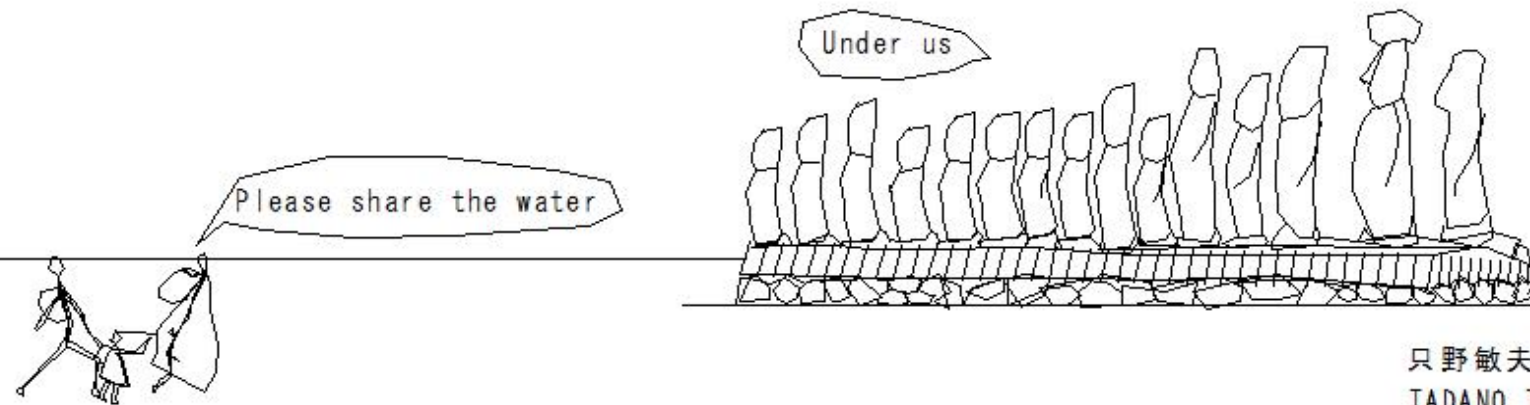


(27)Irrigation(Illustration) in Africa(350-817)

(27)Irrigation(Illustration) in Africa(350-817)

Moai of Easter Island

Moai are monolithic human figures carved by the Rapa Nui people on Rapa Nui in eastern Polynesia between the years 1250 and 1500



只野敏夫
TADANO TOSHIO

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Tadano Toshio

(I350)Shallow well
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(I352)Dam(Earth dam)
(I353)Border lot(Ridge area)
(I354)Arch Dam
(I355)Amenity
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(I357)Culvert Drainage
(I358)Stabilization work
(I359)Stone Dyke
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(I375)Fill in(Backfilling)
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(I379)carrying operation
(I380)Groin towards up stream
(I381)Circle of influence
(I382)Sensitivity ratio
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Shallow well
Dam(Earth dam)
Dam(Earth dam)
Border lot(Ridge area)
Arch Dam
Amenity
RCD method
Culvert Drainage
Stabilization work
Stone Dyke
Stone masonry
Rock Crib Work
Stone Pitching Work
Dam(potential head)
Sodding
Embankment
Well point method
Wash Load
Pumice-stone(Floating stones)
Skelton
Groin(skeleton)
Sewerage(storm outfall(Rainwater outlet))
Sewerage(street inlet(Rainwater basin))
Furrow irrigation
Fill in(Backfilling)
Fill in(Backfilling)
Vertical frame
Slope protection(backing mat method)
Water supply and sewerage(rain gauge)
carrying operation
Groin towards up stream
Circle of influence
Sensitivity ratio
liquefaction

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(I389)Deversoir(overflow)
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(I415)Graded condition of river
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Flood Irrigation(Overflow irrigation)
Groin over the water
Overflow weir
Deversoir(overflow)
Apron
Pressed embankment
Surcharge process:Pressing embankment method
Overlay
Riverbed girdle
Open cut method
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lapel method
Orifice
Water supply
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Sea bottom reclamation (Sea surface reclamation)
Stop log
Estuary improvement
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Semi-permeable groin -wire cylinder masonry work(gabion)
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Embankment(raising)
Shape of river
Center of stream in the river
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Equilibrated grade of river
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River Law
Water supply(activated carbon method)

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Embankment(over compaction)
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River channel improvement
Movable weir(stop log)
Movable weir(Sluice gate)
Movable weir(Stoney Weir)
Movable weir(Rolling gate)
Movable weir(Tentergate)
Movable weir(Drum gate)
Movable weir(Overturning weir)
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Drainage method
Masonry (dry masonry)
Gully erosion
Culvert
Irrigation methods
Environmental Quality Standards
Environment irrigation water
Intermittent settling tank
Fishladder
Cavitation
Weir(notch)
Unscreened gravel
Embankment (wood sinking)
Strut
Pile dyke(groin)
Angle brace
Broken stone
Broken stone foundation
Group of piles
Estimated high-water level
Estimated high-water discharge
Design flood discharge

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(I469)Lake bottom or marsh bottom
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(I483)Hillside works
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(I485)Hillside covering works

Hydraulic radius
Border
Torrent control works
Field permeability test
Water supply(Elevated tank)
Field division(Cultivated area)
Flood control
Flood protection works
Embankment(major bed)
Flood control
Time of concentration of flood
Broad-crested weir
Gradient(Grade)
Ditch(Ditch-side border)
Bank protection
Heading
Lake bottom or marsh bottom
Lake bottom or marsh bottom
Fixed weir
Roller
Concrete pitching
Groin (concrete block groin)
Left bankright bank
Surge-tank
Differential surge-tank
Erosion control works
Triangular weir
Spray irrigation
Sand drain method
Sand pile
Hillside works
Hillside works
Mountainside slope cutter
Hillside covering works

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(I516)Intake dam
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(I518)Vadose water:Circulating water
(I519)Wetted perimeter

Square weir
Levee burst prevention (hurdle work)
Hurdle work(bank protection work)
Tributary
Automatic water gauge
Axial flow pump
Land slide
Natural head
Natural drainage system
Downward groin
Gross pump head
Control section
Bank protection(sodding works)
Self closing tap
Cofferdam
Closing dyke
Wire cylinder(gabion)
Wire cylinder(gabion)
Natural Ground
Slope failure
Supercritical flow(shooting flow /rapid flow)
Boat way
Catchment well(Drainage well)
Infiltration gallery
Free outflow
Gravity water
Gravity dam
Water-intake
Intake
Intake dam
Intake dam
Circular society
Vadose water:Circulating water
Wetted perimeter

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(I551)Scoop
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(I553)Riprap work

Water supply (clean water(Purified water))
Water supply (purification plant)
Intercepting drain
Ordinary flow
Water supply (continuous flow setting basin)
Salt Exclusion
Planted slope protection:Vegetation engineering
River (cut-off)
Silt layer
Seepage line:Infiltration line
Cycle of erosion
Hydraulic pressure
Penstock root
Stage(water level)
Water-level recorder
Water-level recorder
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Relief well(Water gate)
Water pollution
Chamber surge tank
Hydraulic turbine
Efficiency of hydraulic turbine
Water erosion control
Spur dyke(groin)
Gate
Best hydraulic cross-section
Hydraulic water depth
Conduct type water power
Weir
Aqueduct
Undermining
Scoop
Rubble-mound breakwater
Riprap work

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(I585)Angle of repose
(I586)Deposition
(I587)Meandering

Slope protection-Concrete block masonry
Preventing water leakage from embankments
Stoney gate weir
Sliding surface
Sewerage(thickner(Sludge scraper))
Sewerage(sludge treatment)
Sluice gate
Conformity
Productive green tract of land
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Backwater curve
Works for overflow(board work)
Stone levee
Formation level-railroad track
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Water supply (Total head)
Undercurrent
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Water supply (water-conveyance equipment)
Sodding
Traction
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Angle of repose
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Meandering

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Vertical wire cylinder masonry work(gabion)
Thalweg
Dam type power
Dam and conduit type power
Prevent water leakage
Single pile
Fault
Ground water level
Embankment
Rift valley
Erosion control works
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Tidal power type
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Bank protection(mattress)
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Works for overflow
Slope foot protection(Filling pile work)
Riverside land-land side
Embankment(riverside land)
Flow(drop down curve(backwater))
Low water channel work
Low -water discharge
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Infiltration(percolation) of levee

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Slope failure
Section of levee
Embankment(levee normal)
Dam(deflector)
Weir(tainter gate)
Embankment(crown/surface)
Water supply(earthenware pipe)
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Reconnaissance
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Consolidation works
Consolidation work
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Ridge line
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Sheathing work
Slope tamping
Rammer
Trafficability

(I656)Trench cut method
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(I674)Foot protection
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(I684)Bank protection(sure-footing)
(I685)Bank protection(slope covering(lining) works)
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(I687)Sand flash gate
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Trench cut method
Batter board
Impermeable wall
Internal impervious wall
Avalanche gallerry
Avalanche jumping
Avalanche fence
Avalanche stoppage
Nappe
Water supply(Water softening)
Double filtration
Interflow
Strip footing
Trench excavation
Base stone
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Foot protection
Foot protection
Foot protection
Foot protection
Foot protection
Negative friction
Wheel barrow
Wet masonry
Spread foundation
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Stability of the slope(slope pile)
Embankment(slope gradient)
Bank protection(sure-footing)
Bank protection(slope covering(lining) works)
Bank protection(slope protection)
Sand flash gate
Water supply(Water Distribution)
Drainage method

(I690)Water supply(water-tower)
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Water supply(water-tower)
Weir(dentated sill)
Weir(sharp crested weir)
River(branch river)
Baffle pier
Walling
Parapet
Embankment(sodding)
Trailer
Confined ground water
Angle brace
Embankment(secondary levee)
Stay
Secondary levee
Bench terraced fields
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Sluice
Standard penetration test
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(I755)Paddy field land
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Plain precipitation(Normal sedimentation)
Normal water gauge(Ordinary water gauge)
Unsteady flow
Impermeable groin(solid spur)
Impermeability layer
Non-uniform flow
Plane of floatation
Suspended load
Buoyancy
Froude number
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Floating dam
Watershed
Diversion works
Diversion works
Sewerage(Water distribution valve(ferrule))
Sewerage(separate system)
Sewerage(Combined type/ Separate type)
Mean velocity
Equilibrium slope
Parallel drainage
Head tank
Card-board wicks method
Boiling
Groyne net
Groyne net
Groyne wood
Radial drainage
Flood-way
Tail-race surge tank
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Paddy field land
Artesian well
Main levee

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(I765)Spatter's effect(water splash effect)
(I766)Leveling
(I767)Shoulder sodding
(I768)Shoulder sodding
(I769)Wooden beam bridge
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(I771)Submerged discharge
(I772)Banking
(I773)Landslide
(I774)Land reclamation in natural slope
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(I777)Retarding basin,flood storage basin
(I778)Pumped storage power
(I779)Pump-up head
(I780)Landslide restraining works
(I781)Landslide control works
(I782)Cross-levee(Horizontal levee)
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(I784)Quarter crossing joint
(I785)Extra-banking
(I786)Freeboard-margin height (extra embankment)
(I787)Avalanche stoppage
(I788)Avalanche jumping
(I789)Turbulent flow -Laminar flow
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Wooden bridge
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Shoulder sodding
Shoulder sodding
Wooden beam bridge
Submerged orifice
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Retarding basin,flood storage basin
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(1793)Ripper(rippability)
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(1795)Radial drainage
(1796)Run-off coefficient
(1797)Thalweg
(1798)Cross sectional area of stream
(1799)Flow net
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(1801)Diversion filling
(1802)Water course
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(1805)Method of average end areas
(1806)Rill erosion
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(1808)Sounding lead
(1809)Degraded ferro-deficient paddy field
(1810)Rate of filtration
(1811)Filter film
(1812)Filter material
(1813)Mixing work on the way
(1814)Water supply(return back of filtration
(1815)Lock
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Ripper
Ripper(rippability)
Sand flash gate
Radial drainage
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Cross sectional area of stream
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Velocity of flow
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Rate of filtration
Filter film
Filter material
Mixing work on the way
Water supply(return back of filtration
Lock
Rock fill dam
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(I445)Angle brace
(I700)Angle brace
(I585)Angle of repose
(I390)Apron
(I549)Aqueduct
(I354)Arch Dam
(I756)Artesian well
(I490)Automatic water gauge
(I718)Auxiliary dam
(I662)Avalanche fence
(I660)Avalanche gallery
(I661)Avalanche jumping
(I788)Avalanche jumping
(I663)Avalanche stoppage
(I787)Avalanche stoppage
(I491)Axial flow pump
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(I694)Baffle pier
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(I610)Bank protection(back slope protection)
(I606)Bank protection(mattress)
(I608)Bank protection(patch up method)
(I685)Bank protection(slope covering(lining) works)
(I686)Bank protection(slope protection)
(I498)Bank protection(sodding works)
(I684)Bank protection(sure-footing)
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Amenity
Angle brace
Angle brace
Angle of repose
Apron
Aqueduct
Arch Dam
Artesian well
Automatic water gauge
Auxiliary dam
Avalanche fence
Avalanche gallery
Avalanche jumping
Avalanche jumping
Avalanche stoppage
Avalanche stoppage
Axial flow pump
Backwater curve
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Bank protection(back slope protection)
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Bank protection(sure-footing)
Banking
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Base stone
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Batter board
Bench terraced fields
Best hydraulic cross-section

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(I453)Border
(I353)Border lot(Ridge area)
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(I446)Broken stone
(I447)Broken stone foundation
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(I746)Card-board wicks method
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(I570)Cellular sheet pile
(I409)Center of stream in the river
(I539)Chamber surge tank
(I381)Circle of influence
(I517)Circular society
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(I633)Coefficient of permeability
(I500)Cofferdam
(I717)Composite drainage basin
(I472)Concrete pitching
(I547)Conduct type water power
(I699)Confined ground water
(I561)Conformity
(I396)consolidation work
(I643)Consolidation work
(I642)Consolidation works
(I629)Contour line
(I497)Control section
(I428)Cover
(I791)Crawler
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Blade bowl
Boat way
Boiling
Border
Border lot(Ridge area)
Broad-crested weir
Broken stone
Broken stone foundation
Buoyancy
Card-board wicks method
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Cavitation
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(1352)Dam(Earth dam)
(1363)Dam(potential head)
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(1715)Deep well
(1716)Deep well method
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(1586)Deposition
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(1476) Differential surge-tank
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(1803)Discharge
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(1801)Diversion filling
(1737)Diversion works
(1738)Diversion works
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Cross sectional area of stream
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Culvert Drainage
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(I596)Embankment
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(I627)Embankment(crown/surface)
(I624)Embankment(levee normal)
(I460)Embankment(major bed)
(I418)Embankment(over compaction)
(I406)Embankment(raising)
(I407)Embankment(raising)
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(I701)Embankment(secondary levee)
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(I683)Embankment(slope gradient)
(I681)Embankment(slope)
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(I598)Erosion control works
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(I403)Estuary improvement
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(I457)Field division(Cultivated area)
(I455)Field permeability test
(I374)Fill in(Backfilling)
(I375)Fill in(Backfilling)

Embankment
Embankment
Embankment (wood sinking)
Embankment(crown/surface)
Embankment(levee normal)
Embankment(major bed)
Embankment(over compaction)
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Fill in(Backfilling)

(1811)Filter film
(1812)Filter material
(1603)Finishing stake
(1438)Fishladder
(1470)Fixed weir
(1735)Floating dam
(1458)Flood control
(1461)Flood control
(1386)Flood Irrigation(Overflow irrigation)
(1459)Flood protection works
(1752)Flood-way
(1707)Flow (unsteady flow)
(1799)Flow net
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(1464)Gradient (Grade)
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(I380)Groin towards up stream
(I370)Groin(skeleton)-Wire cylinder masonry work(Gabion)
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(I595)Ground water level
(I448)Group of piles
(I748)Groyne net
(I749)Groyne net
(I750)Groyne wood
(I432)Gully erosion
(I745)Head tank
(I467)Heading
(I485)Hillside covering works
(I482)Hillside works
(I483)Hillside works
(I488)Hurdle work(bank protection work)
(I602)Hydraulic jump
(I531)Hydraulic pressure
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(I540)Hydraulic turbine
(I546)Hydraulic water depth
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(I727)Impermeable groin(solid spur)
(I658)Impermeable wall
(I605)Impregnation method
(I509)Infiltration gallery
(I621)Infiltration(percolation) of levee
(I514)Intake
(I515)Intake dam
(I516)Intake dam
(I522)Intercepting drain
(I667)Interflow
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(I659)Internal impervious wall

Groin over the water
Groin towards up stream
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(I468)Lake bottom or marsh bottom
(I469)Lake bottom or marsh bottom
(I582)Laminar flow
(I774)Land reclamation in natural slope
(I492)Land slide
(I773)Landslide
(I781)Landslide control works
(I780)Landslide restraining works
(I397)lapel method
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(I757)Main levee
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(I813)Mixing work on the way
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(I424)Movable weir(Rolling gate)
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(I423)Movable weir(Stoney Weir)

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Jetty
Lake bottom or marsh bottom
Lake bottom or marsh bottom
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Movable weir(Rolling gate)
Movable weir(Sluice gate)
Movable weir(Stoney Weir)

