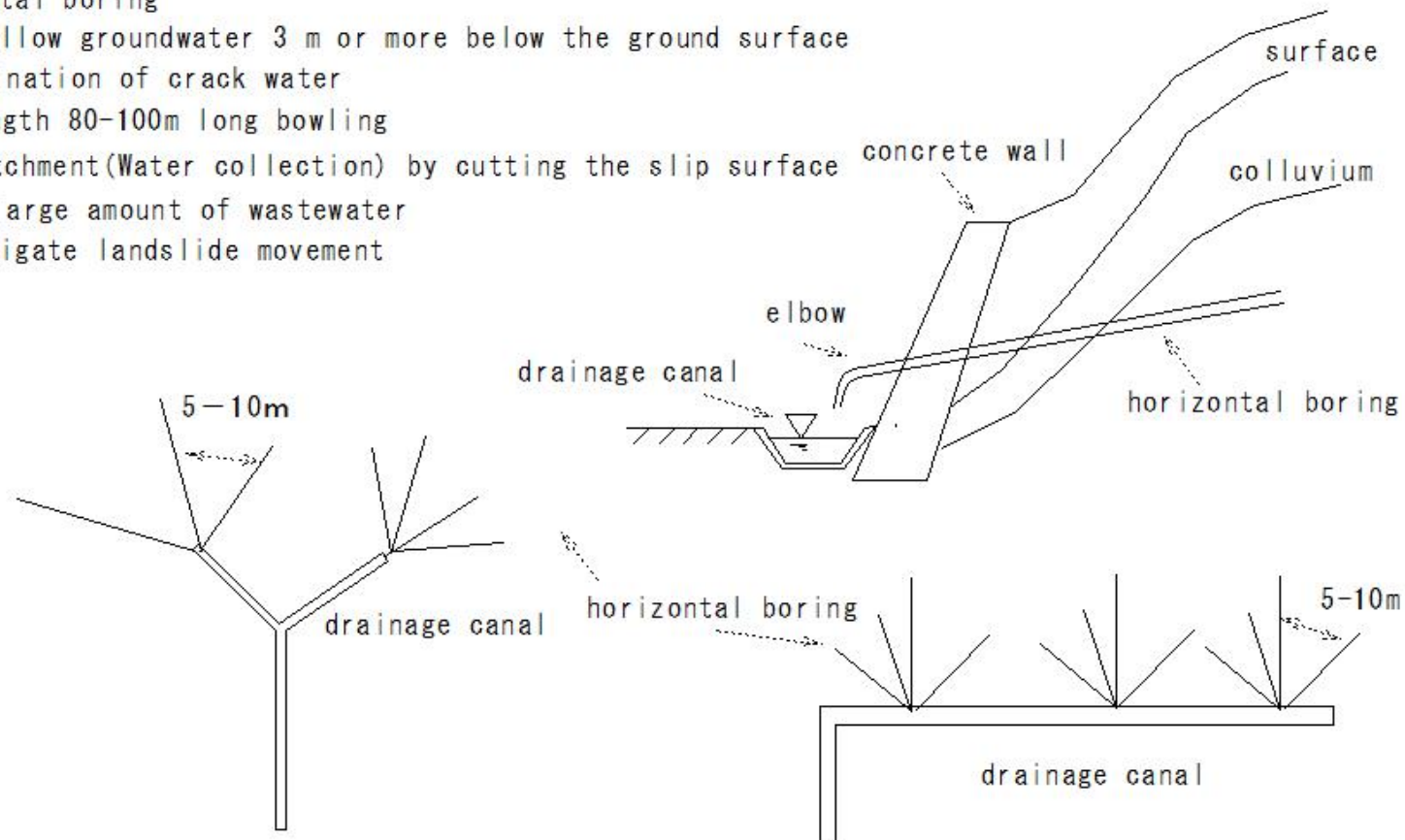


(S137)Landslide prevention(horizontal boring)

(S137)Landslide prevention(horizontal boring)

horizontal boring

- Shallow groundwater 3 m or more below the ground surface
- Elimination of crack water
- Length 80-100m long boring
- catchment(Water collection) by cutting the slip surface
- A large amount of wastewater
- Mitigate landslide movement

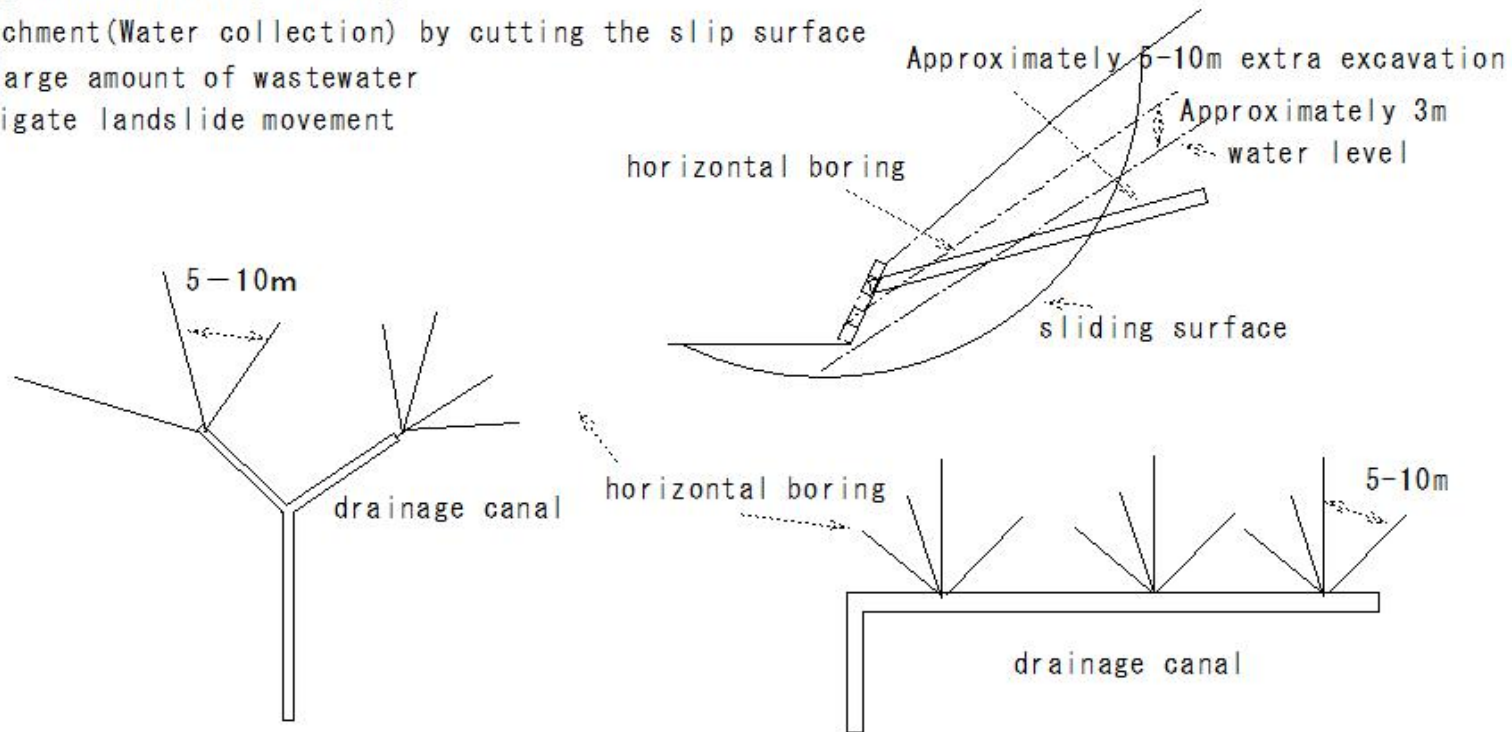


(S138)Landslide prevention(horizontal boring)

(S138)Landslide prevention(horizontal boring)

horizontal boring

- Shallow groundwater 3 m or more below the ground surface
- Elimination of crack water
- Length 80-100m long boring
- catchment(Water collection) by cutting the slip surface
- A large amount of wastewater
- Mitigate landslide movement

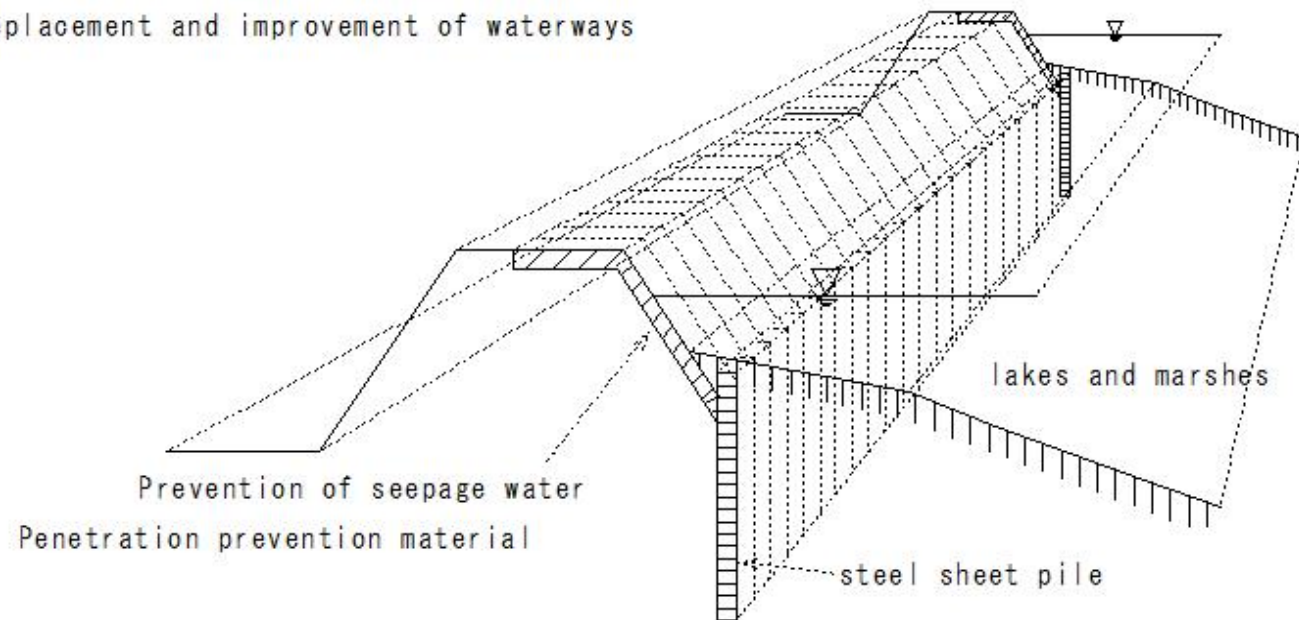


(S139)water leak

(S139)water leak

water leak

- Water flows out from cracks in lakes and waterways.
- Water leakage - Seepage water - Landslide induction
- Permeation prevention work
- Coating with water-impermeable material
- Swamp excavation
- Replacement and improvement of waterways



(S140)check dam(erosion control dam)

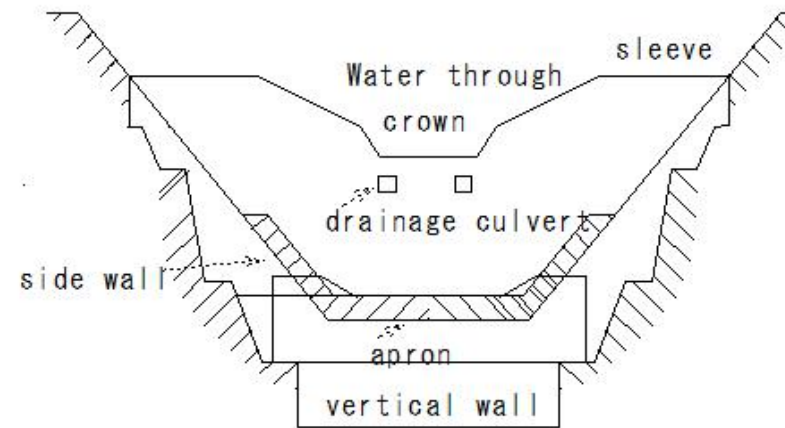
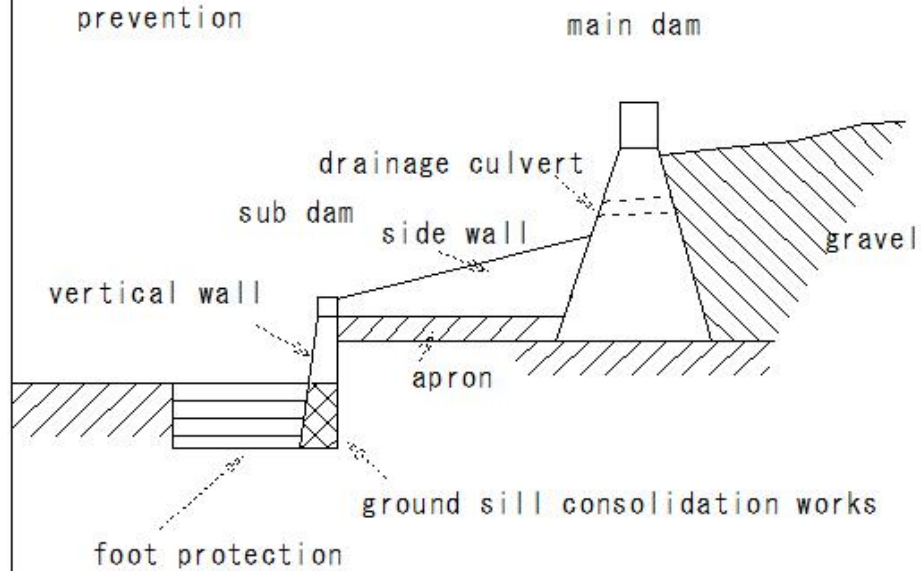
(S140)check dam(erosion control dam)

check dam(erosion control dam)

Mountain stream/ erosion prevention work

- Erosion of the ground surface
- Mountain devastation
avalanche of sand and stone
- Landslide

prevention



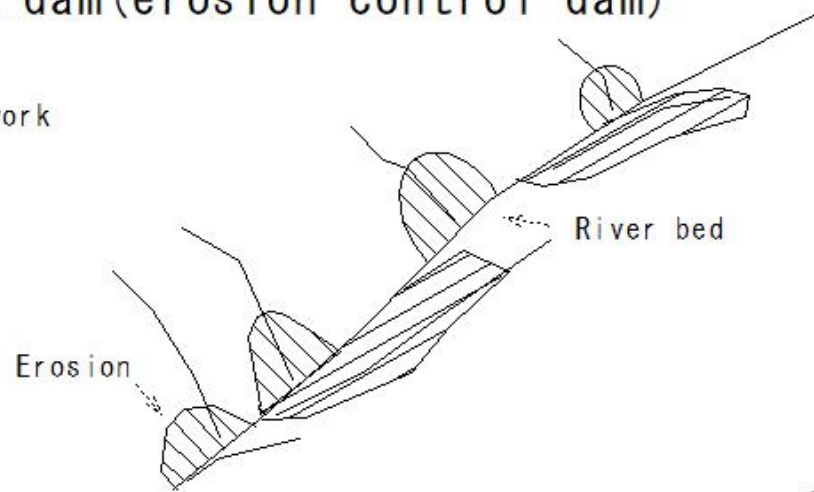
(S141)check dam(erosion control dam)

(S141)check dam(erosion control dam)

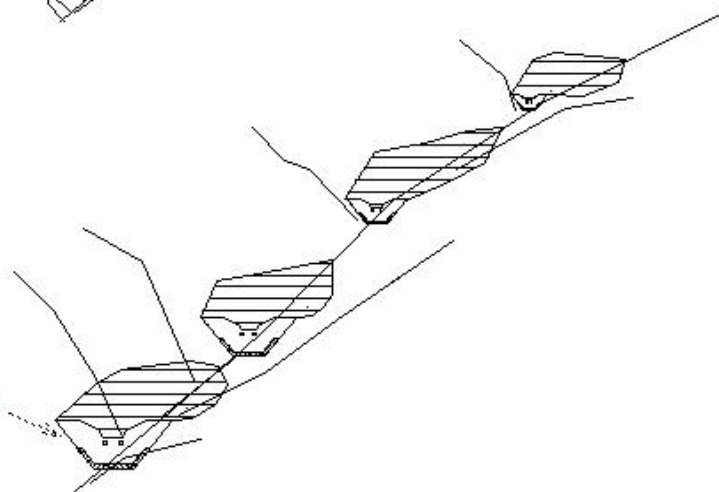
check dam(erosion control dam)

Mountain stream erosion prevention work

- River bed gradient mitigation
- Erosion prevention
- Adjustment of flow bed gravel



check dam(erosion control dam)



(S142)check dam(erosion control dam)

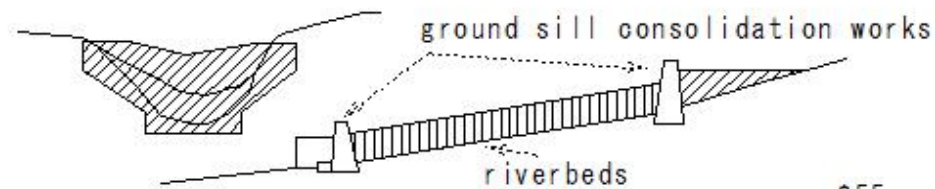
(S142)check dam(erosion control dam)

check dam(erosion control dam)

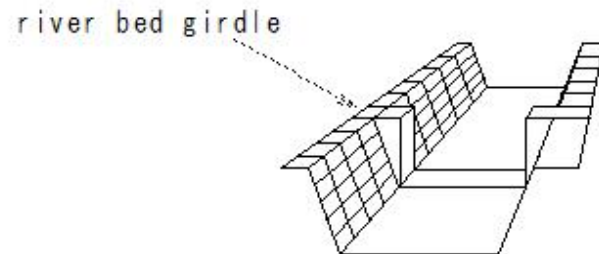
- Stabilization of riverbeds and high water beds
- Cross direction of river

ground sill consolidation works

river bed girdle: Same height as river bed



S55



S102

(S143) torrent control works

(S143) torrent control works

torrent control works

torrent control works

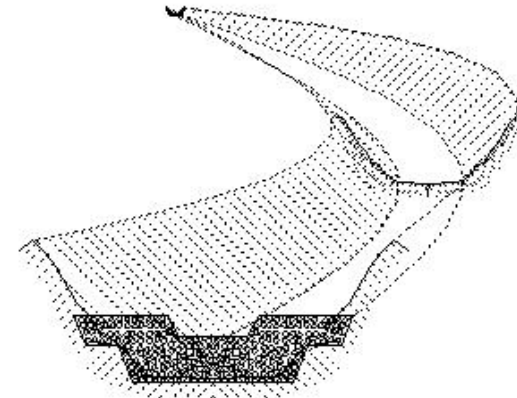
- ① Preventing sand and gravel from flowing out
- Preventing erosion of mountain streams and banks

② torrent control works

Bank protection work (revetment)

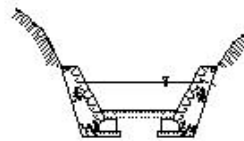
groin

watercourse



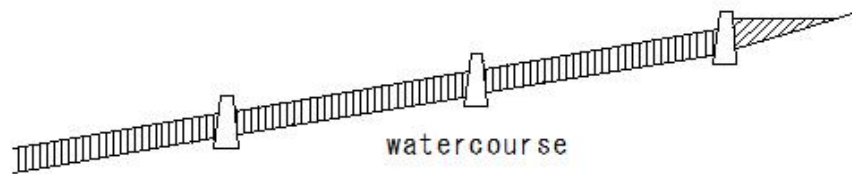
check dam (erosion control dam)

S25



(revetment) bank protection

S66



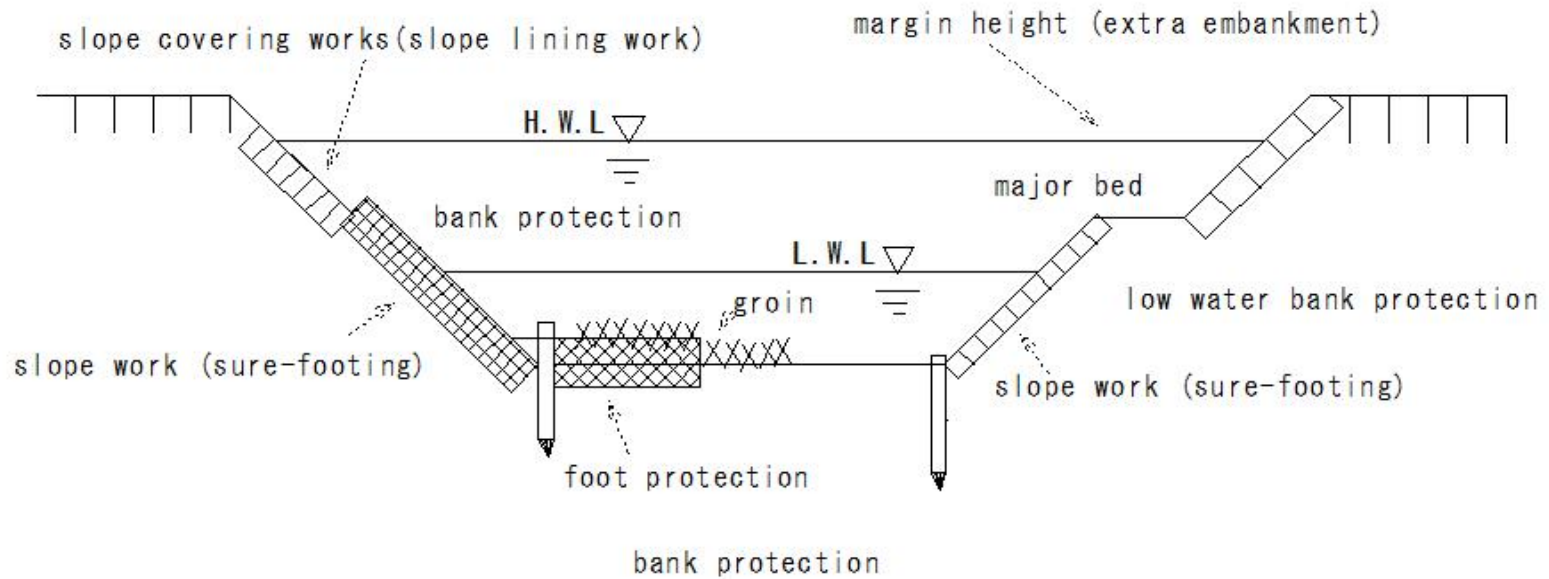
watercourse

S69

(S144) torrent control works

(S144) torrent control works

Mountain stream erosion prevention work
torrent control works
Bank protection work



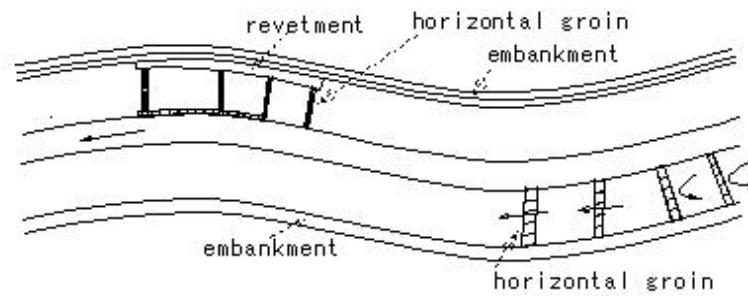
(S145)torrent control works

(S145)torrent control works

Mountain stream erosion prevention work

torrent control works

groin



R178 R179

(S146) torrent control works

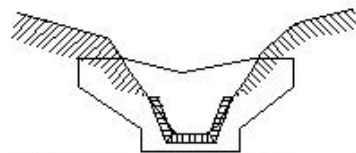
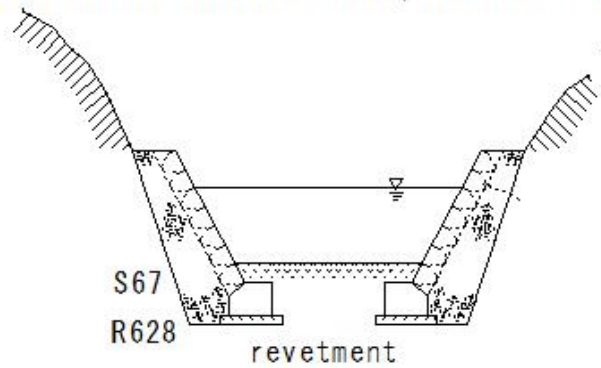
(S146) torrent control works

Mountain stream erosion prevention work

torrent control works

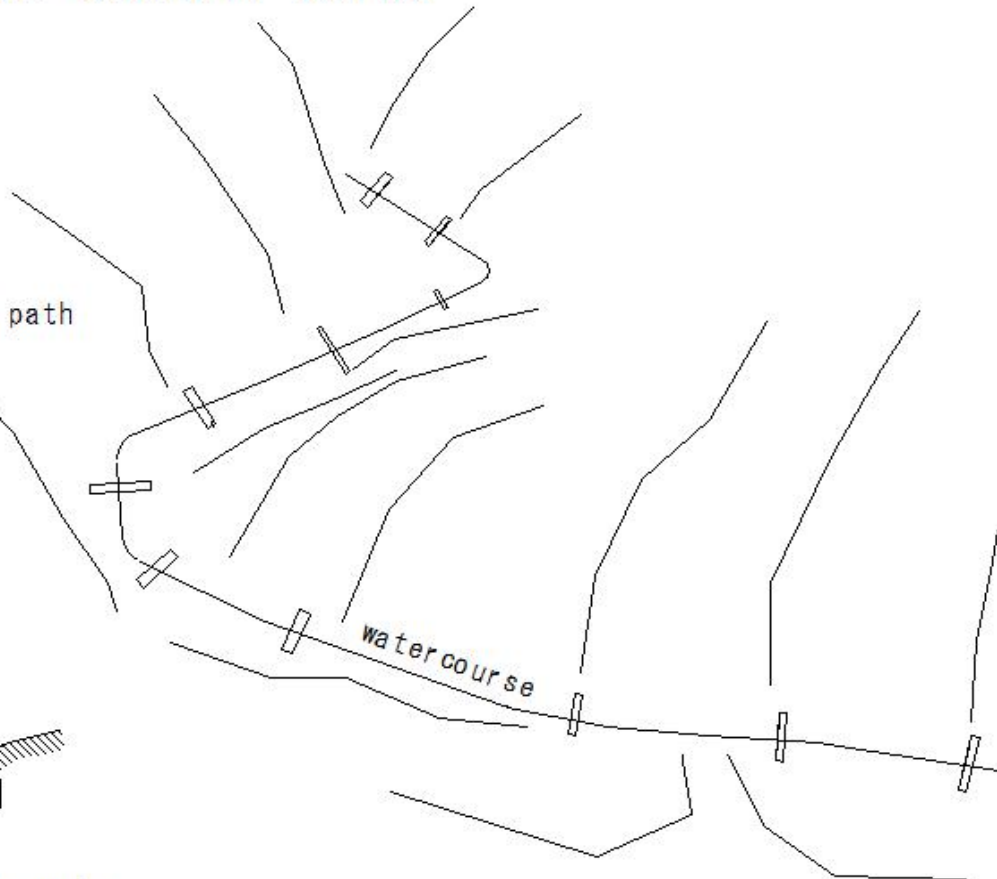
watercourse

- Sand and gravel deposit area
- Mountain foot plains
- Prevention of running water flooding
- Revetment on both banks, certain flow path



ground sill consolidation works

S58



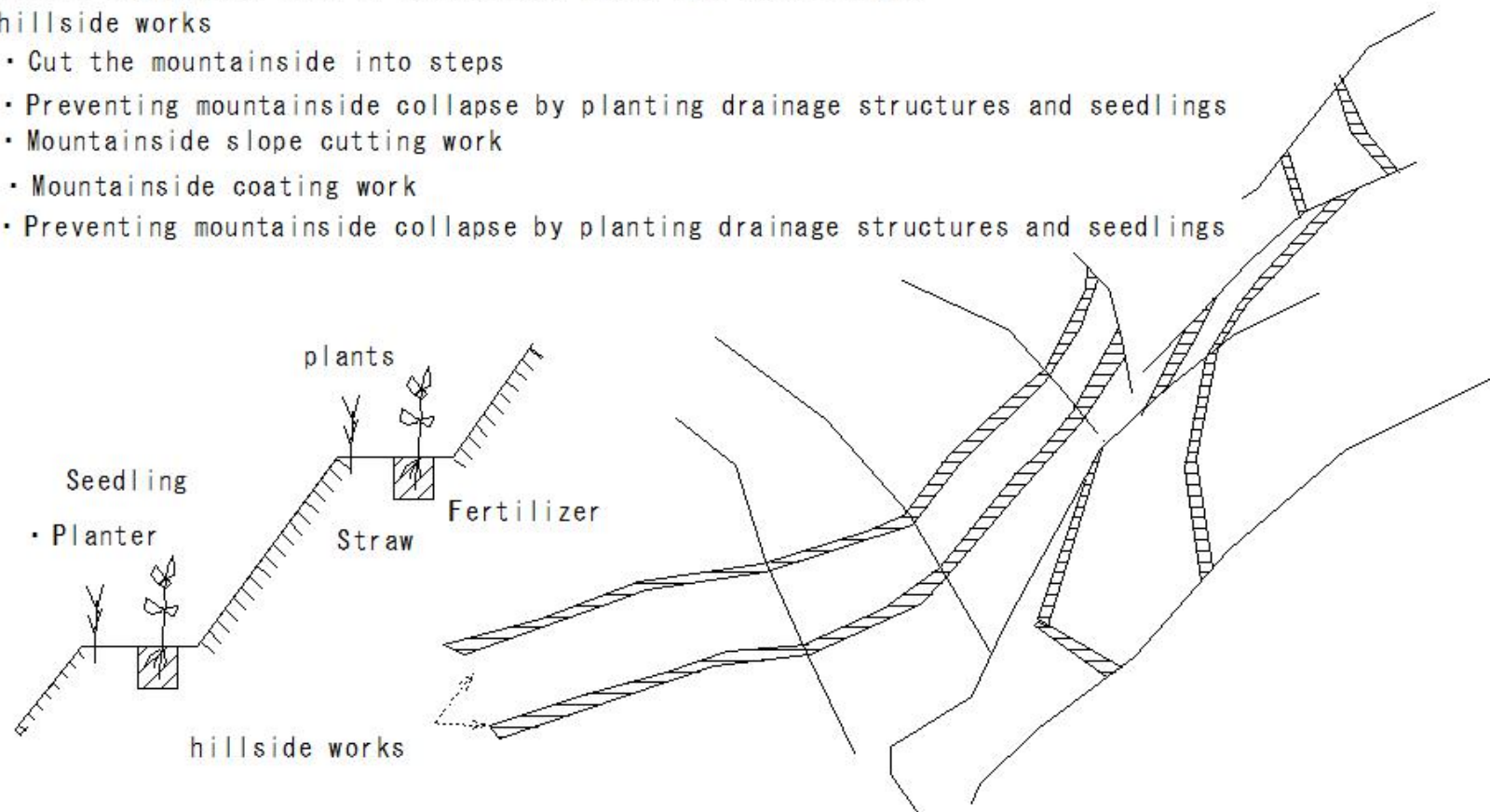
(S147)hillside works

(S147)hillside works

Collapse prevention work in mountainous areas and steep slopes

hillside works

- Cut the mountainside into steps
- Preventing mountainside collapse by planting drainage structures and seedlings
- Mountainside slope cutting work
- Mountainside coating work
- Preventing mountainside collapse by planting drainage structures and seedlings



(S148)hillside works-Mountainside slope cutter

(S148)hillside works

Collapse prevention work in mountainous areas and steep slopes

hillside works

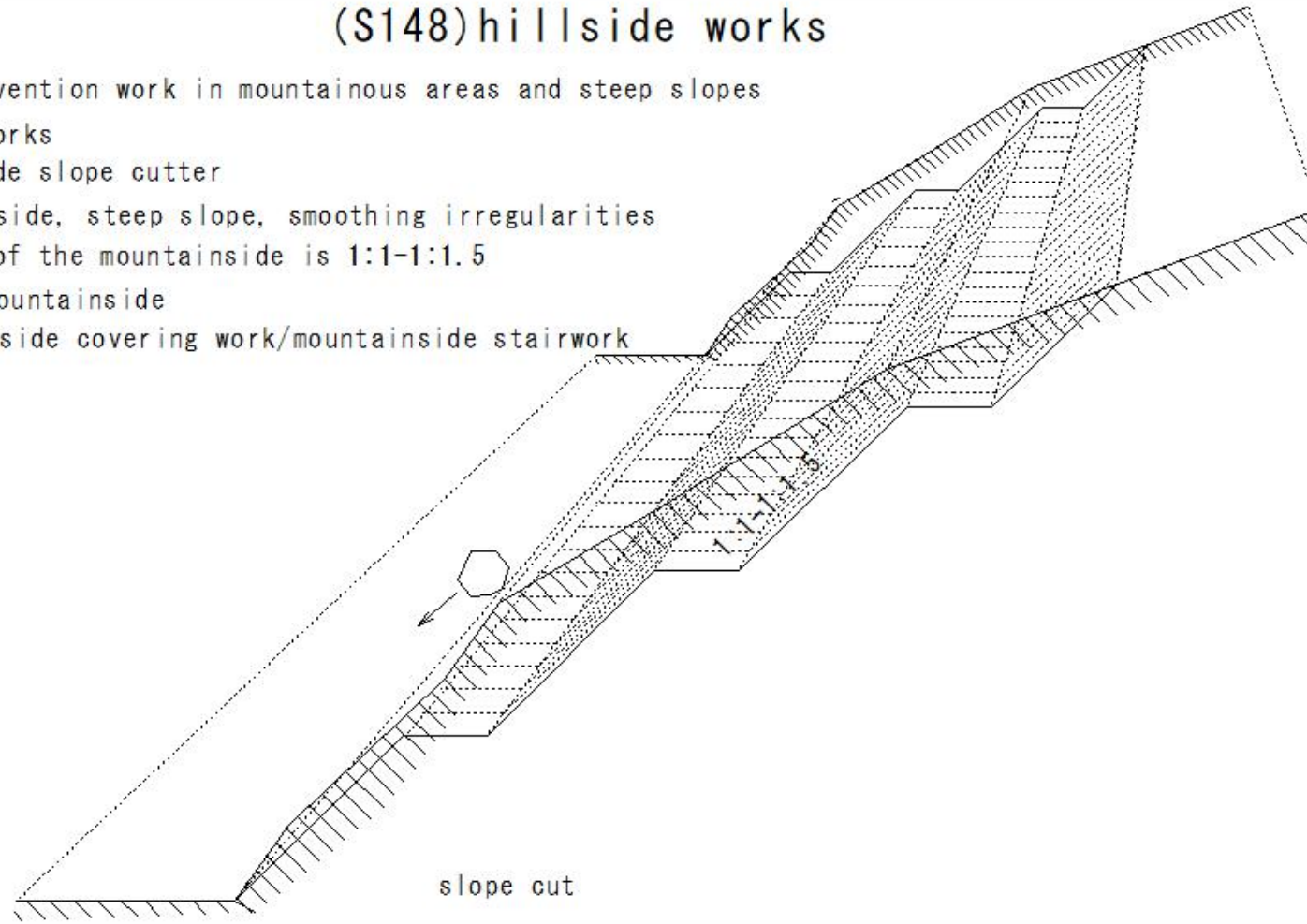
Mountainside slope cutter

①Mountainside, steep slope, smoothing irregularities

The slope of the mountainside is 1:1-1:1.5

trim the mountainside

②Mountainside covering work/mountainside stairwork



(S149)hillside works-Coating work

(S149)hillside works-Coating work

Collapse prevention work in mountainous areas and steep slopes

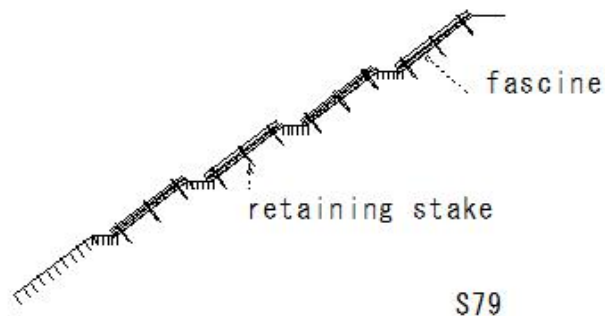
Mountainside coating work

①Erosion by surface water

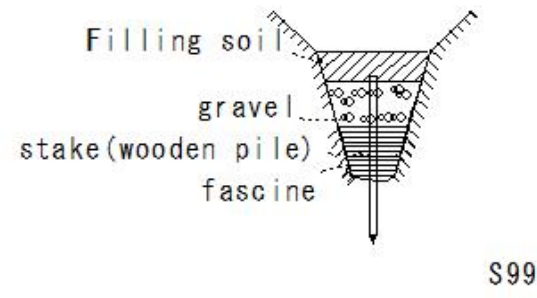
Coating and protecting mountainside slopes from frost and melting snow