(I421)Movable weir(stop log)
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(I664)Nappe
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(I504)Natural Ground
(I493)Natural head
(I677)Negative friction
(I729)Non-uniform flow
(I725)Normal water gauge(Ordinary water gauge)
(I400)Open channel
(I395)Open cut method
(I410)Open levee
(I523)Ordinary flow
(I398)Orifice
(I385)Overflow pipe
(I388)Overflow weir
(I393)Overlay
(I755)Paddy field land
(I744)Parallel drainage
(I696)Parapet
(I671)Penetration
(I632)Penstock (alluvium)
(I532)Penstock root
(I444)Pile dyke(groin)
(I724)Plain precipitation(Normal sedimentation)
(I730)Plane of floatation
(I526)Planted slope protection:Vegetation engineering
(I611)Plastic deformation of the soil
(I734)Preloading
(I391)Pressed embankment
(I592)Prevent water leakage
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(I555)Preventing water leakage from embankments
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Preventing water leakage from embankments
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(I368)Pumice-stone(Floating stones)
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(I779)Pump-up head
(I784)Quarter crossing joint
(I751)Radial drainage
(I795)Radial drainage
(I654)Rammer
(I810)Rate of filtration
(I356)RCD method
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(I777)Retarding basin,flood storage basin
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(I650)Ridge line
(I597)Rift valley
(I806)Rill erosion
(I792)Ripper
(I793)Ripper(rippability)
(I553)Riprap work
(I527)River (cut-off)
(I412)River administer
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(I411)River improvement
(I416)River Law
(I413)River works
(I693)River(branch river)
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Pumice-stone(Floating stones)
Pumped storage power
Pump-up head
Quarter crossing joint
Radial drainage
Radial drainage
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(I552)Rubble-mound breakwater
(I796)Run-off coefficient
(I525)Salt Exclusion
(I480)Sand drain method
(I687)Sand flash gate
(I794)Sand flash gate
(I481)Sand pile
(I551)Scoop
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(I401)Sea bottom reclamation (Sea surface reclamation)
(I703)Secondary levee
(I719)Secondary levee
(I623)Section of levee
(I645)Sediment settling
(I529)Seepage line:Infiltration line
(I499)Self closing tap
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(I405)Semi-permeable groin -wire cylinder masonry work(gabion)
(I382)Sensitivity ratio
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(I741)Sewerage(Combined type/ Separate type)
(I740)Sewerage(separate system)
(I559)Sewerage(sludge treatment)
(I371)Sewerage(storm outfall(Rainwater outlet))
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(I558)Sewerage(thickner (Sludge scraper))
(I739)Sewerage(Water distribution valve(ferrule))
(I612)Shaft sinking
(I350)Shallow well
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(I768)Shoulder sodding
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Sewerage(Water distribution valve(ferrule))
Shaft sinking
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Shoulder sodding
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(I593)Single pile
(I721)Siphon culvert
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(I557)Sliding surface
(I564)Slope crib work
(I505)Slope failure
(I622)Slope failure
(I614)Slope foot protection(Filling pile work)
(I377)Slope protection(backing mat method)
(I554)Slope protection-Concrete block masonry
(I653)Slope tamping
(I705)Sluice
(I708)Sluice
(I560)Sluice gate
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(I580)Sodding
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(I578)Soil stabilizer
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(I765)Spatter's effect(water splash effect)
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(I783)Spillway
(I479)Spray irrigation
(I680)Spread foundation
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(I543)Spur dyke(groin)
(I486)Square weir
(I682)Stability of the slope(slope pile)
(I358)Stabilization work
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(I709)Standard penetration test
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Siphon culvert
Skelton
Sliding surface
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Slope failure
Slope failure
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(I567)Stone levee
(I360)Stone masonry
(I362)Stone Pitching Work
(I556)Stoney gate weir
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(I771)Submerged discharge
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(I644)Subsoil compacting
(I574)Summer dyke
(I506)Supercritical flow(shooting flow /rapid flow)
(I392)Surcharge process:Pressing embankment method
(I710)Surface impermeable wall
(I475)Surge-tank
(I731)Suspended load
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(I599)Test pit
(I589)Thalweg
(I797)Thalweg
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(I462)Time of concentration of flood
(I454)Torrent control works
(I581)Traction
(I655)Trafficability
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Stone levee
Stone masonry
Stone Pitching Work
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Stop log
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Strut
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(I550)Undermining
(I635)Uniform flow
(I441)Unscreened gravel
(I726)Unsteady flow
(I518)Vadose water:Circulating water
(I800)Velocity of flow
(I376)Vertical frame
(I588)Vertical wire cylinder masonry work(gabion)
(I695)Walling
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(I764)Water bound macadam
(I802)Water course
(I804)Water course
(I542)Water erosion control
(I536)Water hammer
(I538)Water pollution
(I399)Water supply
(I520)Water supply (clean water(Purified water))
(I524)Water supply (continuous flow setting basin)
(I521)Water supply (purification plant)
(I576)Water supply (Total head)
(I579)Water supply (water-conveyance equipment)
(I378)Water supply and sewerage(rain gauge)
(I417)Water supply(activated carbon method)
(I628)Water supply(earthenware pipe)
(I456)Water supply(Elevated tank)
(I814)Water supply(return back of filtration
(I711)Water supply(surface washing (Surface cleaning))
(I688)Water supply(Water Distribution)
(I665)Water supply(Water softening)
(I690)Water supply(water-tower)
(I513)Water-intake
(I534)Water-level recorder

Undercurrent
Undermining
Uniform flow
Unscreened gravel
Unsteady flow
Vadose water:Circulating water
Velocity of flow
Vertical frame
Vertical wire cylinder masonry work(gabion)
Walling
Wash Load
Water bound macadam
Water course
Water course
Water erosion control
Water hammer
Water pollution
Water supply
Water supply (clean water(Purified water))
Water supply (continuous flow setting basin)
Water supply (purification plant)
Water supply (Total head)
Water supply (water-conveyance equipment)
Water supply and sewerage(rain gauge)
Water supply(activated carbon method)
Water supply(earthenware pipe)
Water supply(Elevated tank)
Water supply(return back of filtration
Water supply(surface washing (Surface cleaning))
Water supply(Water Distribution)
Water supply(Water softening)
Water supply(water-tower)
Water-intake
Water-level recorder

(I535)Water-level recorder
(I736)Watershed
(I548)Weir
(I563)Weir
(I691)Weir(dentated sill)
(I631)Weir(head works)
(I440)Weir(notch)
(I692)Weir(sharp crested weir)
(I626)Weir(tainter gate)
(I366)Well point method
(I679)Wet masonry
(I519)Wetted perimeter
(I678)Wheel barrow
(I713)Wind erosion control
(I714)Wind erosion farm
(I754)Windbreak
(I502)Wire cylinder(gabion)
(I503)Wire cylinder(gabion)
(I769)Wooden beam bridge
(I607)Wooden bridge
(I762)Wooden bridge
(I763)Wooden bridge
(I384)Works for overflow
(I613)Works for overflow
(I566)Works for overflow(board work)
(I571)Zero air voids curve

Water-level recorder
Watershed
Weir
Weir
Weir(dentated sill)
Weir(head works)
Weir(notch)
Weir(sharp crested weir)
Weir(tainter gate)
Well point method
Wet masonry
Wetted perimeter
Wheel barrow
Wind erosion control
Wind erosion farm
Windbreak
Wire cylinder(gabion)
Wire cylinder(gabion)
Wooden beam bridge
Wooden bridge
Wooden bridge
Wooden bridge
Works for overflow
Works for overflow
Works for overflow(board work)
Zero air voids curve

(I350) Shallow well

(I350) Shallow well

Shallow well

① $2r_o$ (well diameter)

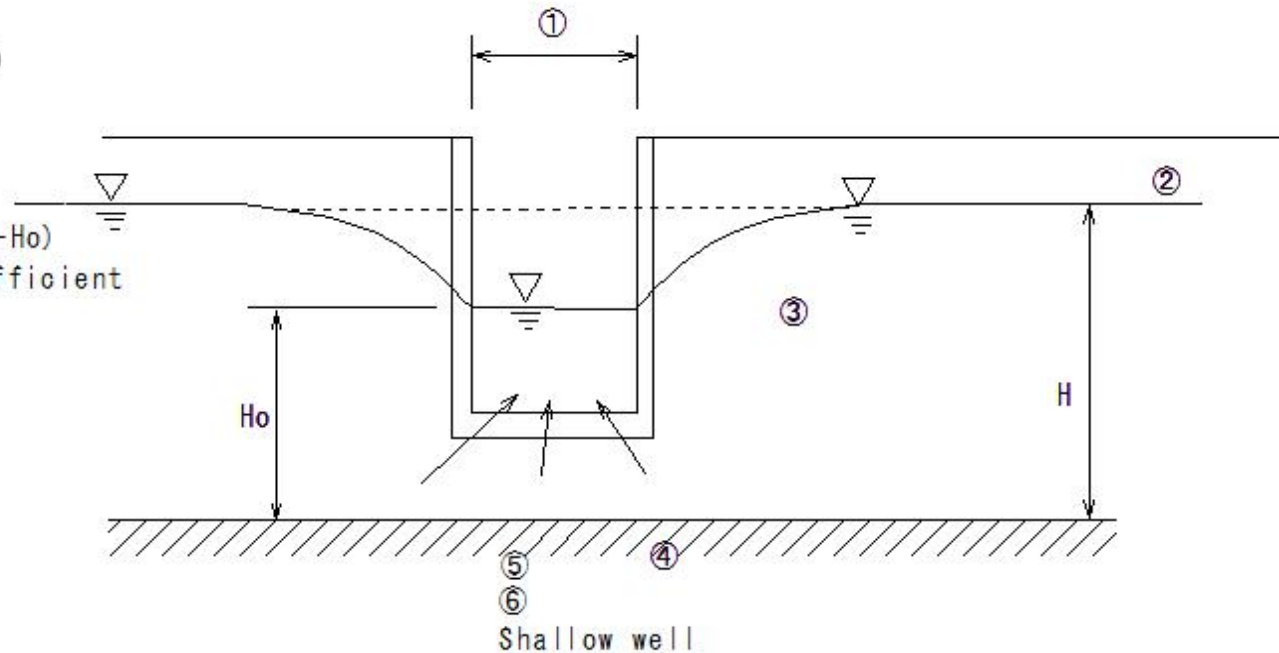
② Ground water level

③ Aquifer

④ Impermeable layer

⑤ Flow rate $Q=4k\gamma_o(H-H_o)$

⑥ k : Permeability coefficient



- ① A shallow well is a well that pumps groundwater
- ② It is roughly 10 meters deep
- ③ It uses unpressurized groundwater close to the surface
- ④ It is easily affected by the surrounding environment
- ⑤ The water quality and quantity are easily affected

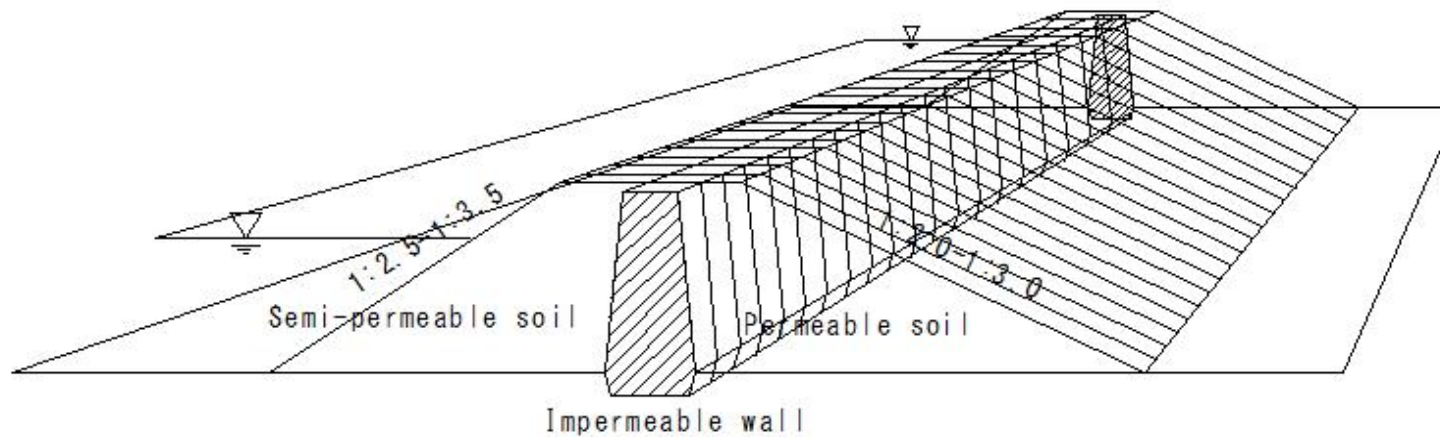
(I351)Dam(Earth dam)

(I351) Dam (Earth dam)

Earth dam

Embankment body is soil

- Can be constructed even in places where the foundation ground (bearing capacity) is small



- Central impermeable wall type
- For imperviousness, carefully compact the sticky soil.
- Reinforced concrete using steel plates, etc.

Earth Dam is a dam constructed primarily using earth and shaped like a trapezoid.

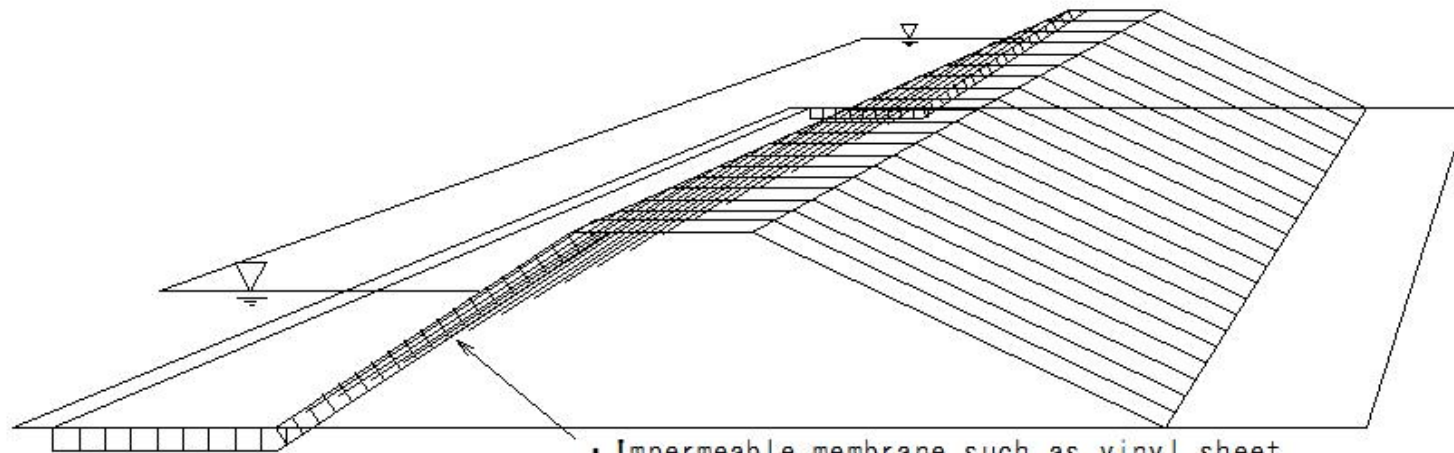
(I352)Dam(Earth dam)

(I352) Dam (Earth dam)

Earth Dam

Embankment body is soil

- Can be constructed even in places where the foundation ground (bearing capacity) is small



- Impermeable membrane such as vinyl sheet
- Front impermeable wall type

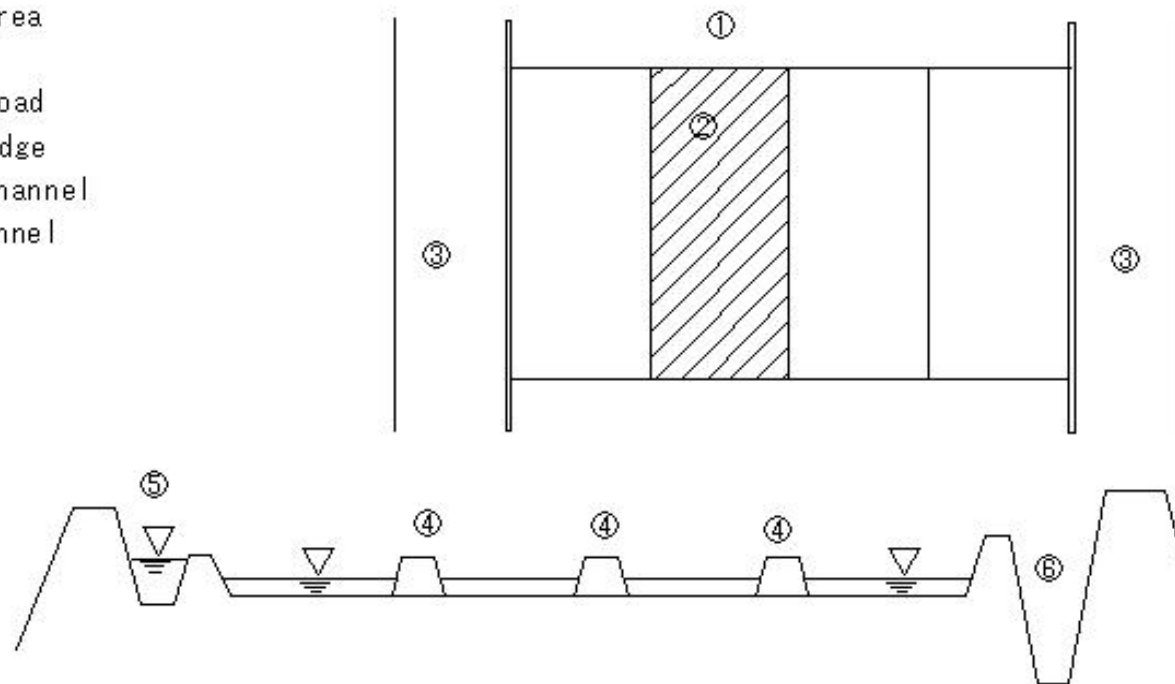
Earth Dam

(I353)Border lot(Ridge area)

(I353)Border lot(Ridge area)

Border lot(Ridge area)

- ① Cultivated area
- ② Ridge area
- ③ Cultivated road
- ④ Temporary ridge
- ⑤ Irrigation channel
- ⑥ Drainage channel



Ridge: The bank between rice fields

Ridge: A path along the ridge

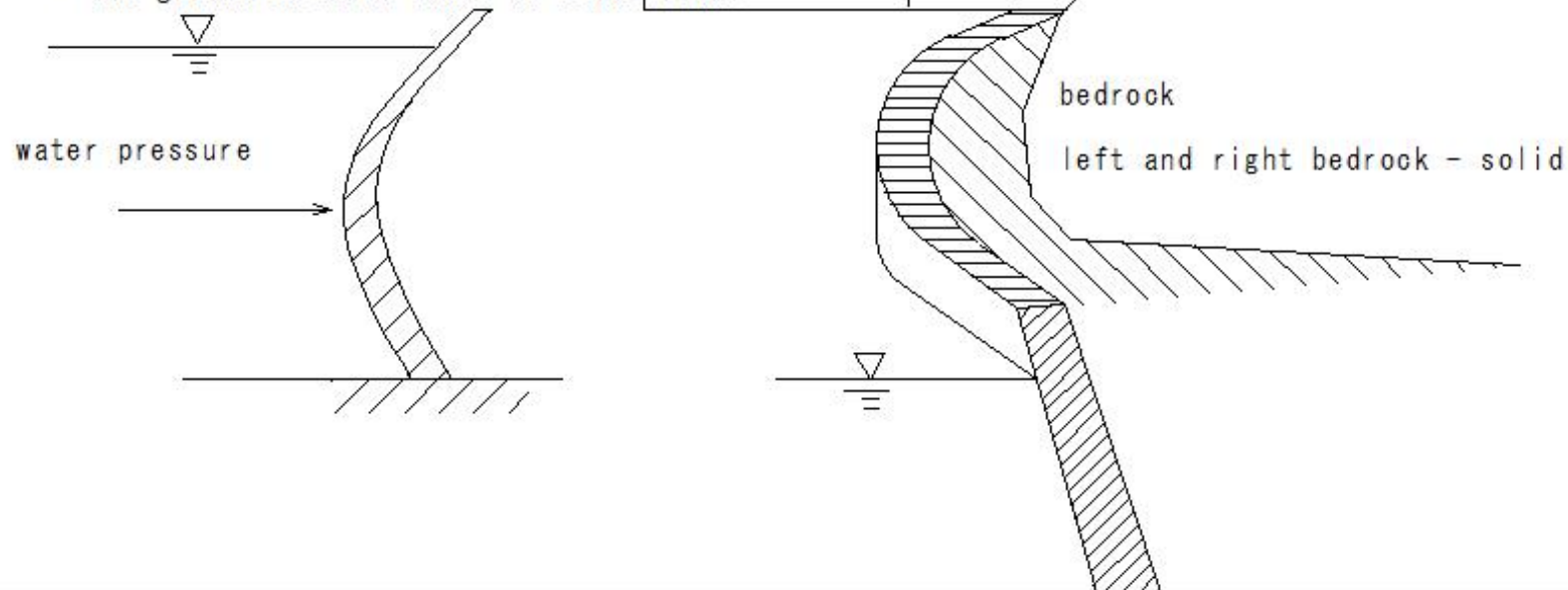
Boundary: The boundary between plots separated by ridges

(I354) Arch Dam

(I354) Dam (Arch dam)

Arch Dam

- Horizontal cross section is arch-shaped
- Vertical section is cantilevered
- Concrete dam
- The dam body is arch-shaped
- Only compressive force acts
- Amount of concrete - small
- The ground on both sides is solid rock.



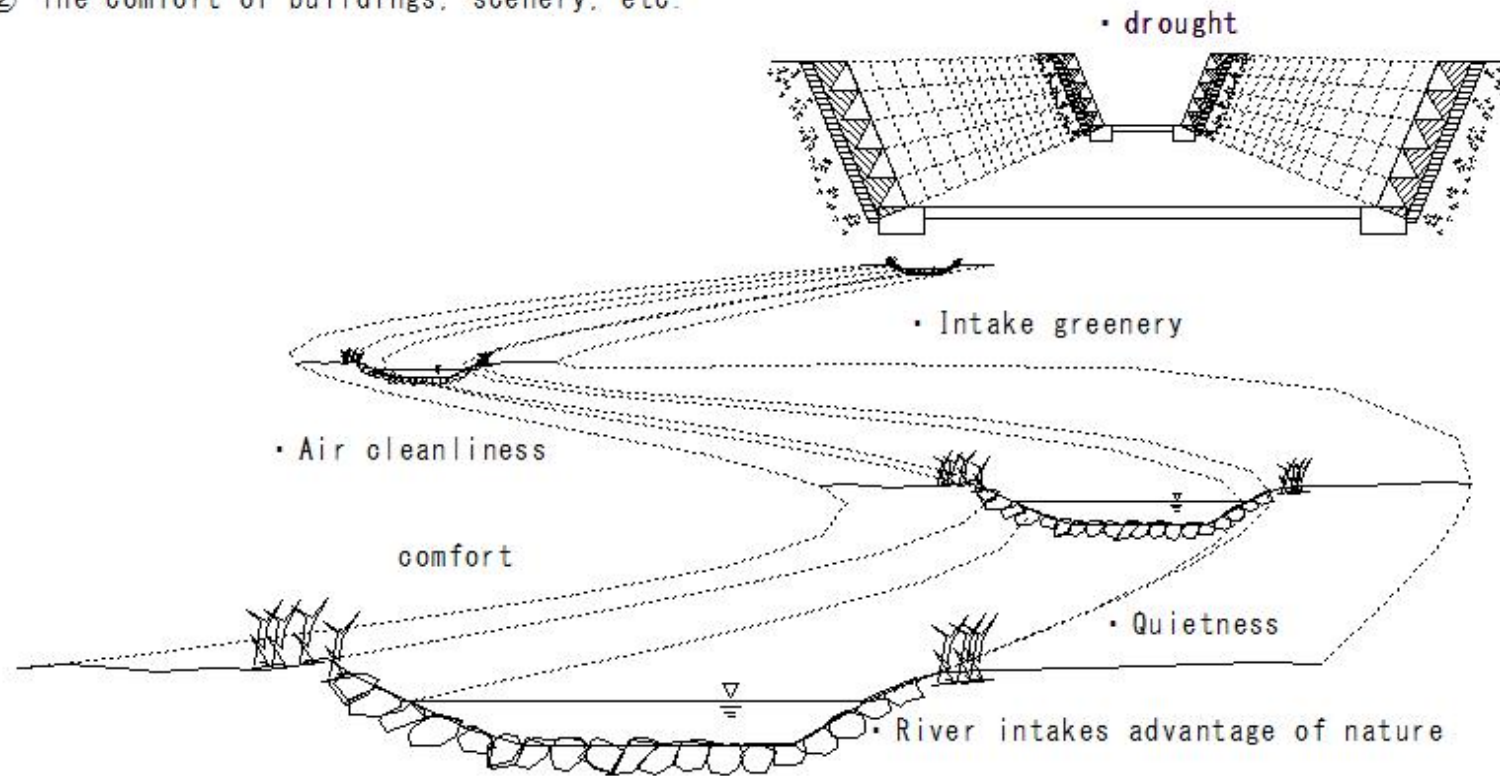
D174
C1233

(I355)Amenity

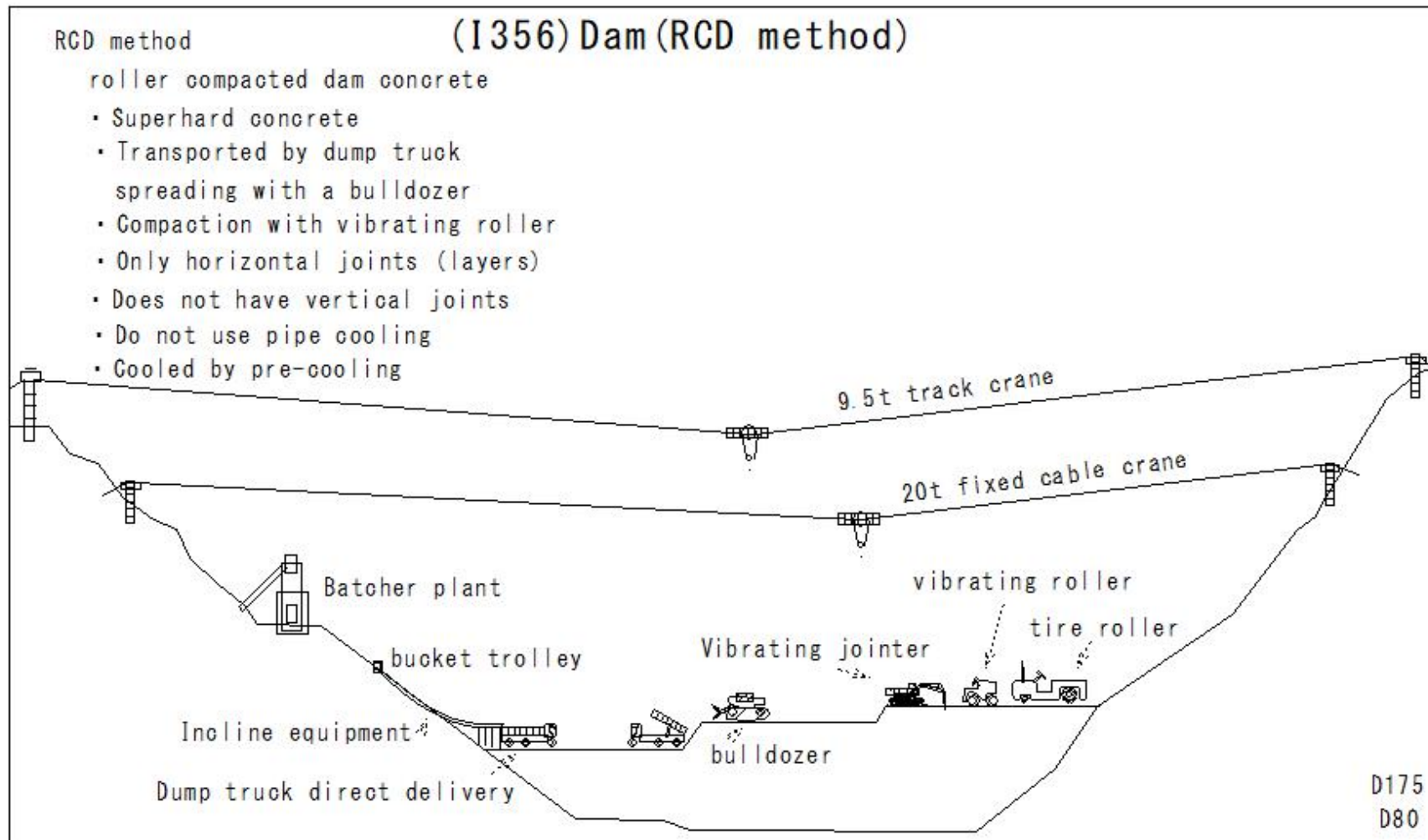
(I355)Amenity

Amenity

- ① Amenity is a word that means comfort, coziness, an attractive environment, etc.
- ② The comfort of buildings, scenery, etc.

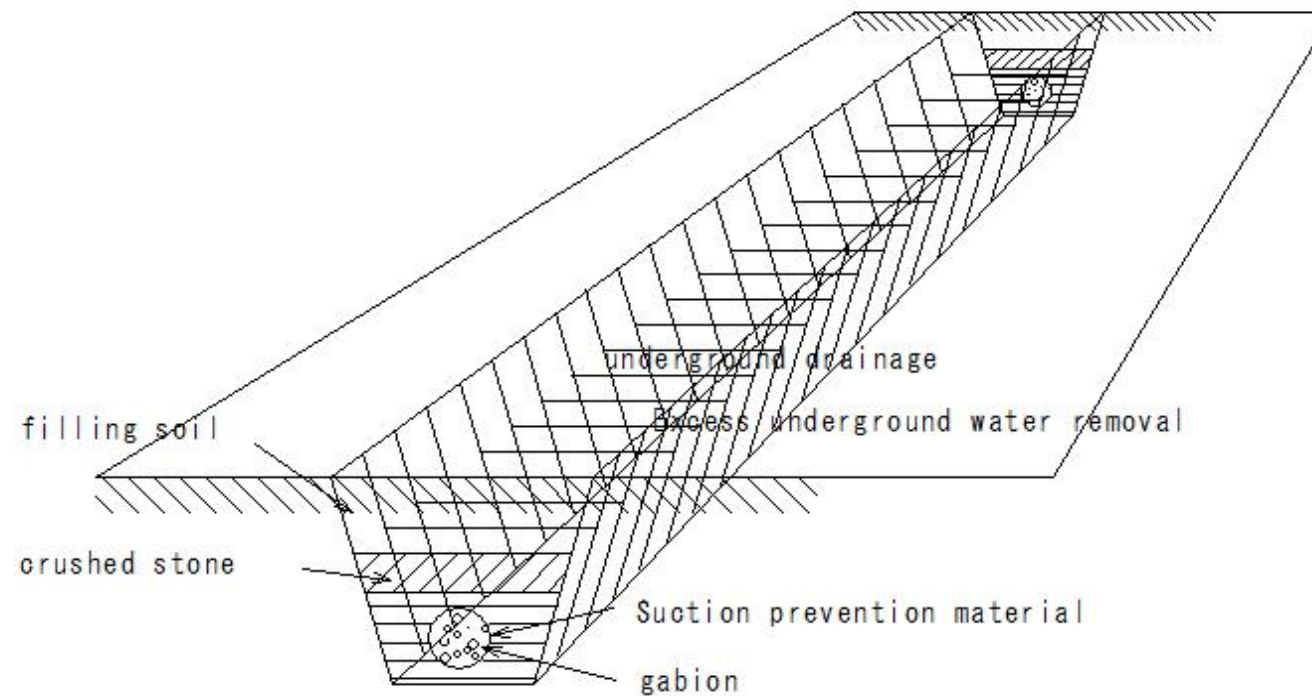


(I356)RCD method



(I357) Culvert Drainage

(I357) Culvert Drainage



Culvert drainage is a method of improving drainage of land by using underground waterways (culverts).

E496

(I358)Stabilization work

(I358)Stabilization work

Stabilization work

Physical methods

- ① On-site soil + aggregate → improves particle size distribution
- ② Wet soil + lime → strength increase
- ③ Wet soil + cement → soil cement (strength increase)
- ④ On-site soil + bituminous material → increases adhesion, impermeability, and waterproofing
- ⑤ On-site soil + (calcium silicate, calcium acrylate) → stabilized by precipitation, addition polymerization, etc.

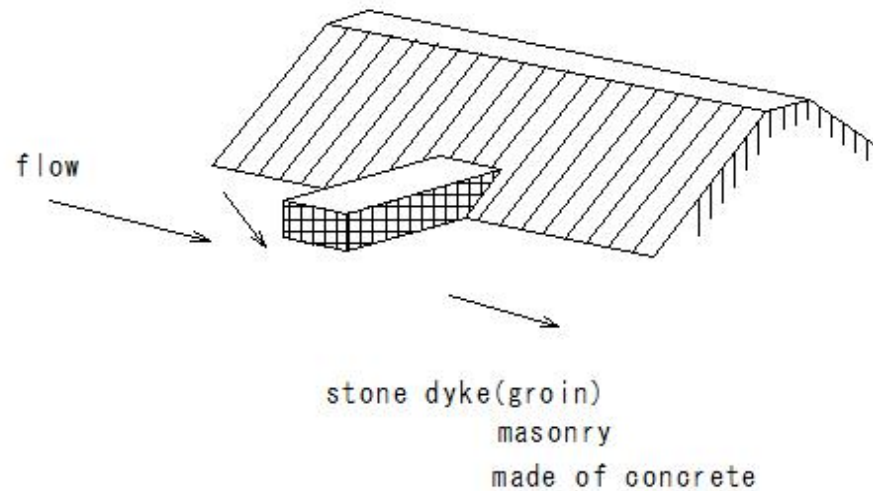
Stabilization work is a method of improving the soil quality of the ground and roadbed, and strengthens the bonds between soil particles by adding stabilizers such as cement and lime.

(I359)Stone Dyke

(I359) Stone Dyke (groin)

Stone Dyke(groin)

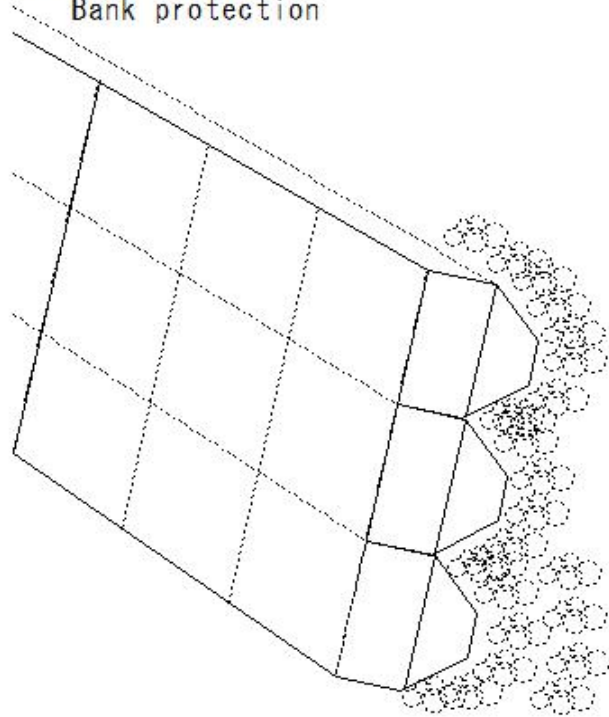
- Weakening the flow force of the river
- Direct flow to the center



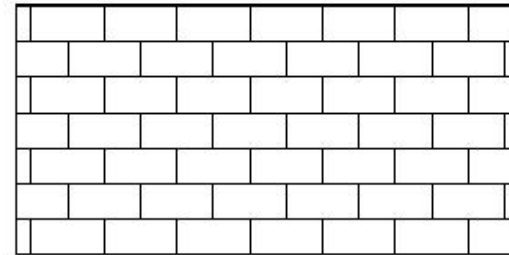
(I360)Stone masonry

(I360) Stone Masonry

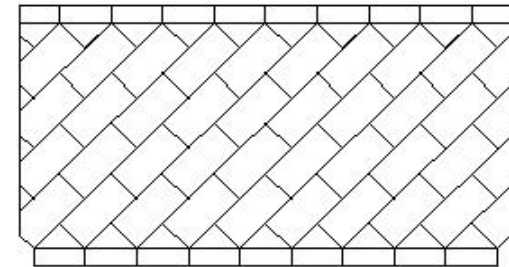
Stone masonry
Retaining stone wall
Bank protection



Stone masonry



Fabric stacking



Valley stacking

R282

(I361)Rock Crib Work

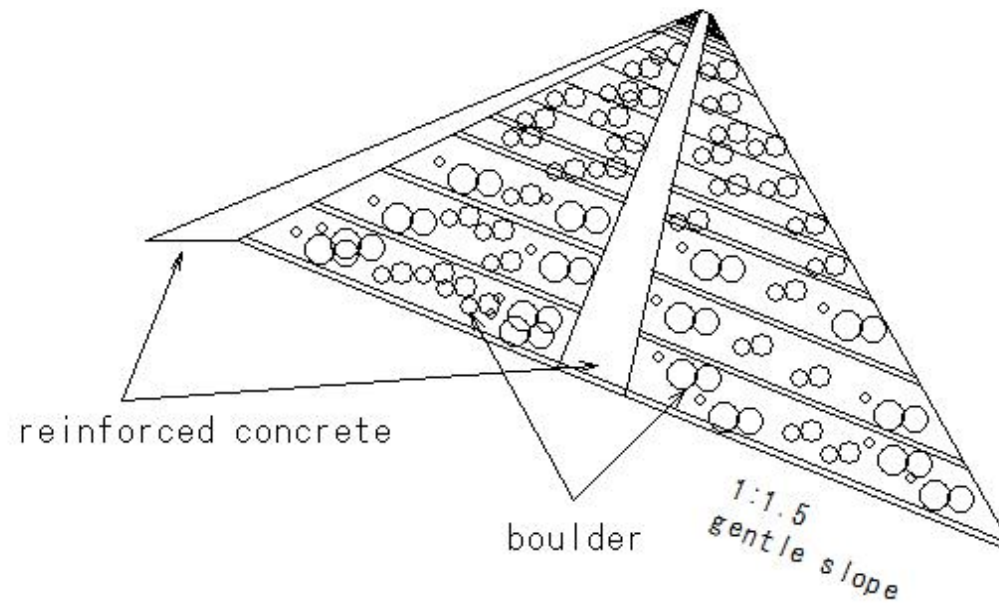
(I361)Rock Crib Work

Rock Crib work

reinforced concrete crib work

Packing of cobblestones, gravel, and gravel

Assemble a frame on the slope of the embankment



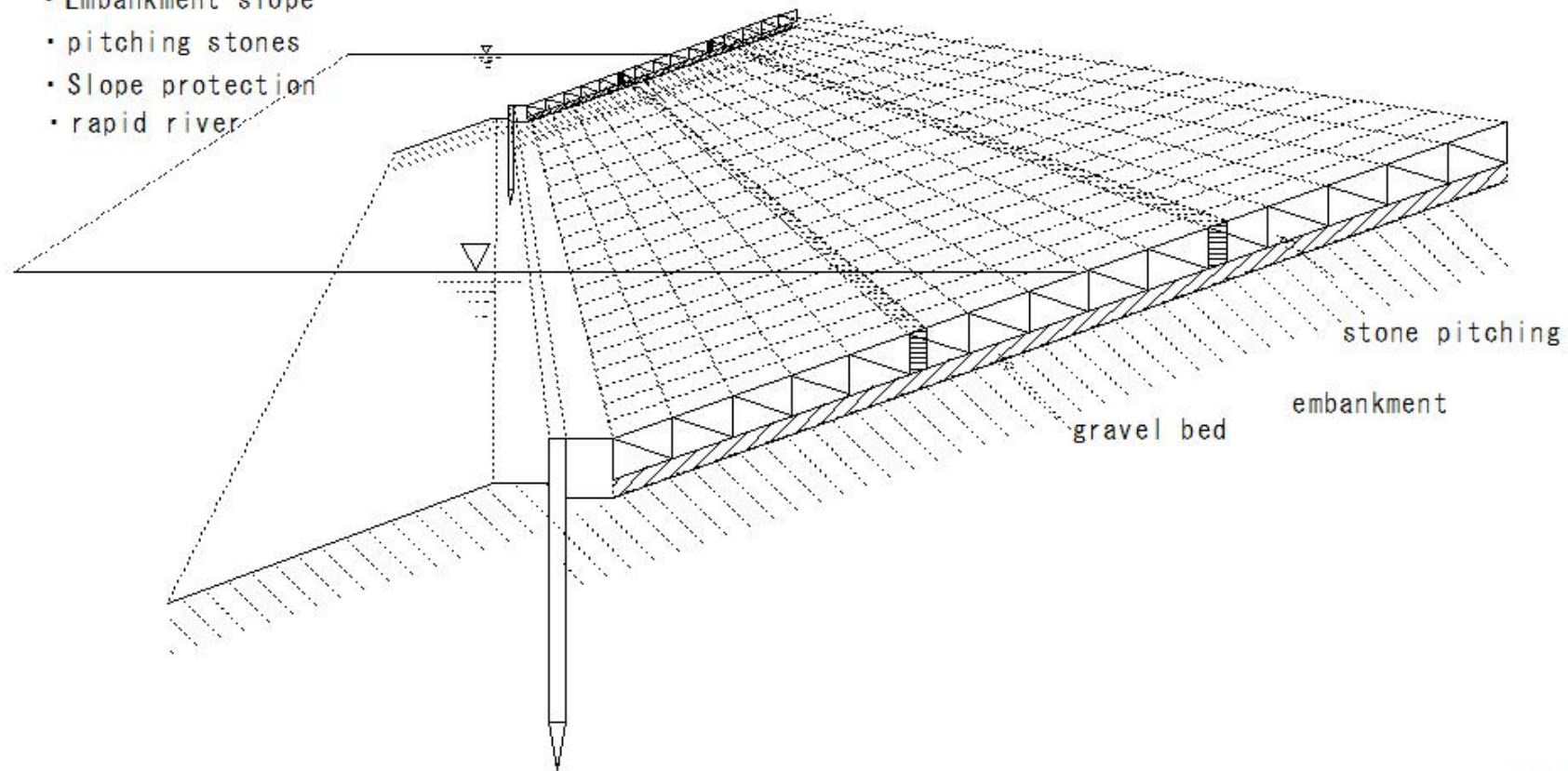
R283

(I362)Stone Pitching Work

(I362) stone pitching work

stone pitching work

- Embankment slope
- pitching stones
- Slope protection
- rapid river



R284

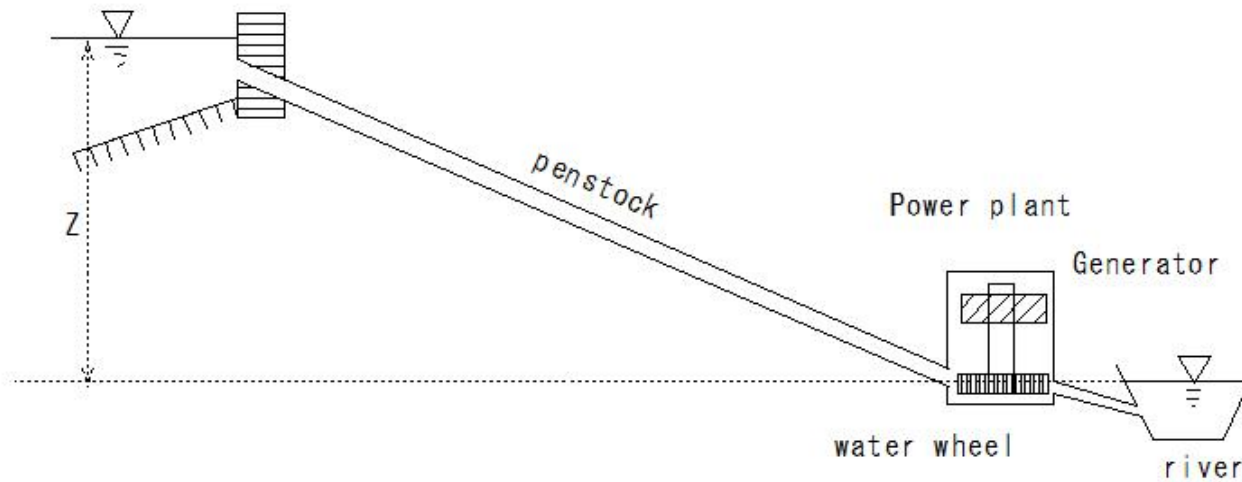
(I363)Dam(potential head)