②fascine laying work fascine bundle work

③Valley area: Valley stop works and drainage works installed



fascine work



fascine-filled culvert

(S150)hillside works-mountainside stairwork

(S150)hillside works-mountainside stairwork

hillside works-mountainside stairwork

Collapse prevention work in mountainous areas and steep slopes

mountainside stairwork

① Slope of mountainside

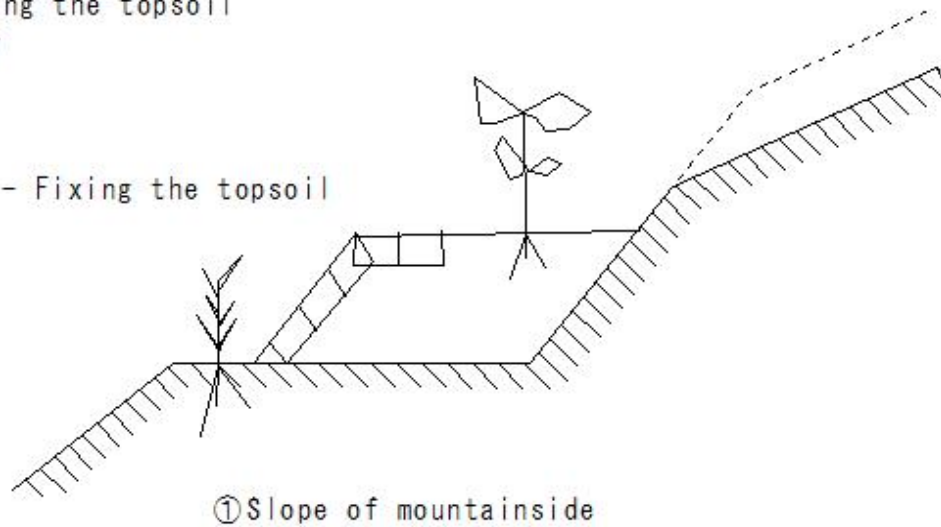
set up stairs

Stabilize the slope

Planting - Fixing the topsoil

② Stone masonry

Planting - Fixing the topsoil



(S151)hillside works-Landslide prevention work

(S151)hillside works-Landslide prevention work

Collapse prevention work in mountainous areas and steep slopes

Landslide prevention work

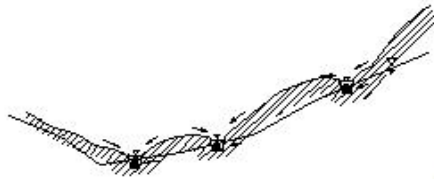
①Canal network - Drainage - Channel works

②Preventing the rise of groundwater level

Culverts, catchment(water collection) wells, horizontal borings, drainage tunnels

Groundwater drainage works

Canal network

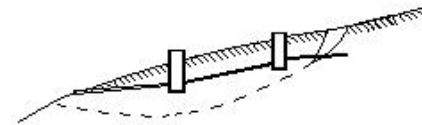


S133

Drainage culvert



catchment(water collection) wells



S101

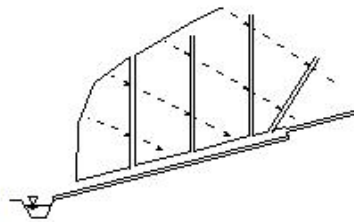
S119

horizontal borings



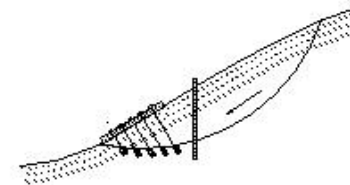
S119

drainage tunnels



S126

Pile work



S94

(S152)Landslide prevention work

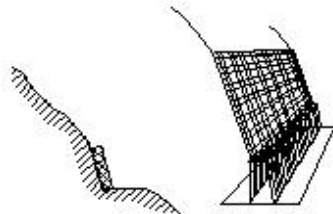
(S152)Landslide prevention work

Collapse prevention work in mountainous areas and steep slopes

Landslide prevention work

- ① Retaining wall work
- ② frame(crib) work
- ③ Concrete spraying work

Retaining wall



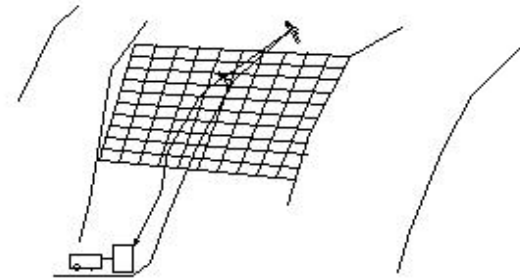
S96

Concrete frame work



C926

Concrete spraying



C1324

(S153)gully protection dam

(S153)gully protection dam

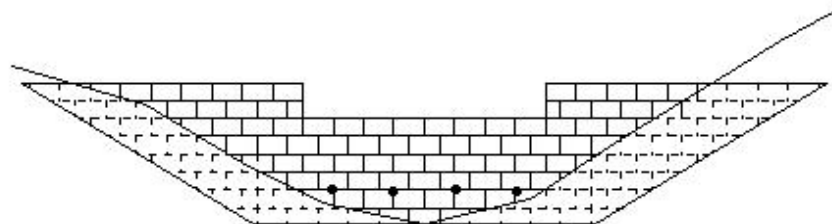
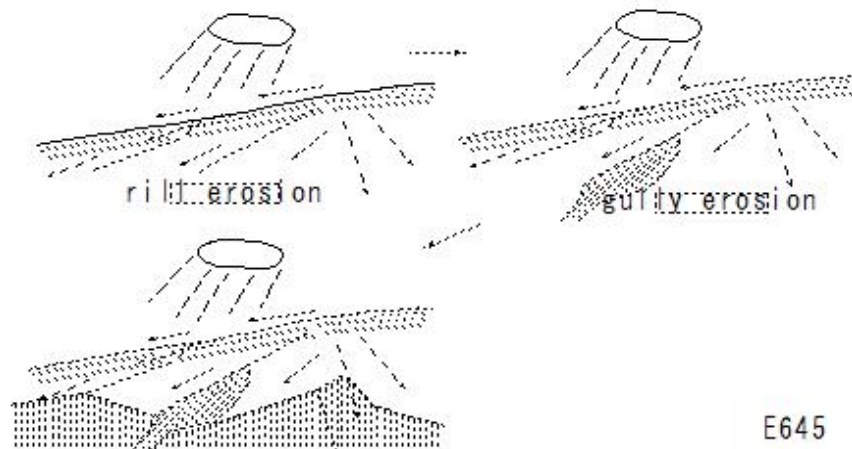
gully protection dam

- Prevention of gully expansion
- Weir

gully stabilization work

drainage hole

masonry dam



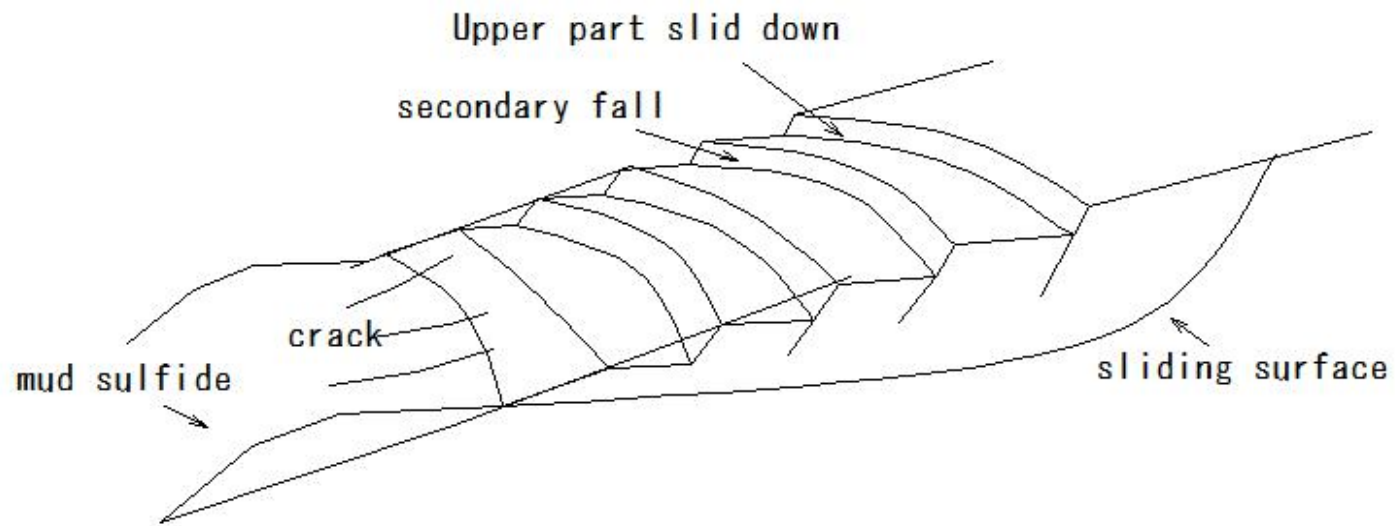
drainage hole

masonry dam

gully protection dam

(S154)landslide

(S154) Landslide

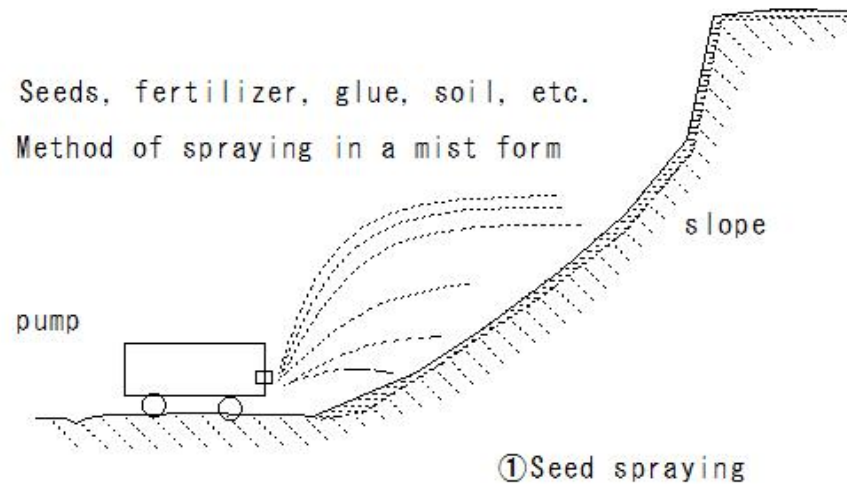


E466

(S155)sodding(Seed spraying)

(S155) sodding (Seed spraying)

sodding



(S156)sodding(Vegetation mat work)

(S156) sodding (Vegetation mat work)

sodding

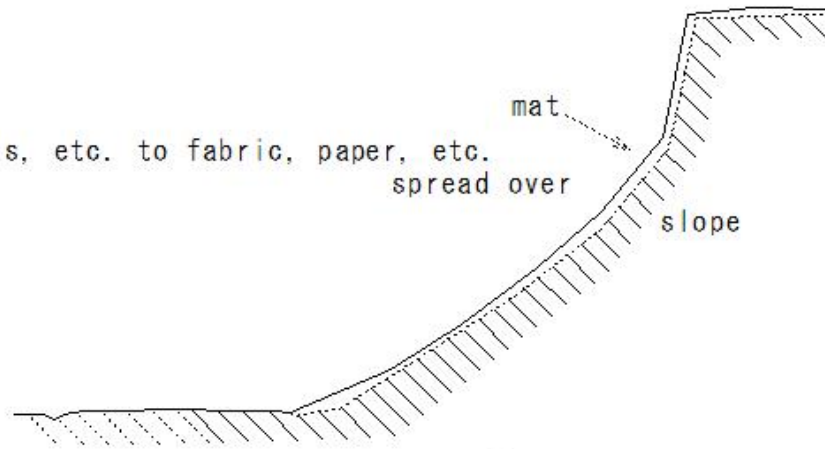
②Vegetation mat work

Adhesive seeds, fertilizers, etc. to fabric, paper, etc.

spread over

mat

slope

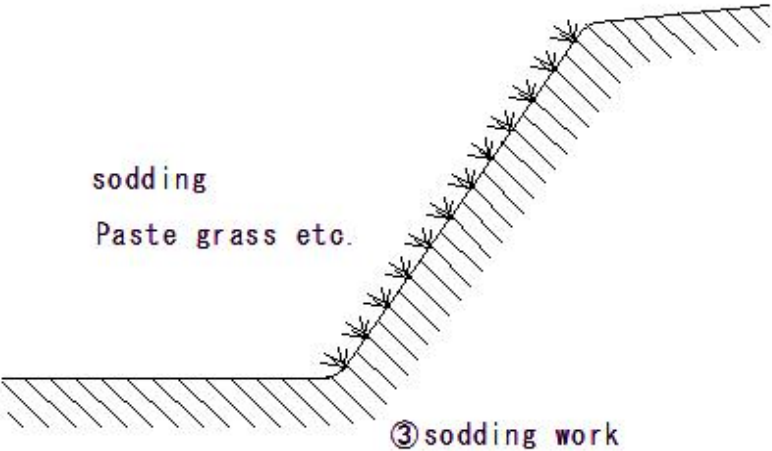


②Vegetation mat work

(S157)sodding(sodding work)

(S157) sodding (sodding work)

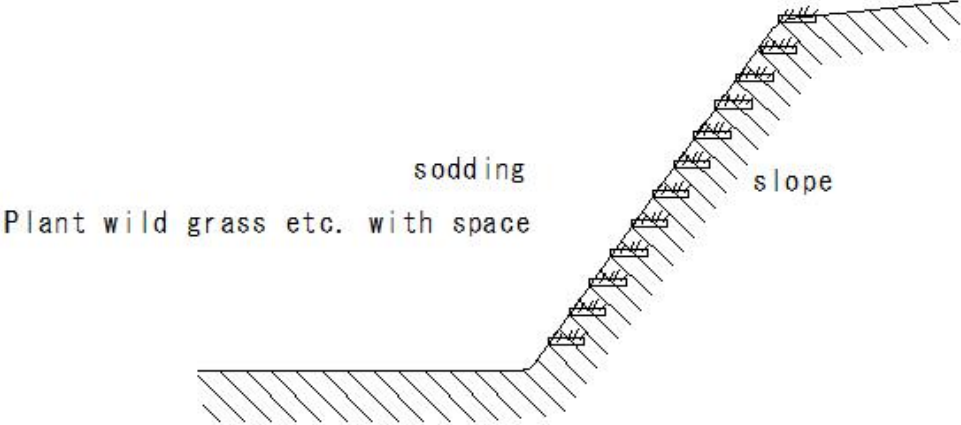
sodding
③ sodding work



(S158)sodding(sodding work)

(S158) sodding (sodding work)

sodding
④ sodding work



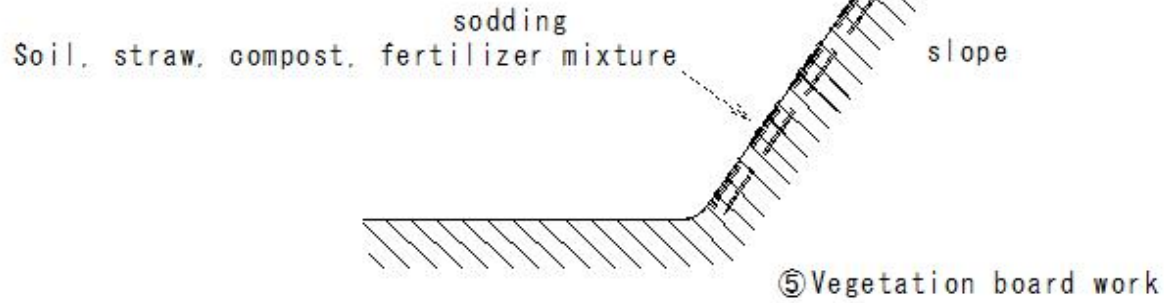
④ sodding work

(S159)sodding(Vegetation board work)

(S159) sodding (Vegetation board work)

sodding

⑤ Vegetation board work



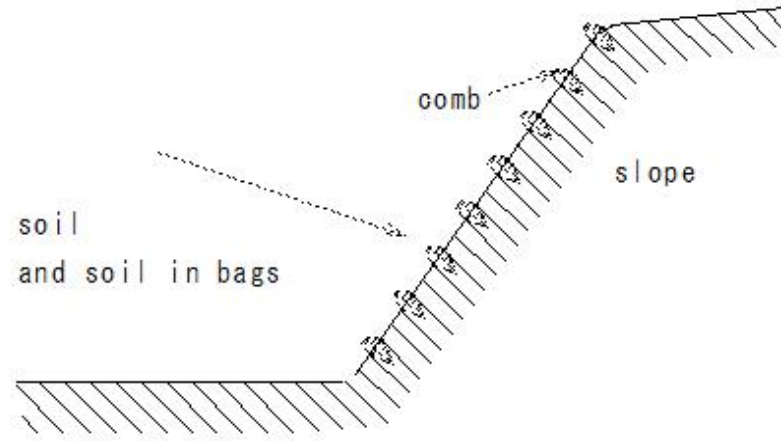
(S160)sodding(Vegetation bagging)

(S160) sodding (Vegetation bagging)

sodding

⑥Vegetation bagging

sodding
vegetation bag
Seeds, fertilizer, soil
Seeds, fertilizer, and soil in bags



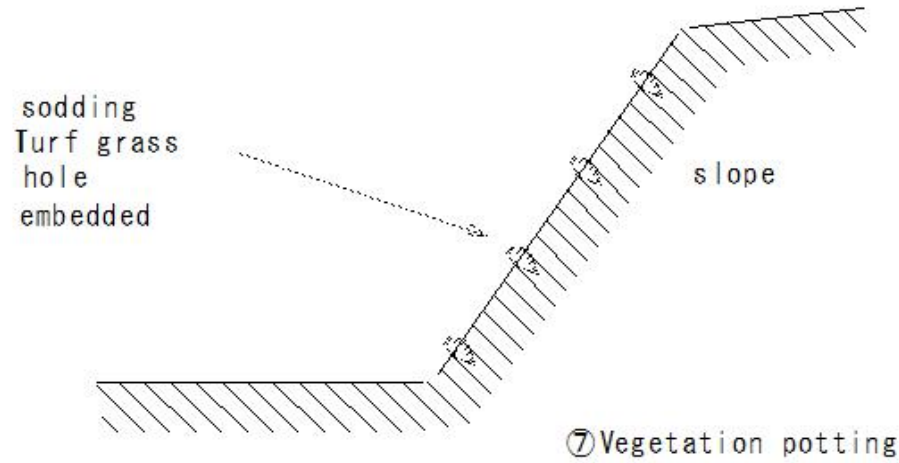
⑥Vegetation bagging

(S161)sodding(Vegetation potting)

(S161) sodding (Vegetation potting)

sodding

⑦Vegetation potting



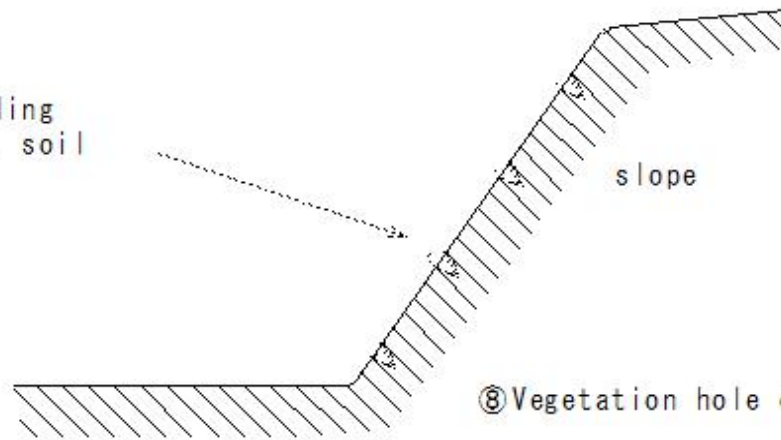
(S162)sodding(Vegetation hole drilling)

(S162) sodding (Vegetation hole drilling)

sodding

⑧ Vegetation hole drilling)

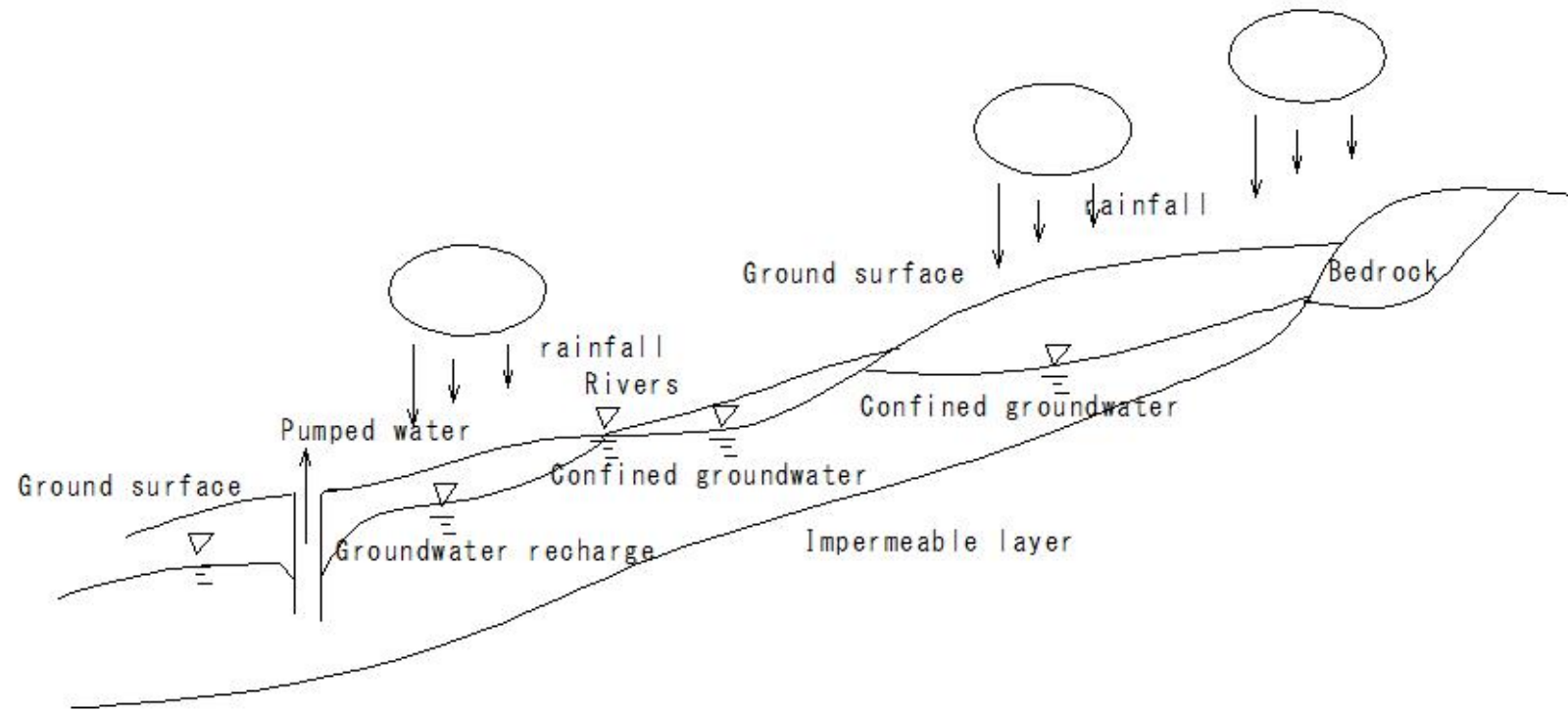
sodding
Seeds, fertilizers, soil
hole
embedded



⑧ Vegetation hole drilling)

(S163)groundwater

(S163) groundwater



E470
R557

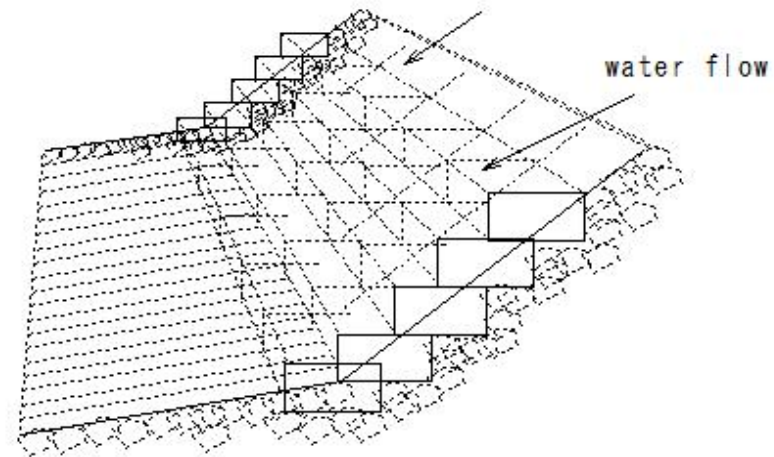
(S164)ground sill consolidation works

(S164)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed
cross the river

- River bed gradient - mitigation - low dam
- head-fall-drop/Drop work: Ancillary work to prevent river bed decline



ground sill consolidation works

R569 C1359

(S165)ground sill consolidation works

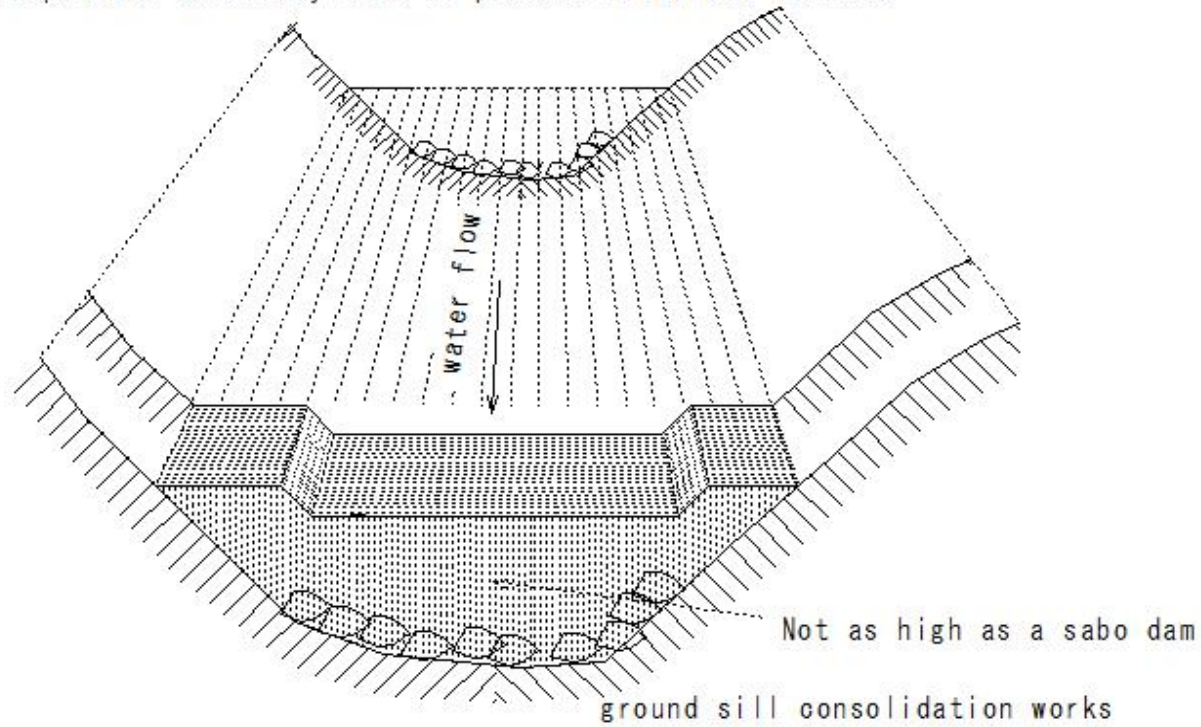
(S165)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

- River bed gradient - mitigation - low dam
- head-fall-drop/Drop work: Ancillary work to prevent river bed decline



R573 C1363

(S166)ground sill consolidation works

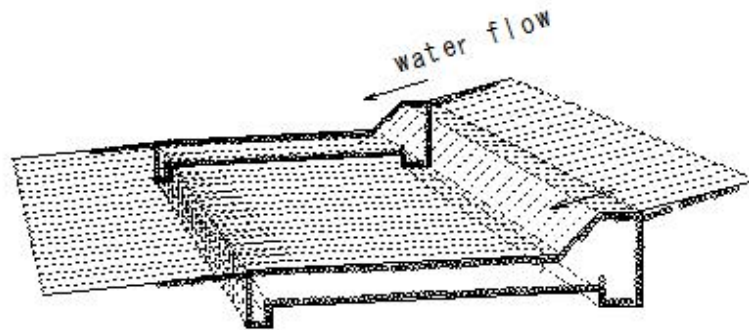
(S166)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

- River bed gradient - mitigation - low dam
- head-fall-drop/Drop work: Ancillary work to prevent river bed decline



ground sill consolidation works

R570 C1360

(S167)ground sill consolidation works

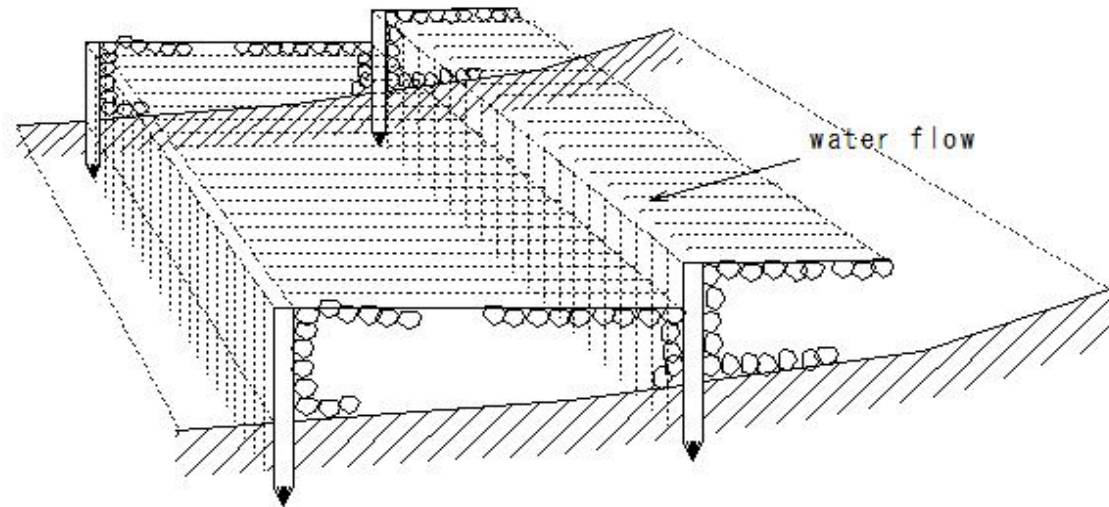
(S167)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

- River bed gradient - mitigation - low dam
- head-fall-drop/Drop work: Ancillary work to prevent river bed decline



ground sill consolidation works

R571 C1361

(S168)ground sill consolidation works

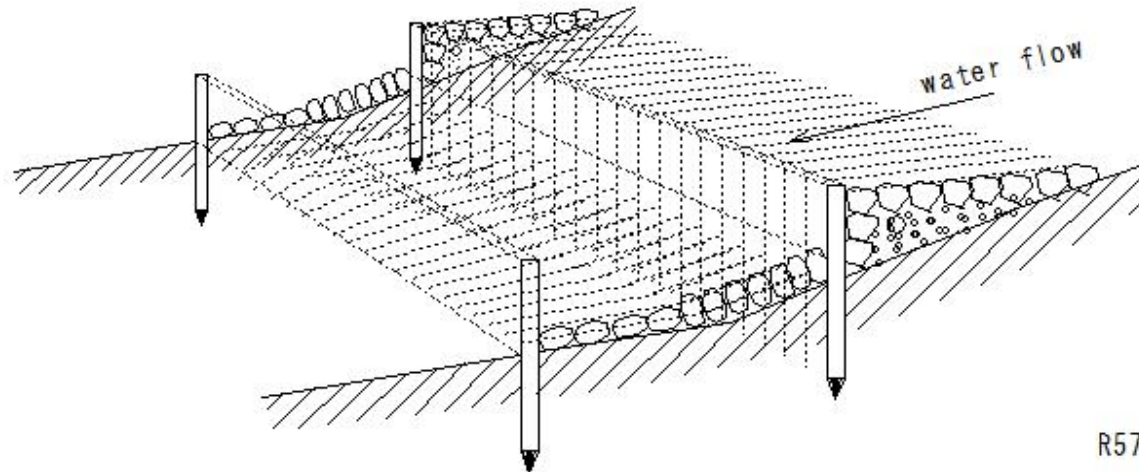
(S168)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

- River bed gradient - mitigation - low dam
- head-fall-drop/Drop work: Ancillary work to prevent river bed decline



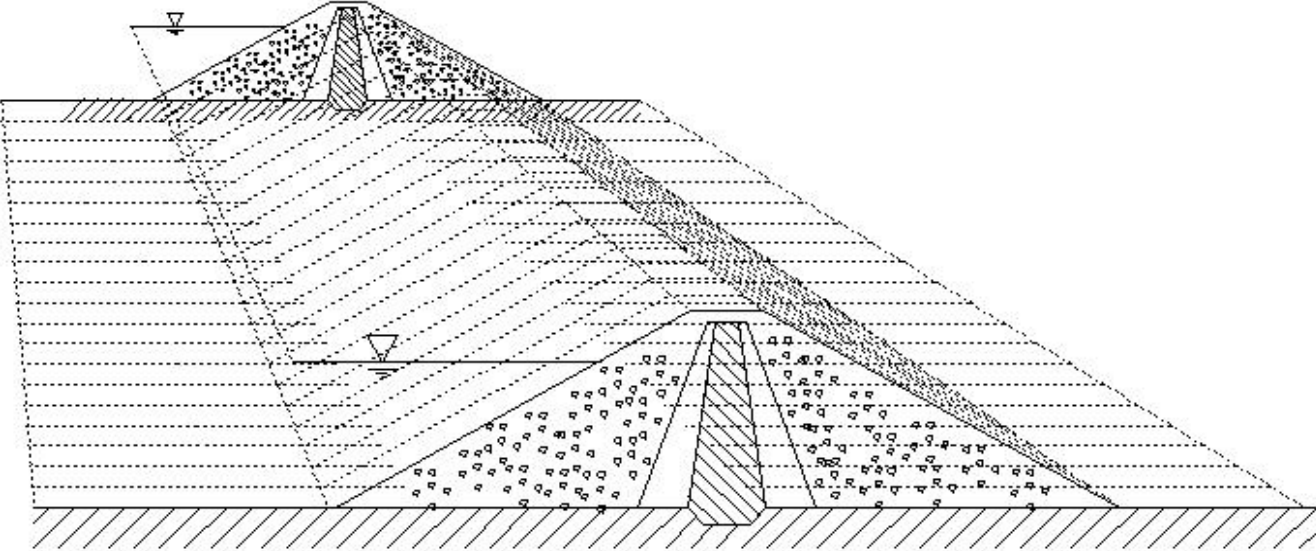
R572 C1362

ground sill consolidation works

(S169)fill-type dam

(S169) fill-type dam

- fill-type dam
- soil, gravel, rock
- Embankment materials
- earth dam
- rockfill dam



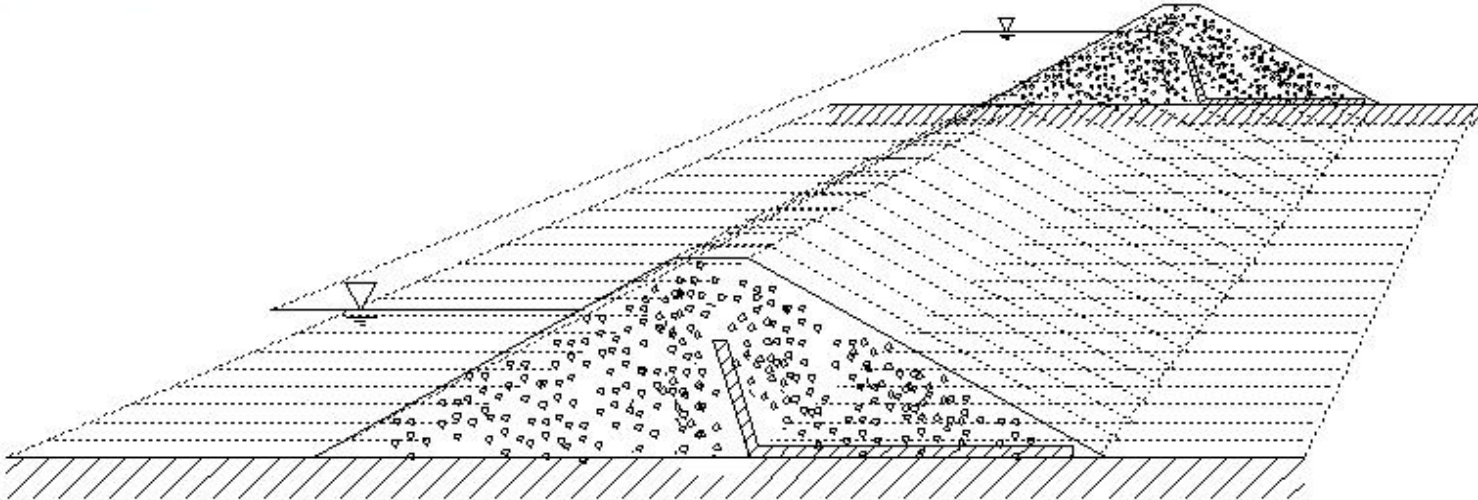
zone type

spillway installed on the ground

(S170)fill-type dam

(S170)fill-type dam

- fill-type dam
- soil, gravel, rock
- Embankment materials
- earth dam
- rockfill dam



Uniform type

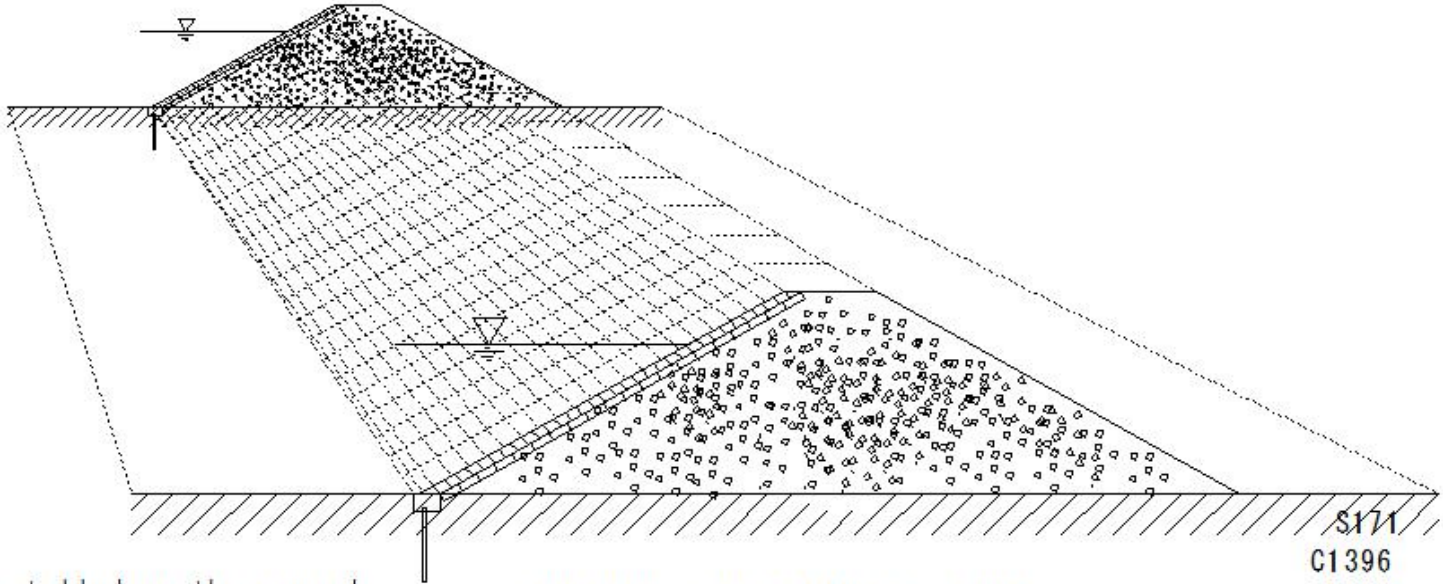
spillway installed on the ground

R591
D318
G1395

(S171)fill-type dam

(S171)fill-type dam

fill-type dam
soil, gravel, rock
Embankment materials
earth dam
rockfill dam



spillway installed on the ground

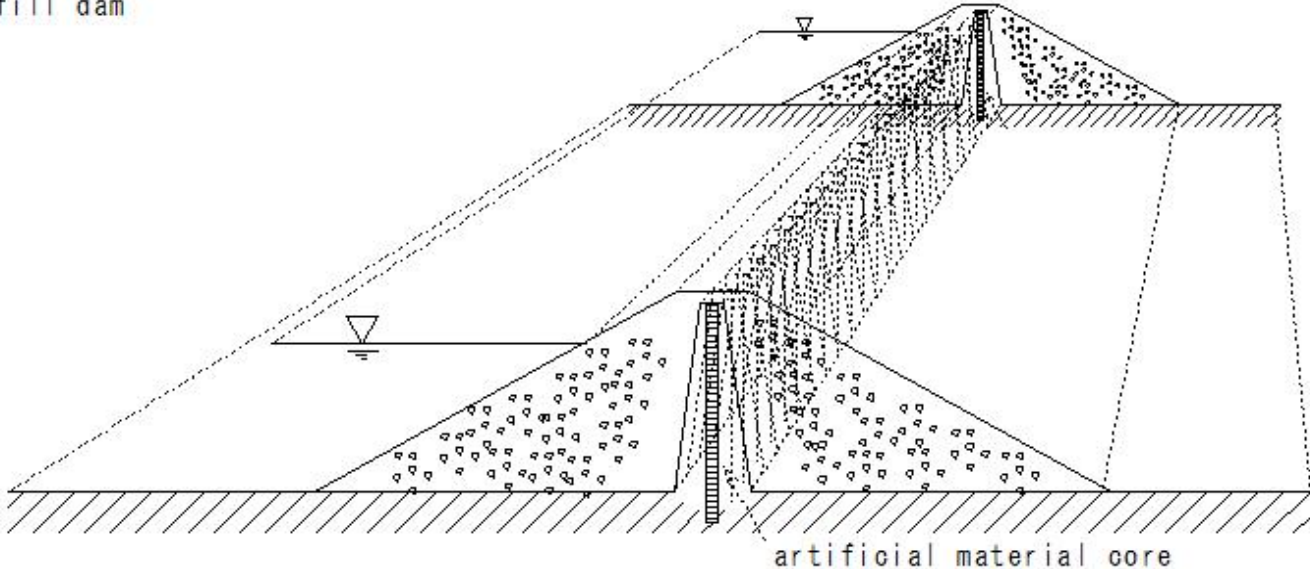
Surface impermeable wall type

S171
C1396
R592
D319

(S172)fill-type dam

(S172) fill-type dam

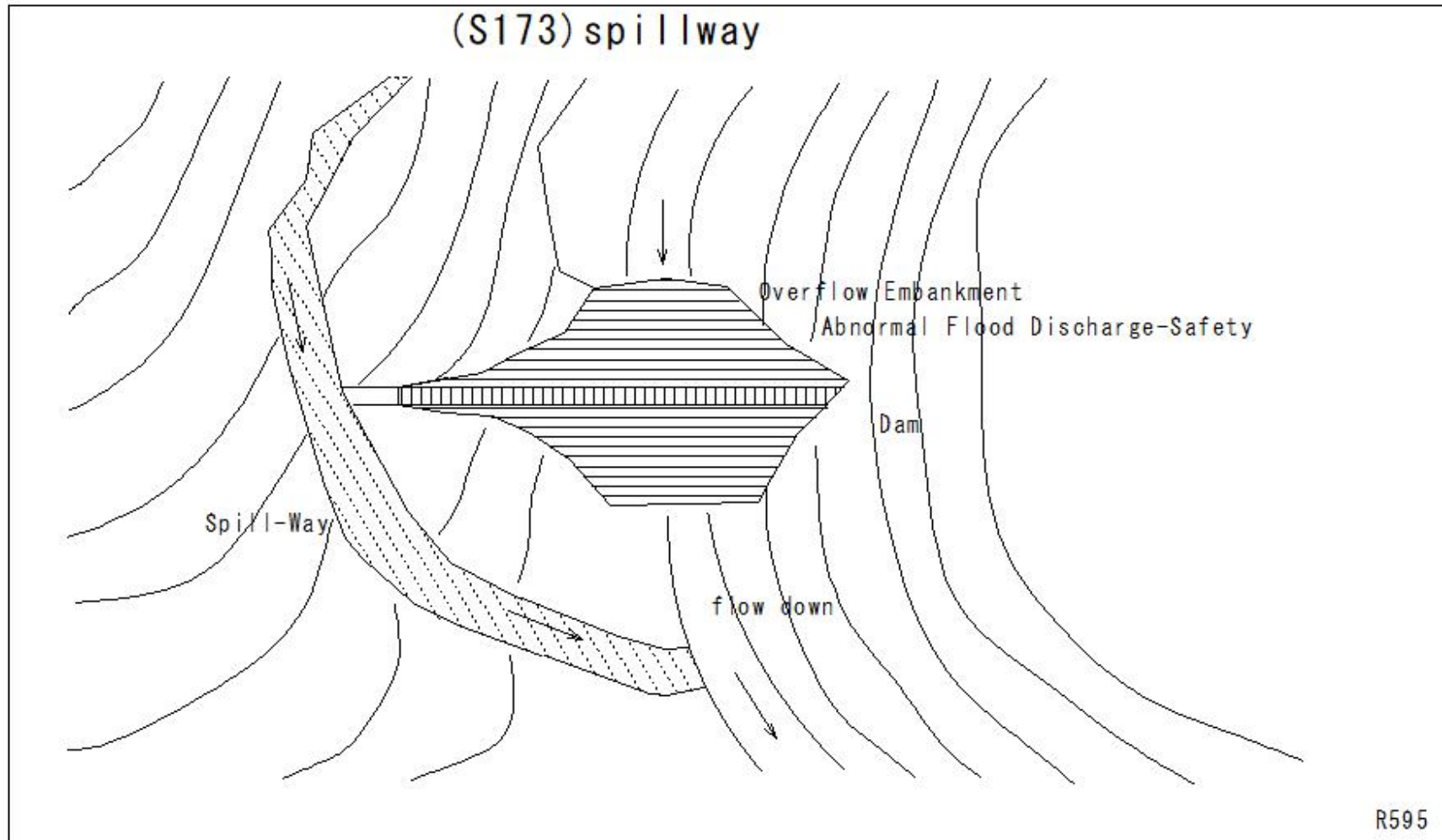
- fill-type dam
- soil, gravel, rock
- Embankment materials
- earth dam
- rockfill dam



spillway installed on the ground

Core type

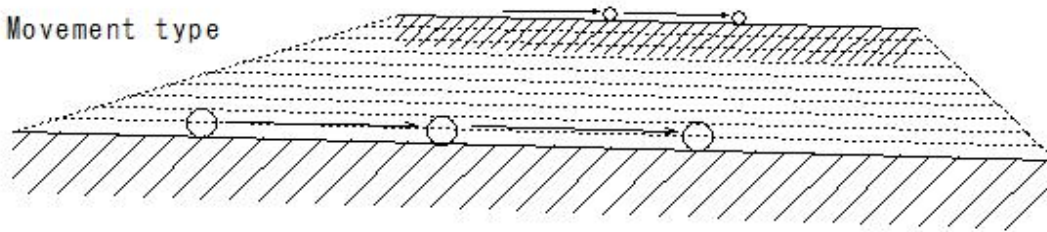
(S173)spillway



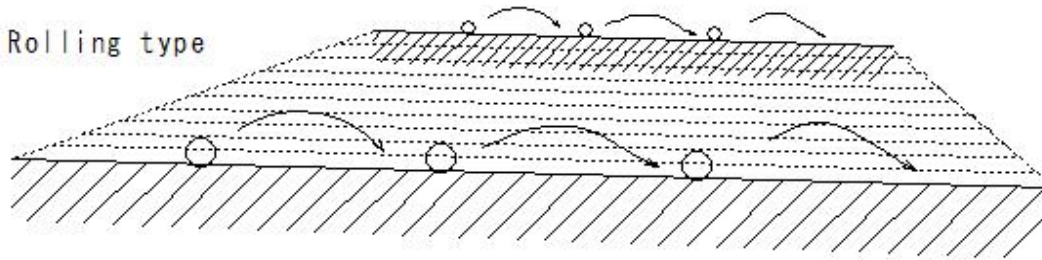
(S174) sediment

(S174) sediment (sediment load)

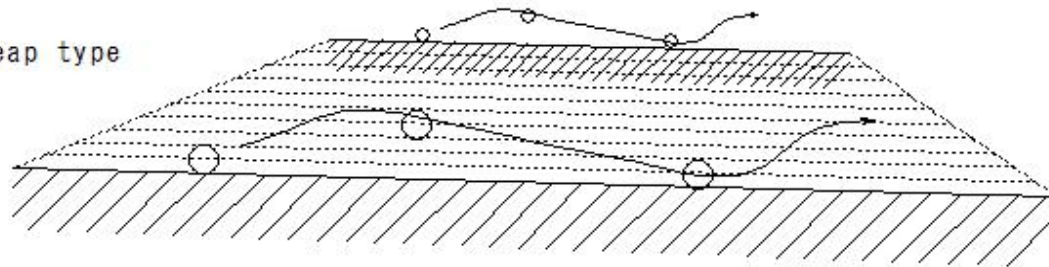
Movement type



Rolling type



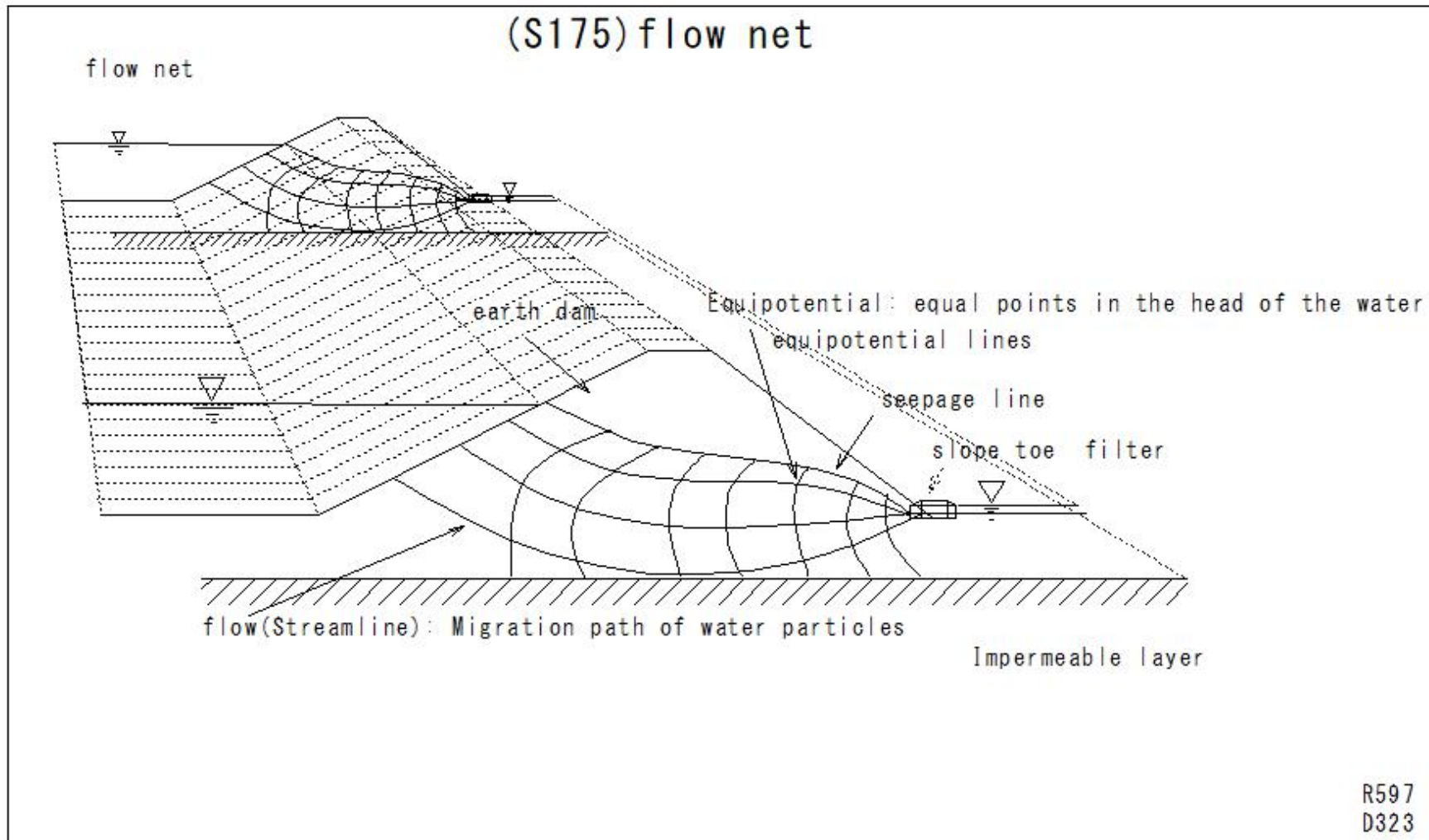
Leap type



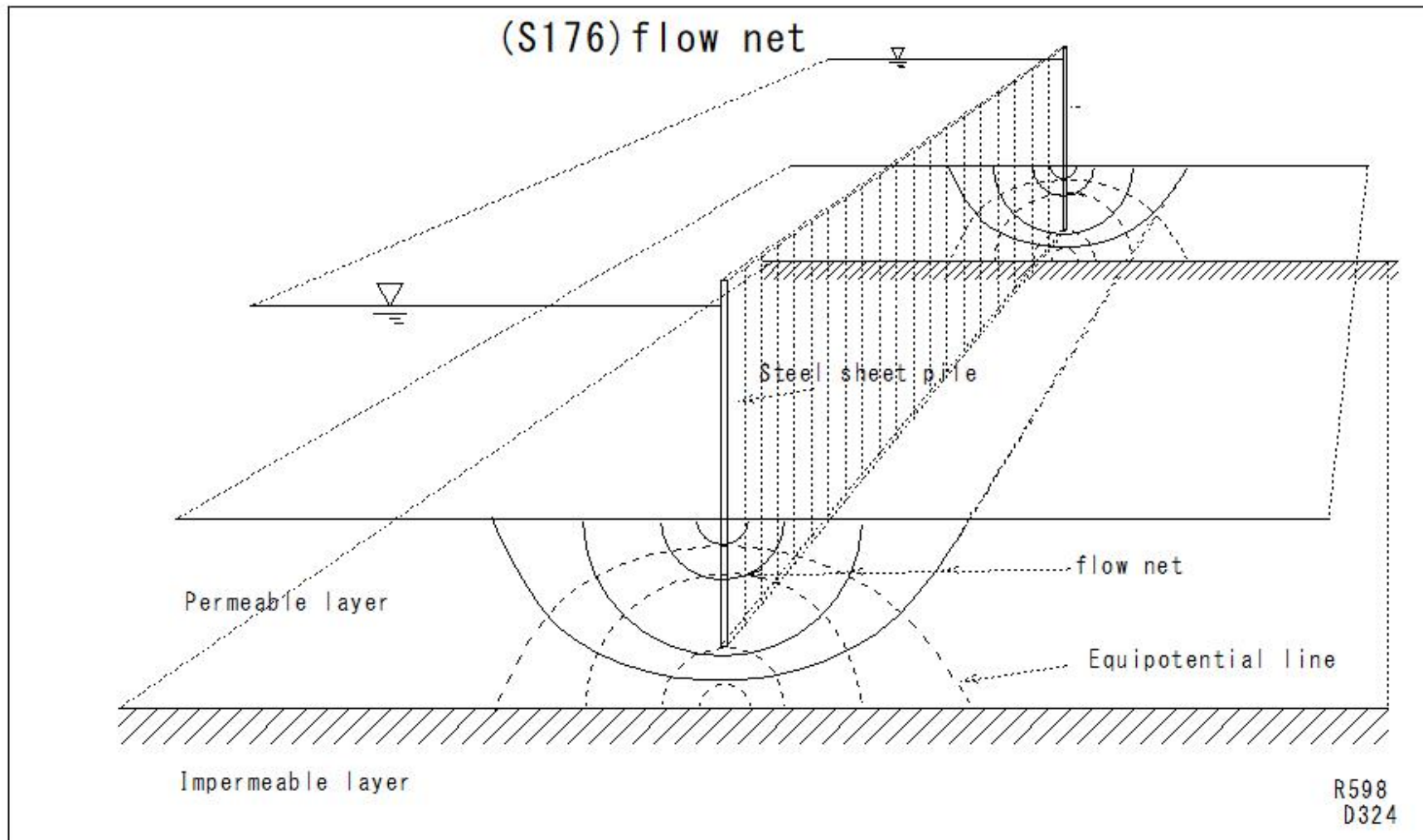
Flowing sand River bed

R596
C1416

(S175)flow net

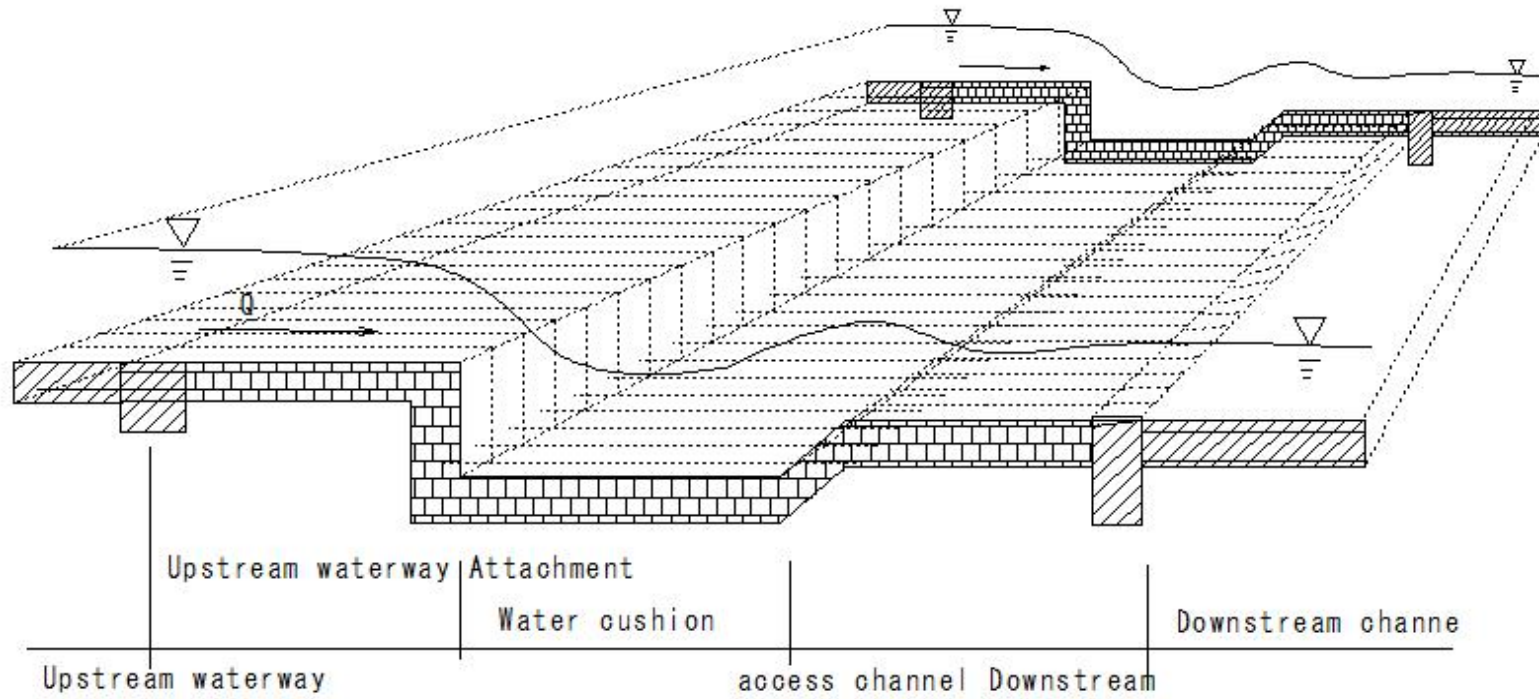


(S176) flow net



(S177)head-fall-drop

(S177) head-fall-drop



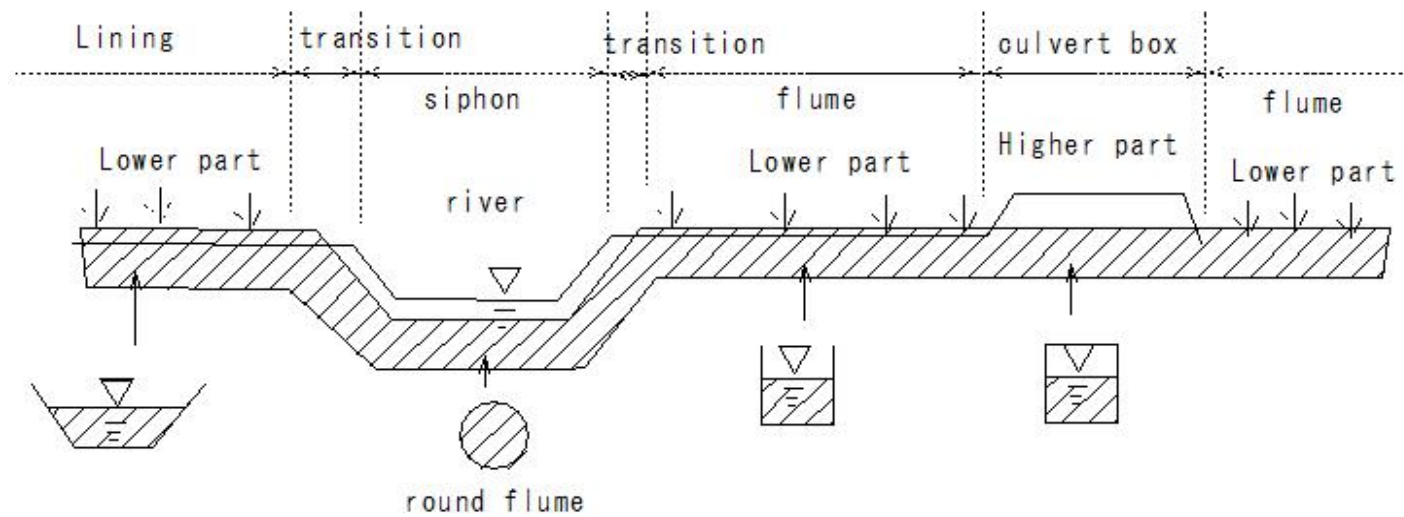
Upstream waterway Water cushion Downstream access channel Downstream channel

G1417
R599

(S178)lining canal

(S178) lining cannal

lining cannal



C1418
R602

(S179)carrying operation

(S179)carrying operation

carrying operation

Solvent: Dissolving and flowing in water

Floating current: floating and flowing in water

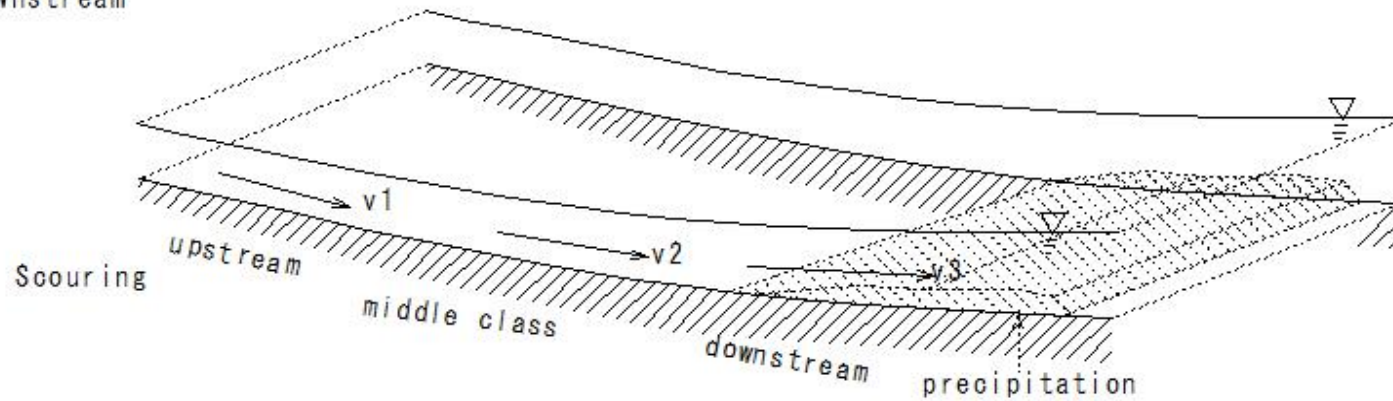
Sweep: Flowing by rolling on the river bed

river

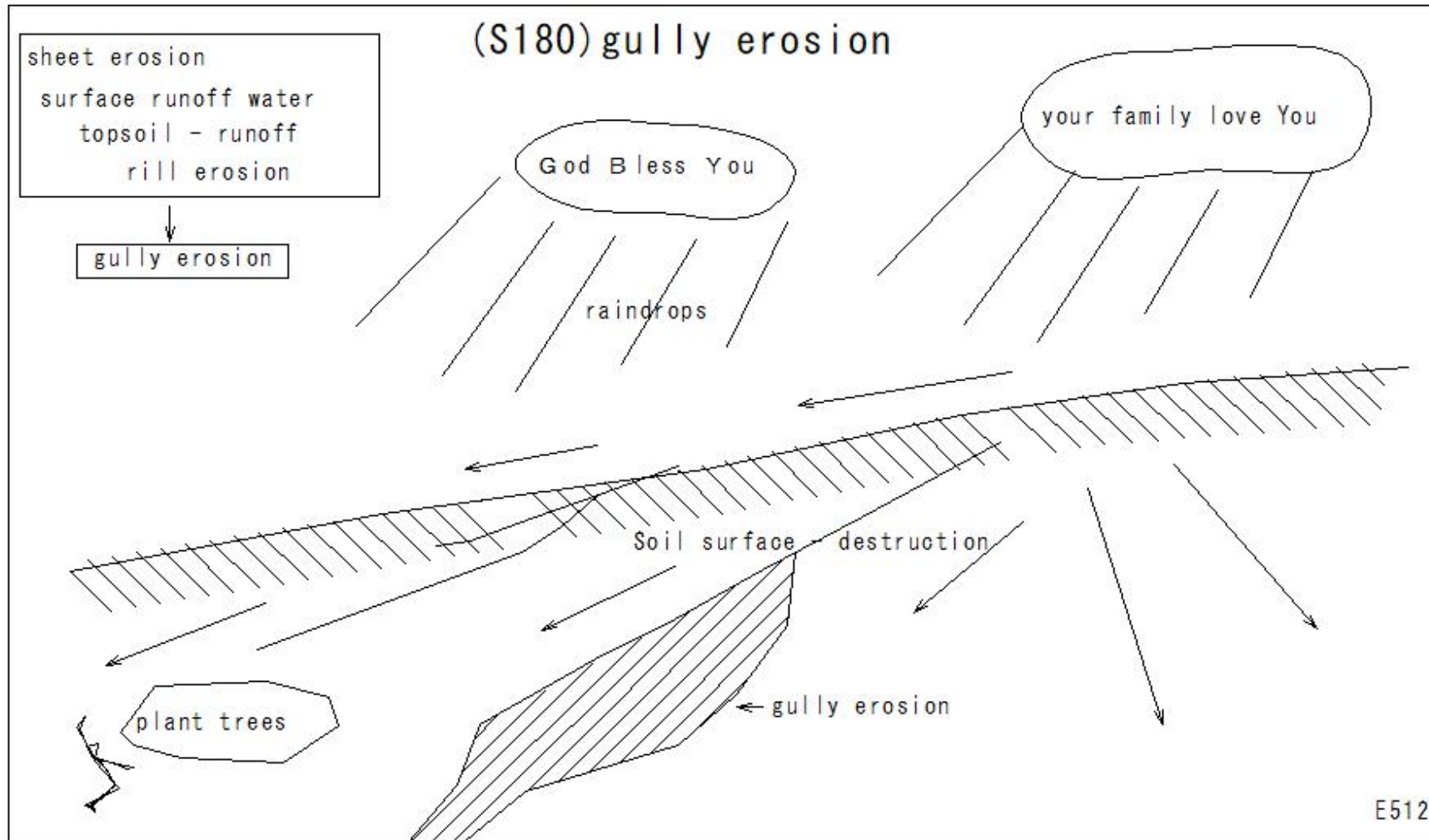
erosion effect

Sediment grains

flow downstream



(S180)gully erosion



(S181) torrent control works

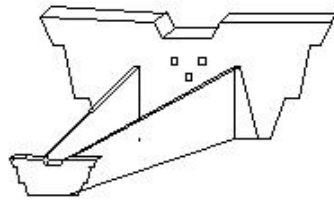
(S181) torrent control works

torrent control works

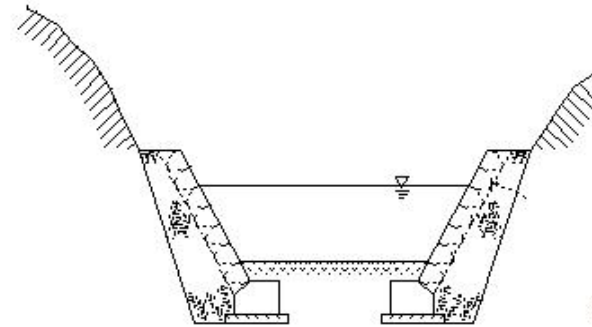
Mountain stream bed stabilization work

- Preventing sand and gravel from flowing out
- River bed: Prevention of river bank erosion
- Dam construction, bank protection work, revetment, channel construction