(I363) Dam (potential head)

potential head

- Bernoulli's theorem
- Express the energy at the position where water is placed in the unit of height (m)
- Convert positional water head into electrical energy

Z (position head) (m) Total head in hydropower generation

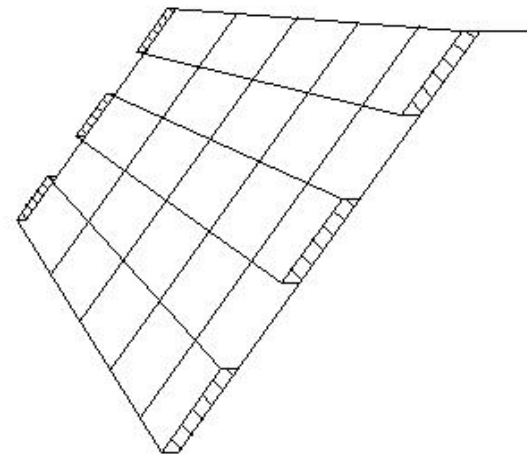
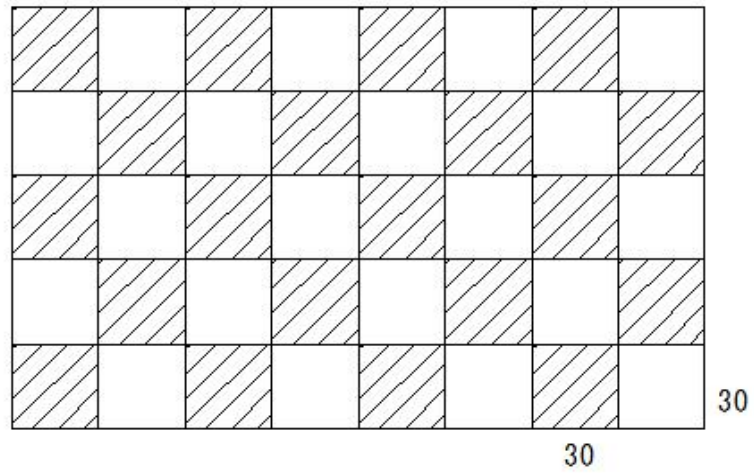


Z : (potential head) (m) Total head in hydropower generation

(I364) Sodding

(I364) Sodding

Sodding

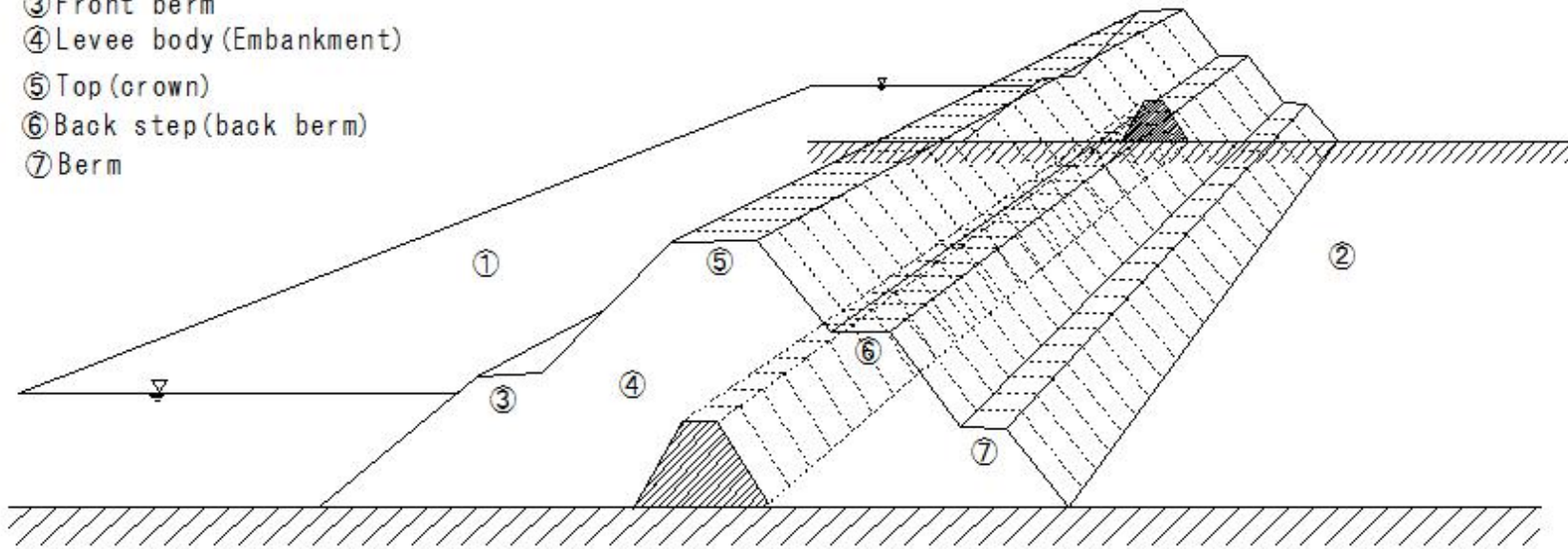


(I365) Embankment

(I365) Embankment

Embankment

- ① Land outside the embankment (riverside land)
- ② Inland land
- ③ Front berm
- ④ Levee body (Embankment)
- ⑤ Top (crown)
- ⑥ Back step (back berm)
- ⑦ Berm



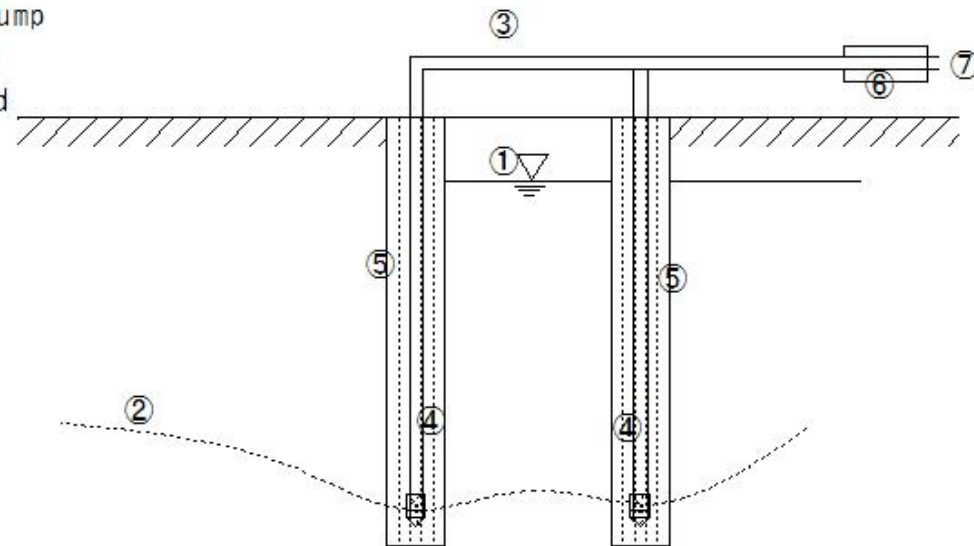
(I366)Well point method

(I366)Well point method

Well point method

- ① Initial groundwater level
- ② Groundwater level after construction
- ③ Collection pipe
- ④ Well point
- ⑤ Filtration layer (sand)
- ⑥ Vacuum pump
- ⑦ Drainage

Sandy ground



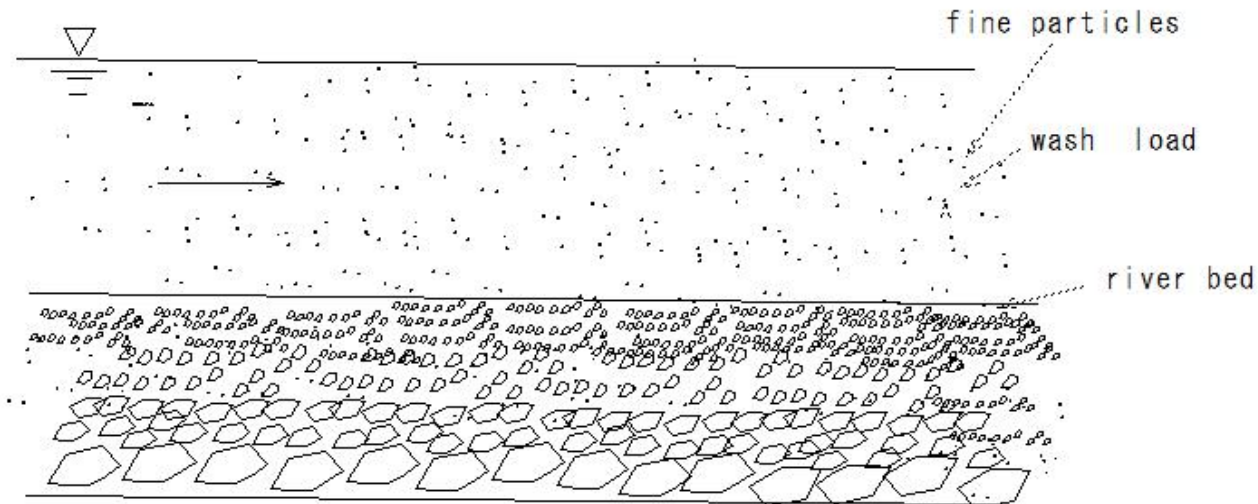
The well point method is a method of installing many small wells called well points collecting groundwater by vacuum suction and pumping and draining it.

(I367)Wash Load

(I367)Wash Load

Wash load

Fine particles
Transported from upstream
Reservoir - Buried



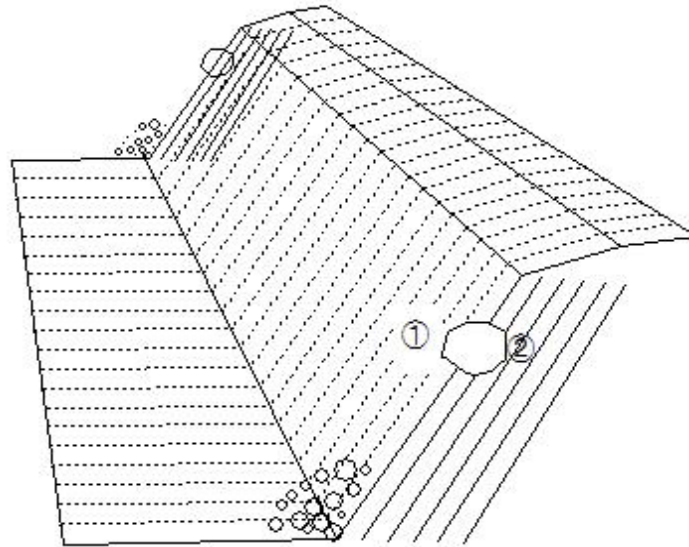
- ① A wash load is a type of moving sediment composed of finer grains of soil than the riverbed gravel.
- ② Even if the flow rate slows, it does not settle easily, so once it is incorporated into the flowing water, it can easily flow long distances.

(I368) Pumice-stone (Floating stones)

(I368) Pumice-stone (Floating stones)

Pumice-stone (Floating stones)

- ① Floating stones
- ② Cracks



Excavation of the ground

Unstable stones:

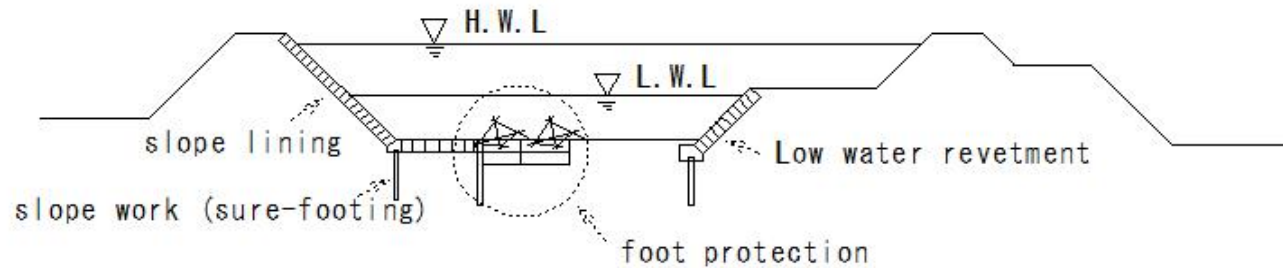
These are stones that easily crumble and are often found on slopes in mountainous areas.

(I369) Skelton

(I369) Skelton

Skelton

- ① To weaken the force of the water flow
- ② To prevent erosion of the embankment
- ③ Made of wood



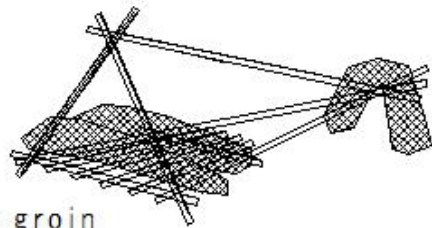
Skelton

(I370)Groyne(skeleton)-Wire cylinder masonry work(Gabion)

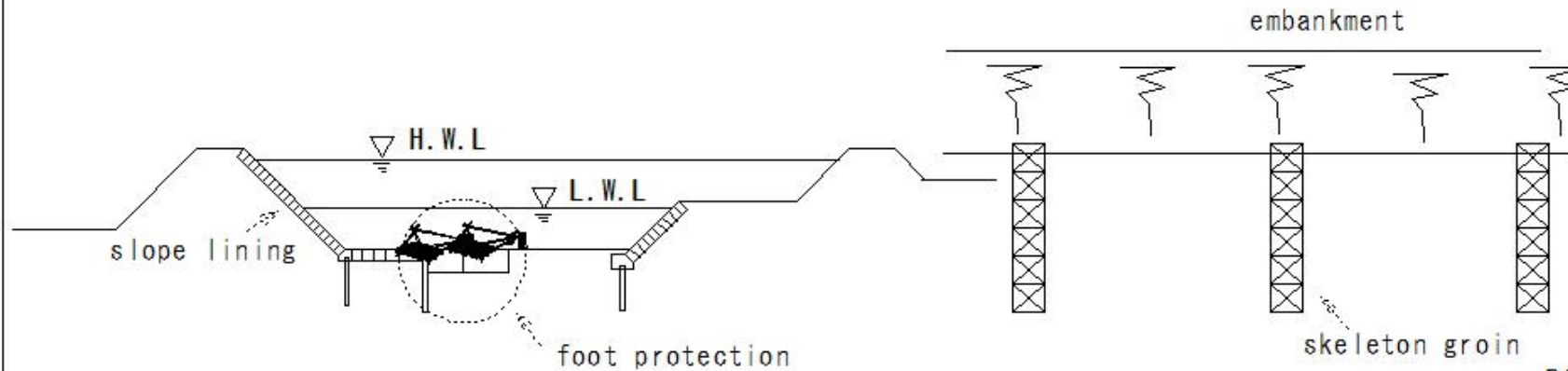
(I370)groyne(skeleton)-wire cylinder masonry work(gabion)

skeleton

Purpose of river construction
foot protection groyne



skeleton groyne
wire cylinder masonry work(gabion)



R287

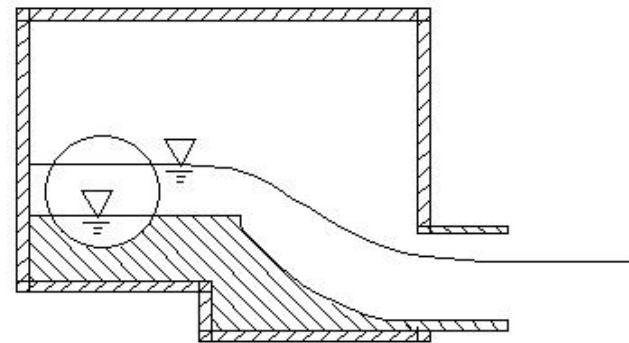
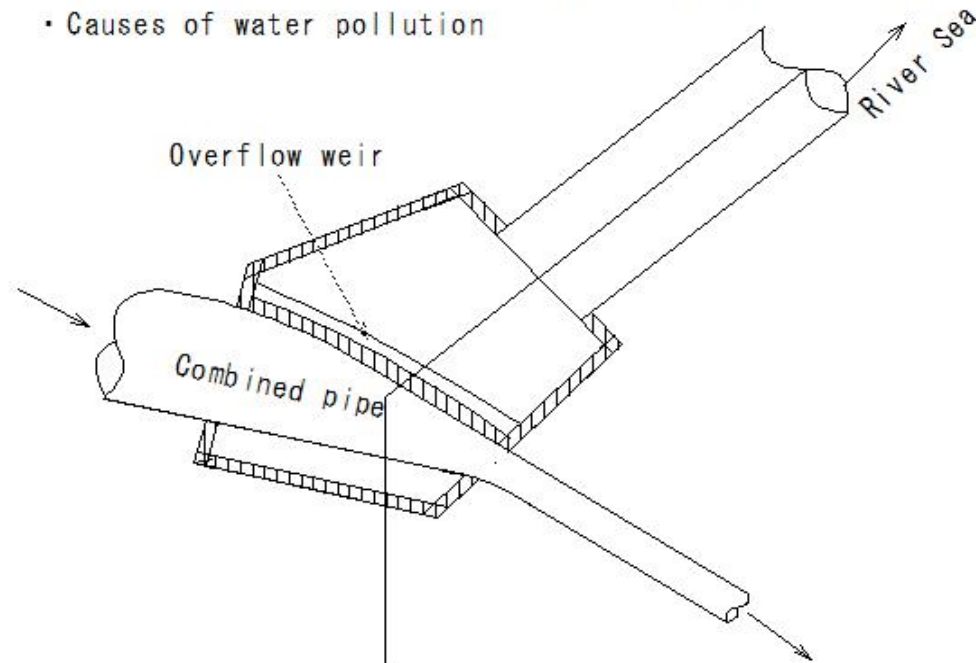
(I371)Sewerage(storm outfall(Rainwater outlet))