check dam



revetment

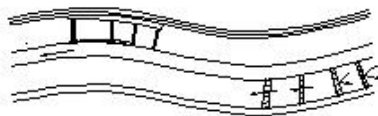


S128

S67

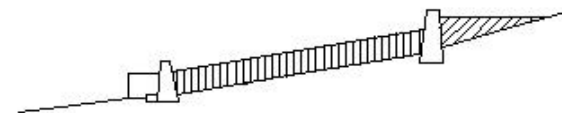
watercourse

groin

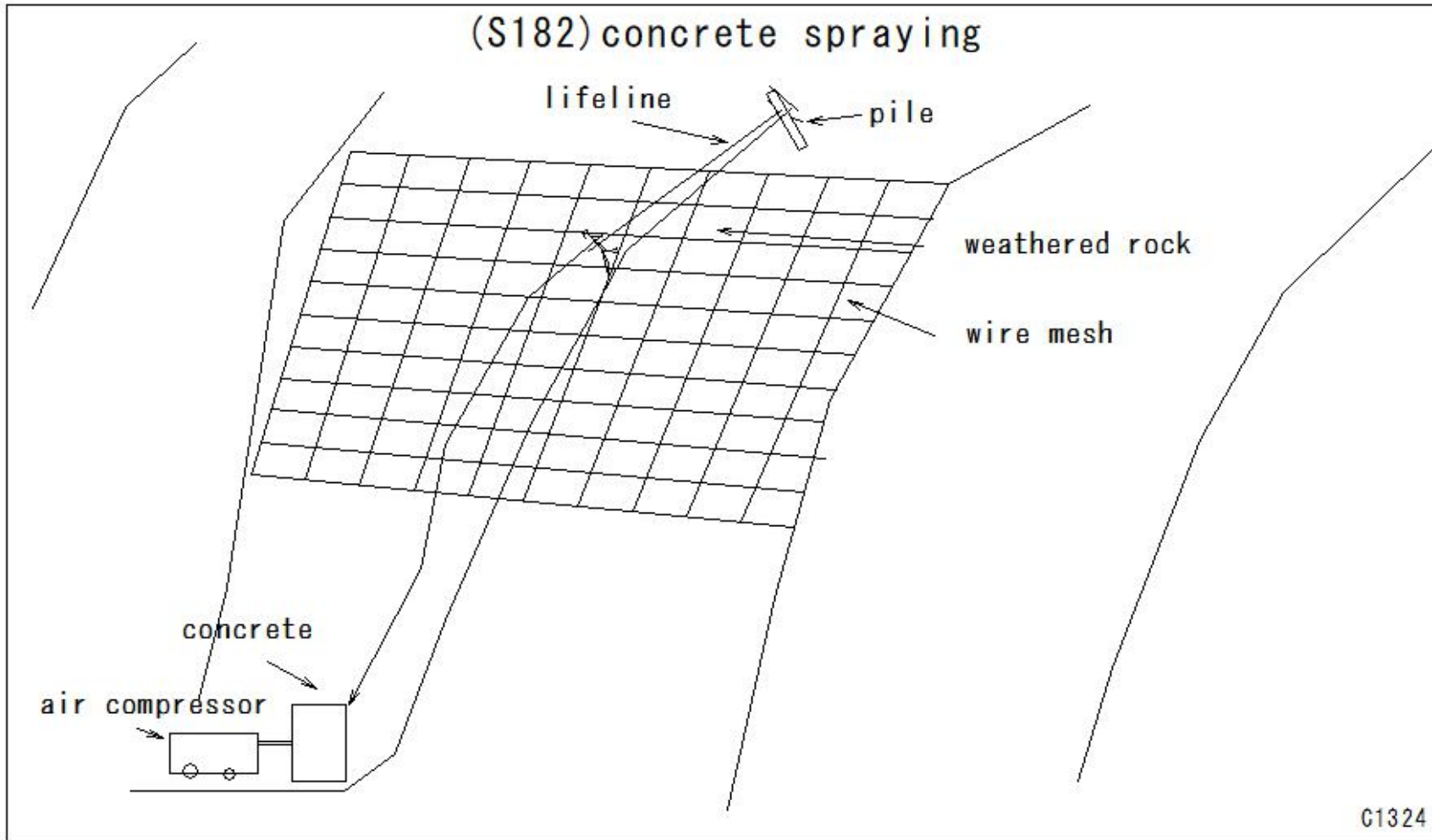


S145

S142



(S182)concrete spraying



G1324

(S183)hillside works

(S183)hillside works

hillside works

mountainside stairwork

- Steep slope of mountainside
- Stairs - Fixed slope
- Stable soil

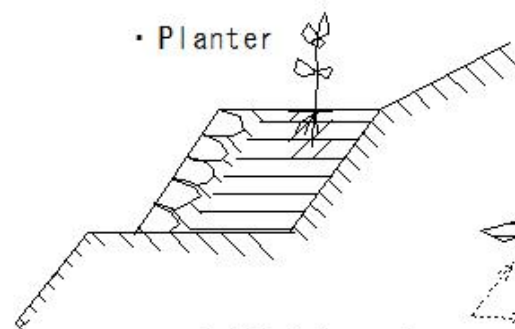
kinds

masonry

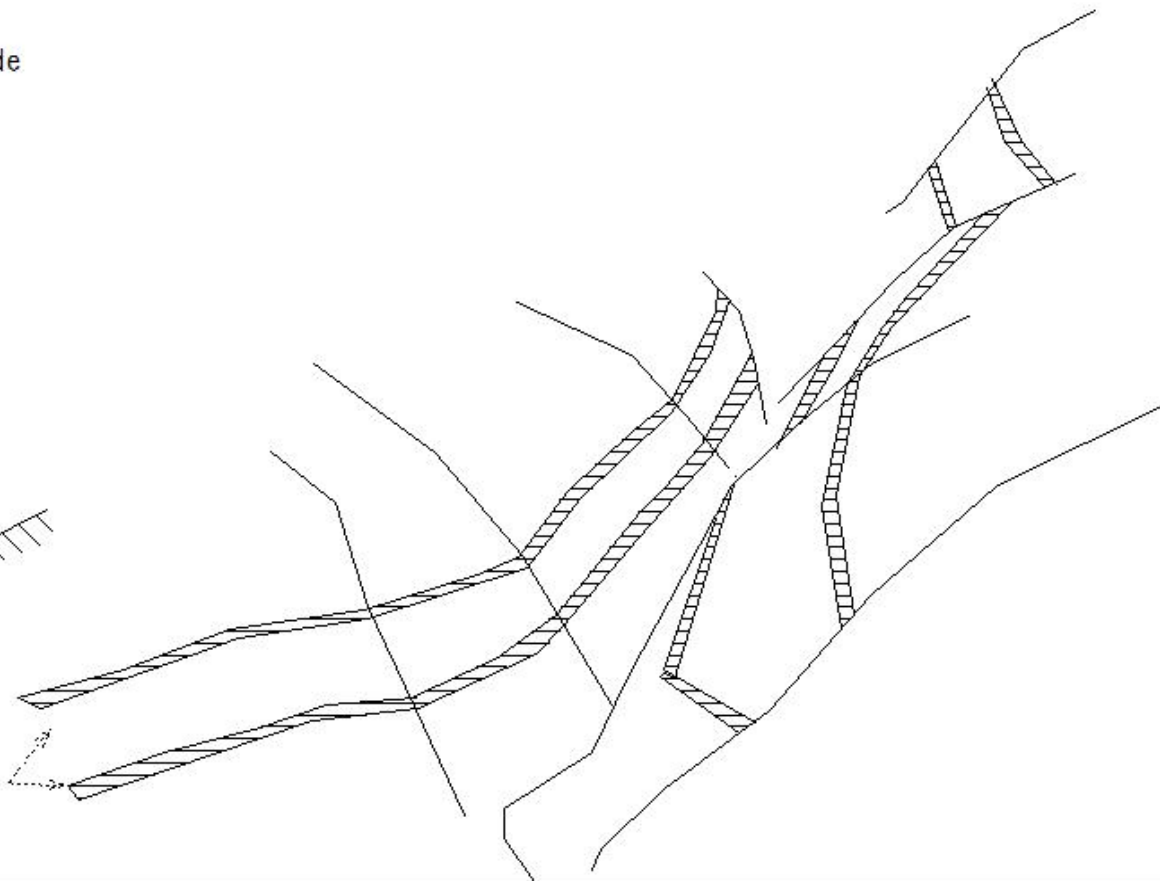
Seedling pile

stone masonry

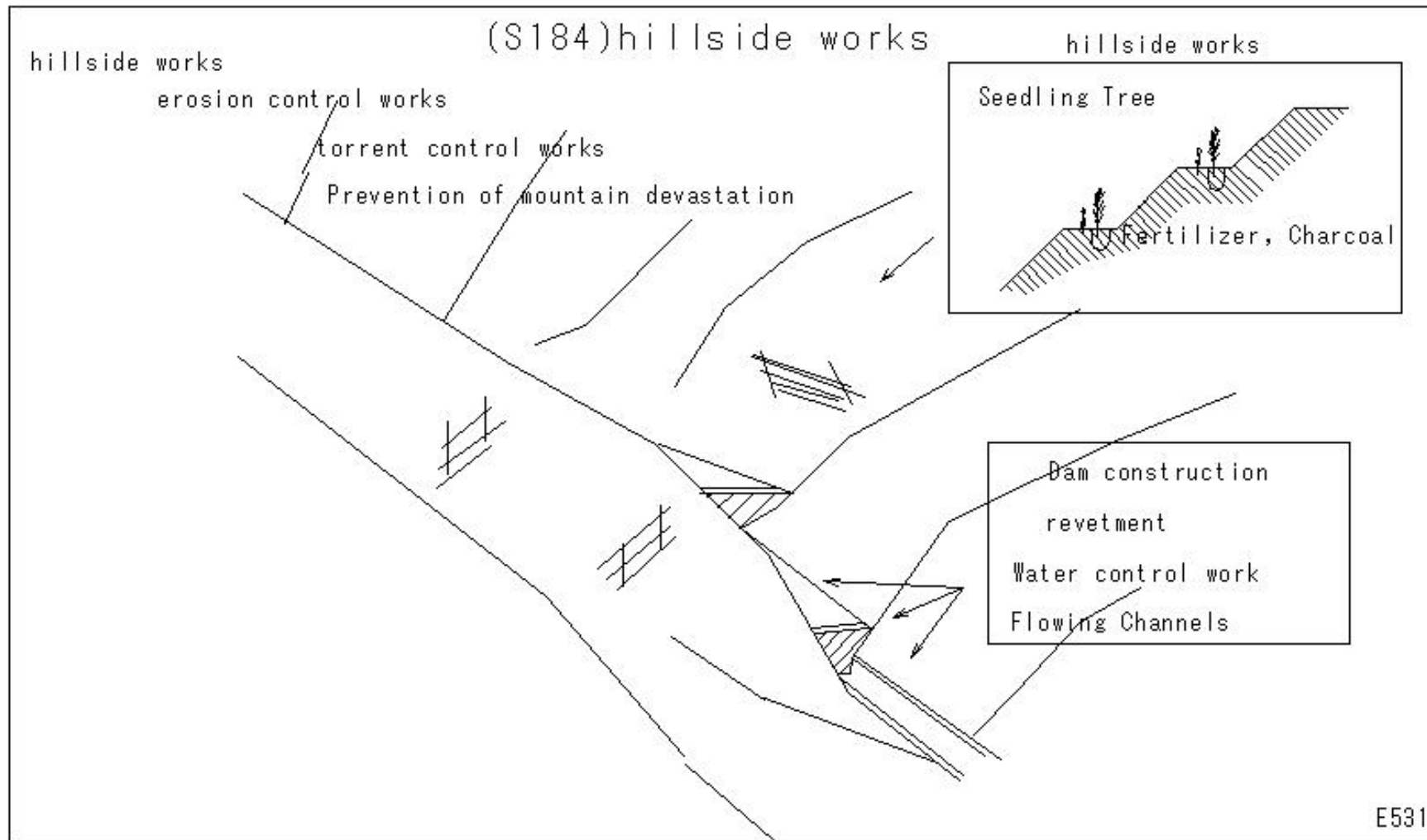
Piles and fencing



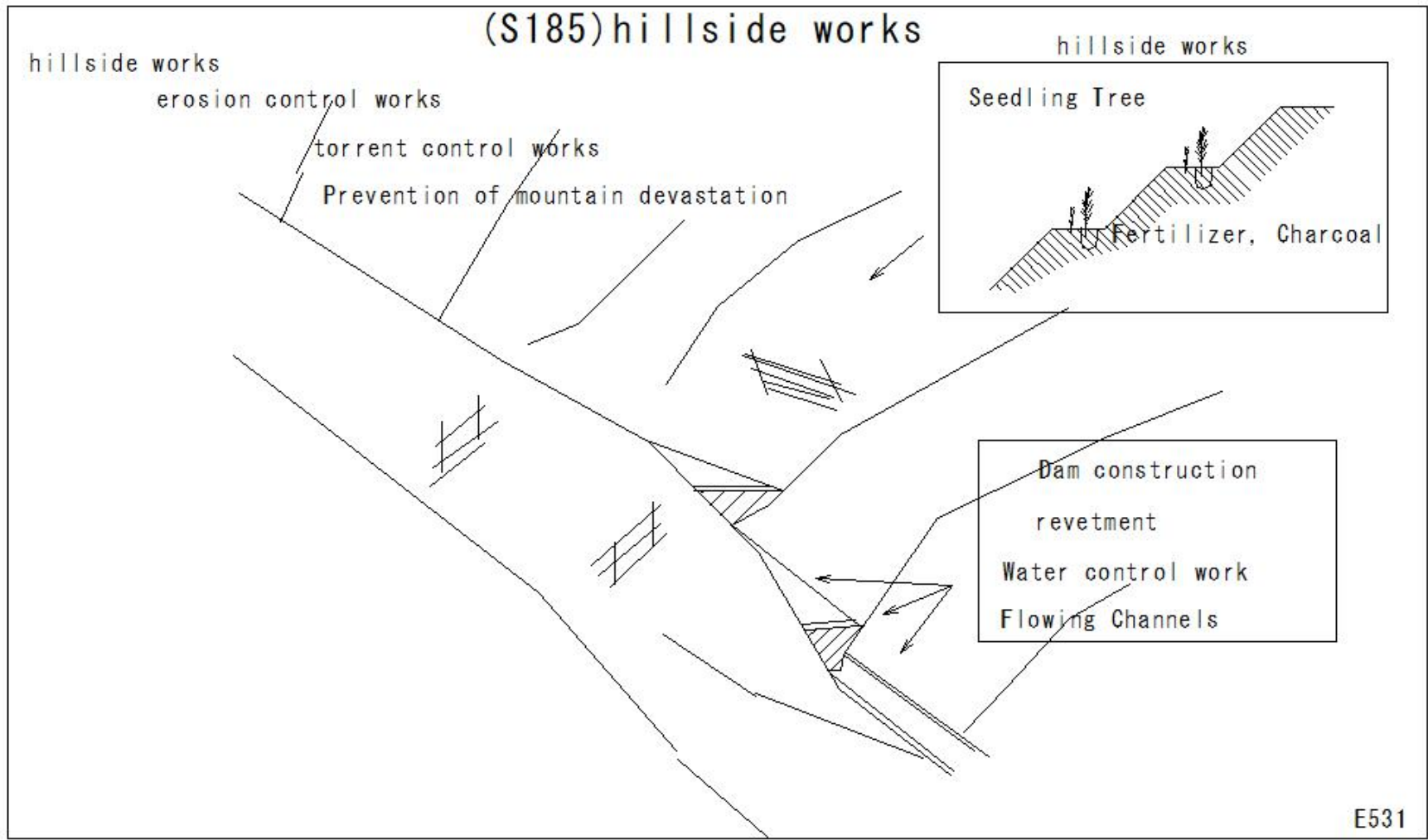
hillside works



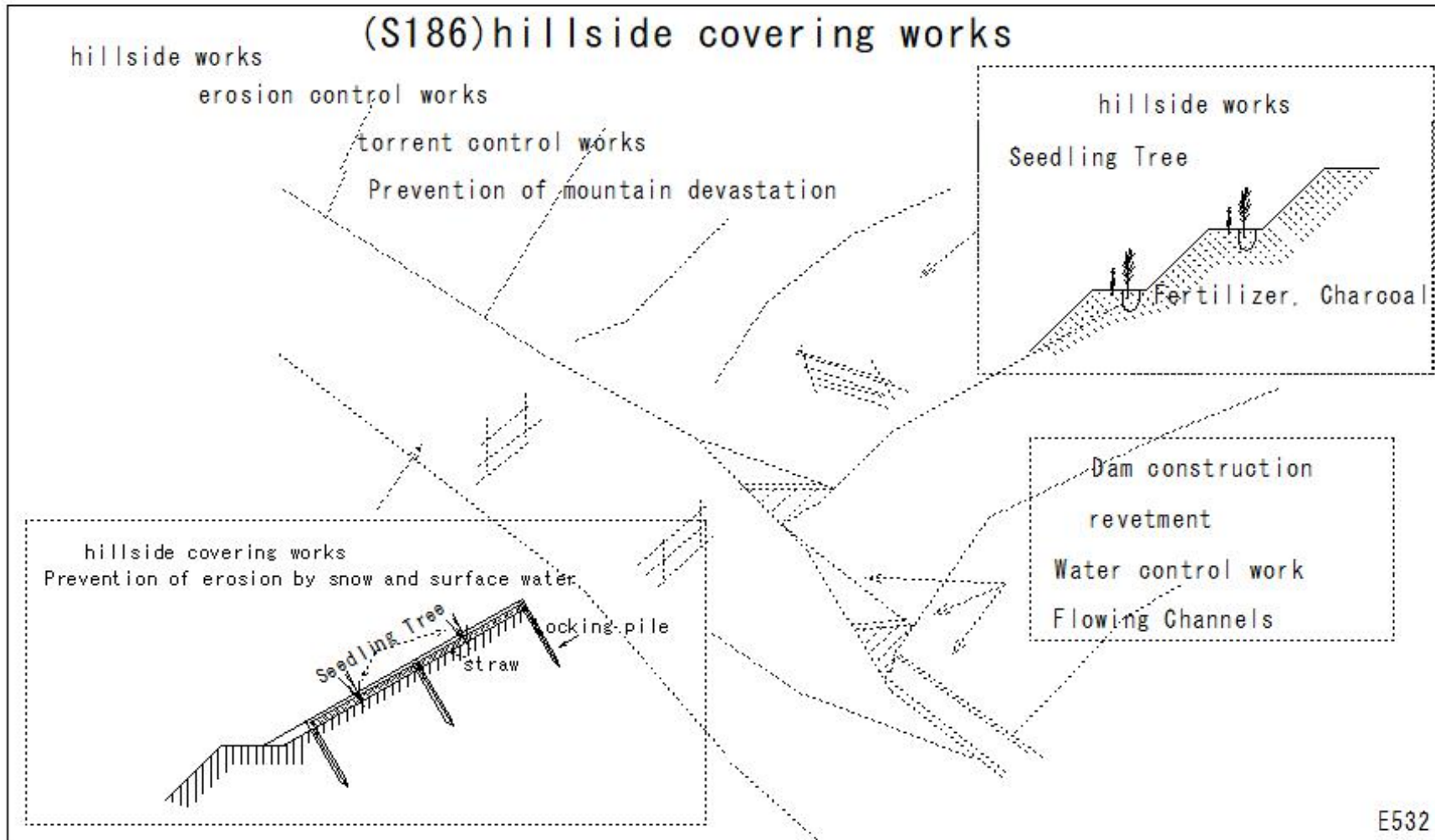
(S184)hillside works



(S185)hillside works

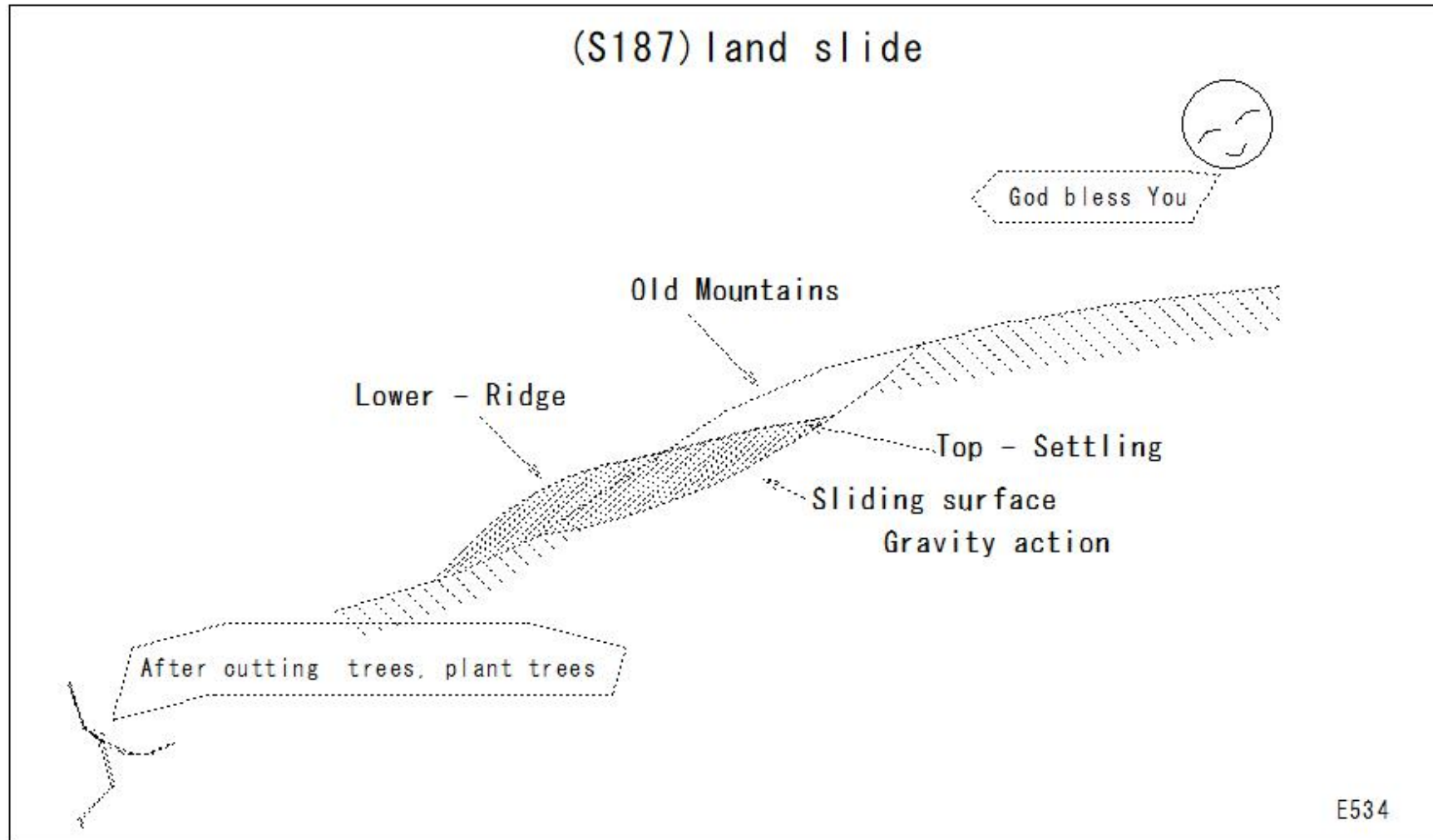


(S186)hillside covering works

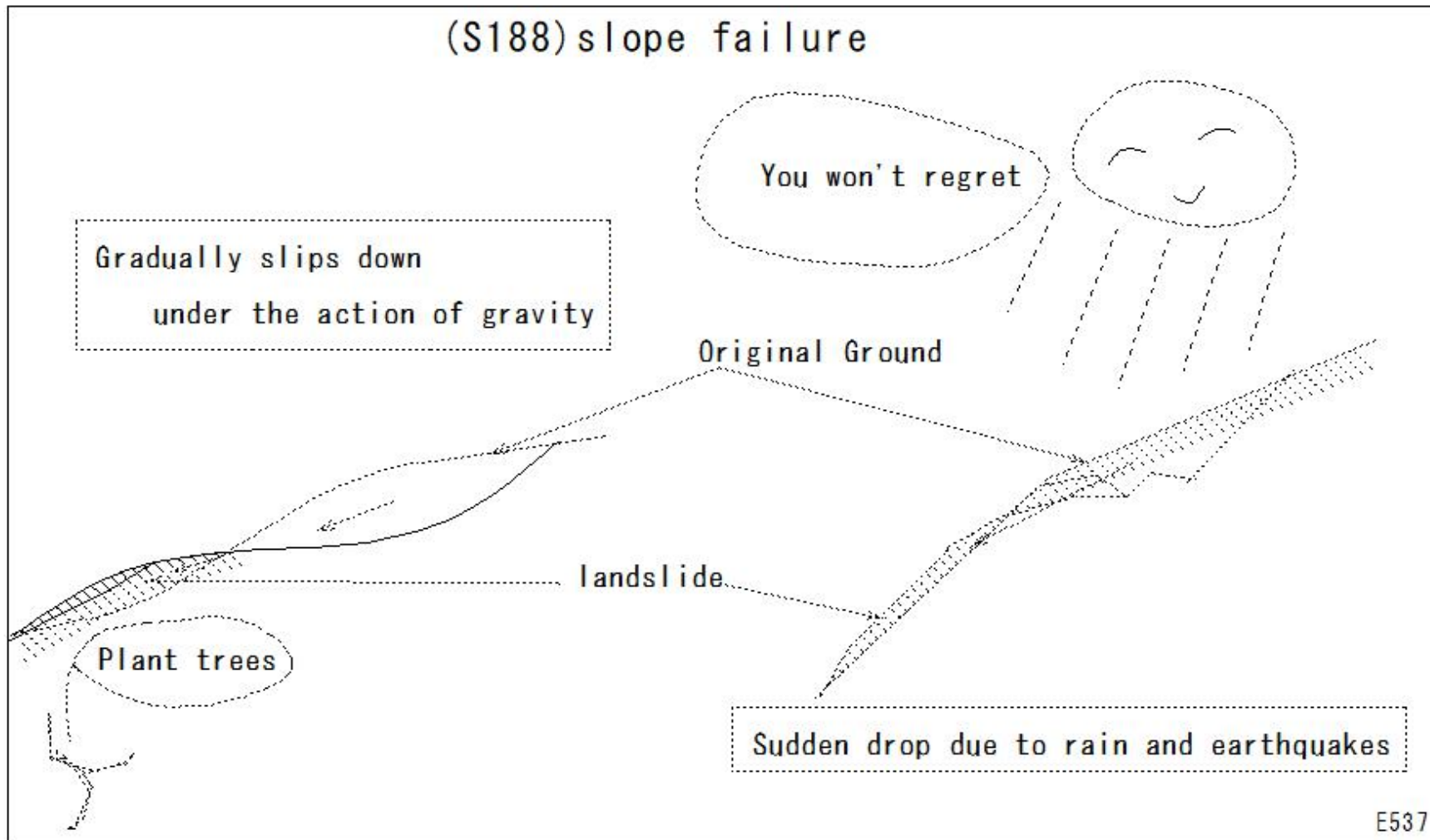


(S187)land slide

(S187) land slide



(S188)slope failure



(S189) catchment well

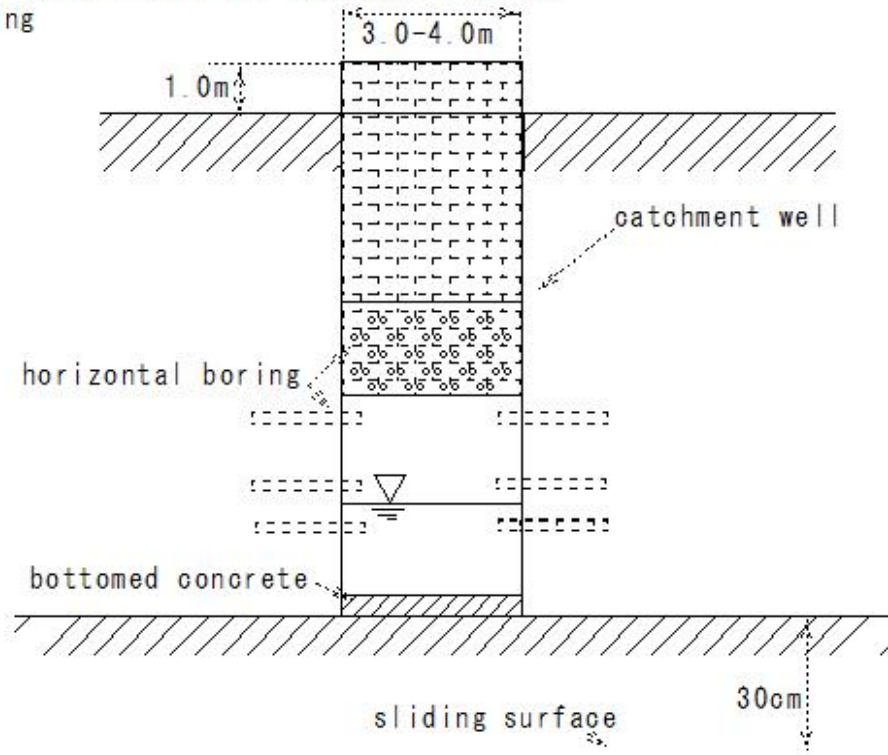
(S189) catchment well

catchment well

Landslide surface

a well collects water above the landslide surface

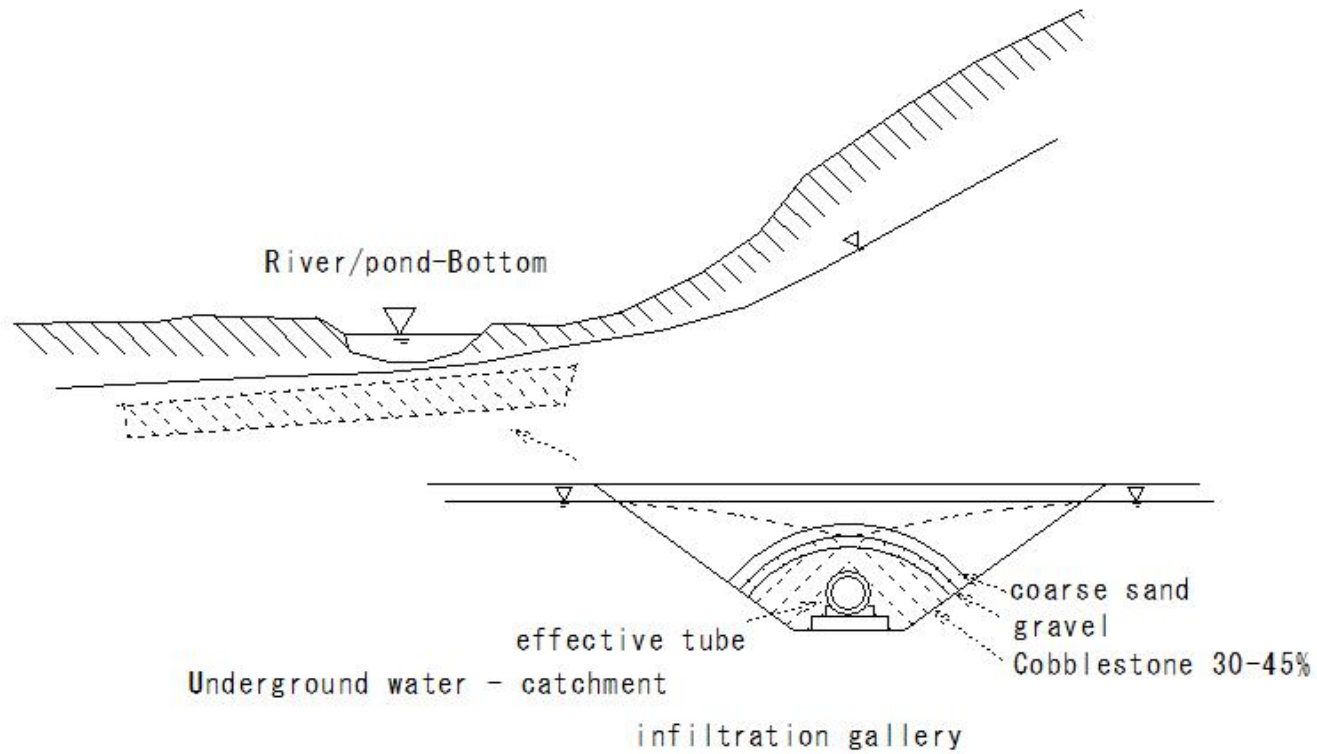
horizontal boring



(S190)infiltration gallery

(S190) infiltration gallery

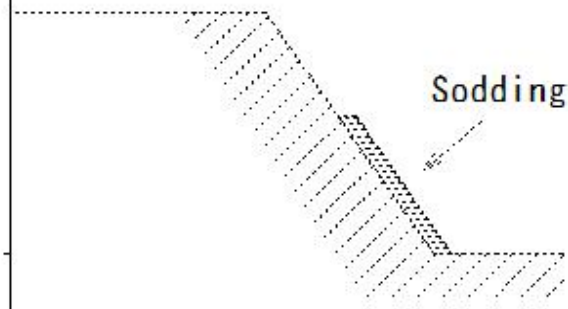
infiltration gallery



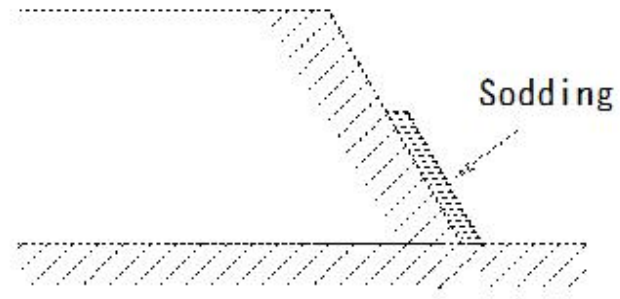
(S191)planted slope protection:Vegetation engineering

(S191)planted slope protection:Vegetation engineering

Slope protector



Cut

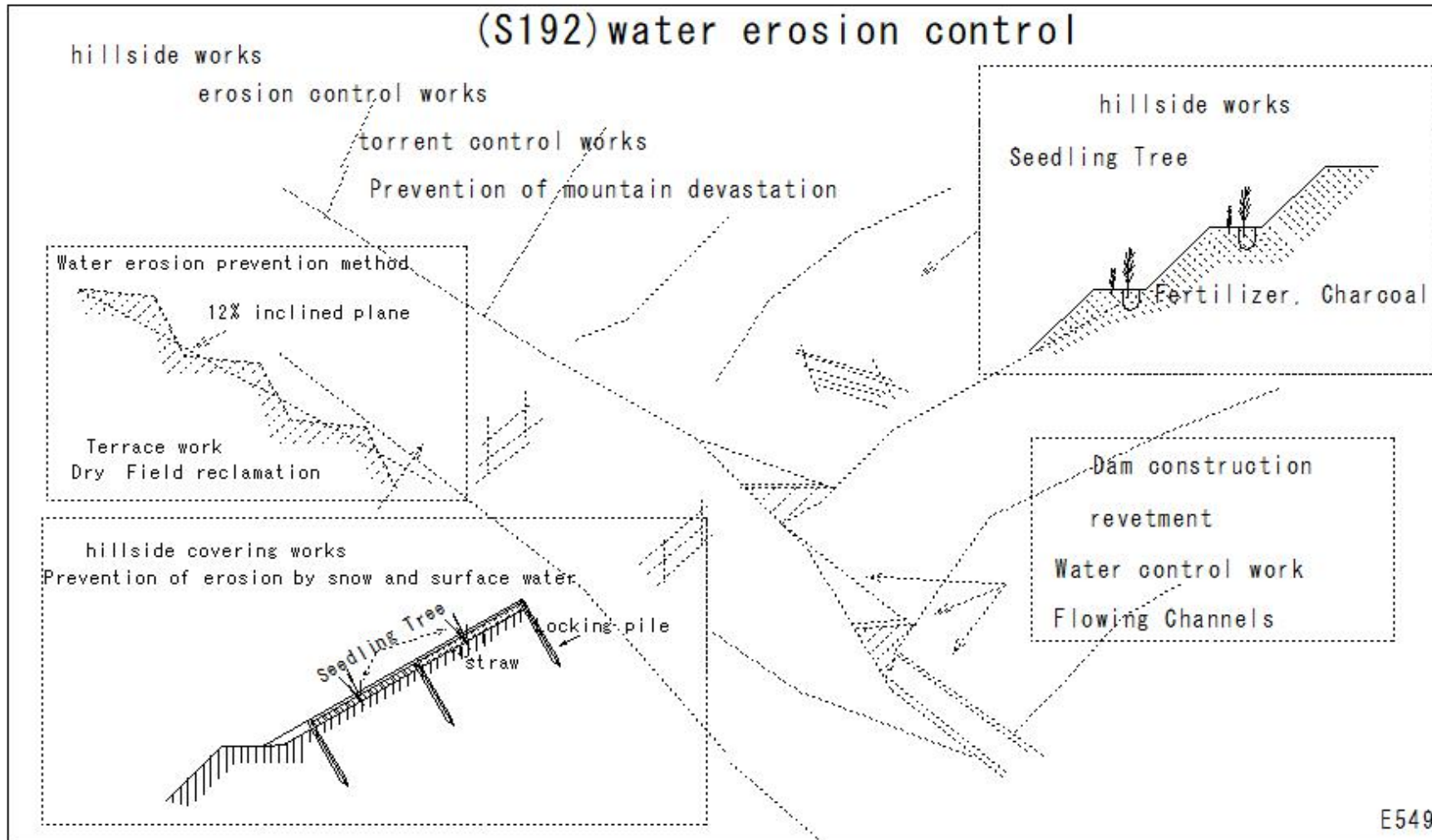


Embankment

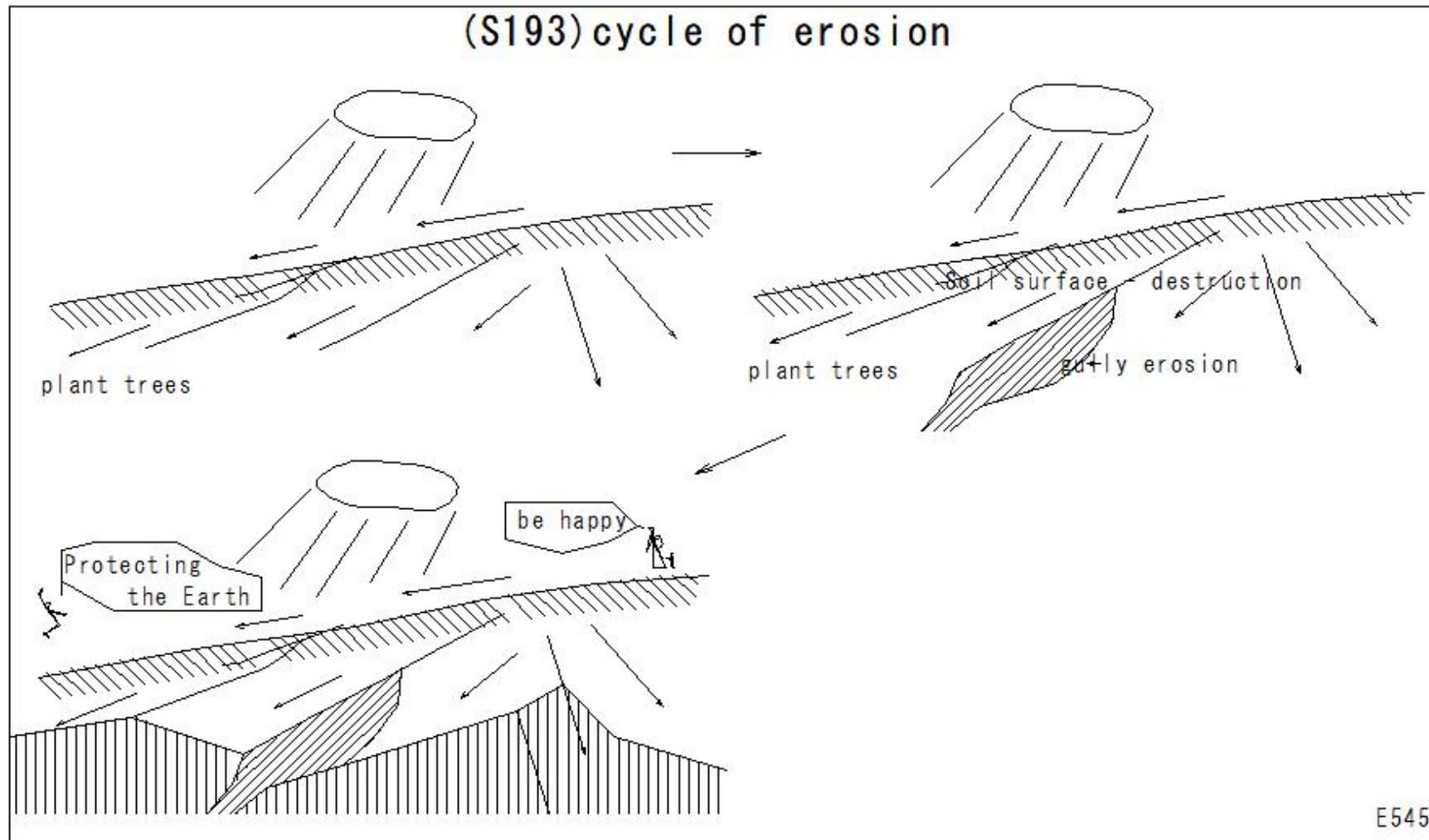
E543

(S192)water erosion control

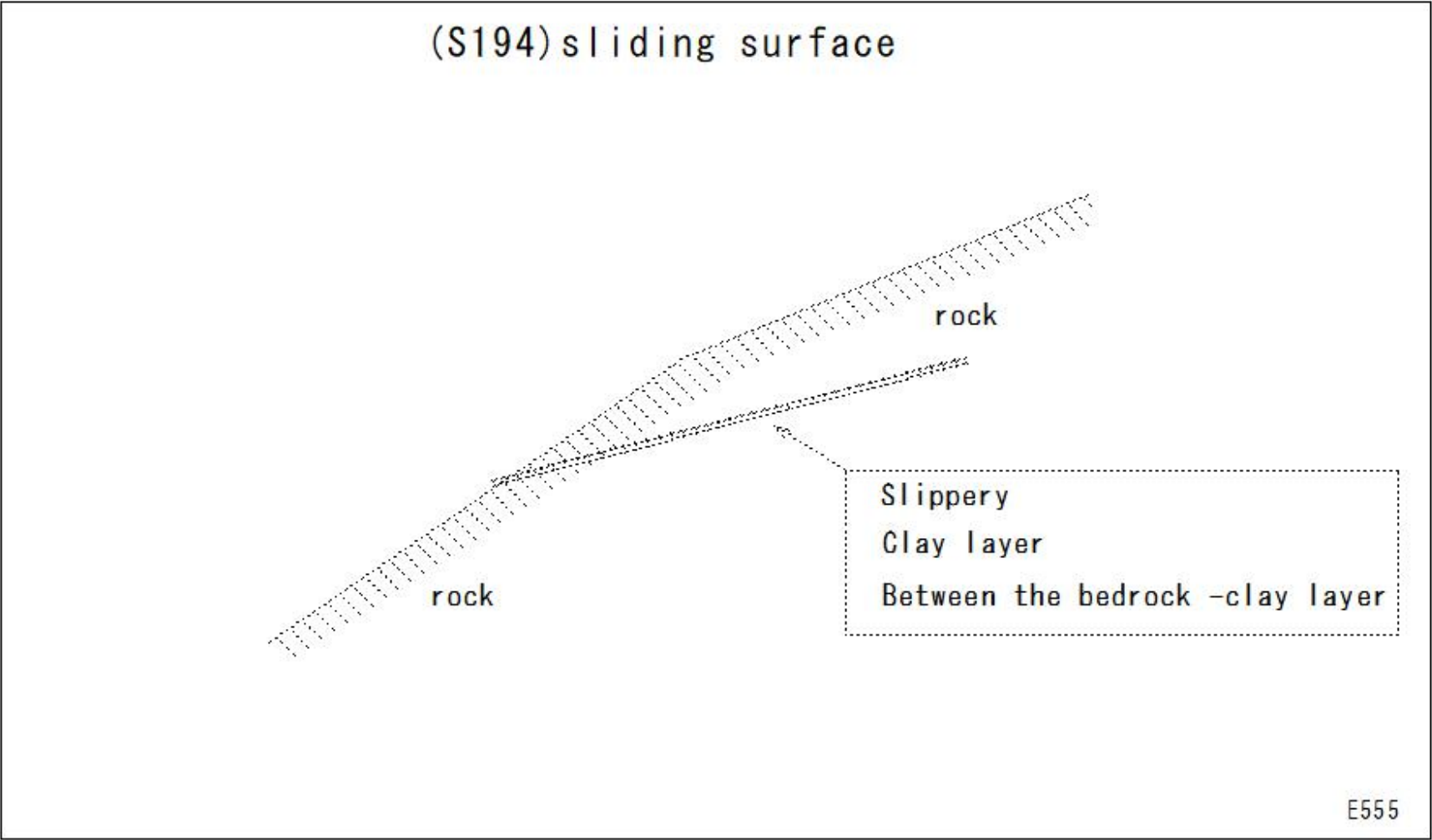
(S192)water erosion control



(S193)cycle of erosion

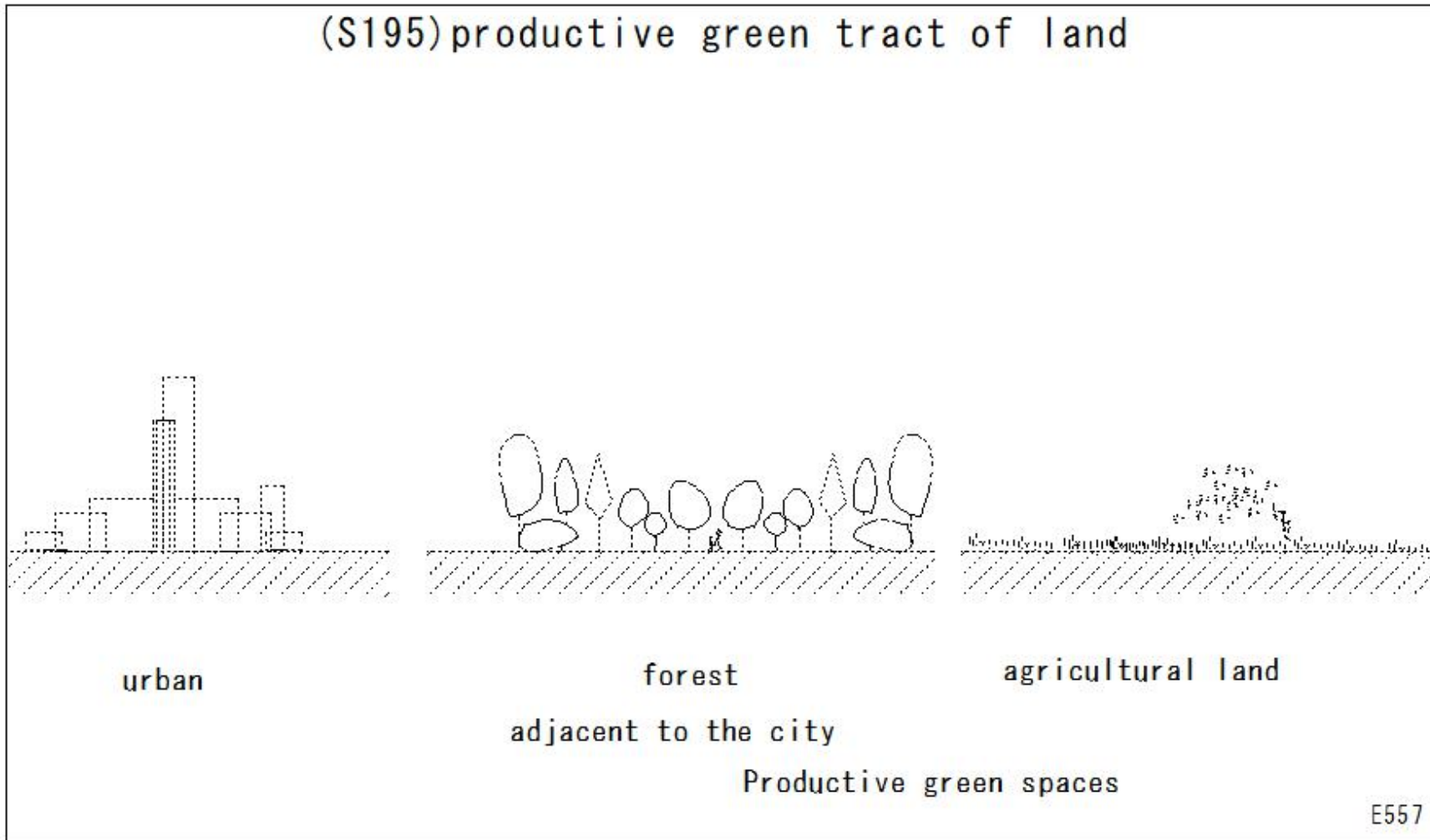


(S194)sliding surface



(S195)productive green tract of land

(S195)productive green tract of land



(S196)traction

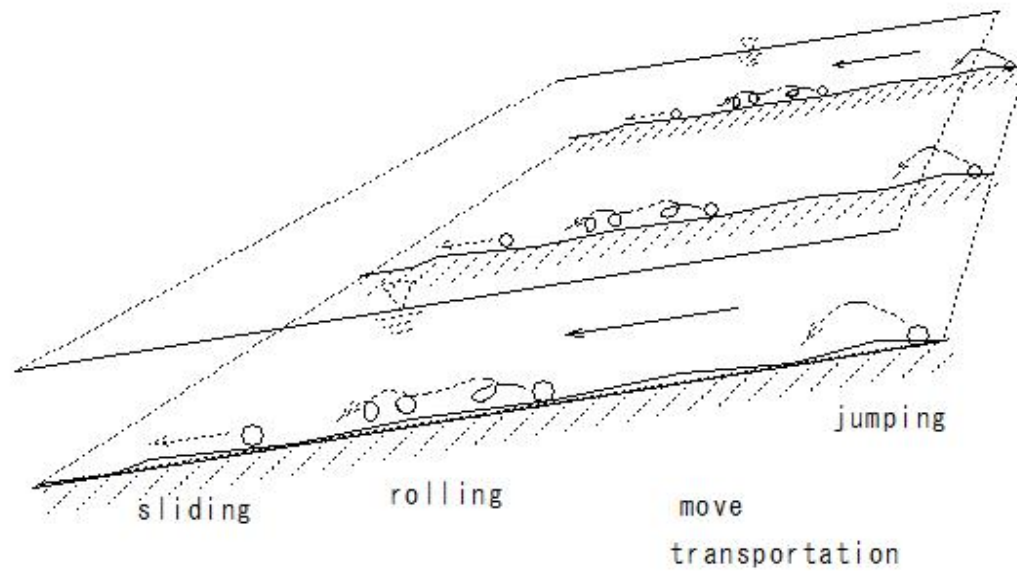
(S196) traction

traction: Flowing by rolling on the river bed

Sediment on the riverbed is Scouring

flow out

Sediment on the river bed

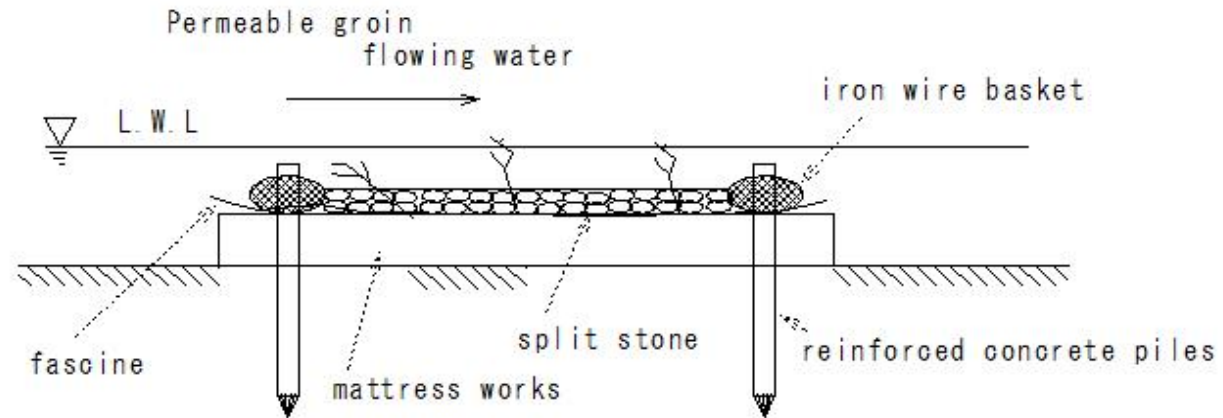


R407

(S197)fascine

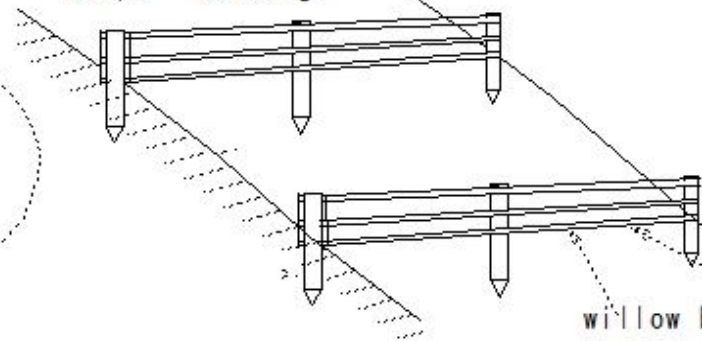
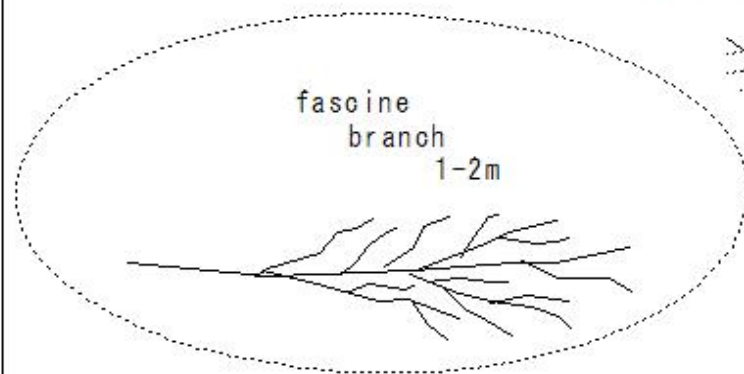
fascine
mountainside
bank protection
groin
Flood protection

(S197) fascine



Used as material for landslide prevention facilities

Slope - sodding



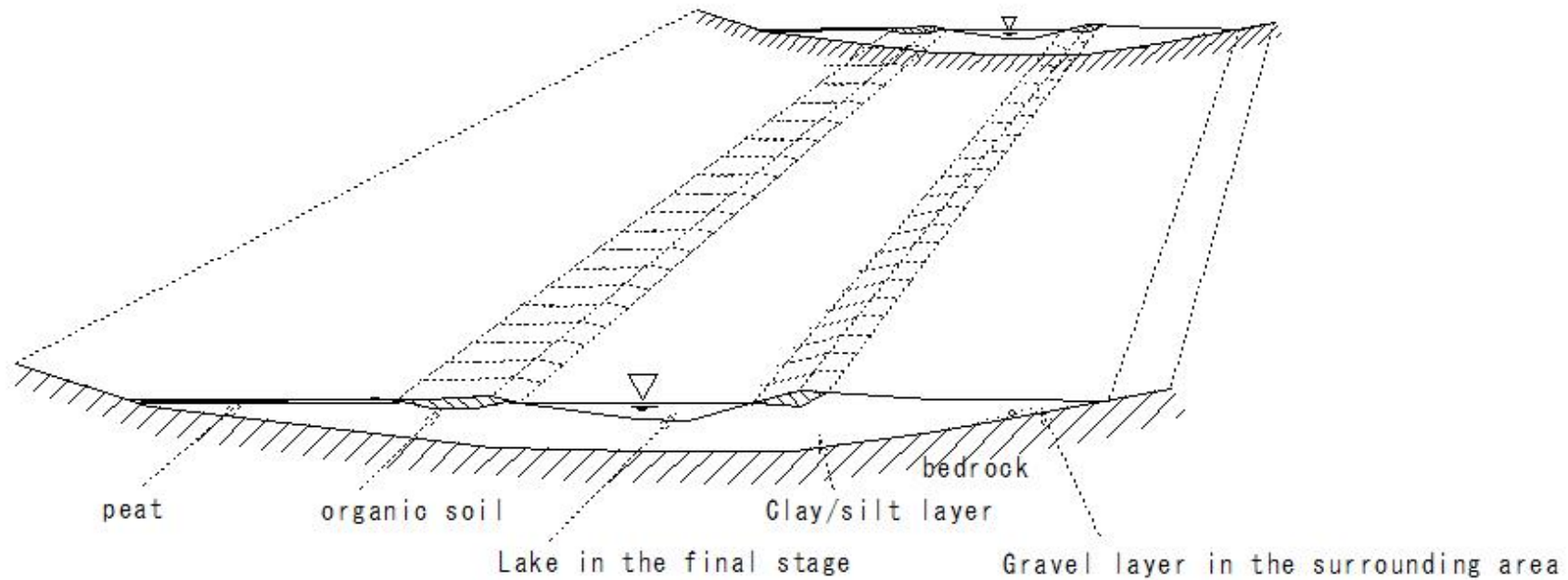
(S198)deposition

(S198) deposition

deposition

Rocks eroded by running water
transported and deposited

Formation of lacustrine sedimentary soil

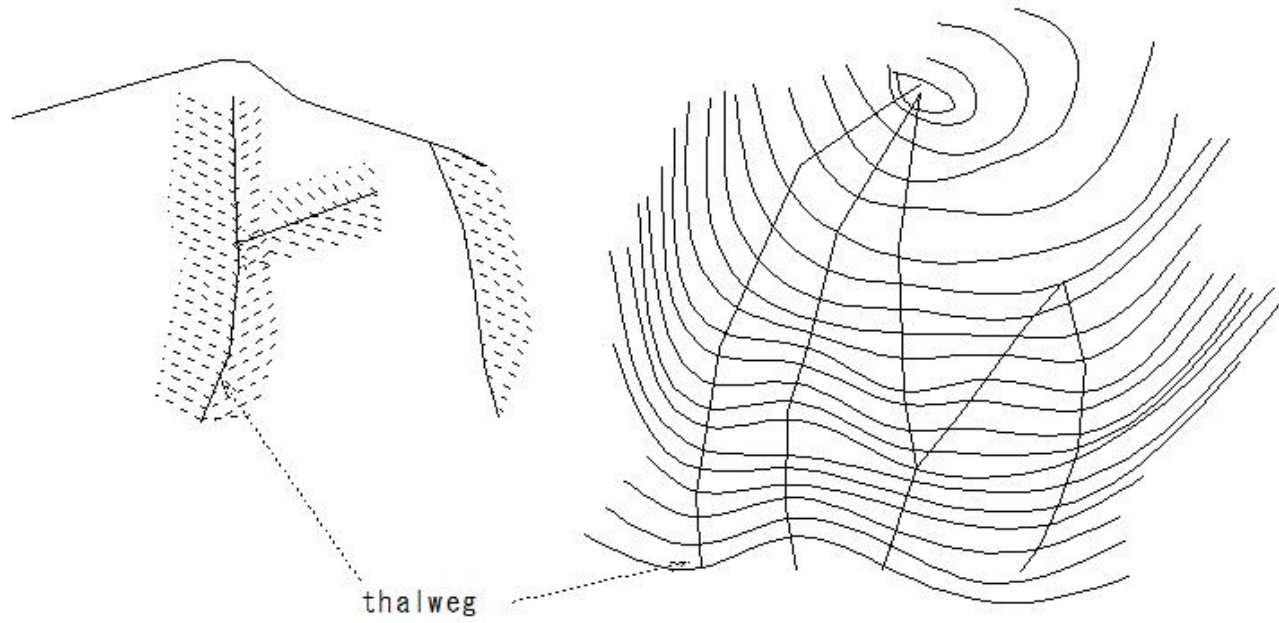


R411

(S199)thalweg

(S199) thalweg

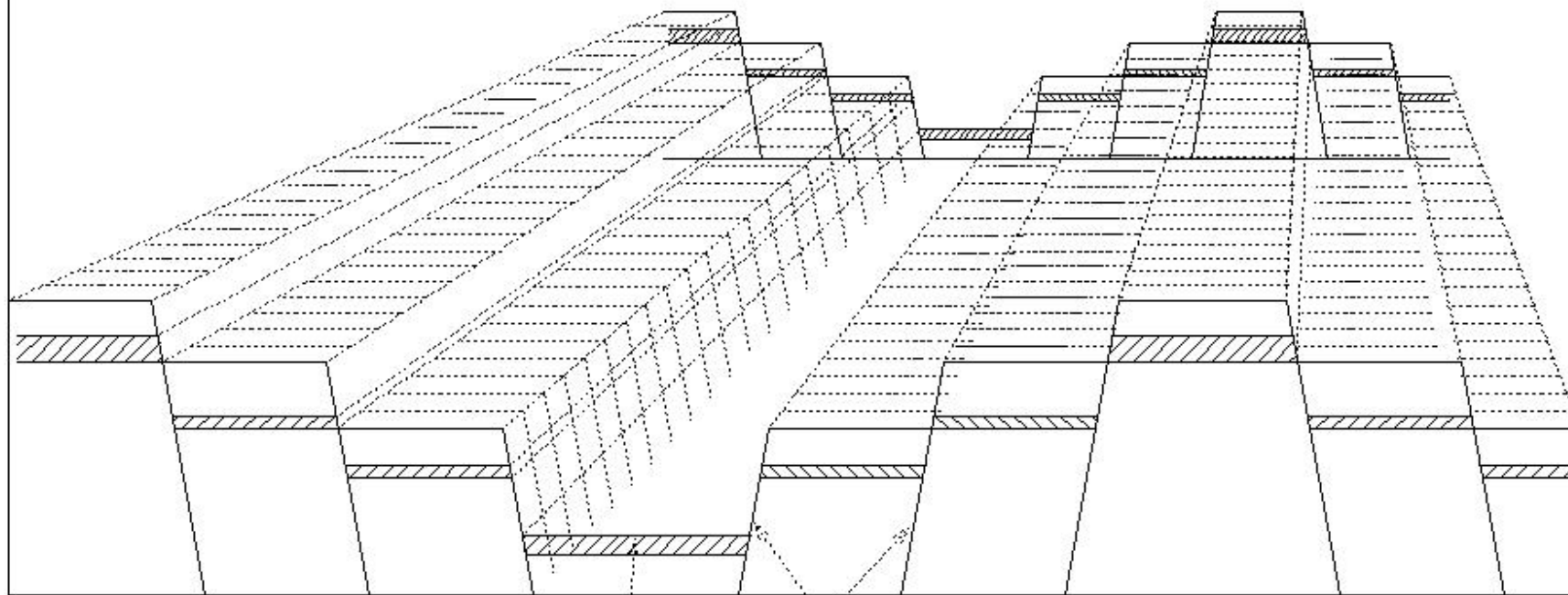
thalweg



(S200)rift valley

(S200)rift valley

rift valley



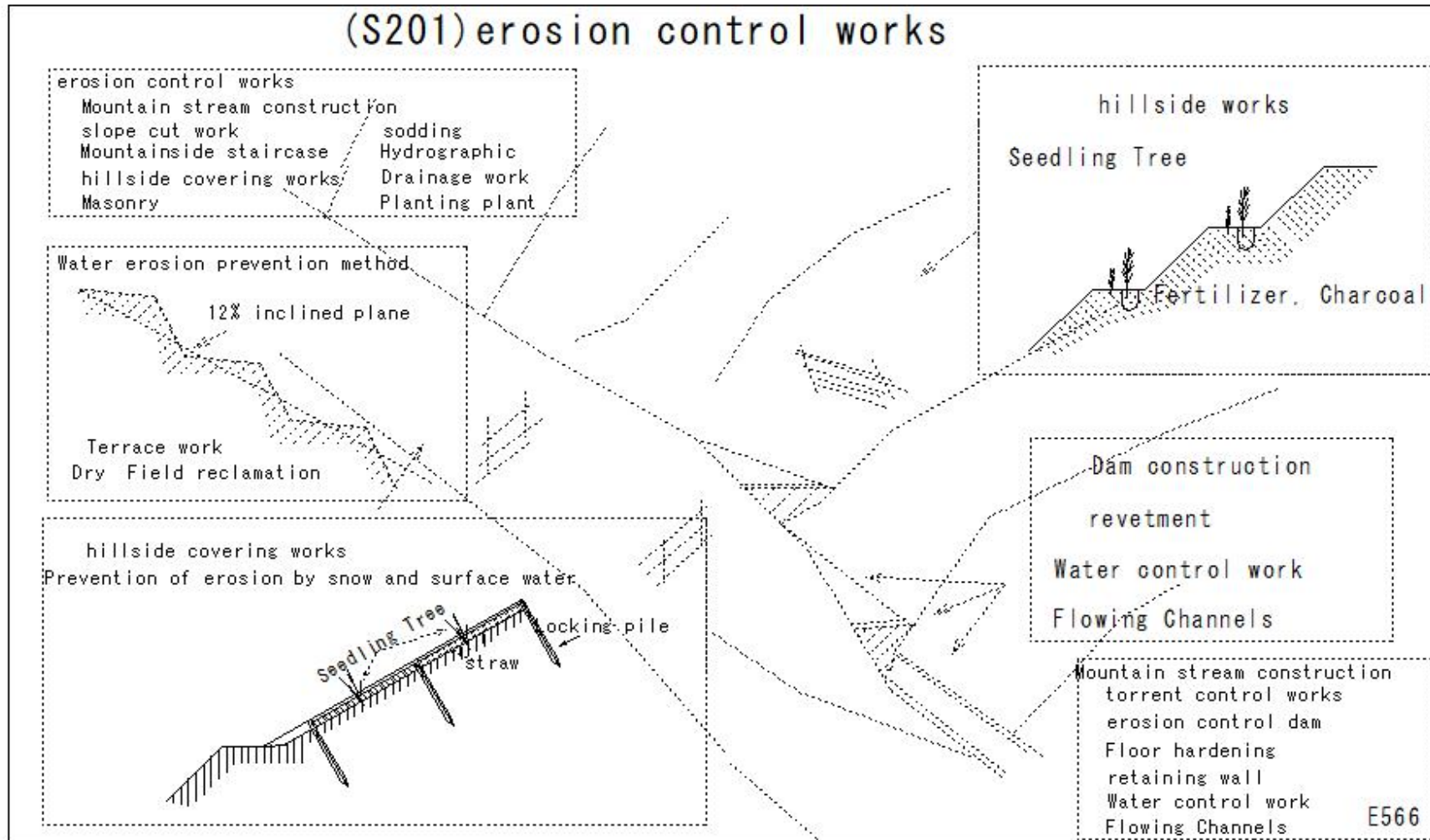
center - low

rift valley

fault

R417

(S201)erosion control works



(S202) Geological map

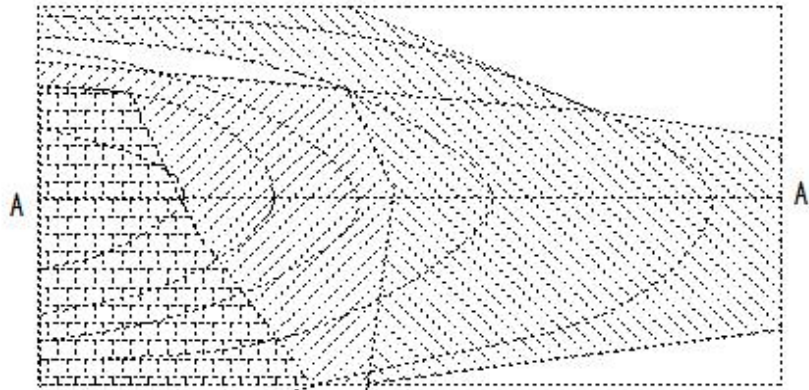
(S202) Geological map

Geological map

Defined symbols

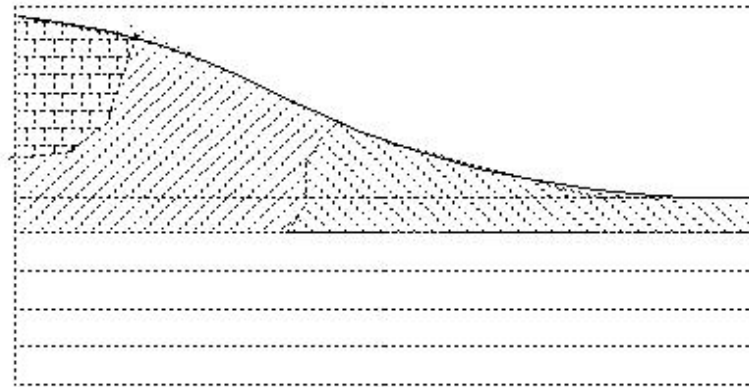
Geological distribution

Formation: Inclined Fault



Geological distribution map

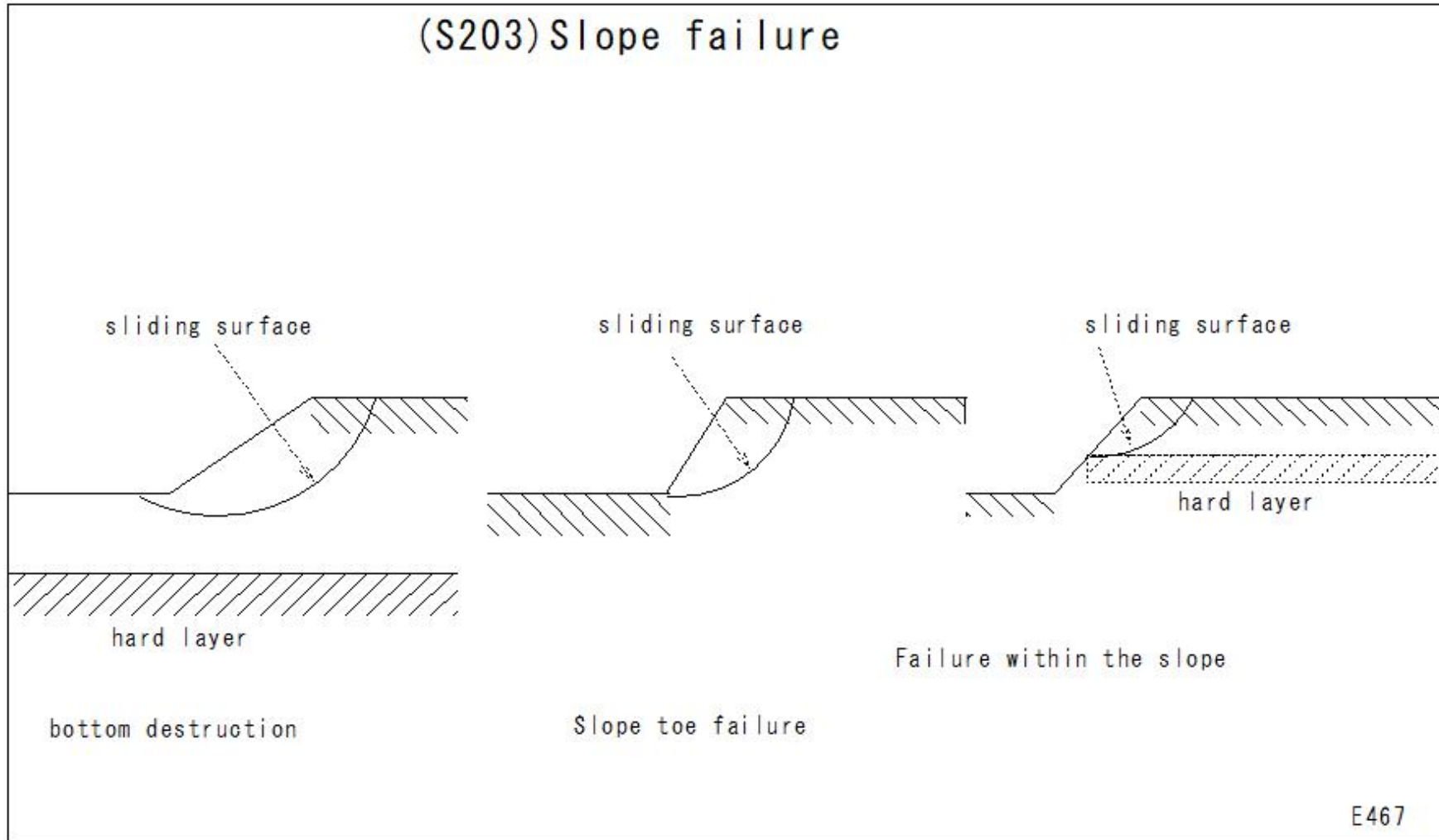
A-A section



Geological cross-sectional view

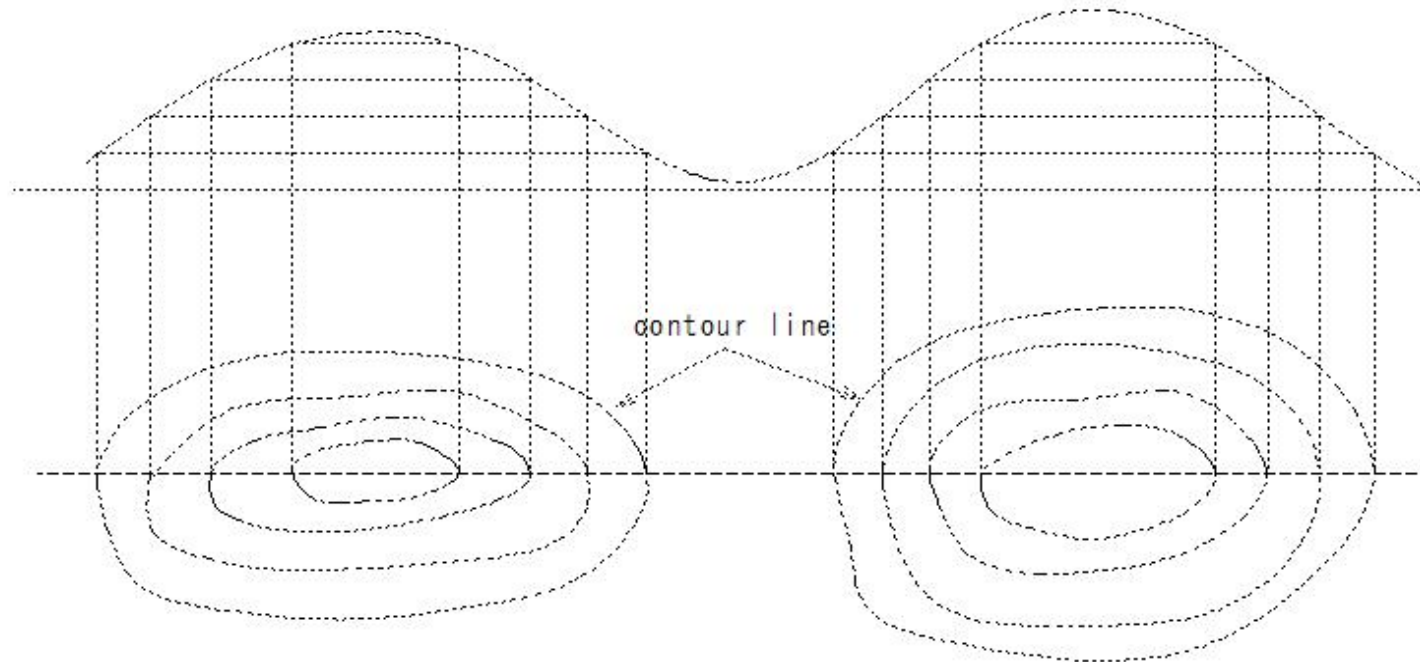
(S203)base failure

(S203) Slope failure



(S204)contour line

(S204) contour line



E575

(S205)sediment settling

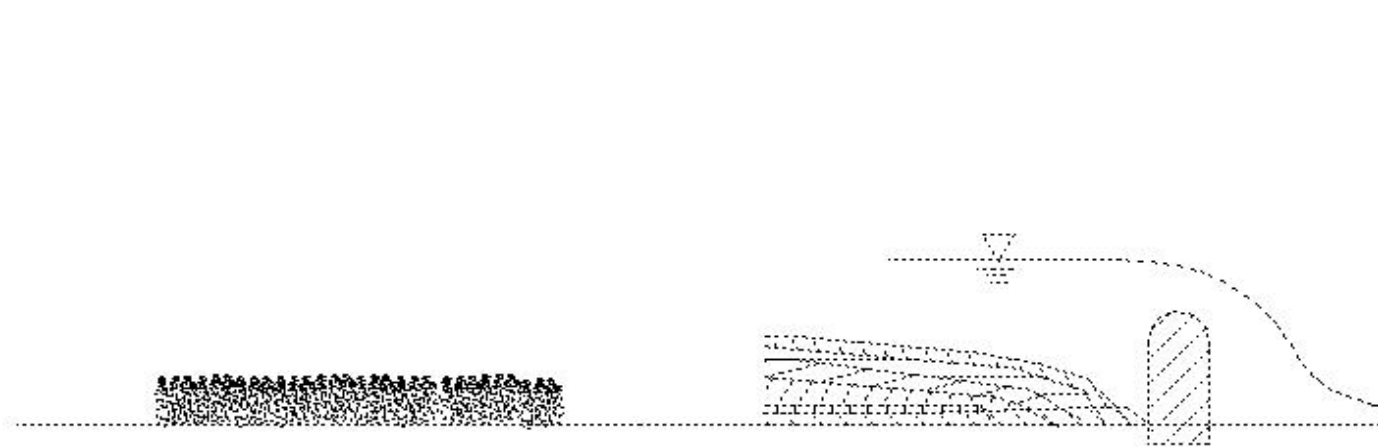
(S205) sediment settling

sediment settling

Water flow

Stationary soil pressure

Sediment in water - precipitation



Precipitation in still water
The lower layer has a larger particle size

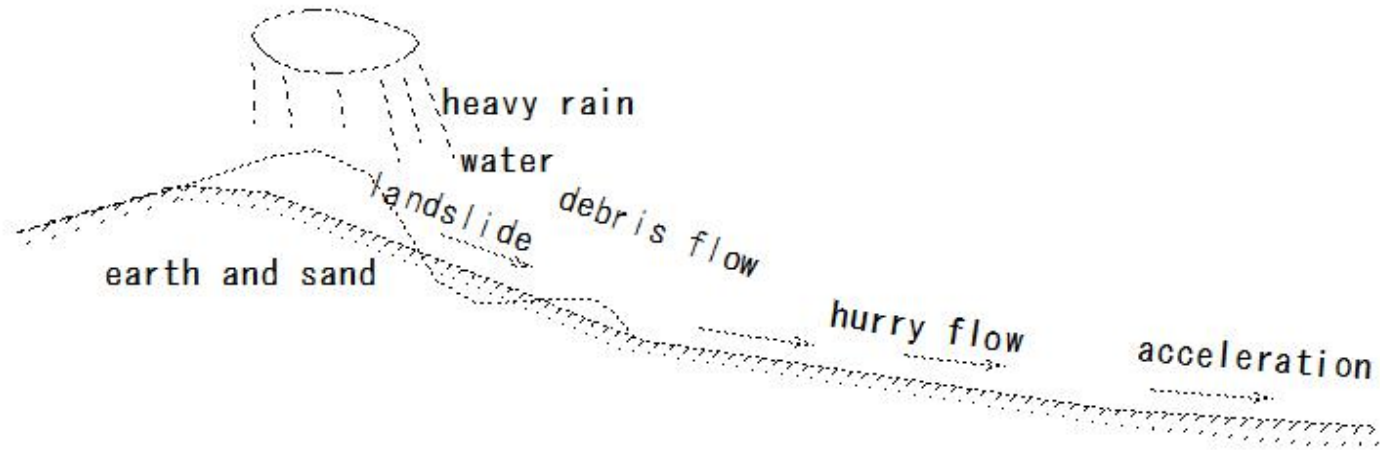
The tip is attached to the dam
Deposition