(I371) Sewerage (storm outfall (Rainwater outlet))

Sewerage

storm outfall (Rainwater outlet)

- Rainwater - Dirt is diluted
- Sewage volume - 2-3 times or more the amount of sewage
- Other sewage - Overflows the weir and is discharged into the river or sea
- Causes of water pollution



W220

(I372)Sewerage(street inlet(Rainwater basin))

(I372) Sewerage (street inlet (Rainwater basin))

Sewerage

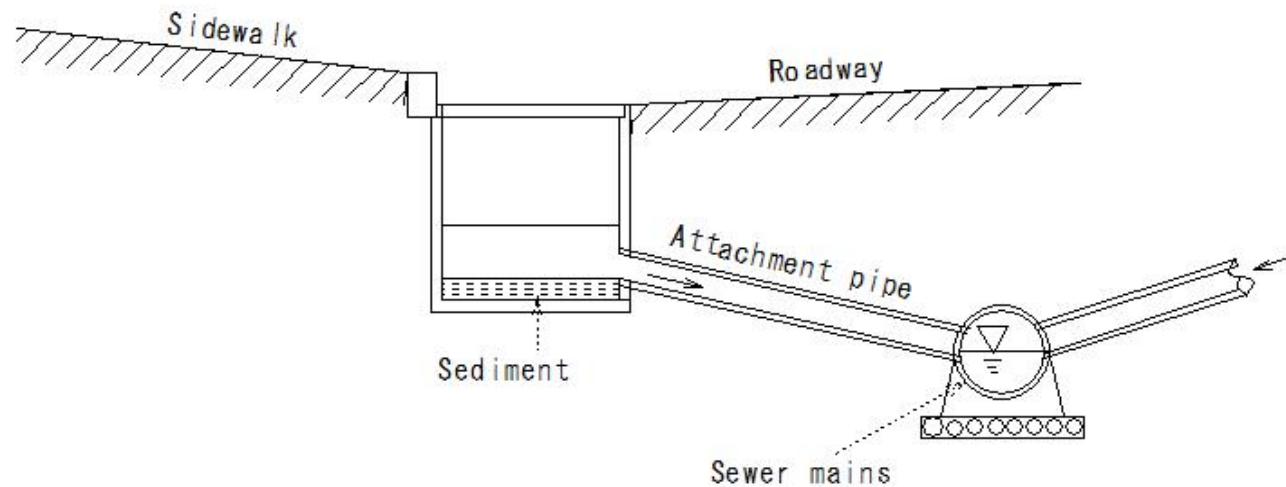
street inlet(Rainwater basin)

Every 30~50m.

round, rectangular, concrete pit

Sediment at the bottom

Prevents sediment from flowing into sewer pipes



W221

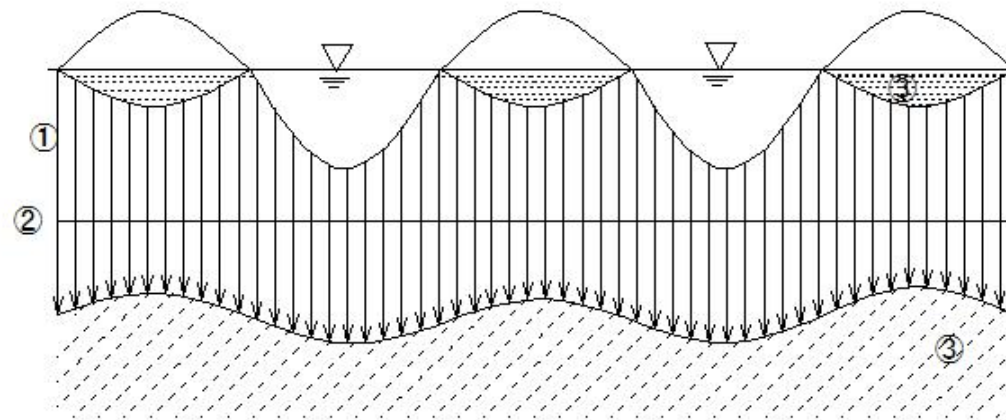
(I373)Furrow irrigation

(I373)Furrow irrigation

Furrow irrigation

The condition in which water seeps into the furrows

- ① Gravity water zone
- ② The boundary between the topsoil and the till pan
- ③ Capillary water zone

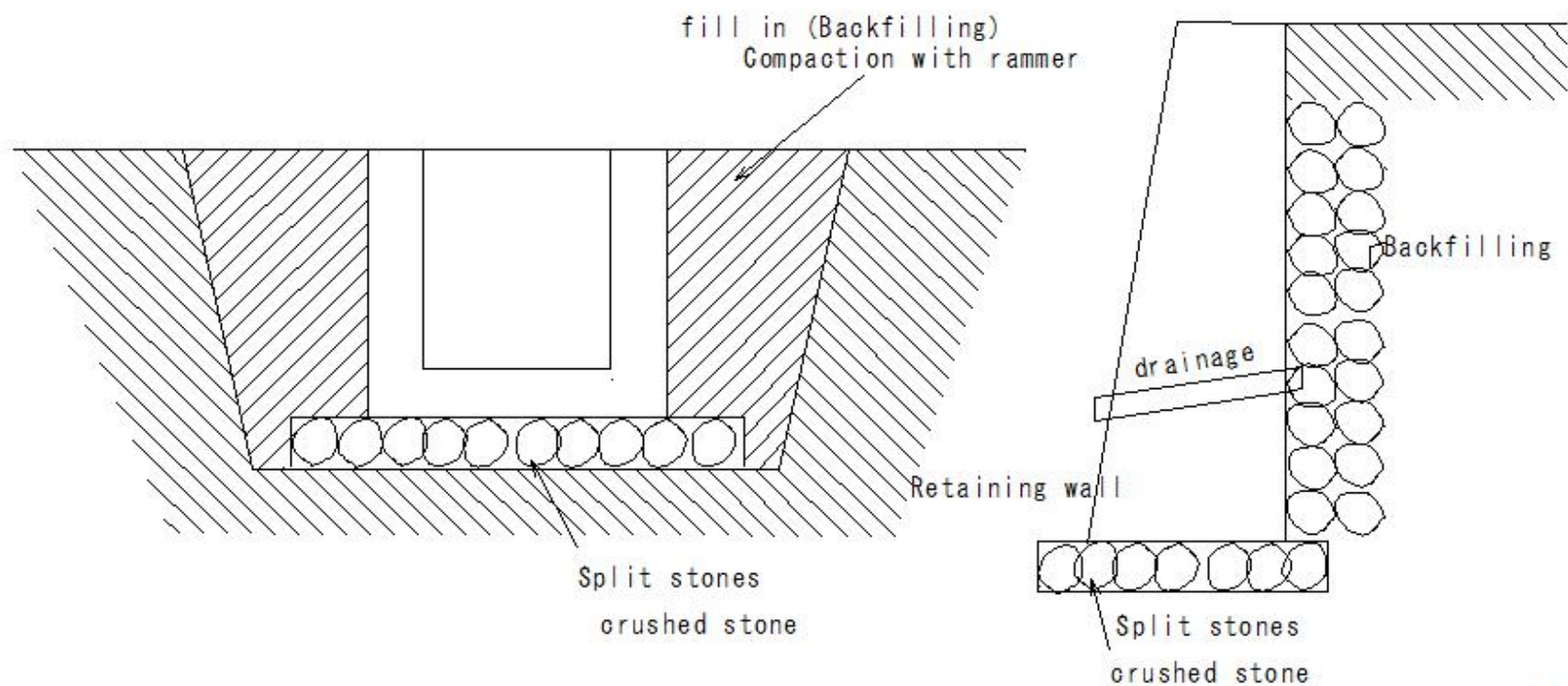


The condition in which water seeps into the furrows

(I374)Fill in(Backfilling)

(I374)Fill in (Backfilling)

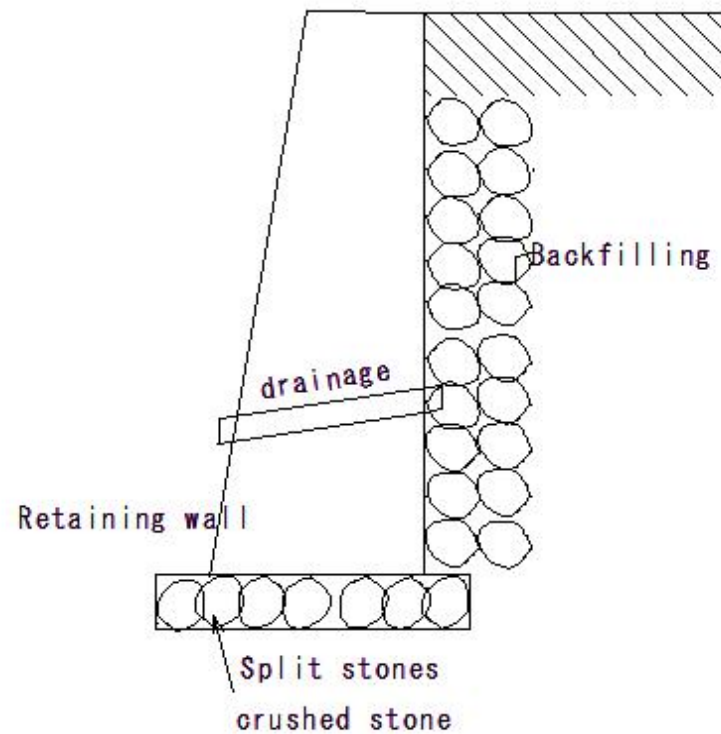
Backfilling refers to returning soil to the excavated area after underground construction and foundation work are completed.



(I375)Fill in(Backfilling)

(I375)Fill in (Backfilling)

Backfilling refers to returning soil to the excavated area after underground construction and foundation work are completed.

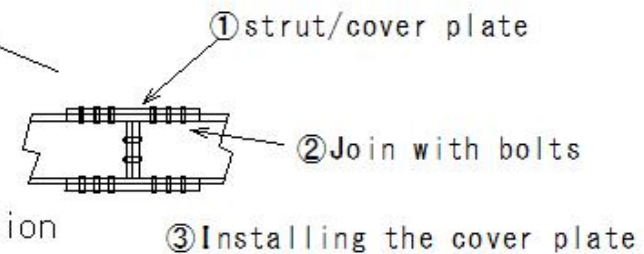
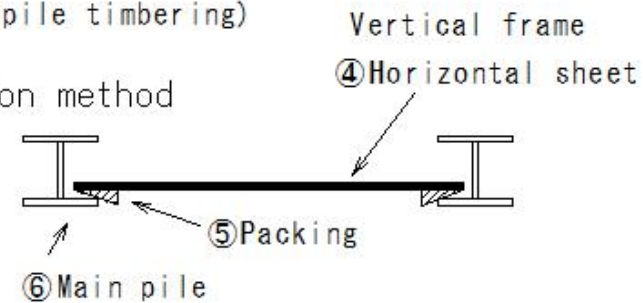
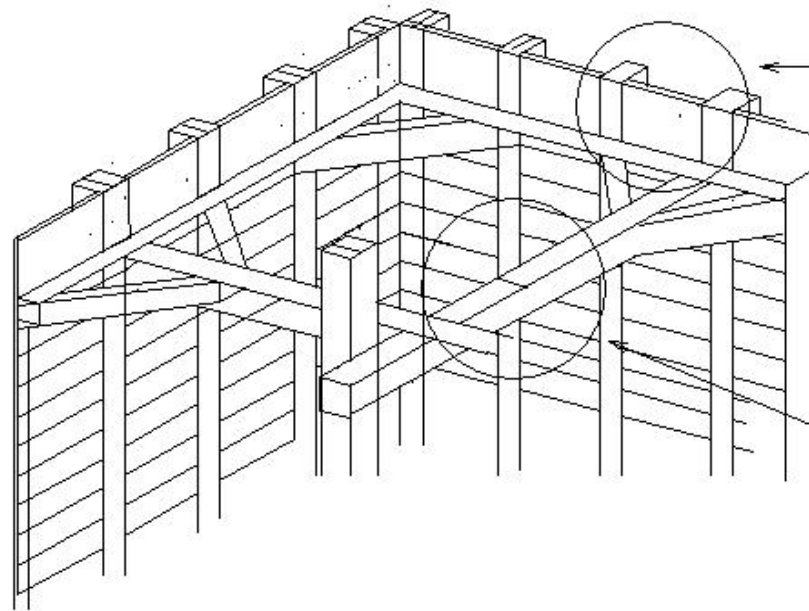


(I376)Vertical frame

(I376)Vertical frame

Earth retaining work(Main piles horizontal sheet pile timbering)
Earth retaining wall timbering method

- Main pile horizontal sheet pile strut construction method



- Horizontal sheet pile installation

(I377) Slope protection (backing mat method)

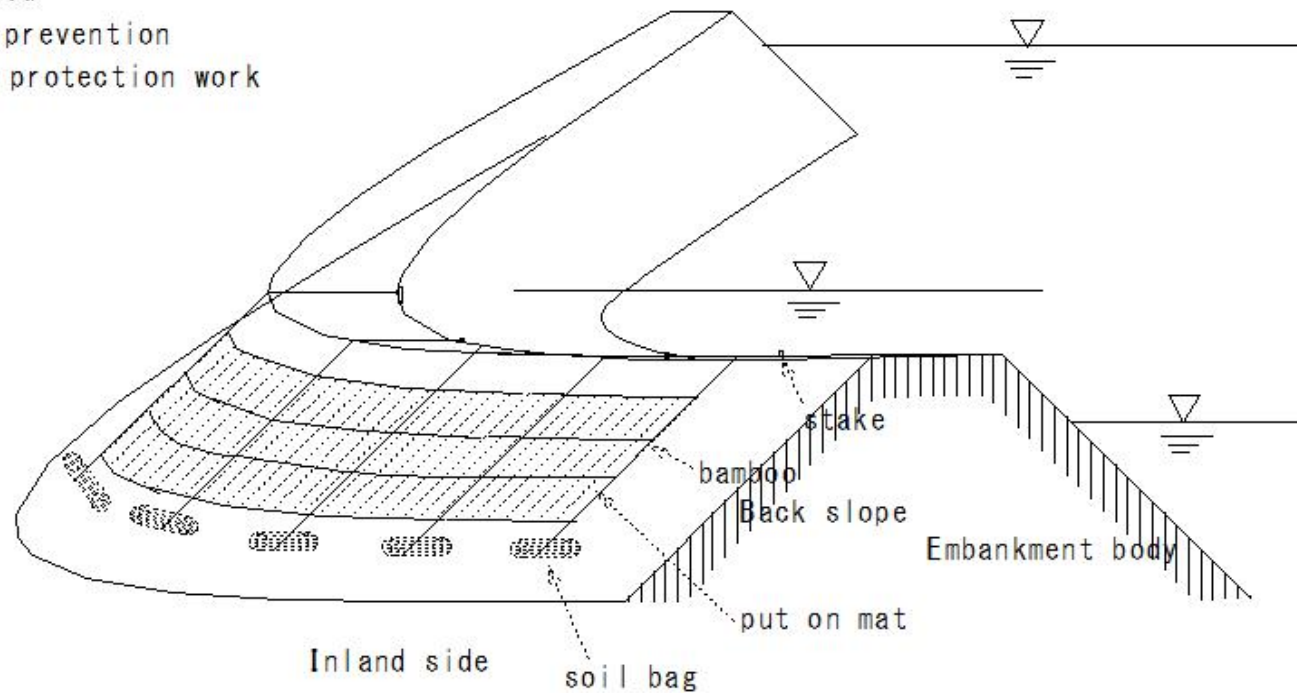
(I377) Slope protection (Backing mat method)

backing mat method

case of flood

Water leak prevention

Back slope protection work



(I378)Water supply and sewerage(rain gauge)

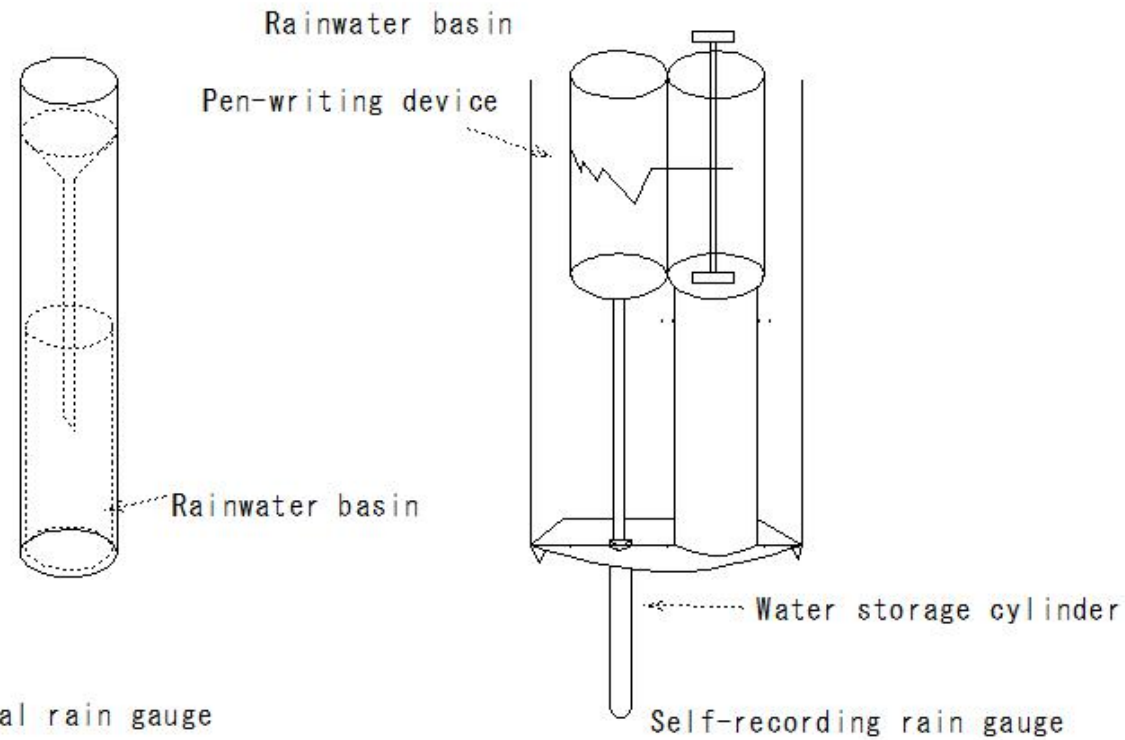
(I378)Water supply and sewerage(rain gauge)

Water supply and sewerage

Rain gauge

Measures the amount of rainfall by the height of the rainwater in a rainwater basin