E580

(S206)debris flow

(S206) debris flow

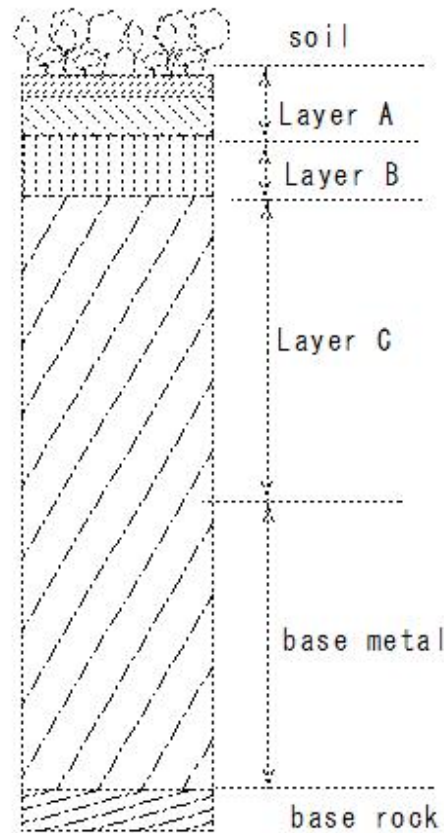
debris flow



E582

(S207)soil profile

(S207) soil profile



Layer A: Contains a lot of corrosive and organic substances

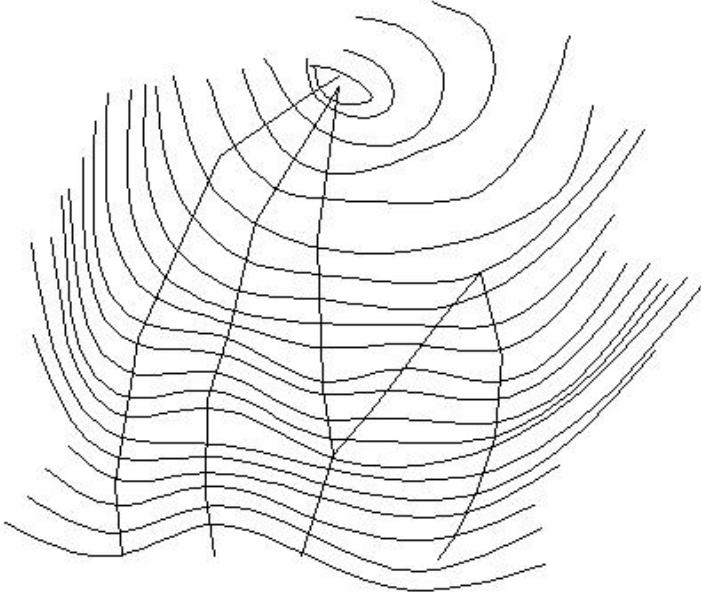
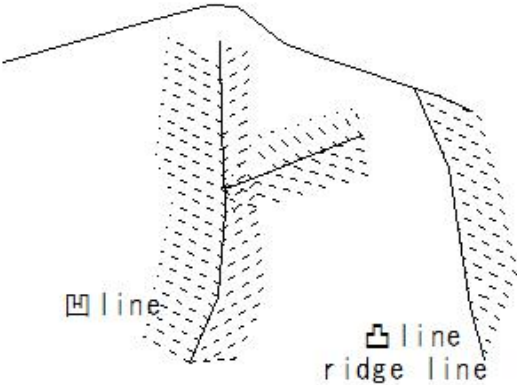
Layer B: Contains a lot of fine particles

Layer C: Weathered sedimentary soil of base rock with a low degree of weathering

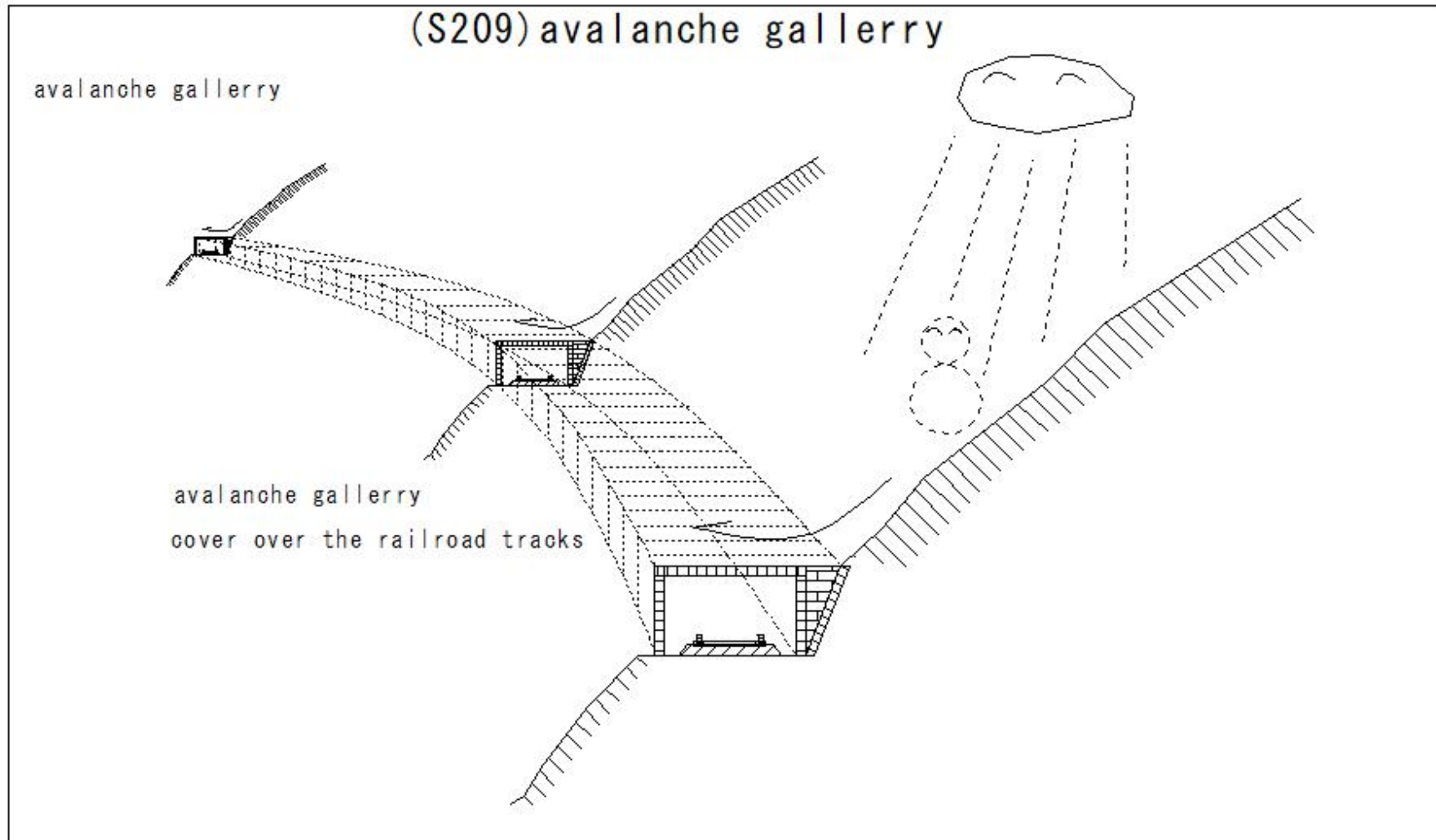
(S208)ridge line

(S208) ridge line

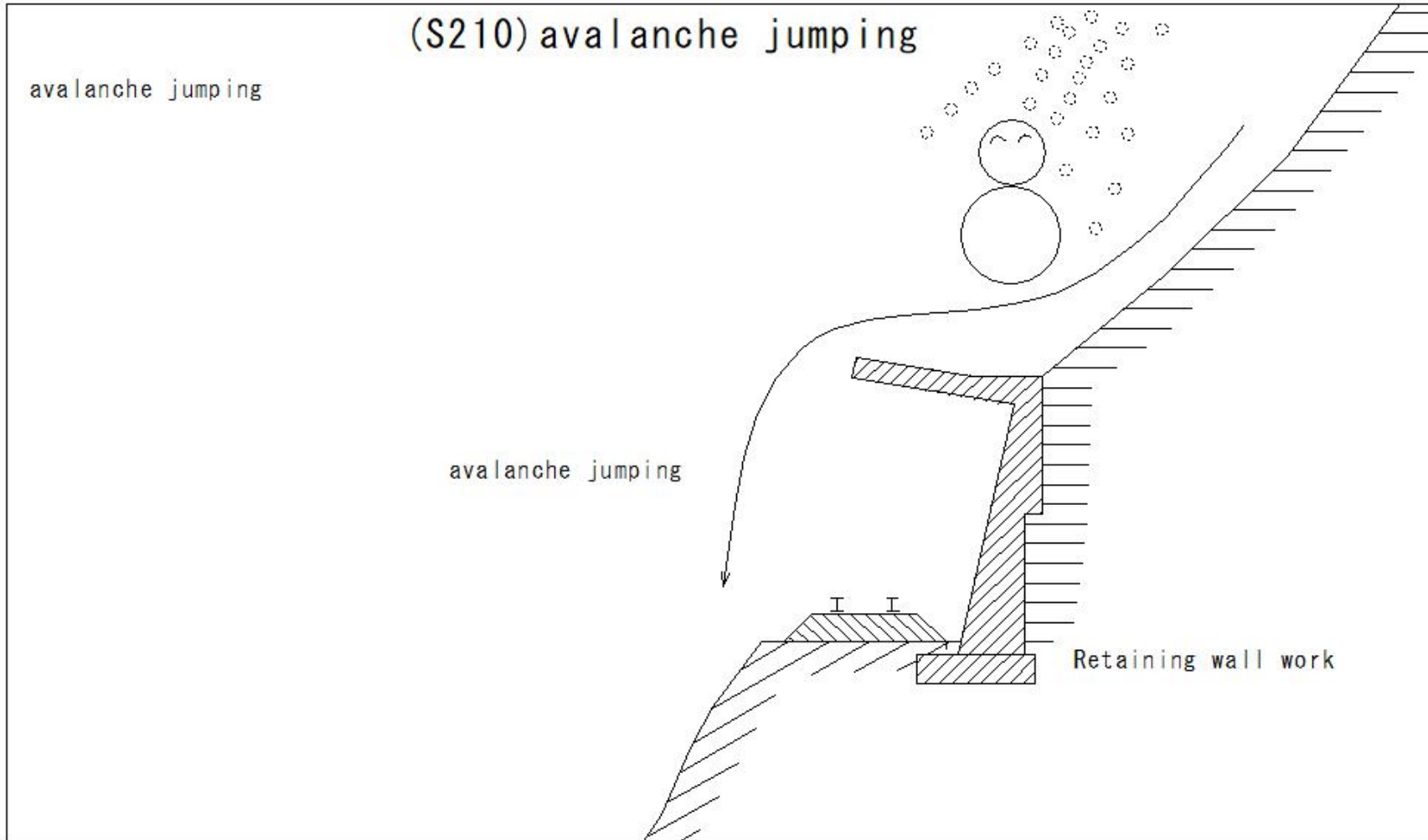
ridge line



(S209)avalanche gallery



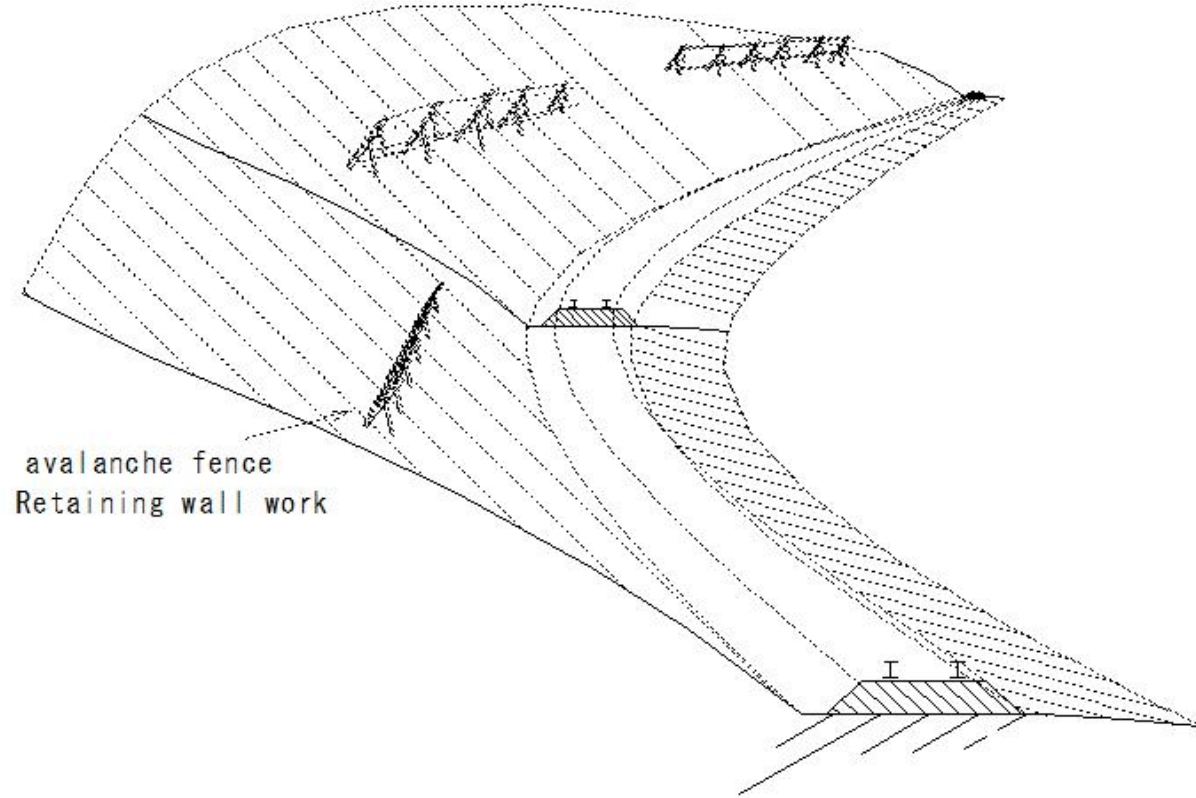
(S210)avalanche jumping



(S211)avalanche fence

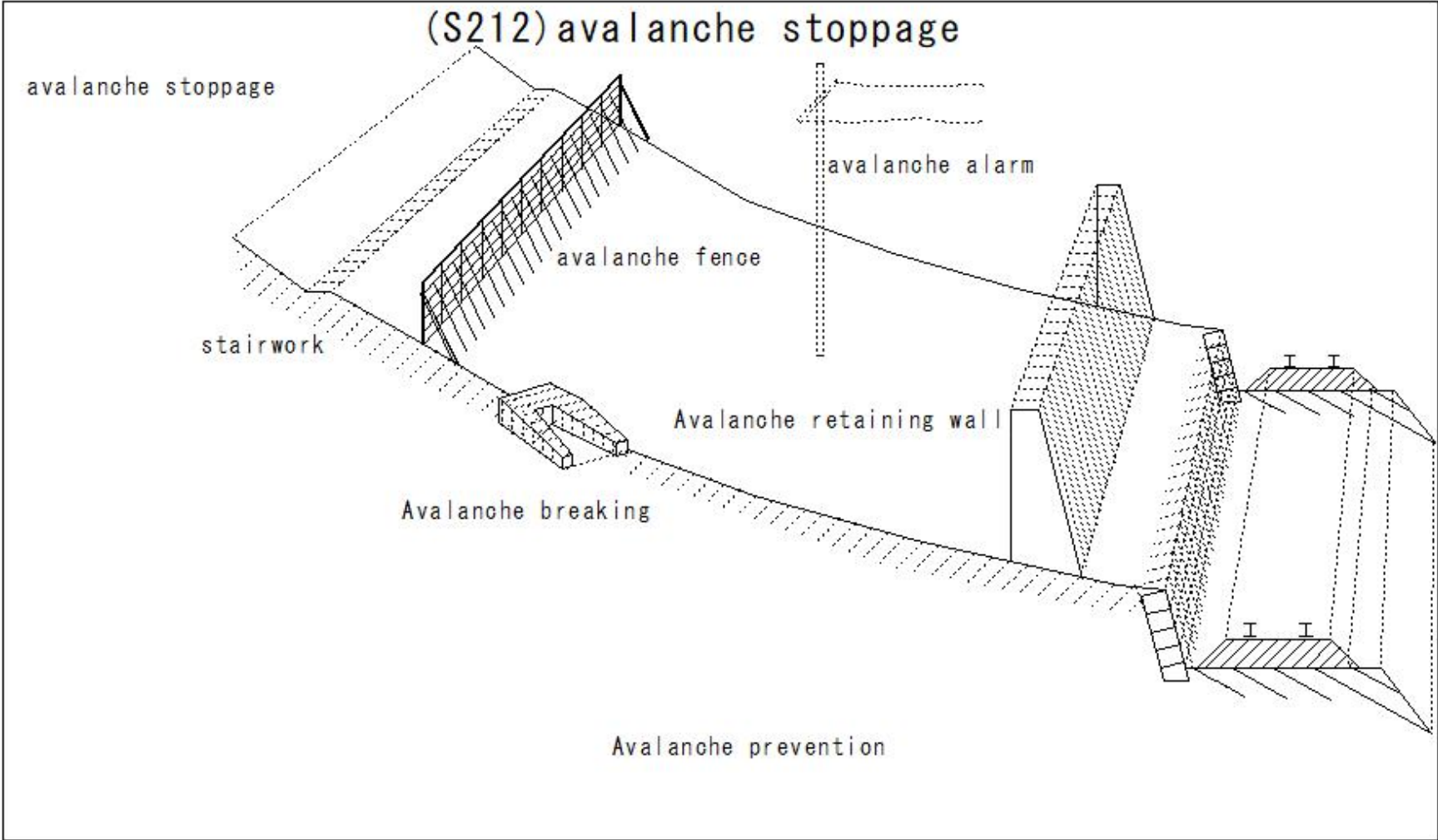
(S211) avalanche fence

avalanche fence



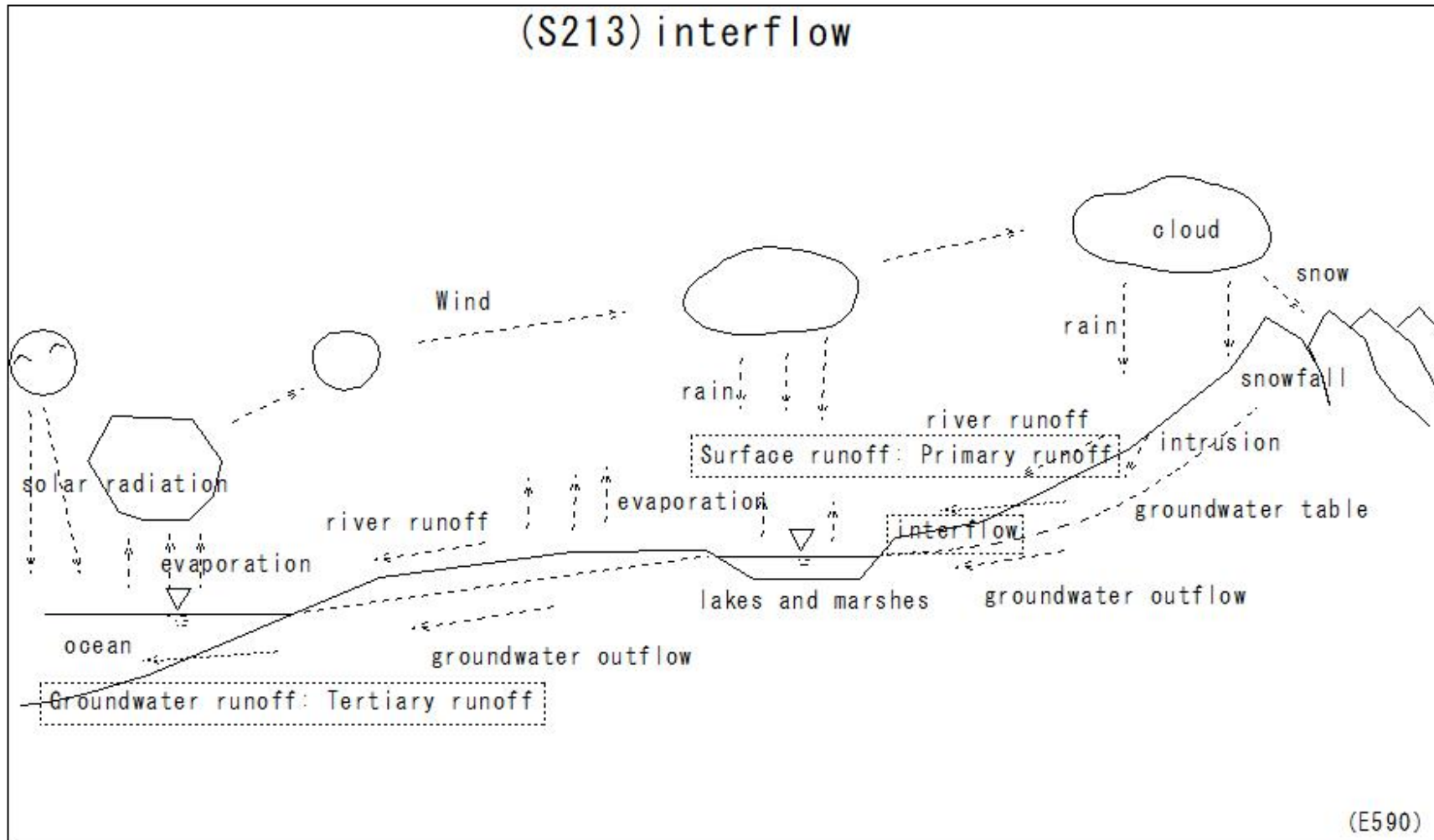
avalanche fence
Retaining wall work

(S212)avalanche stoppage



(S213)interflow

(S213) interflow



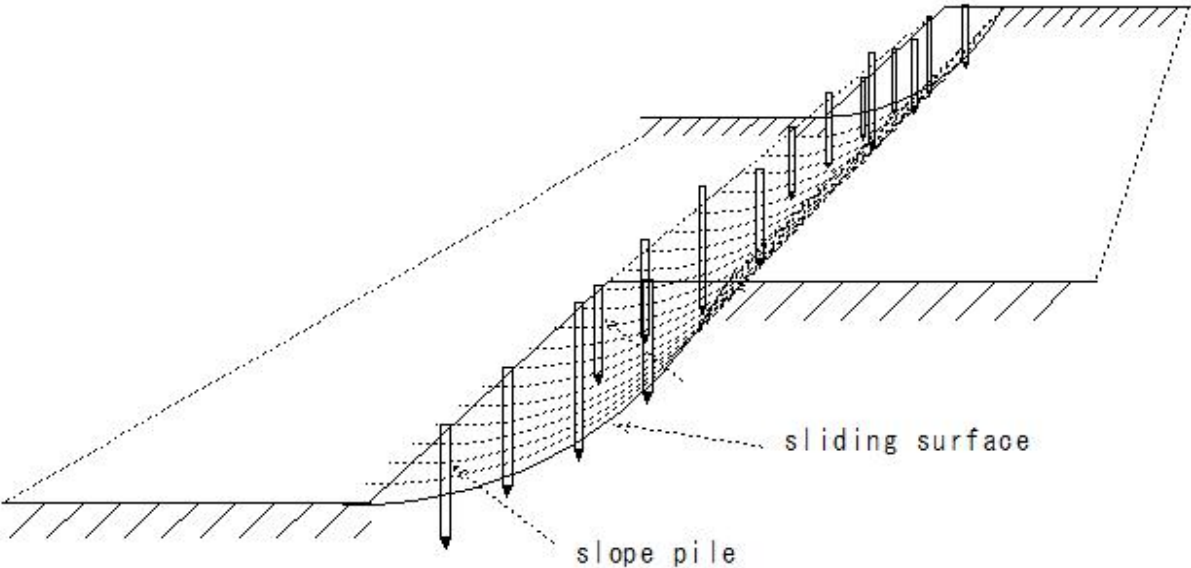
(S214)stability of the slope(slope pile)

(S214)stability of the slope(slope pile)

slope pile

Driving piles to strengthen the stability of the slope

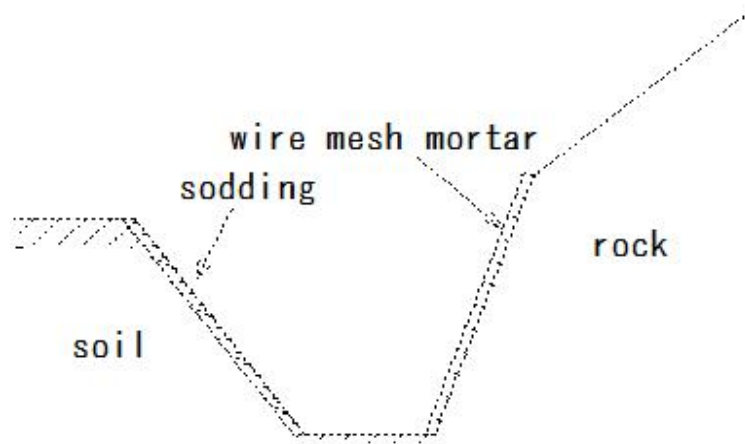
Penetrate the sliding surface



(S215)slope protection

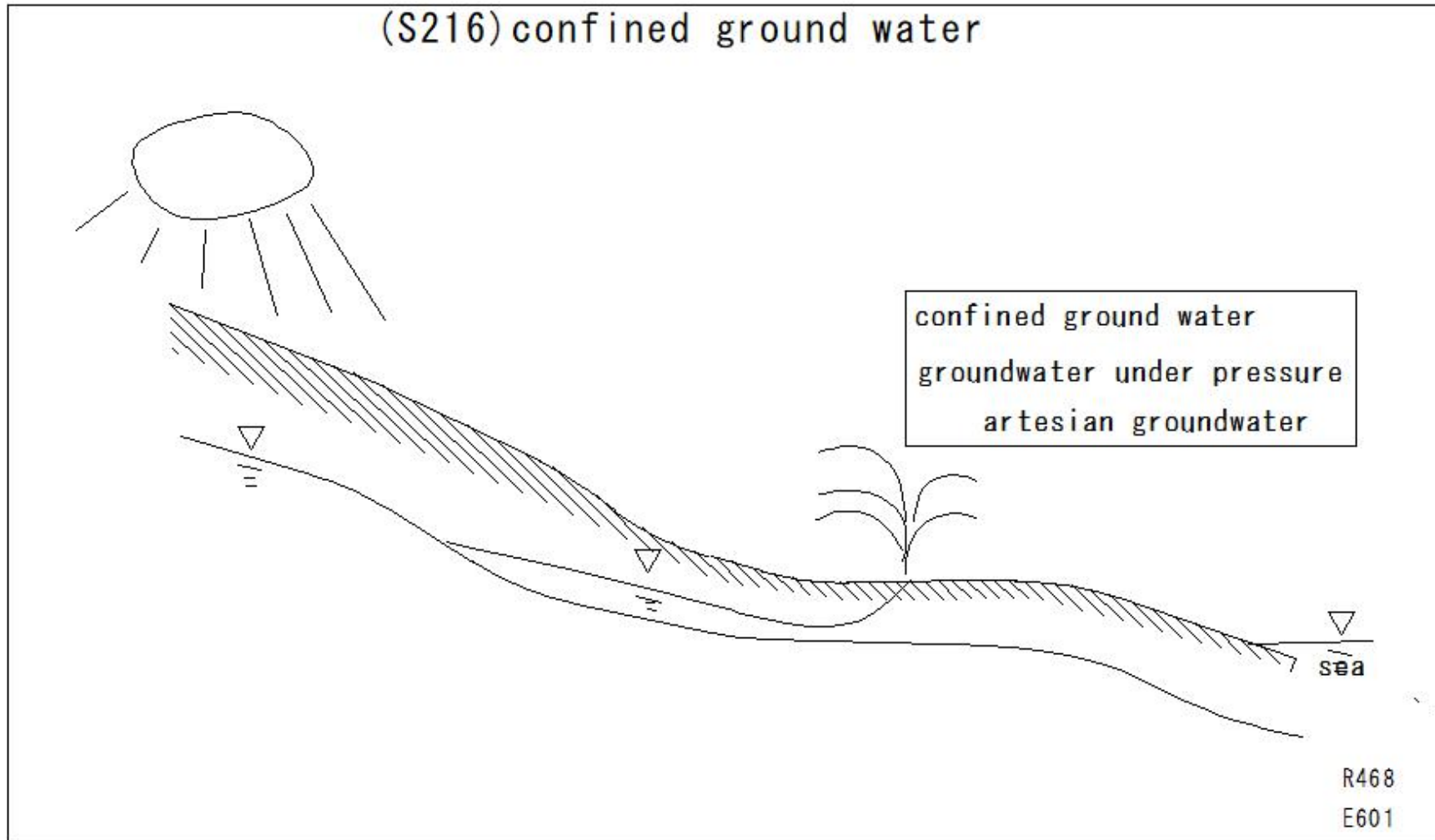
(S215) slope protection

slope protection



(S216)confined ground water

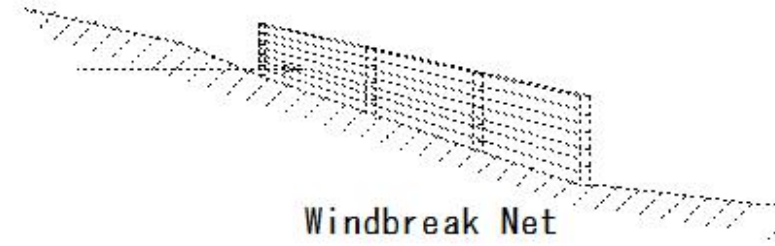
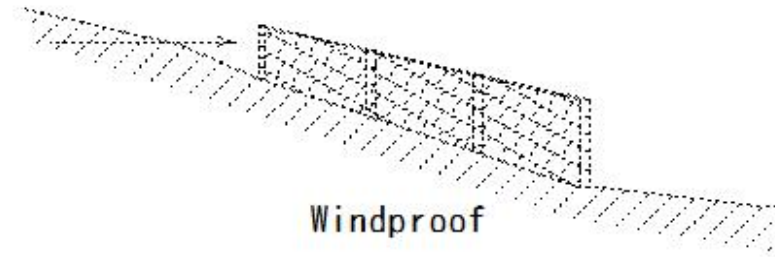
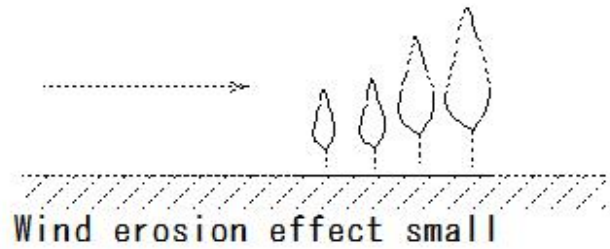
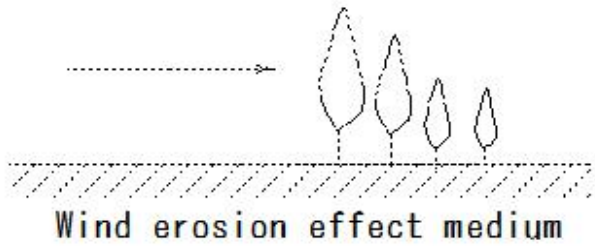
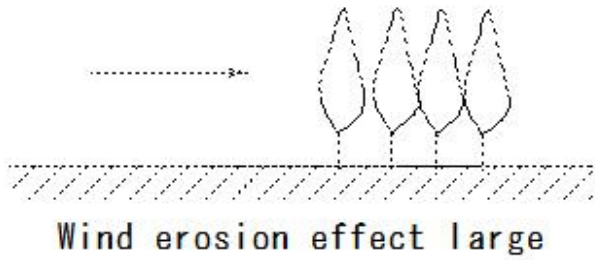
(S216)confined ground water



(S217)wind erosion control

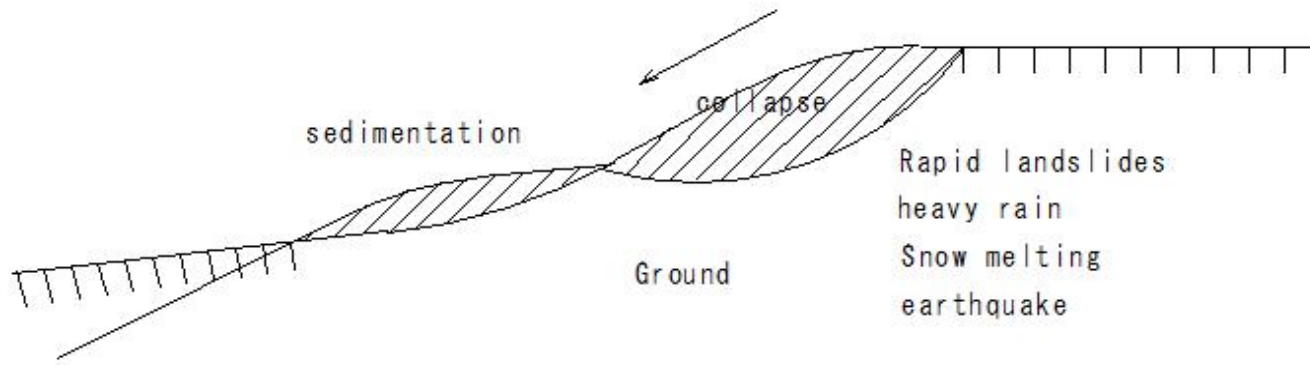
(S217)wind erosion control

Wind erosion prevention method



(S218)landslide

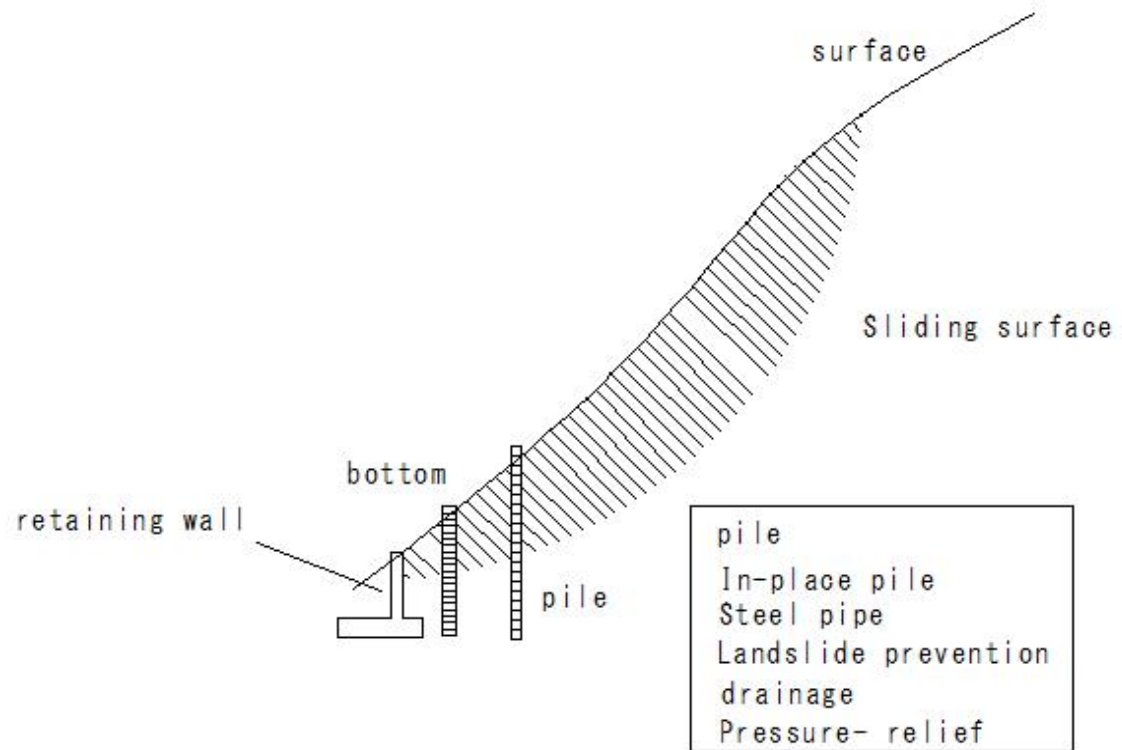
(S218) landslide



E631

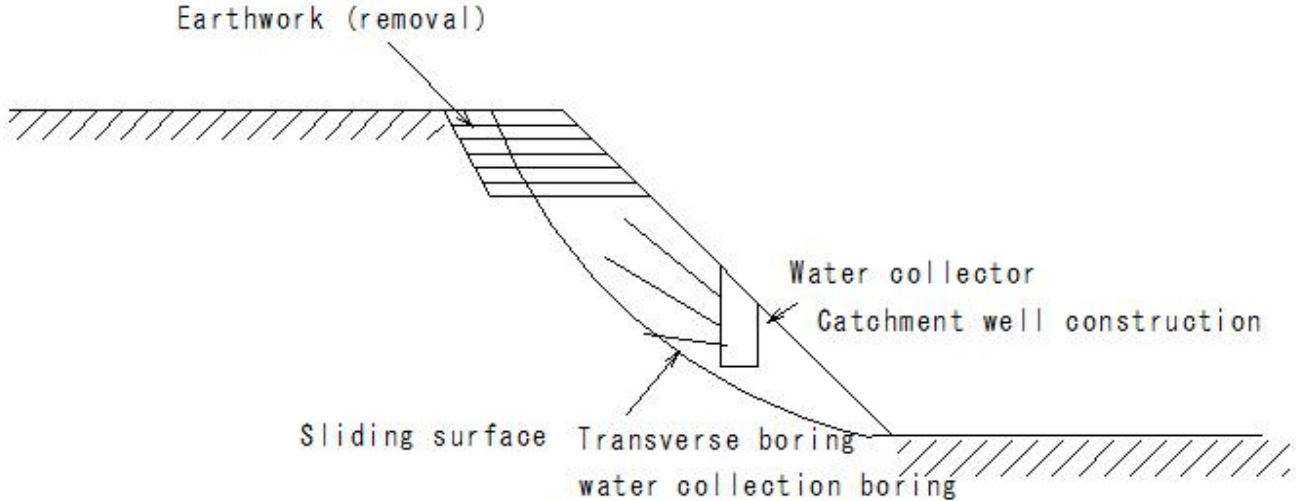
(S219) landslide restraining works

(S219) landslide restraining works



(S220) landslide control works

(S220) landslide control works



Causes of landslides - eliminating water

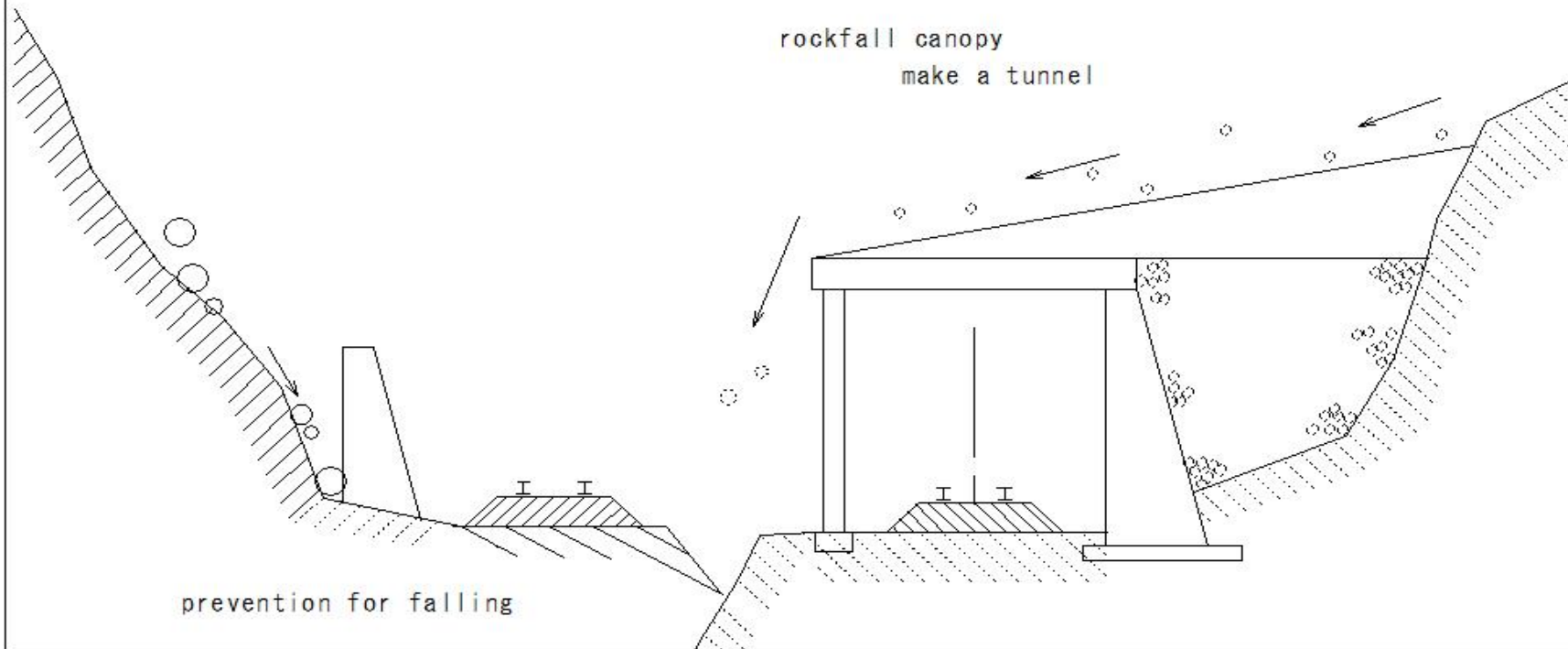
(S221)prevention for falling

(S221)prevention for falling

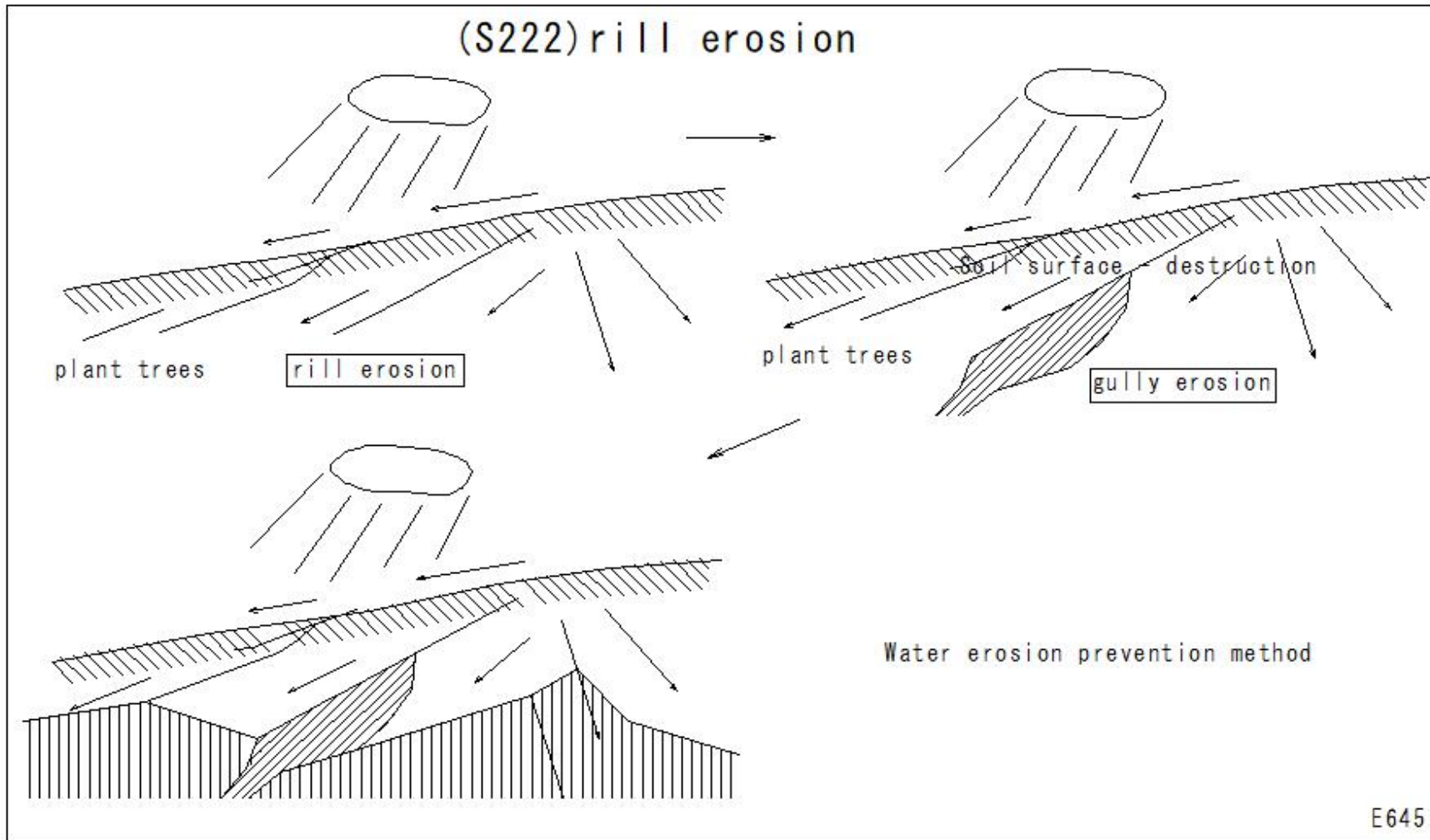
protection from falling rocks

rockfall canopy
make a tunnel

prevention for falling



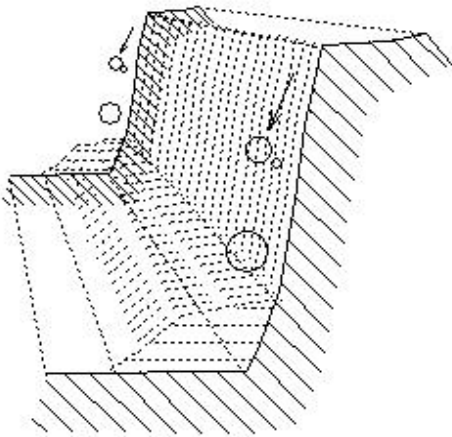
(S222)rill erosion



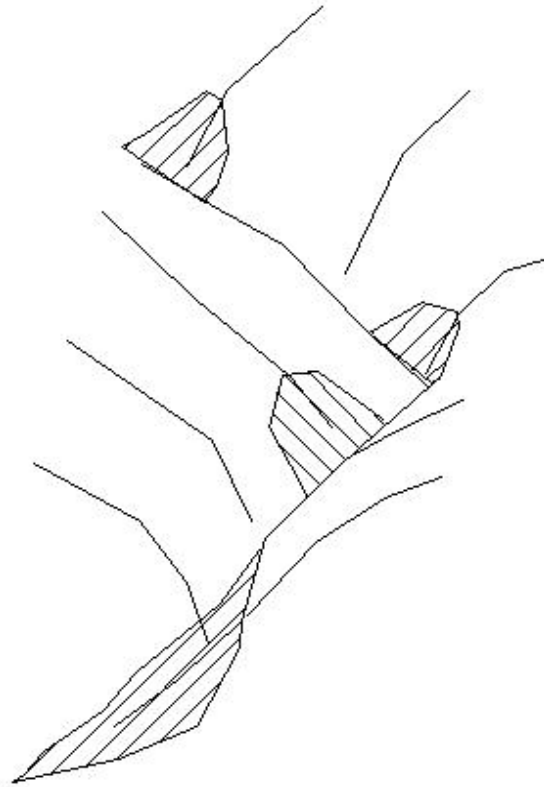
(S223)landslide

(S223) landsl ide

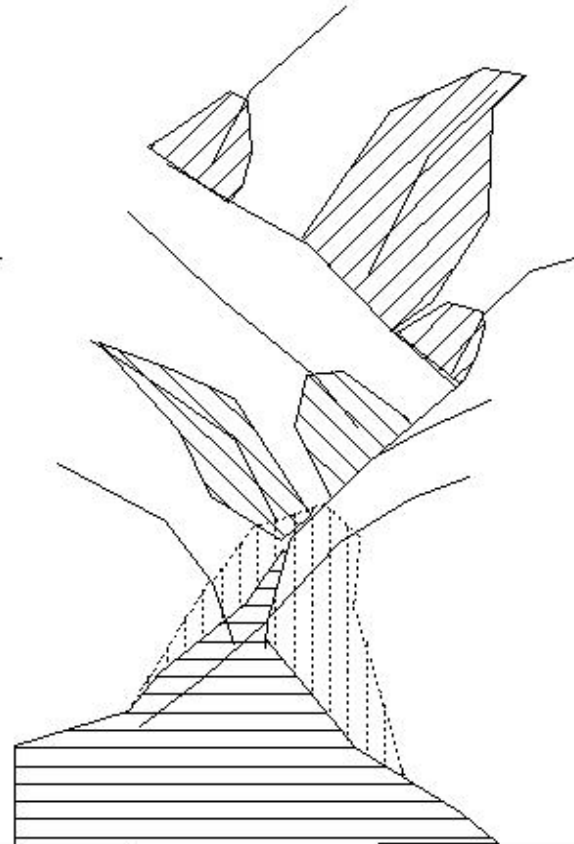
landslide



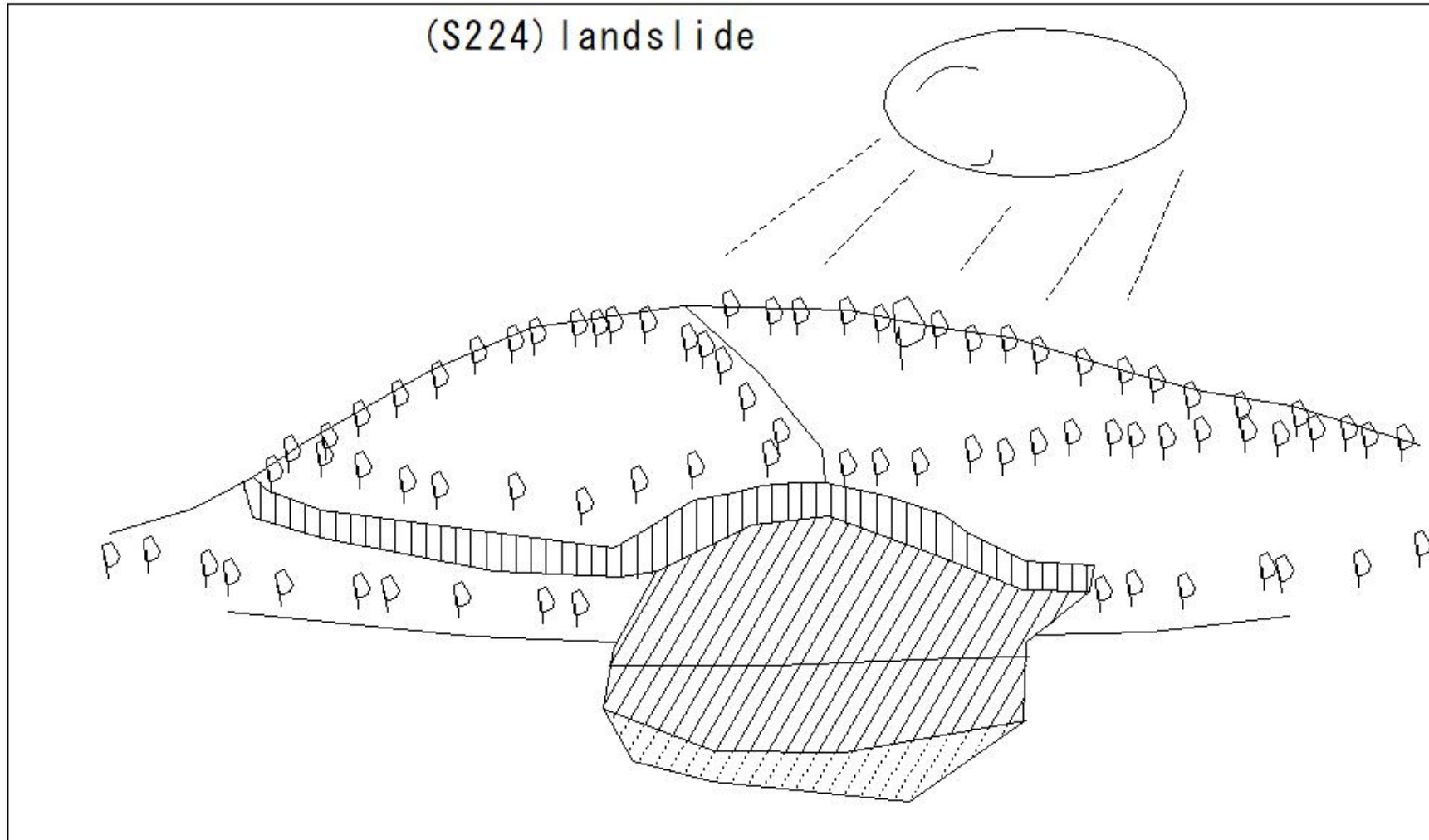
landslide



avalanche of sand and stone



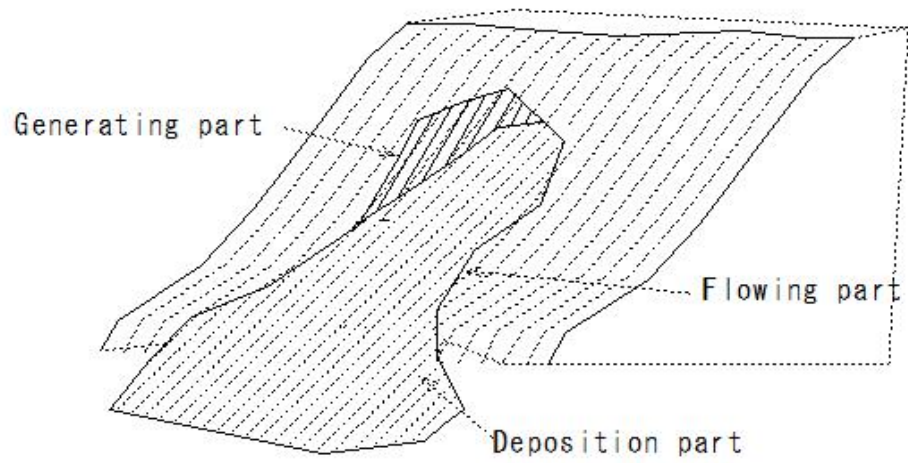
(S224) landslide



(S225)landslide

(S225) landslide

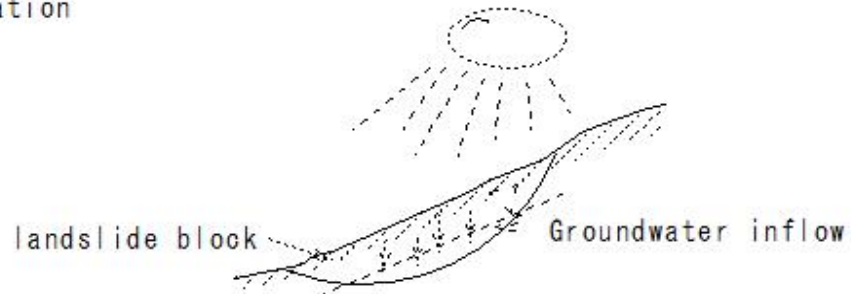
landslide



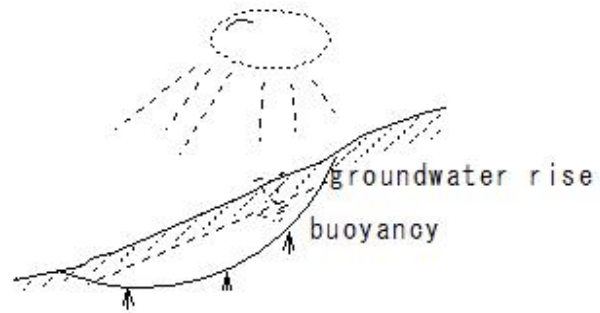
(S226) landslide

(S226) landslide

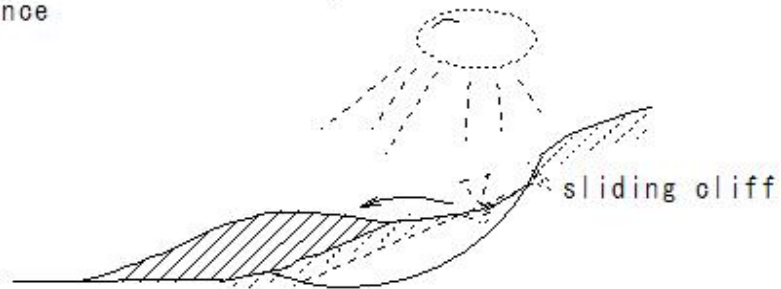
① Rainwater penetration



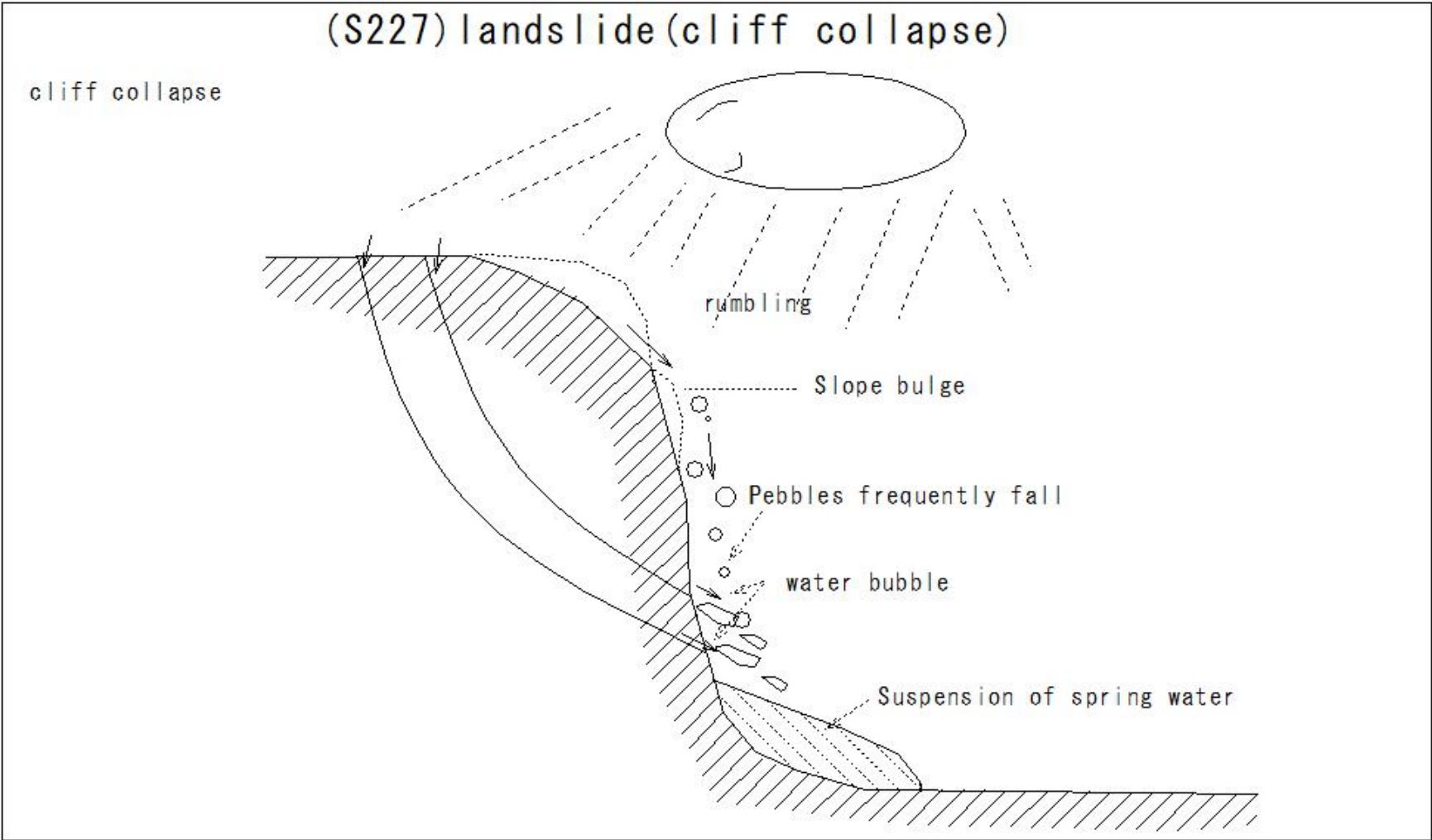
② Rise in groundwater



③ Landslide occurrence



(S227) landslide (cliff collapse)



(S228)landslide(cliff collapse)

(S228) landslide (cliff collapse)

cliff collapse

collapse of steep slopes

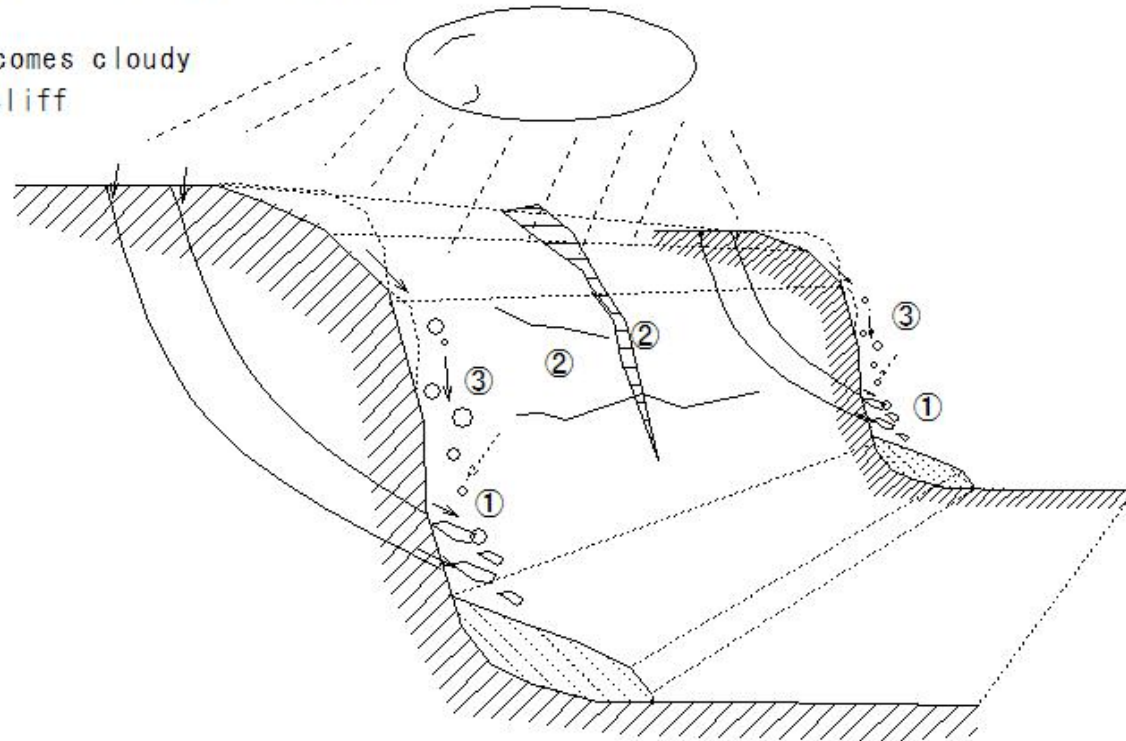
• Reduced resistance between underground water and soil
Slopes suddenly collapse due to rain and earthquakes

• Premonition phenomenon

① Water from the cliff becomes cloudy

② A crack appears in the cliff

③ Pebbles fall



(S229)avalanche of sand and stone(debris flow)

(S229) avalanche of sand and stone (debris flow)

avalanche of sand and stone (debris flow)

Mountain stream: Stones and sediment on the riverbed are damaged by long rains or torrential rains. swept downstream at once

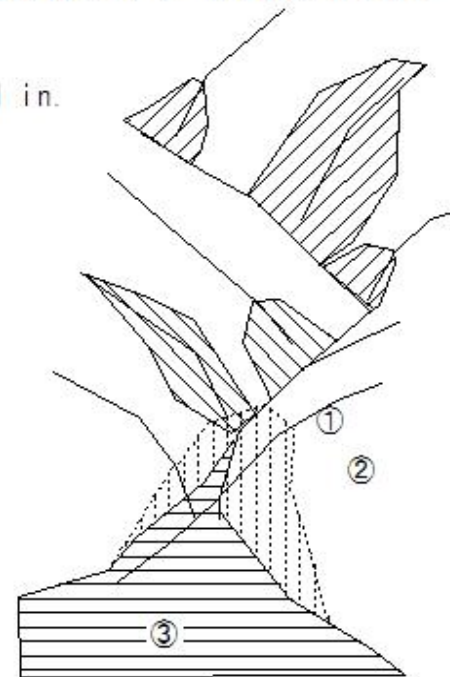
• Premonition phenomenon

① Mountain sound

② River water level falls

③ The river flow becomes muddy and driftwood is mixed in.

avalanche of sand and stone



S223

(S230) landslide

(S230) landslide

landslide

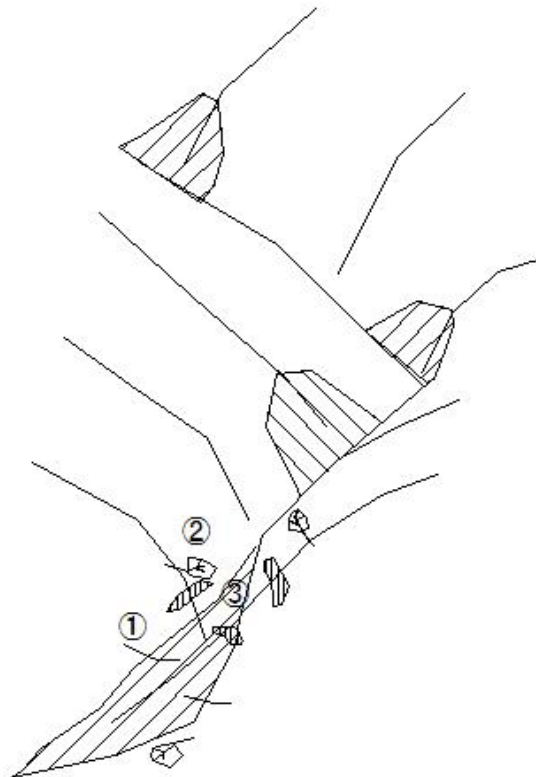
Part of the slope (front part) moves down the slope due to the influence of groundwater and gravity

• Premonition phenomenon

① Cracks and steps occur in the ground

② Trees fall down

③ Water gushes out from the slope

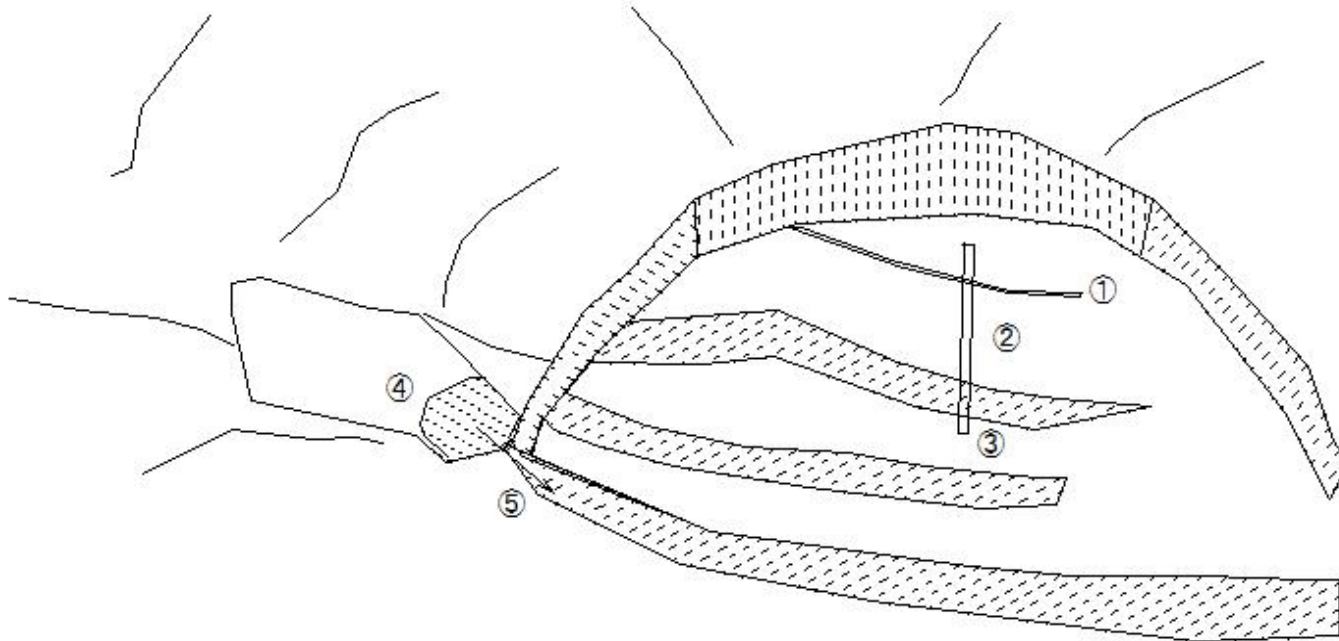


(S231)landslide

(S231) landslide

landslide

- ① Irrigation canal disruption
- ② Paddy field - water is not collected
- ③ Road - Unusable
- ④ River - Sediment is deposited
- ⑤ Dammed earth and sand - avalanche of sand and stone (debris flow)

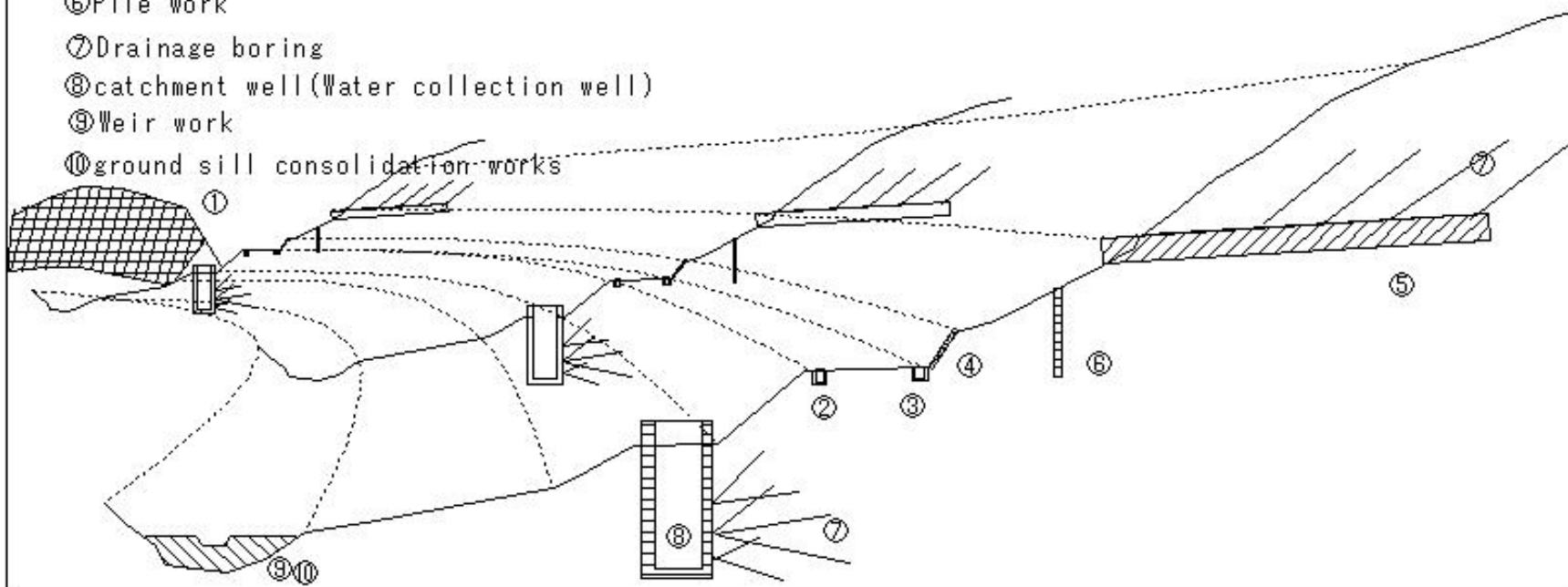


(S232)Landslide prevention works

(S232)Landslide prevention works

Landslide prevention works

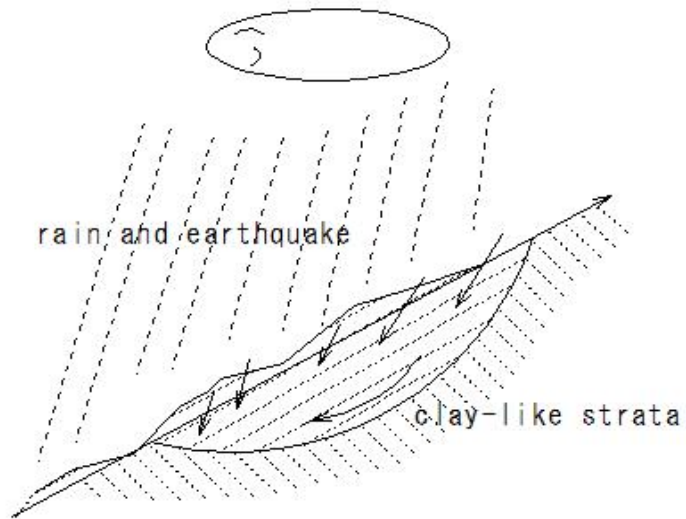
- ①Anchor work
- ②Waterway
- ③Drainage channel
- ④Retaining wall work
- ⑤Drainage tunnel construction
- ⑥Pile work
- ⑦Drainage boring
- ⑧catchment well(Water collection well)
- ⑨Weir work
- ⑩ground sill consolidation works



(S233)Landslide prevention works

(S233)Landslide prevention works

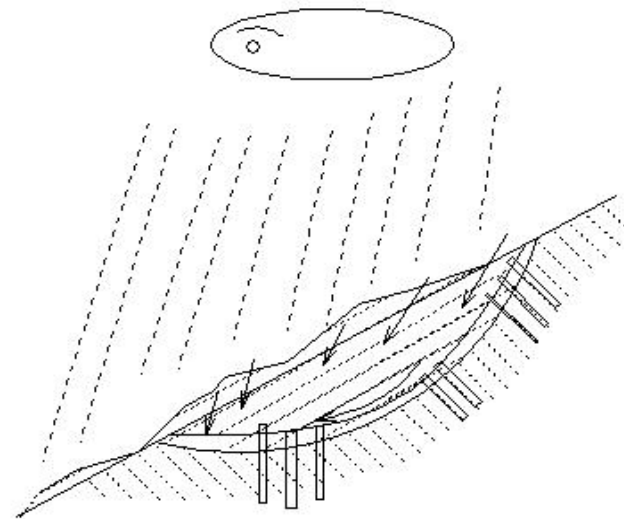
Landslide prevention works



rain and earthquake

clay-like strata

The entire ground begins to slide

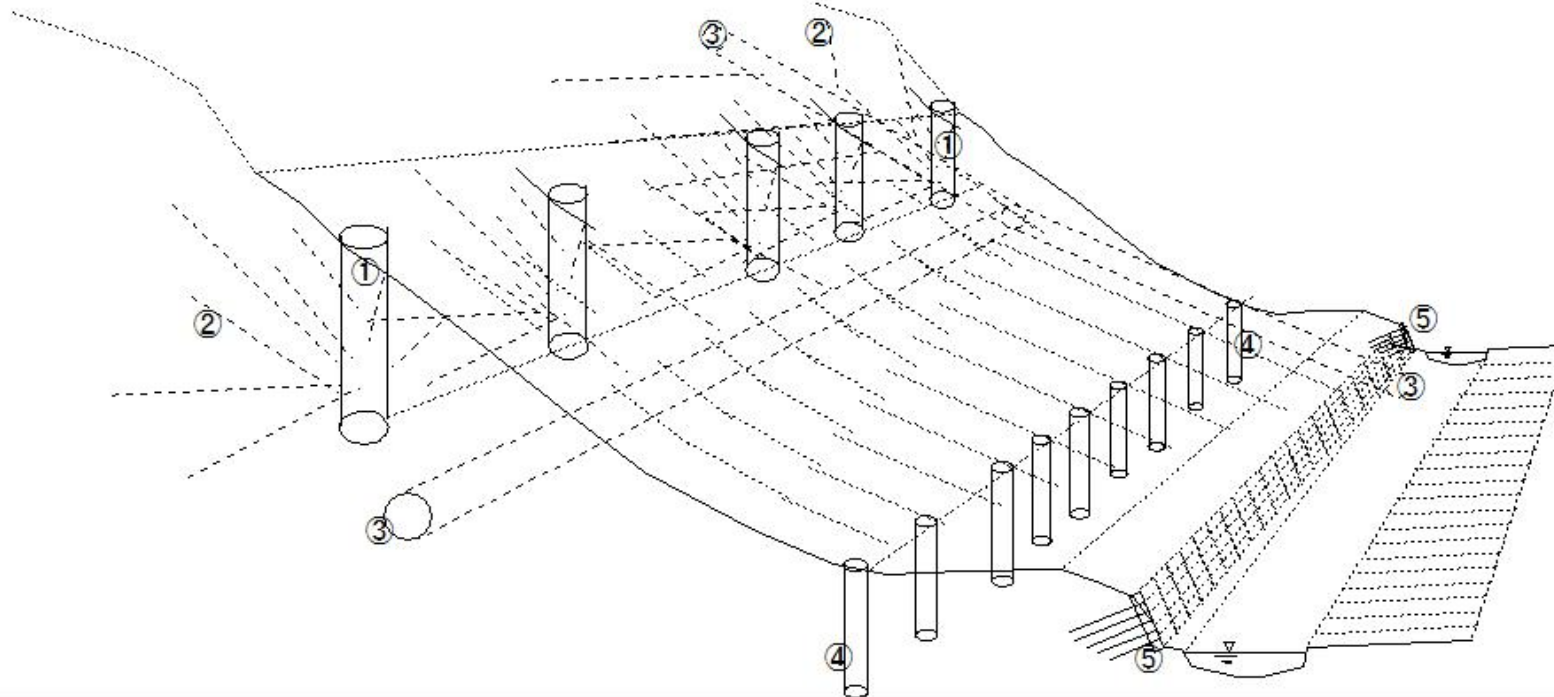


(S234)Landslide prevention works

(S234)Landslide prevention works

Landslide prevention works

- landslide control works to drain groundwater from underground and increase safety
landslide control works (①catchment wells, ②catchment borings, ③drainage tunnels)
directly stop the movement of the landslide with force.
- landslide restraining works(④deep foundation work, ⑤anchored slope work)