Normal rain gauge



Normal rain gauge

Self-recording rain gauge

(I379)carrying operation

(I379)carrying operation

carrying operation

Solvent: Dissolving and flowing in water

Floating current: floating and flowing in water

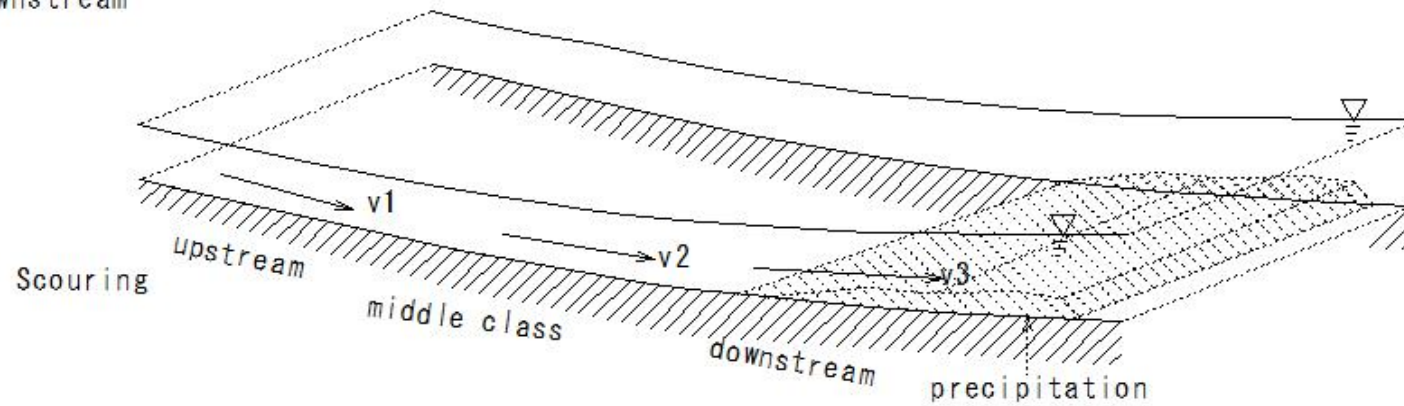
Sweep: Flowing by rolling on the river bed

river

erosion effect

Sediment grains

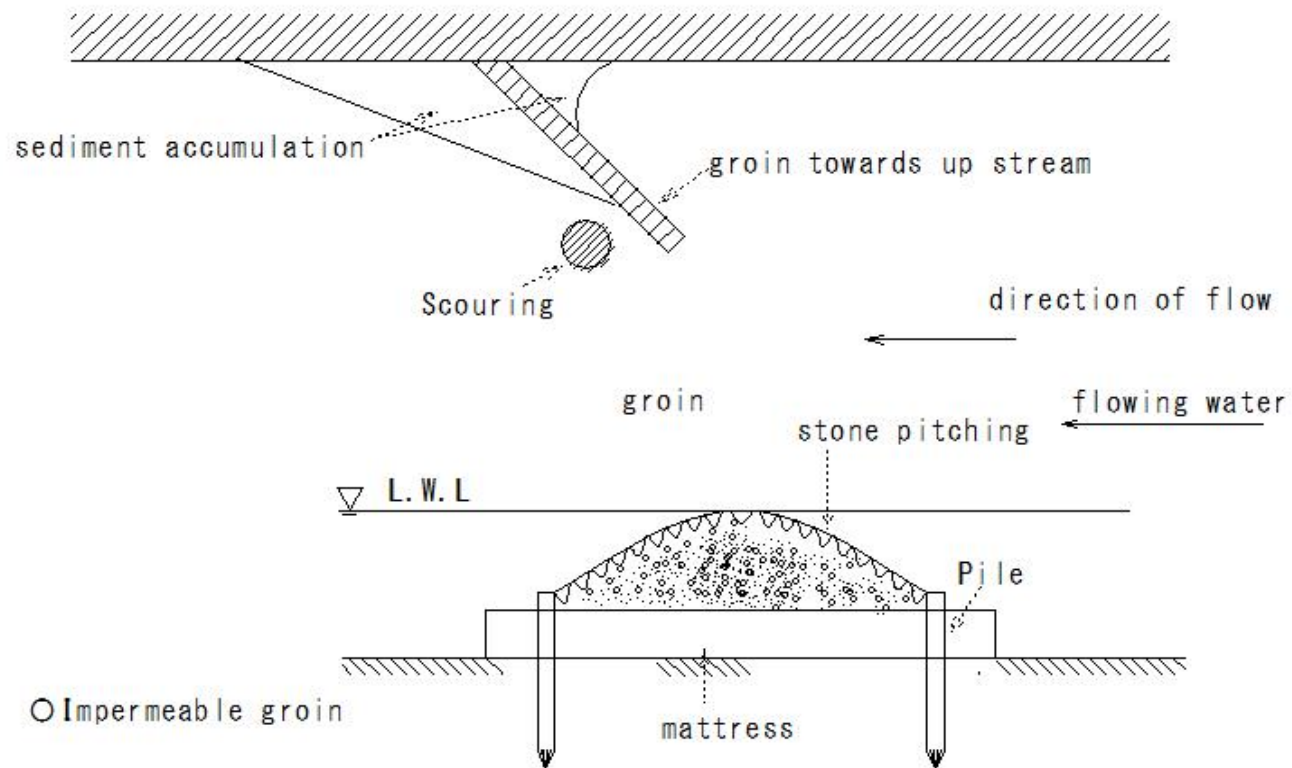
flow downstream



(I380)Groyne towards up stream

(I380)Groyne towards up stream

groyne towards up stream - pedestal - deposition
groyne that juts out on the upstream side



R289

(I381)Circle of influence

(I381)Circle of influence

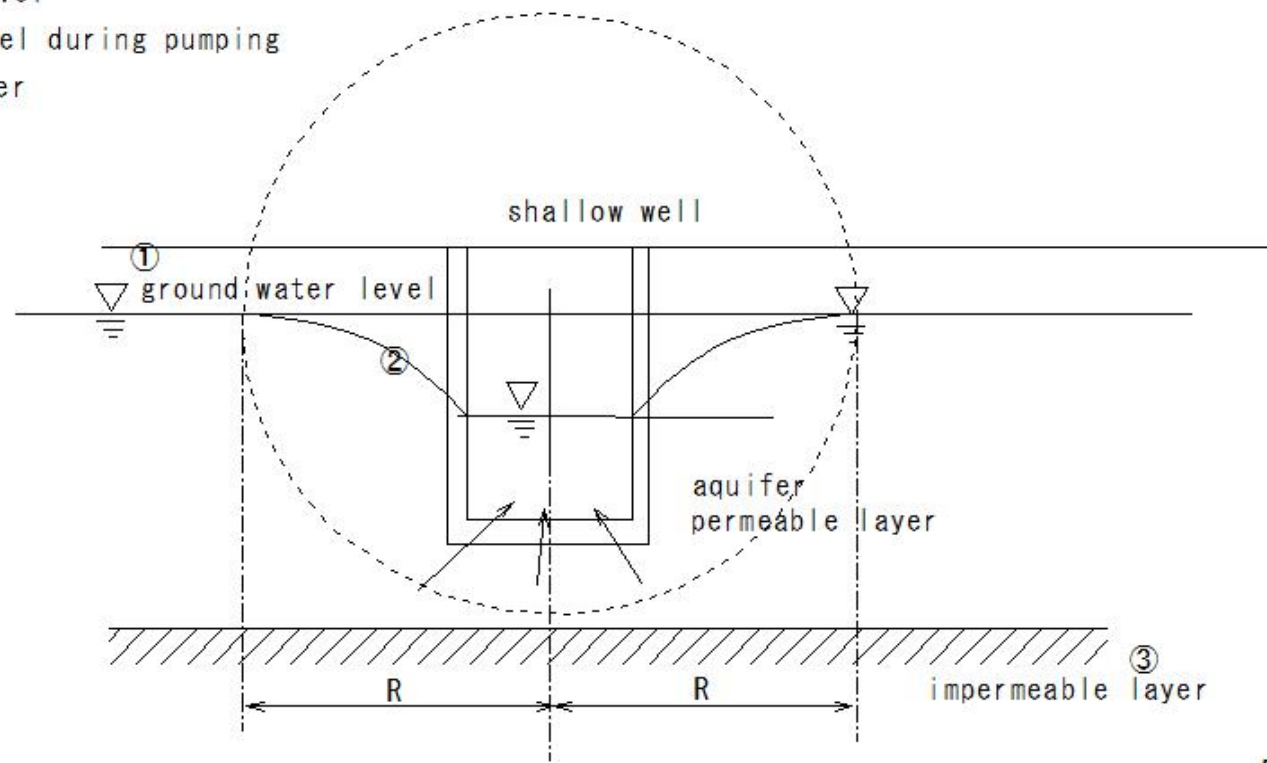
Circle of influence

shallow well

① ground water level

② Groundwater level during pumping

③ Impermeable layer

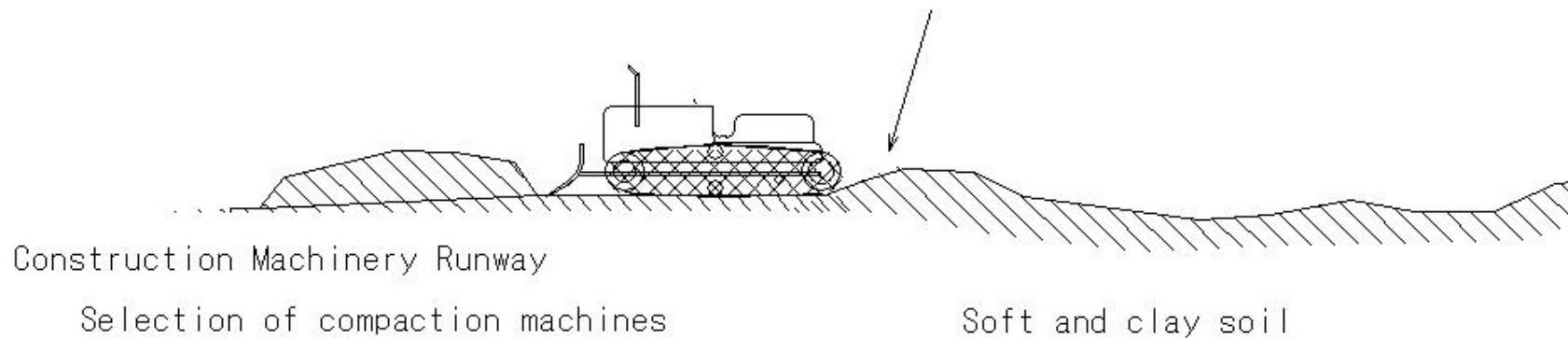


E495

(I382)Sensitivity ratio

(I382) Sensitivity ratio

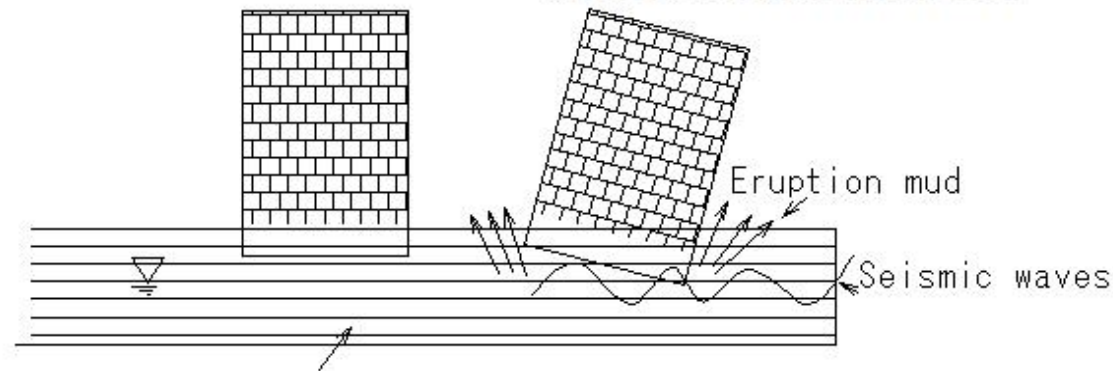
Sensitivity ratio - large
Kneading
Unable to drive



E499

(I383)liquefaction

(I383) liquefaction

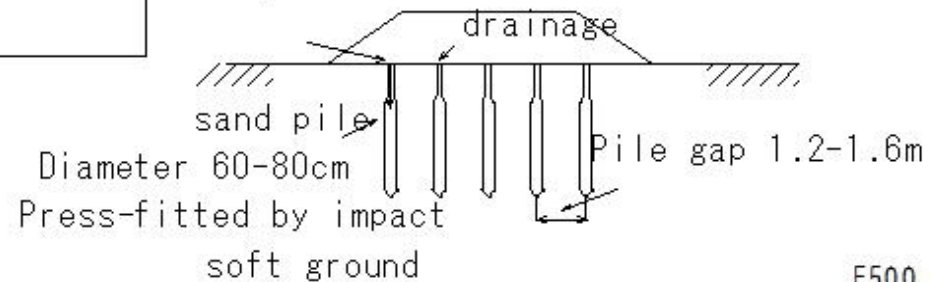


Groundwater level - high
Loose sandy ground
Earthquake - horizontal force
Ground liquefaction

countermeasure

Sand piles - ground improvement

Sand press-in



E500

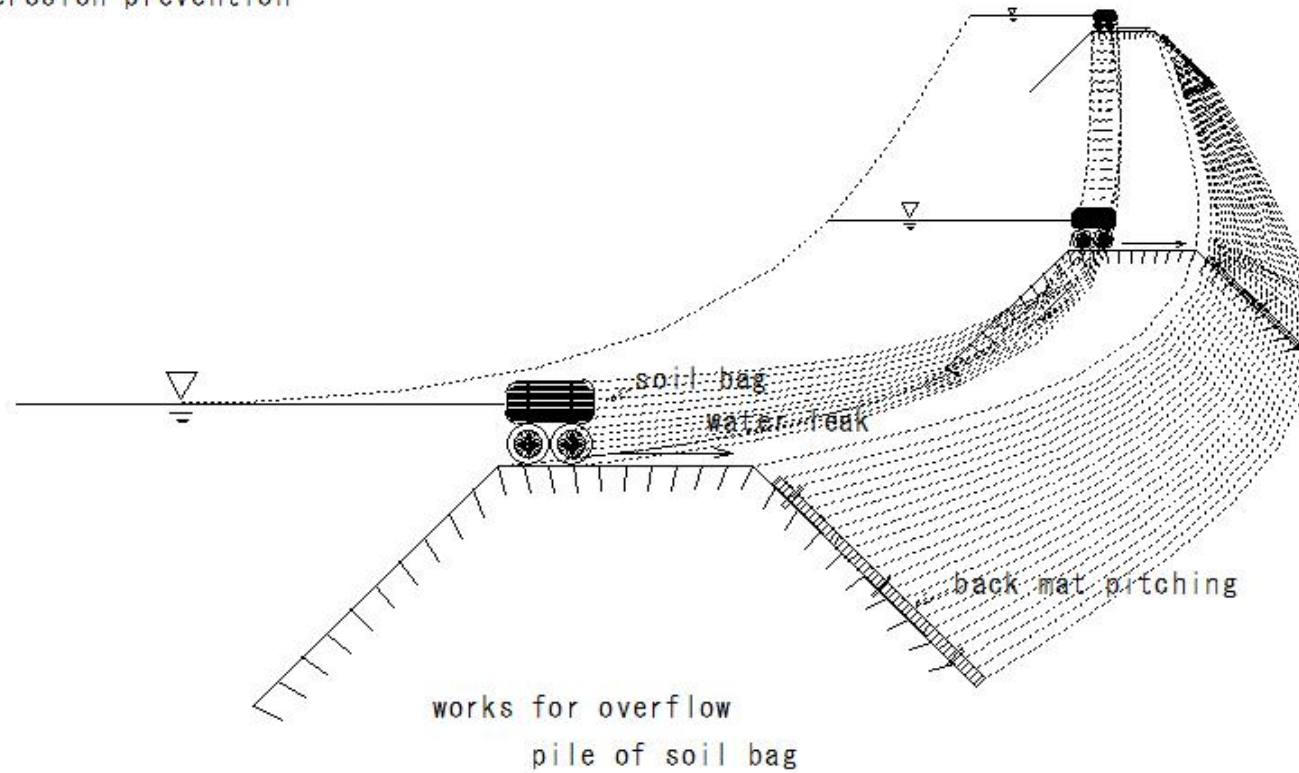
Liquefaction is a phenomenon in which sandy ground filled with groundwater temporarily turns into liquid due to the shaking of an earthquake.

(I384)Works for overflow

(I384)Works for overflow

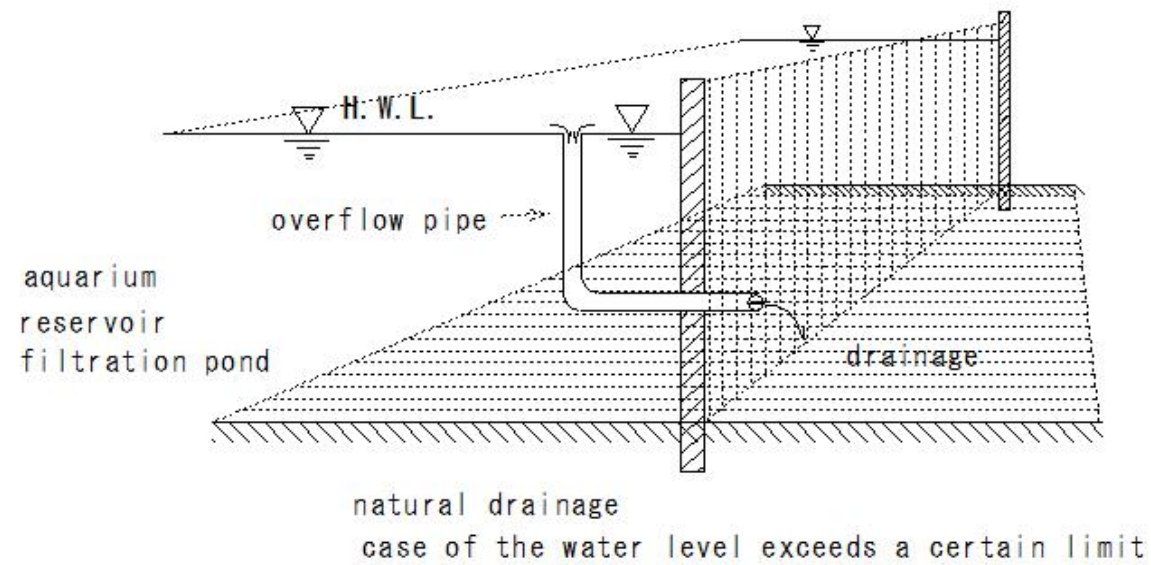
works for overflow

Preventing water from overflowing on the embankment
erosion prevention



(I385) Overflow pipe

(I385) overflow pipe

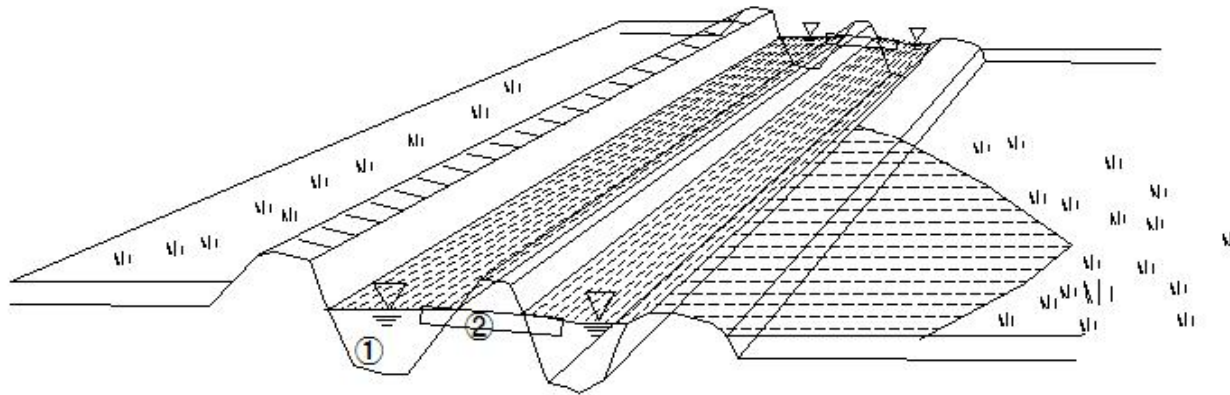


(I386)Flood Irrigation(Overflow irrigation)

(I386)Flood Irrigation(Overflow irrigation)

Flood Irrigation(Overflow irrigation)

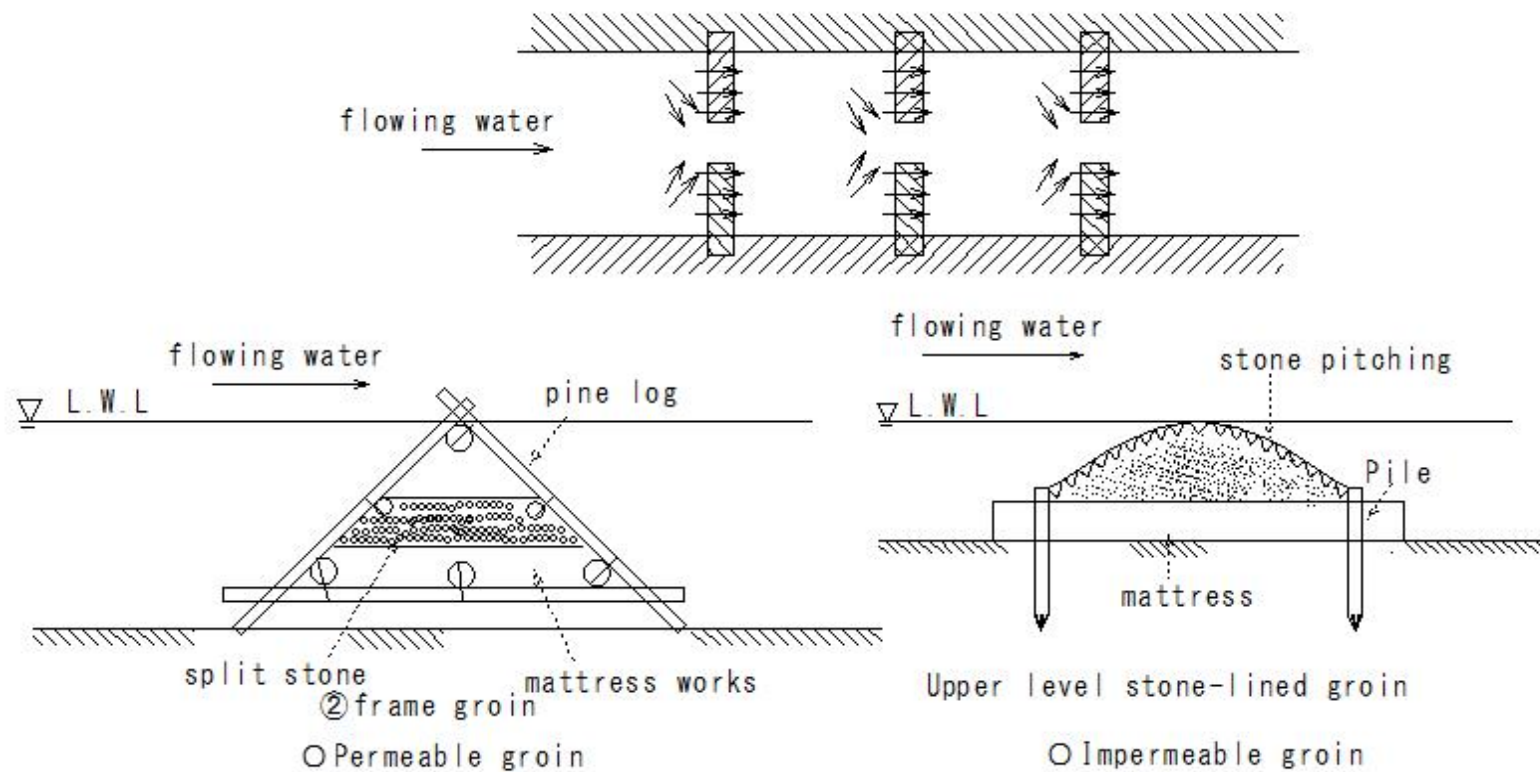
- ① Branch canal
- ② Irrigation canal



Overflow irrigation is a method of watering crops by allowing water to flow into areas where water accumulates, such as between ridges or in lowlands.

(I387)Groyne over the water

(I387)Groyne over the water

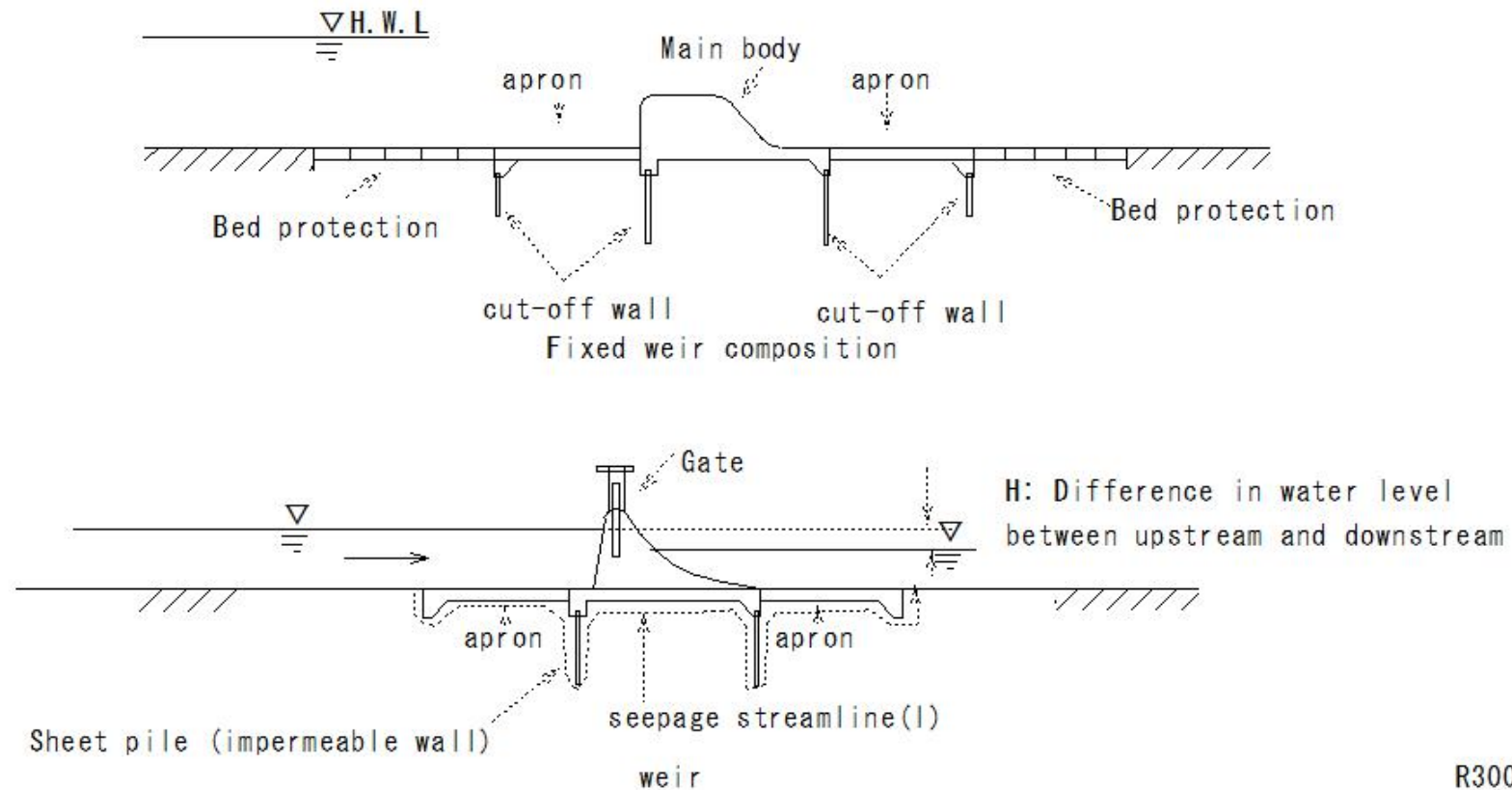


(I388) Overflow weir

(I388) Overflow weir

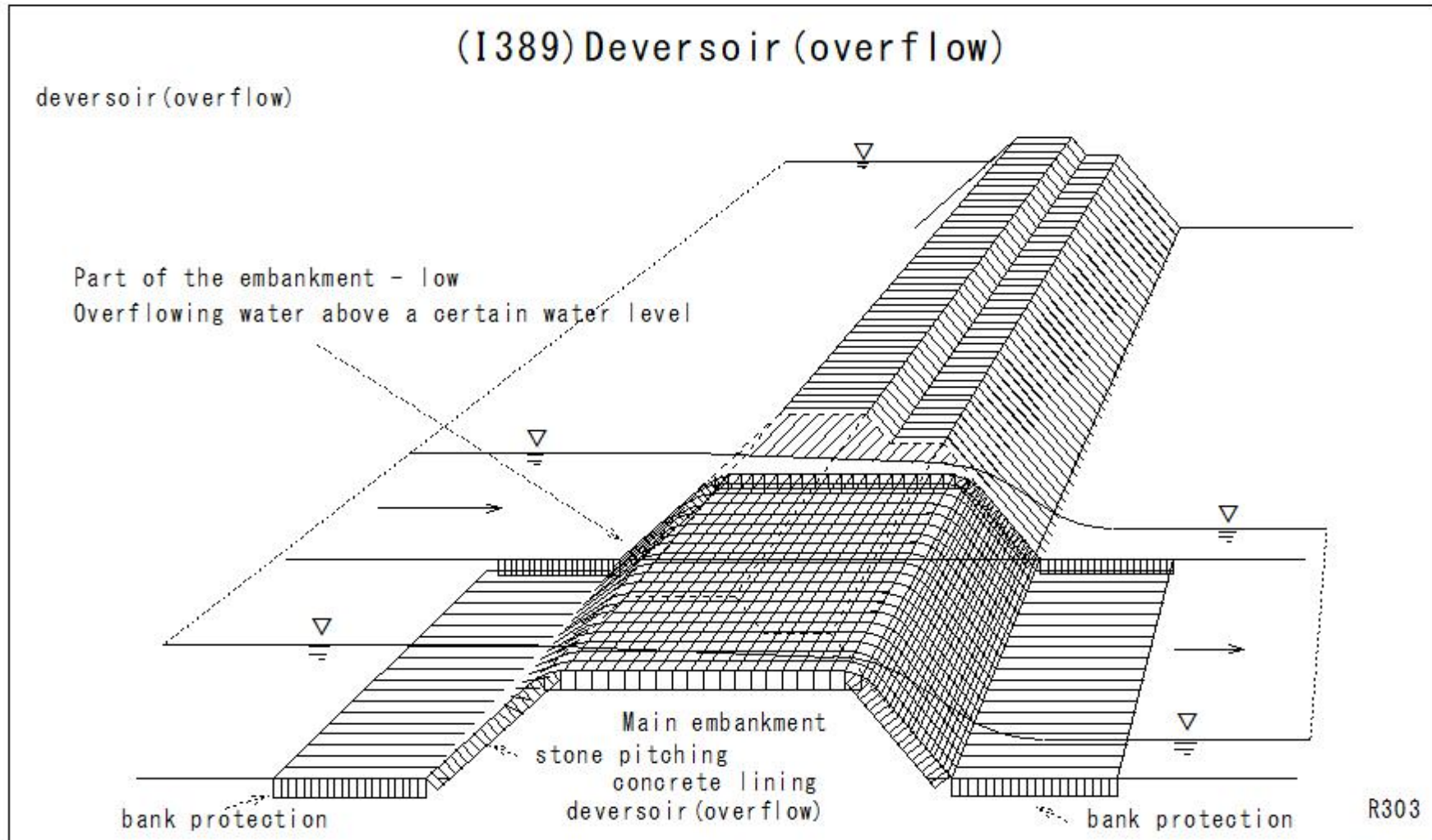
overflow weir

Water flows over the top



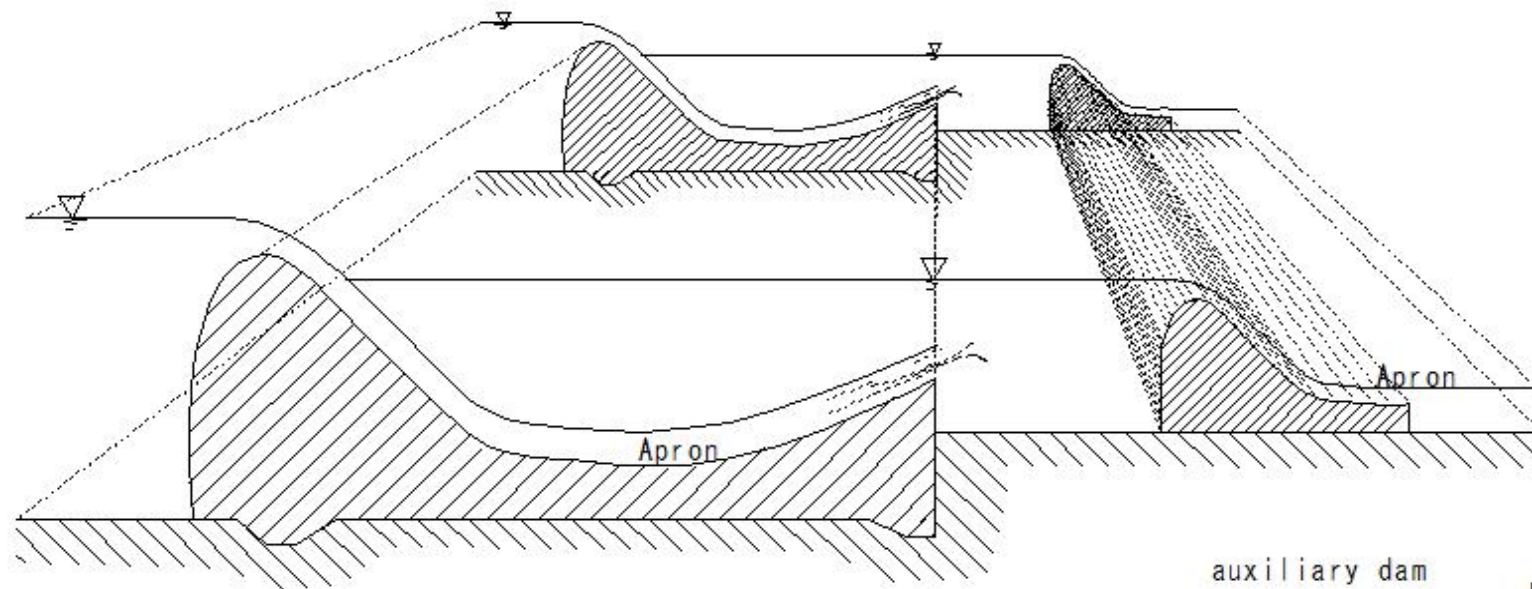
R300

(I389)Deversoir(overflow)



(I390)Apron

(I390) Apr on

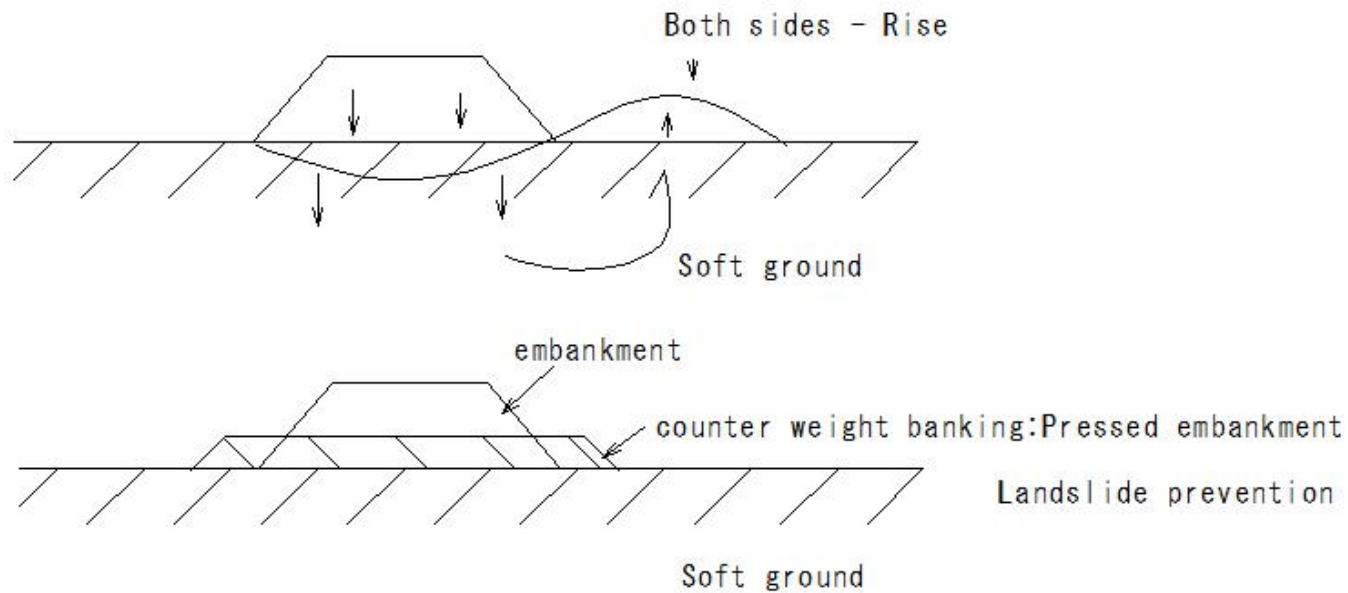


R476

(I391)Pressed embankment

(I391)counter weight banking:Pressed embankment

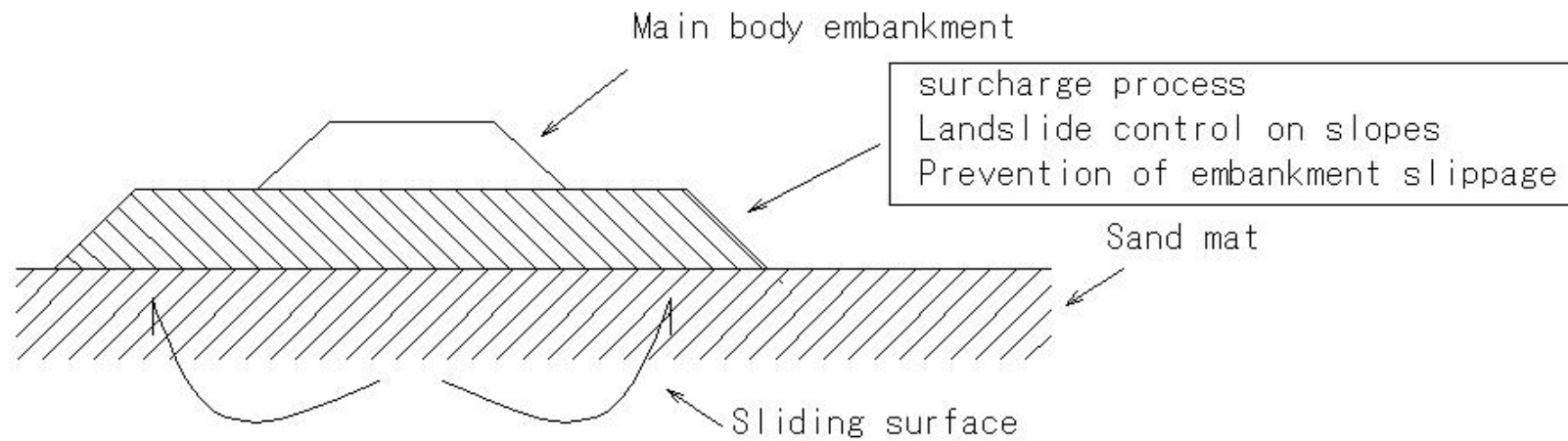
counter weight banking:Pressed embankment



Adding landslide resistance by filling the bottom of the landslide block.