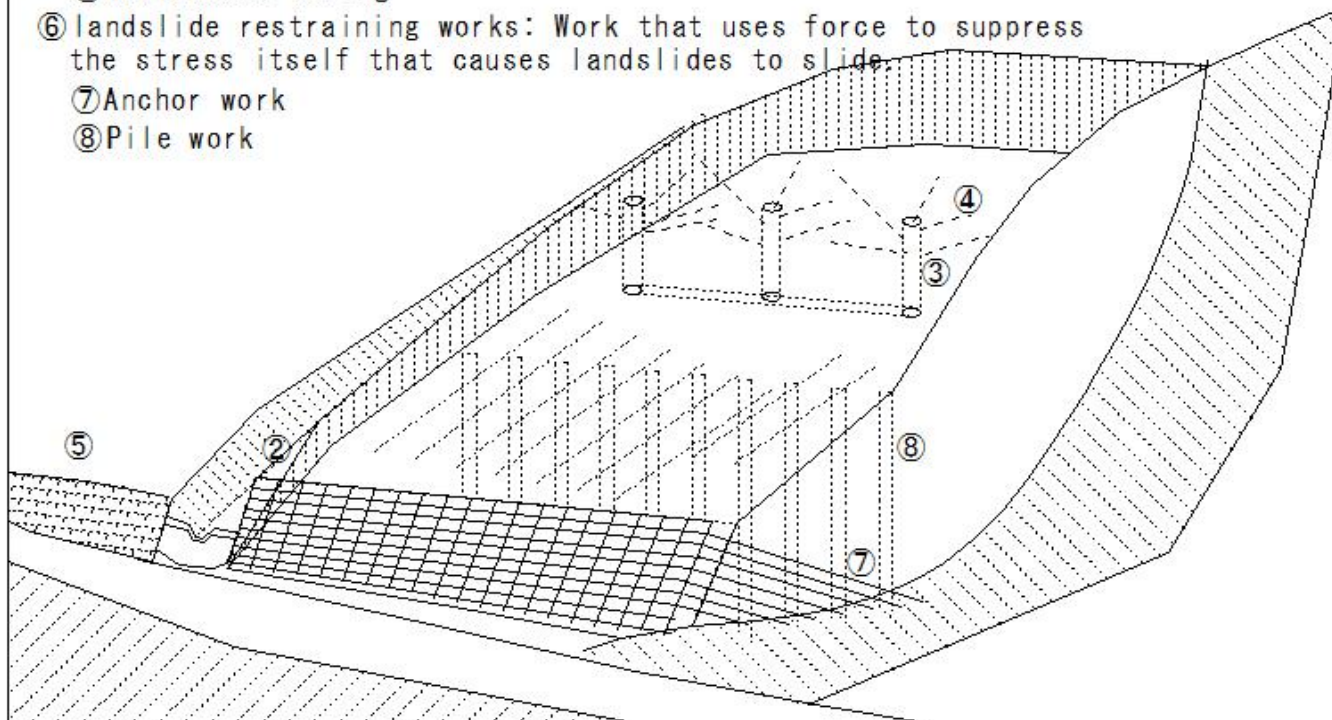


(S235)Landslide prevention works

(S235)Landslide prevention works

Landslide prevention works

- ① landslide control works : Work to remove stress caused by topography, groundwater, etc.
- ② Surface drainage work
- ③ catchment well (Water collection well)
- ④ Horizontal boring
- ⑥ landslide restraining works: Work that uses force to suppress the stress itself that causes landslides to slide.
- ⑦ Anchor work
- ⑧ Pile work



(S236)Landslide prevention works

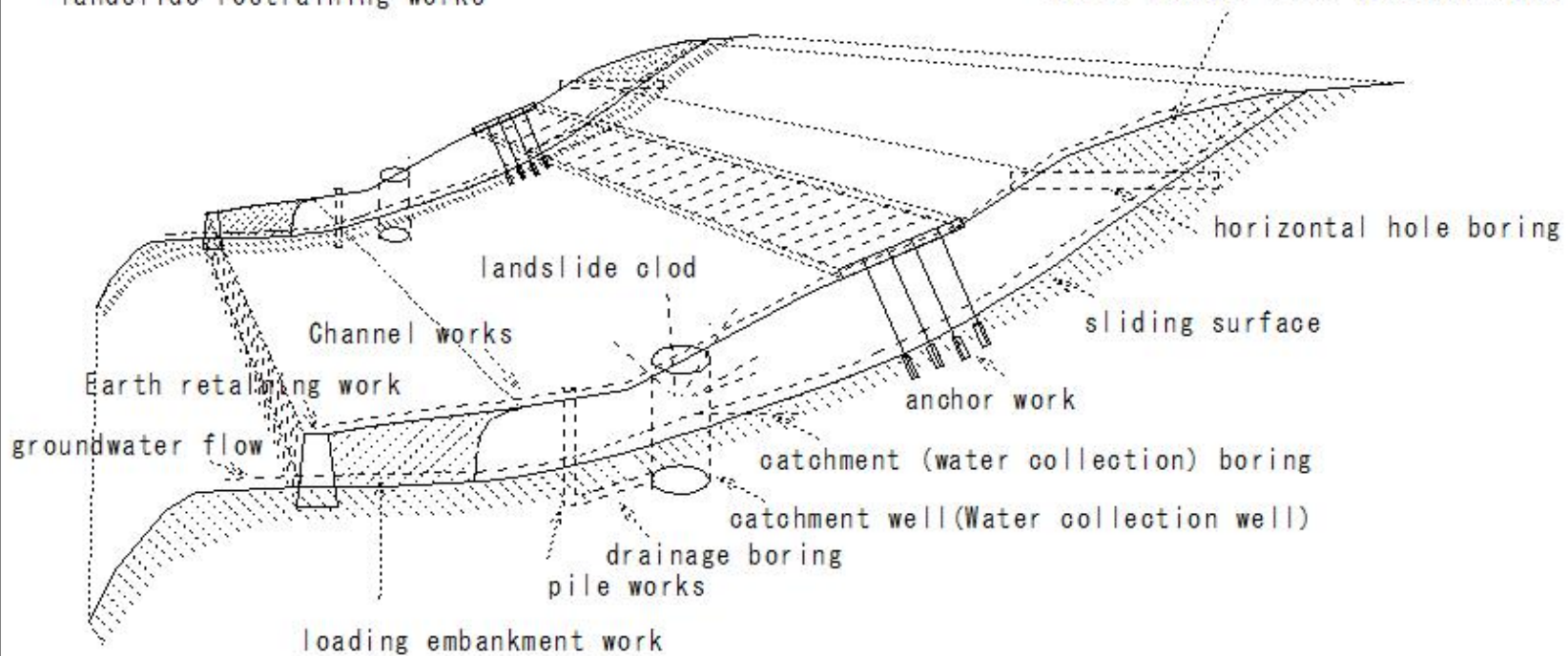
(S236)Landslide prevention works

Landslide prevention works

landslide control works

landslide restraining works

Earth removal work (cutting work)



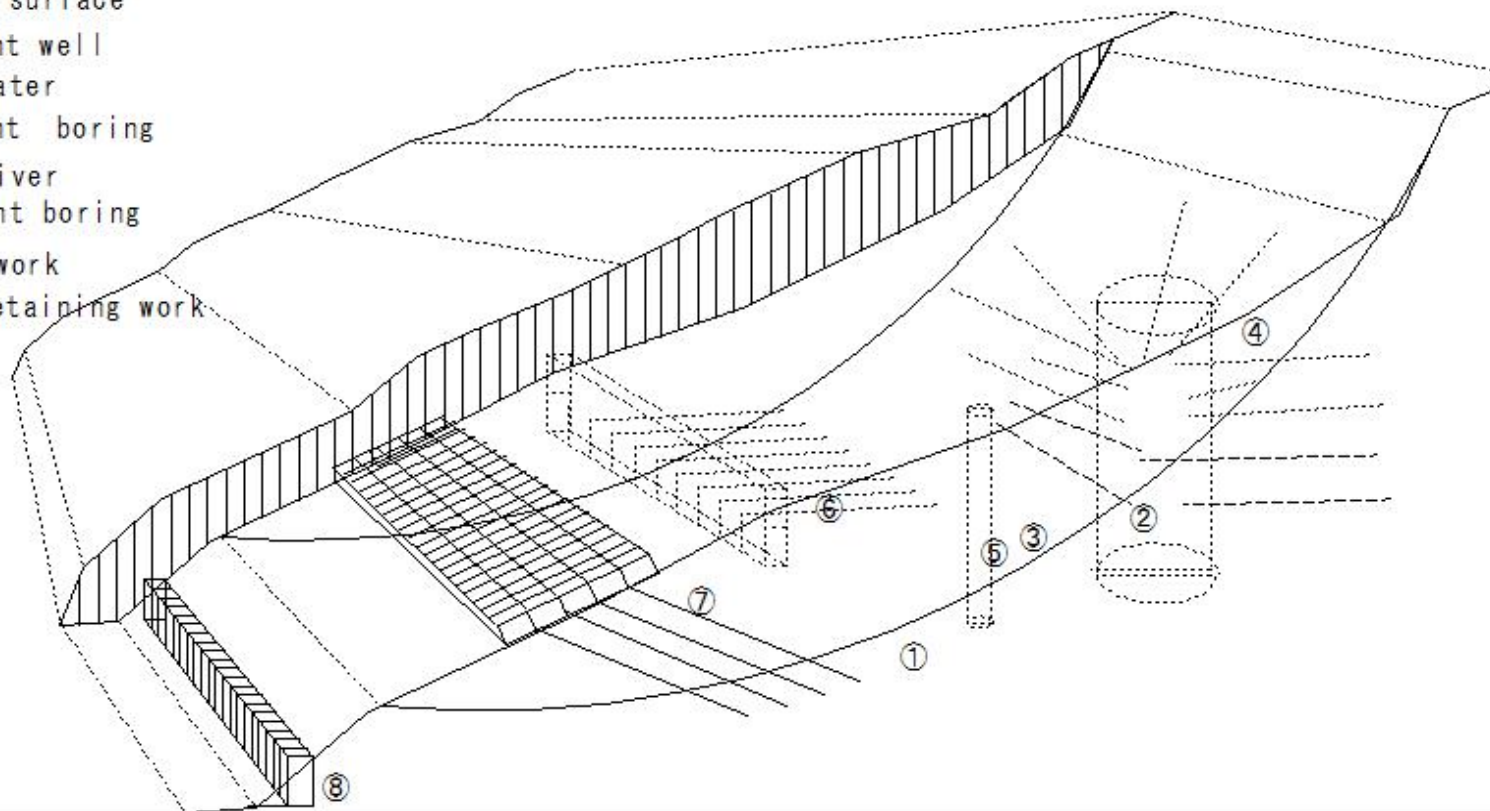
(S237)Landslide prevention works

(S237)Landslide prevention works

Landslide prevention works

Restoration work

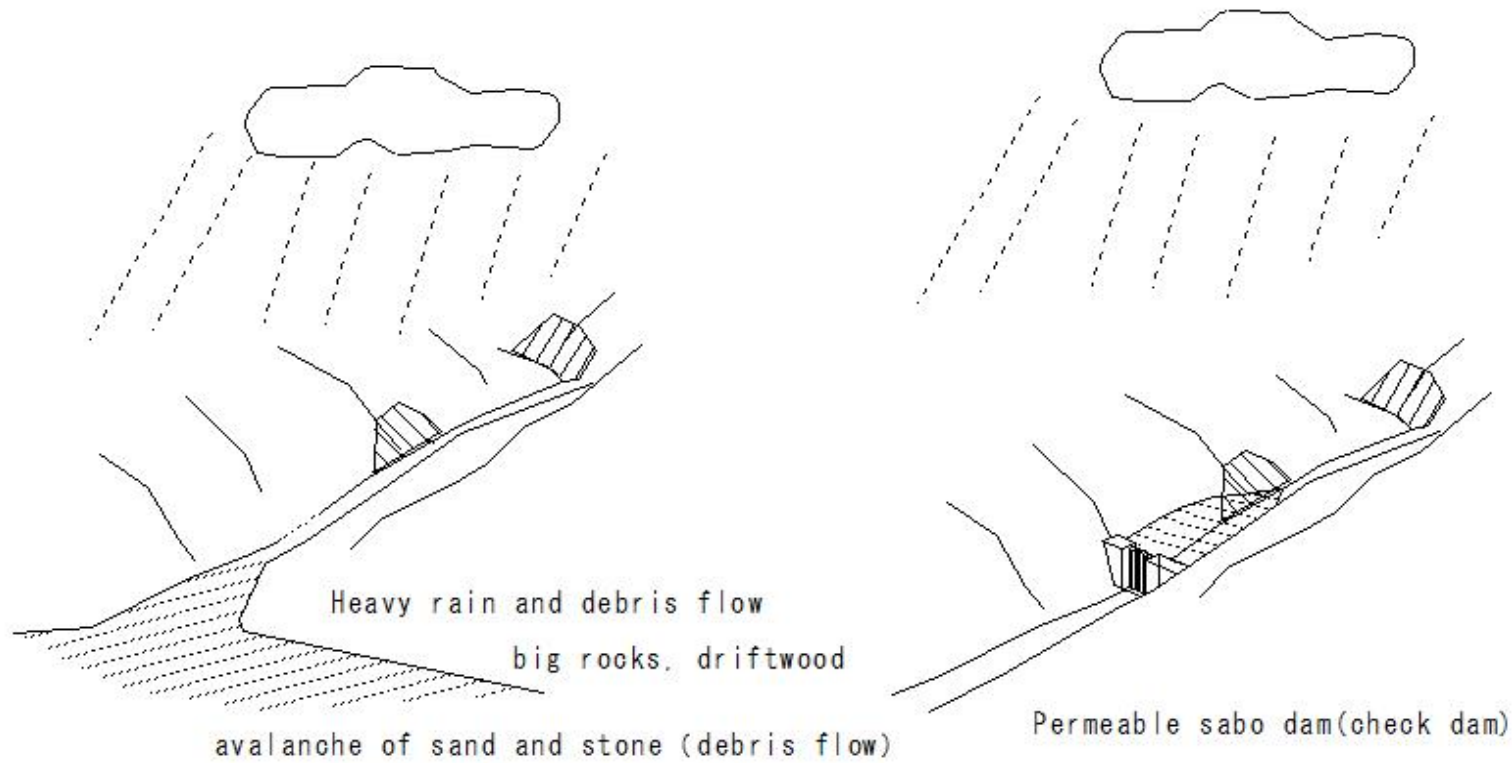
- ① sliding surface
- ② catchment well
- ③ Groundwater
- ④ catchment boring
- ⑤ pile driver
- ⑥ catchment boring
- ⑦ anchor work
- ⑧ Earth retaining work



(S238)Permeable sabo dam(check dam)

(S238) Permeable sabo dam(check dam)

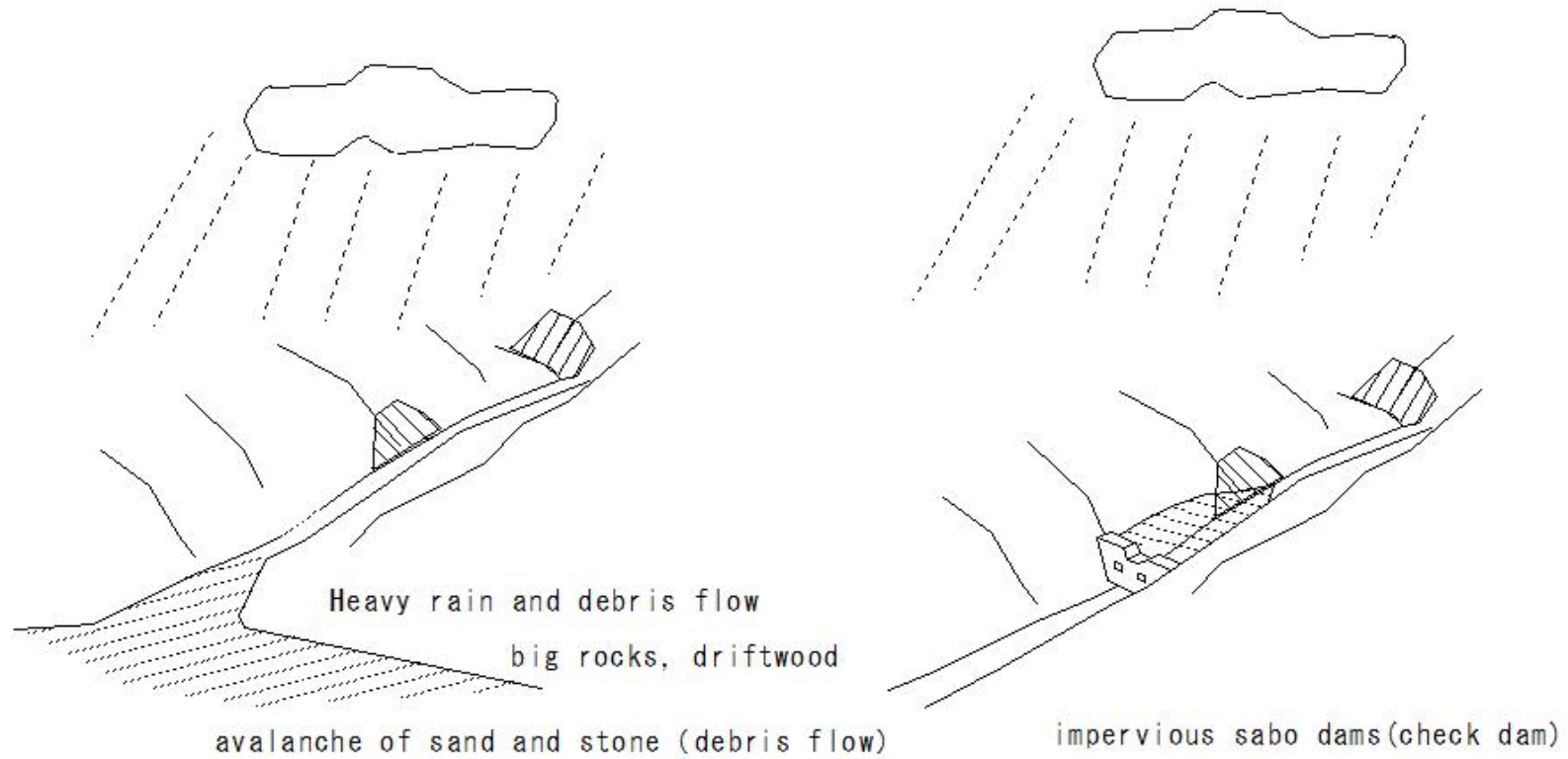
Function to catch avalanche of sand and stone (debris flow)



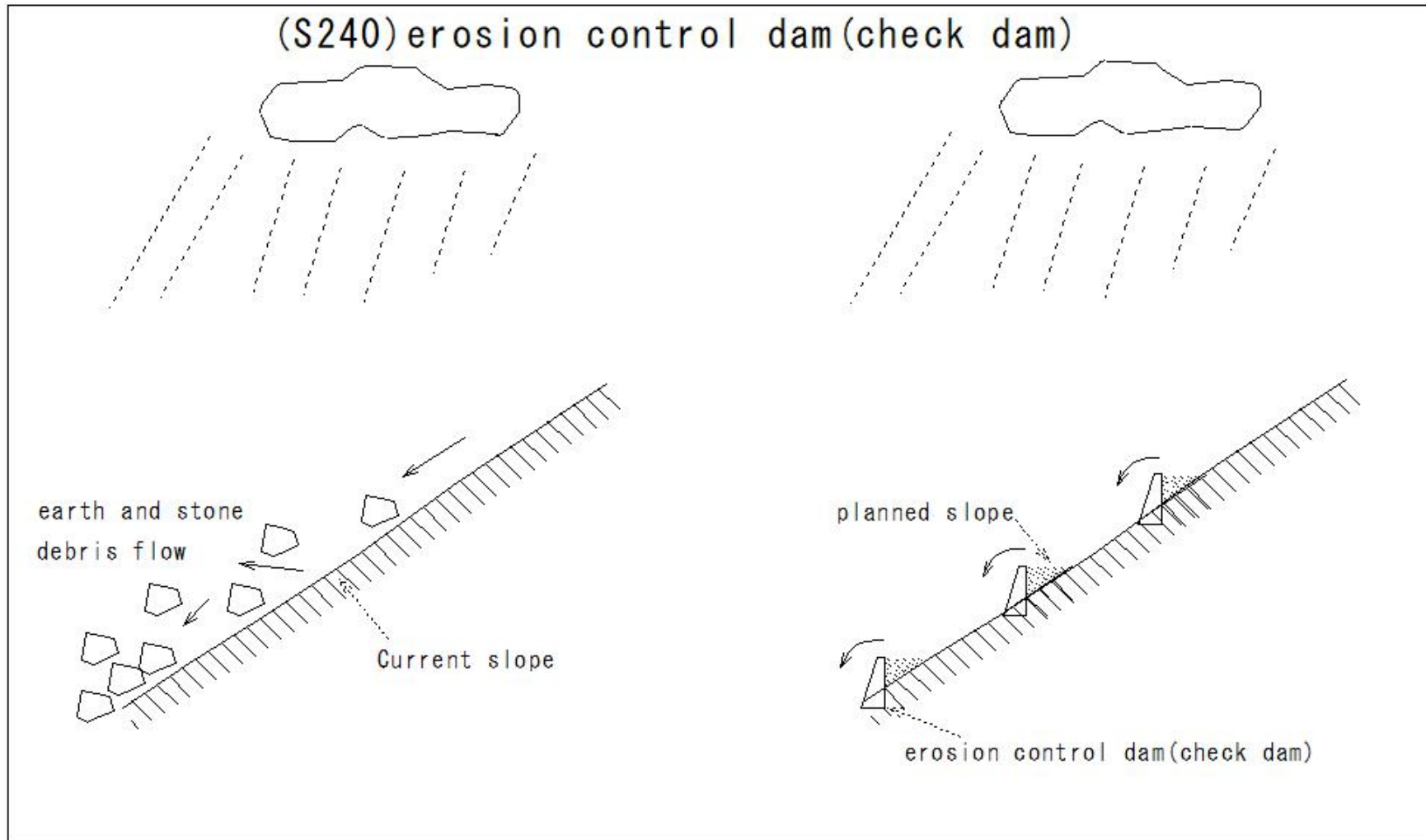
(S239) impervious sabo dams(check dam)

(S239) impervious sabo dams(check dam)

Function to catch avalanche of sand and stone (debris flow)



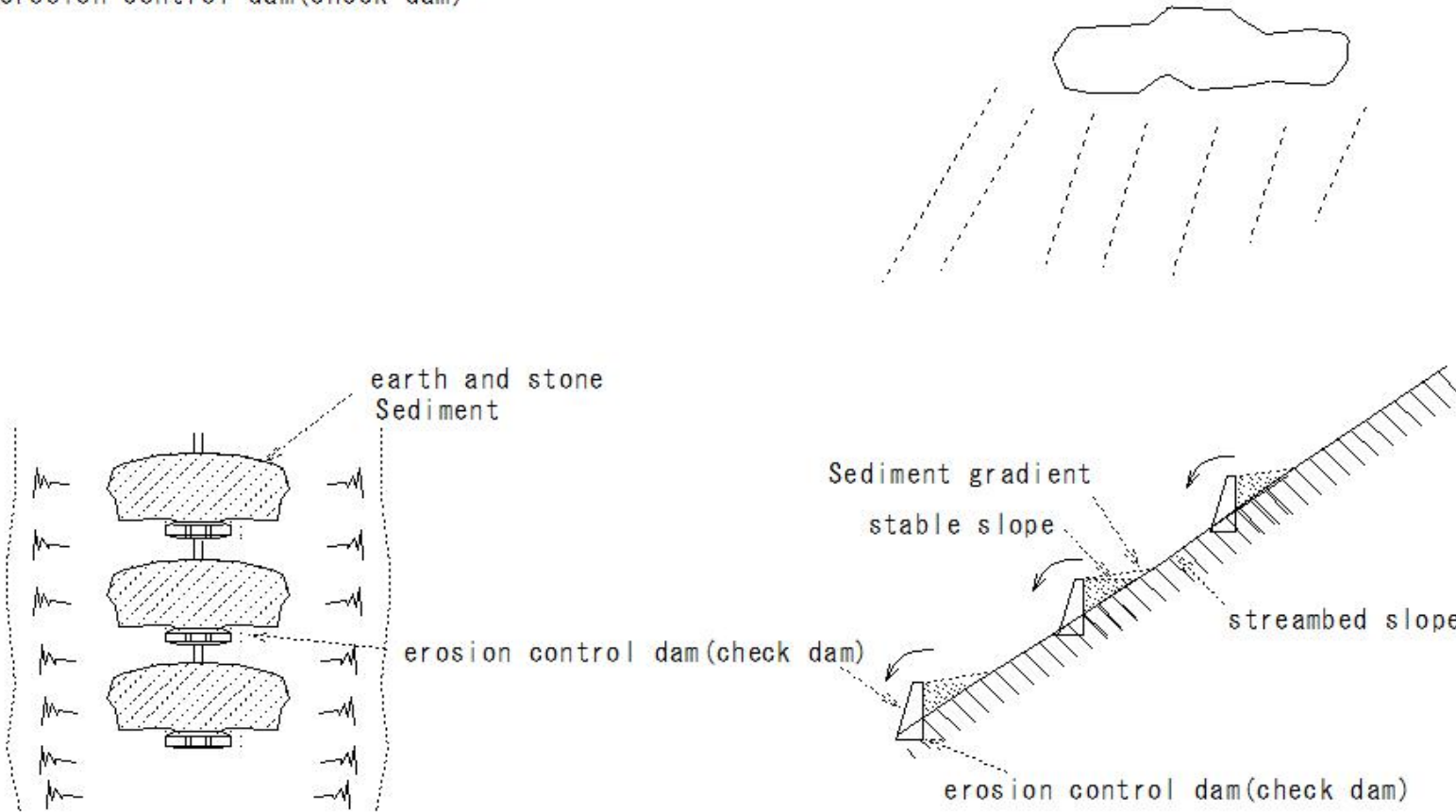
(S240)erosion control dam(check dam)



(S241)erosion control dam(check dam)

(S241)erosion control dam(check dam)

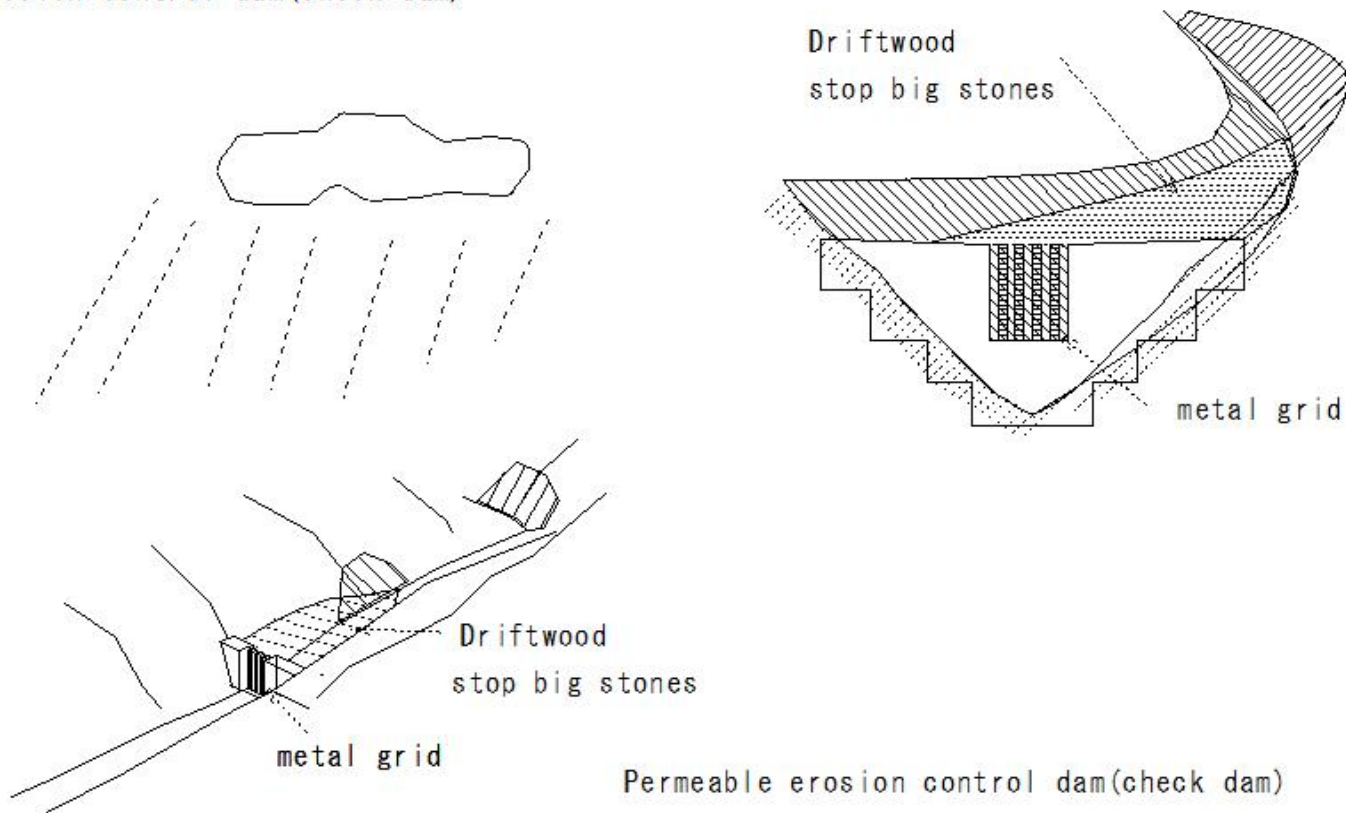
erosion control dam(check dam)



(S242)erosion control dam(check dam)

(S242)erosion control dam(check dam)

Permeable erosion control dam(check dam)



S28
S238

(S243)erosion control dam(check dam)

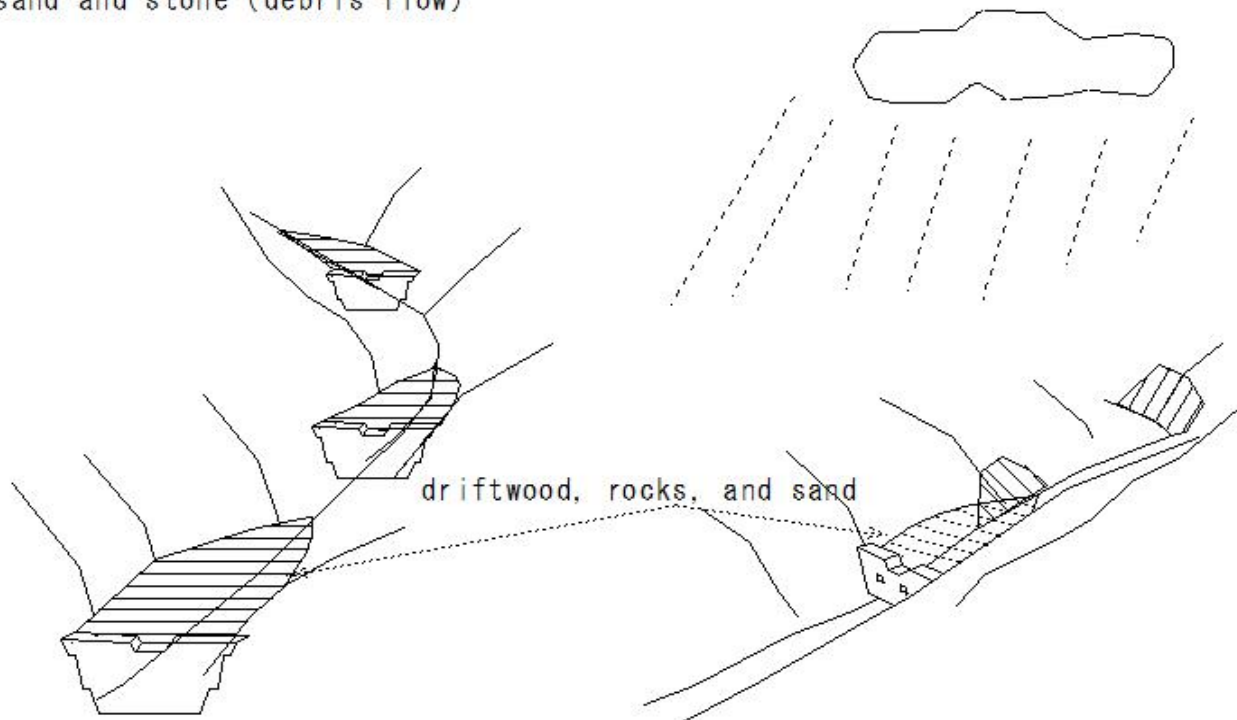
(S243)erosion control dam(check dam)

impervious sabo dams(check dam)

Possibility of floating driftwood crossing the dam

Collect driftwood, rocks, and sand

avalanche of sand and stone (debris flow)

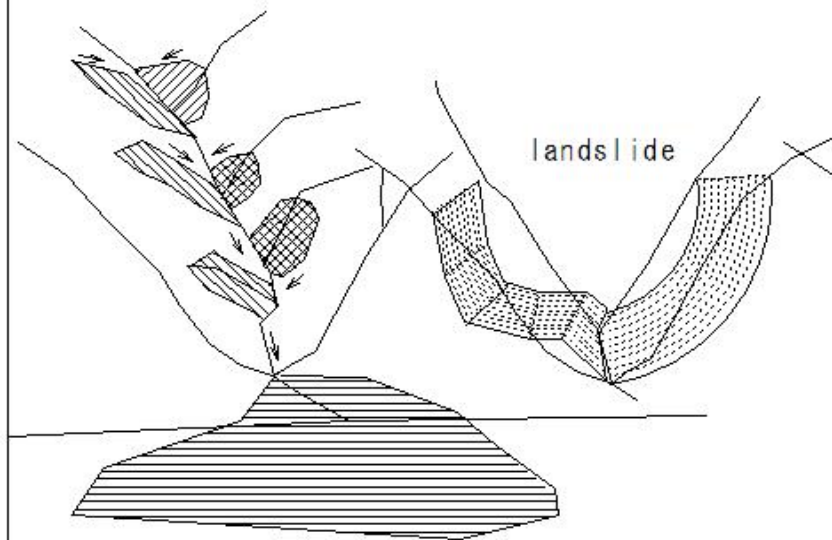


impervious sabo dams(check dam)

S130
S239

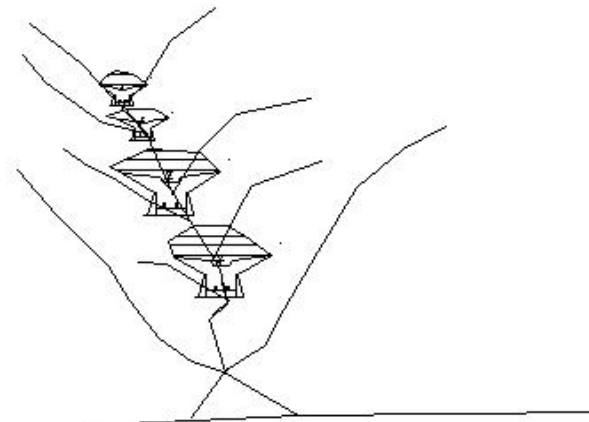
(S244)erosion control dam(check dam)

(S244)erosion control dam(check dam)



avalanche of sand and stone

Before construction



erosion control dam(check dam)

After construction