(I392) Surcharge process: Pressing embankment method

(I392) Surcharge process: Pressing embankment method



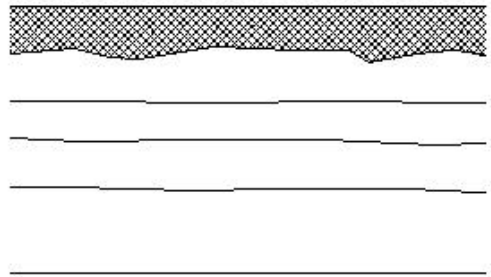
(I393)Overlay

(I393) Overlay

Overlay

Overlay is a method of repairing cracks and fissures that occur mainly on the surface of roads and asphalt.

- ① Repairs can be completed in a short time at low cost.
- ② The overlay method repairs by adding the work on top of the existing pavement surface.
- ③ No loud noise or vibrations.
- ④ No work is required to remove the asphalt.
- ⑤ No cutting machines or heavy machinery are used.

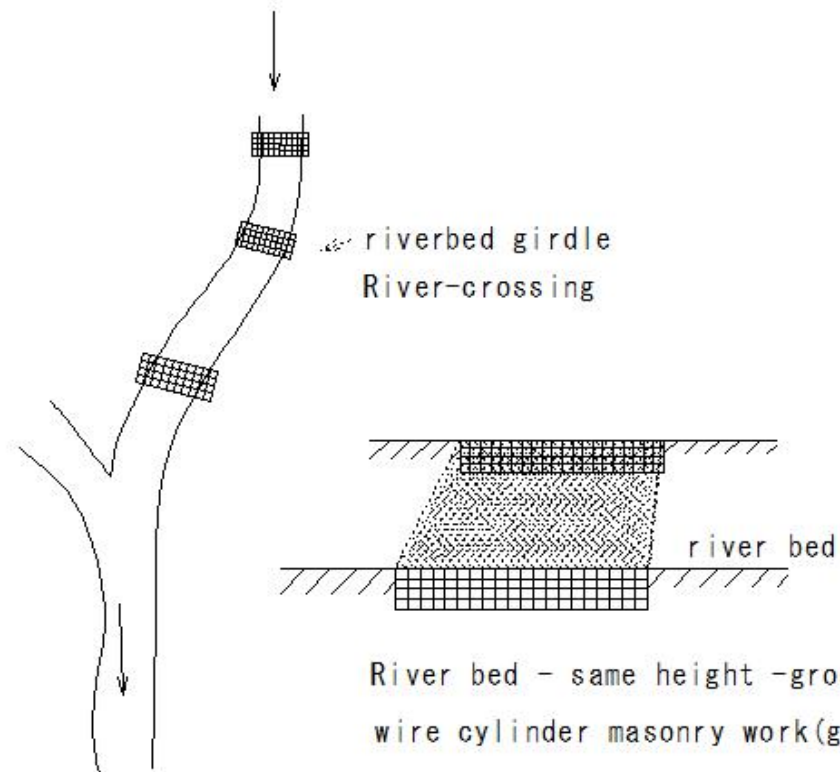


Overlay

(I394)Riverbed girdle

(I394)Riverbed girdle

Riverbed girdle



River bed - same height -ground sill consolidation
wire cylinder masonry work(gabion)

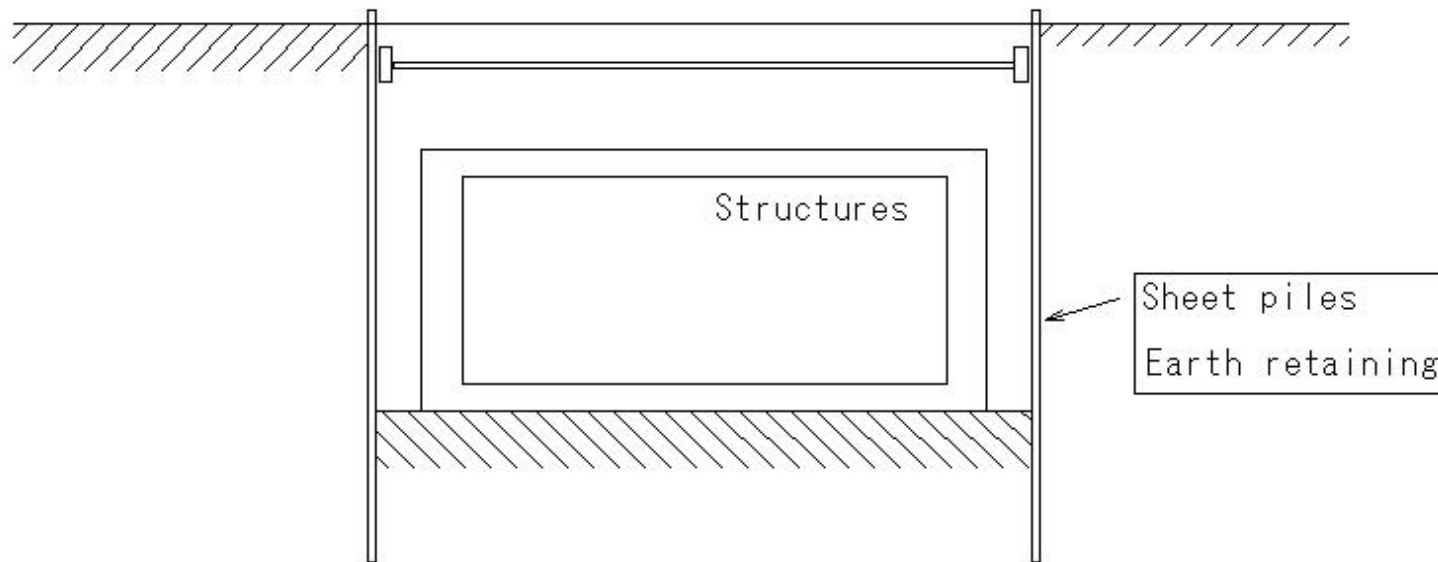
Turbulent flow - Prevention of river bed decline

R304

(I395)Open cut method

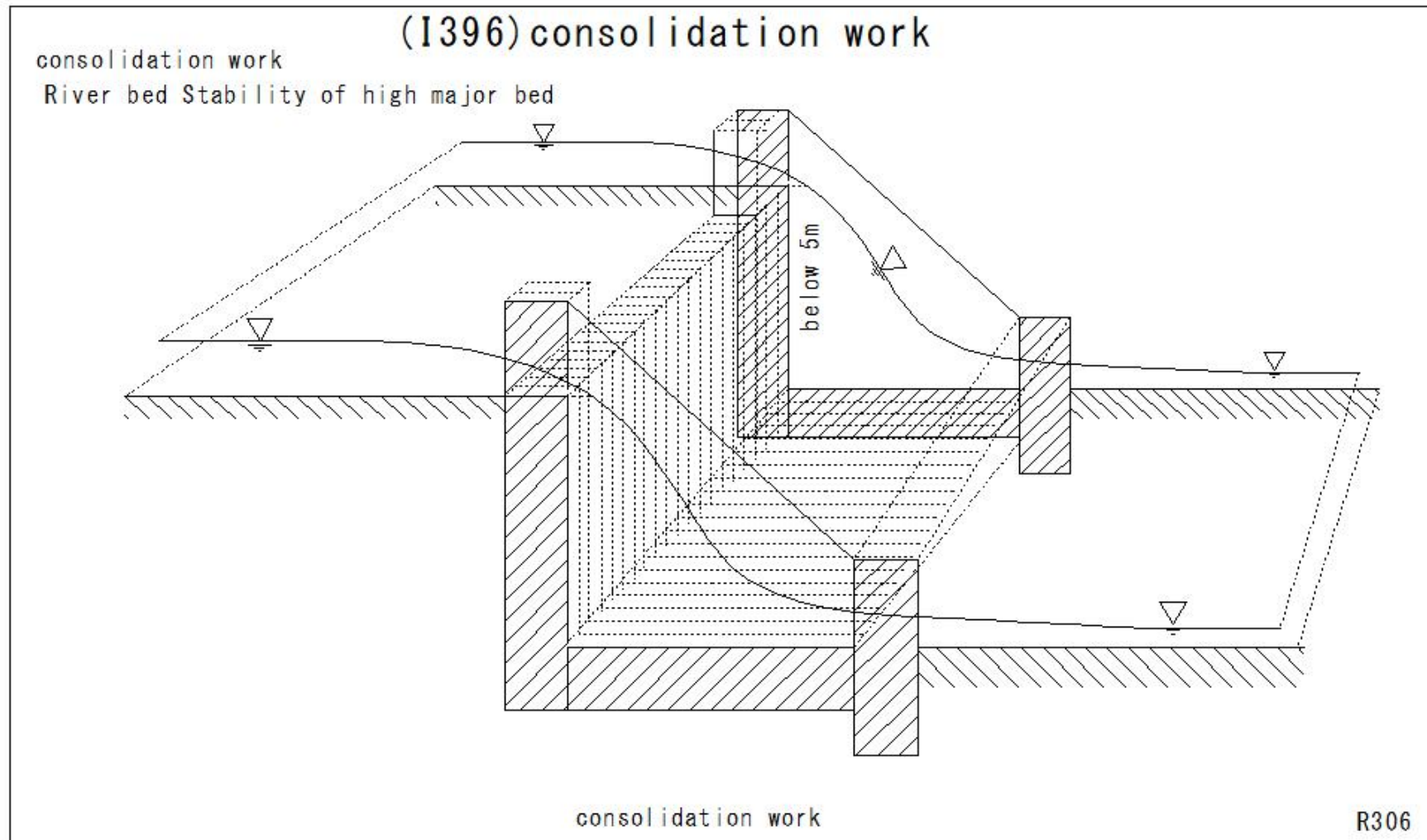
(I395)Open cut method

Open cutting method

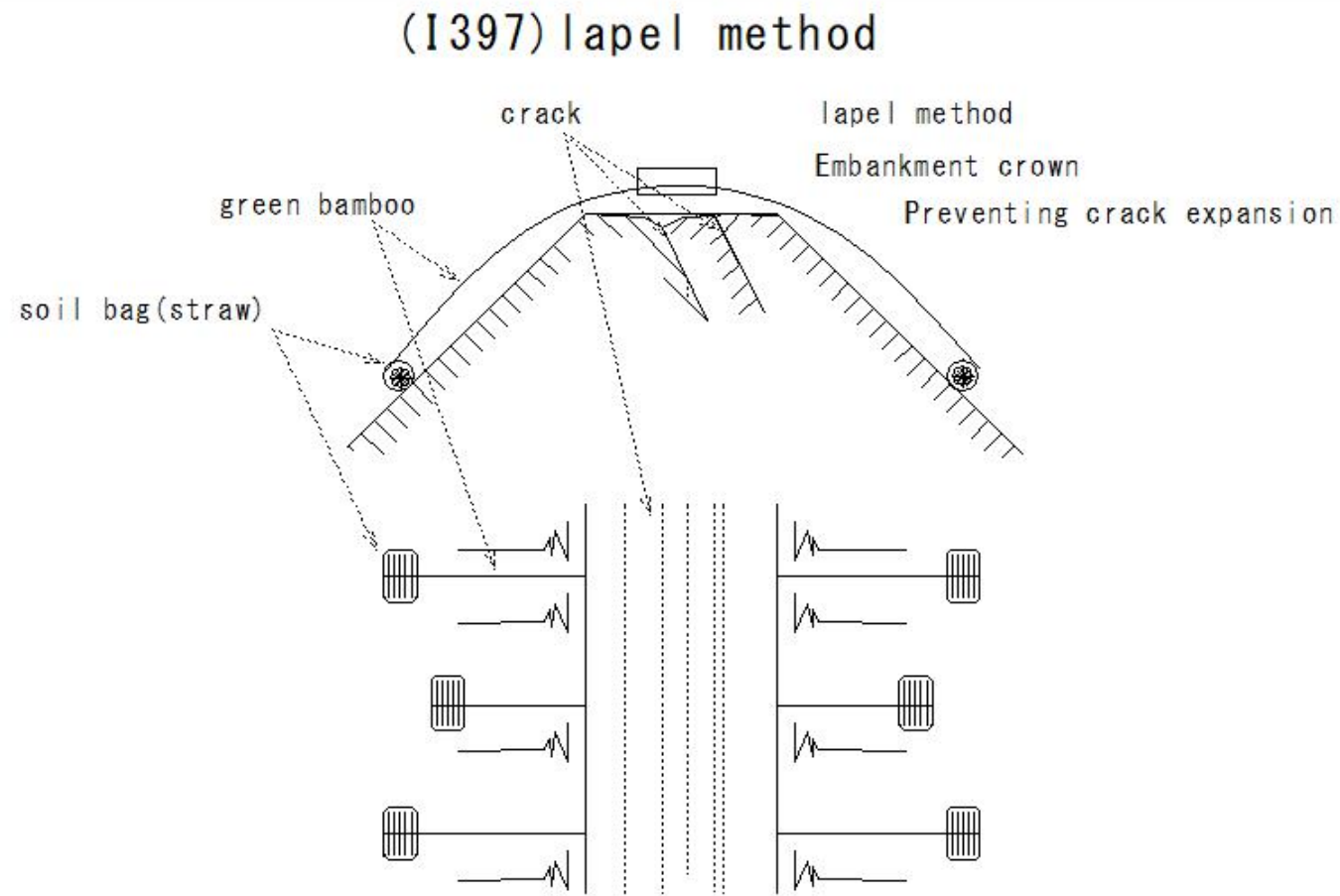


E503

(I396)consolidation work



(I397)lapel method



R307

(I398)Orifice

(I398) Orifice

Orifice

Standard orifice

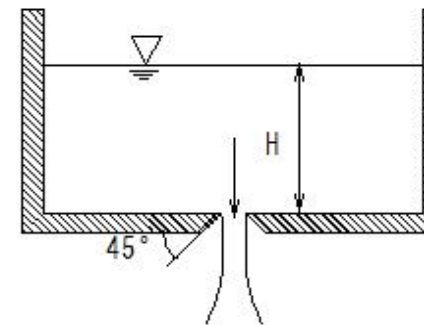
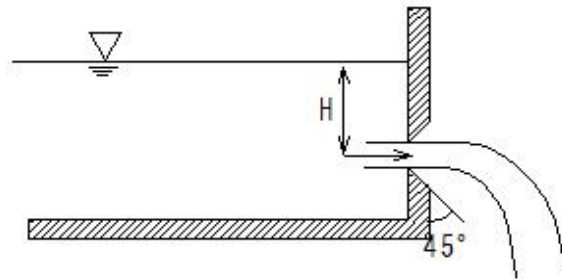
Flow rate $Q = Ca\sqrt{2gH}$

C : Flow coefficient

a : Cross-sectional area of the orifice

g : Gravitational acceleration

Standard orifice



A water outlet opened in the wall of a water tank or a board that blocks running water

(I399)Water supply(pumping flow system(Pressurized water distribution method))

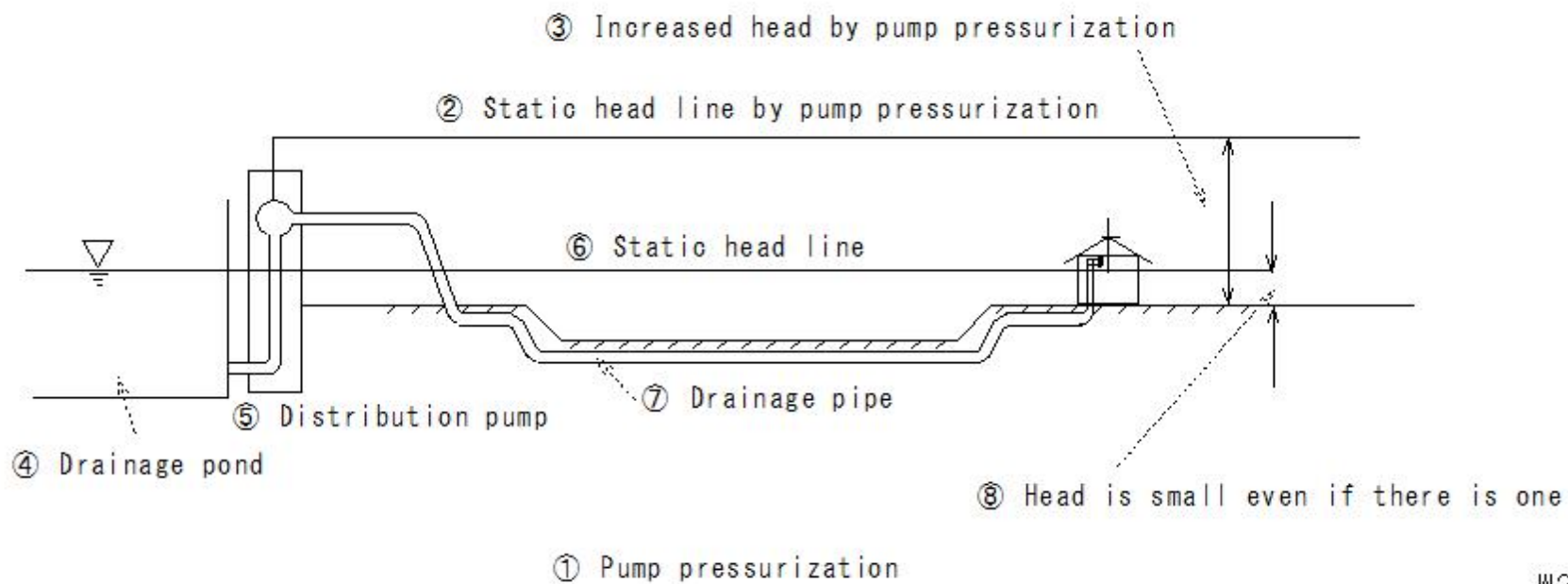
(I399)Water supply(pumping flow system(Pressurized water distribution method))

Water supply

pumping flow system(Pressurized water distribution method)

in case of there is no high ground due to water distribution

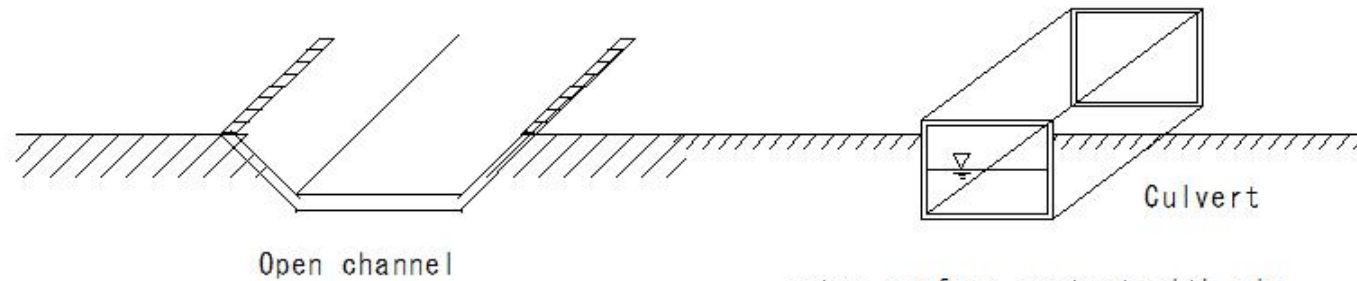
A method of directly delivering water by applying pressure using a pump



(I400)Open channel

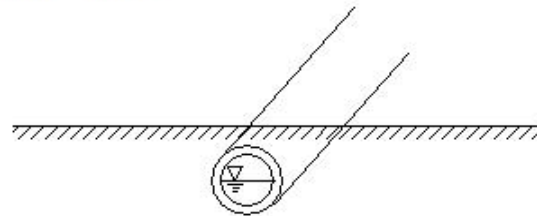
(I400) Open channel

Water surface - in contact with the atmosphere - waterway



water surface-contact with air
Channel slope - current velocity - gravity flow

waterway tunnel



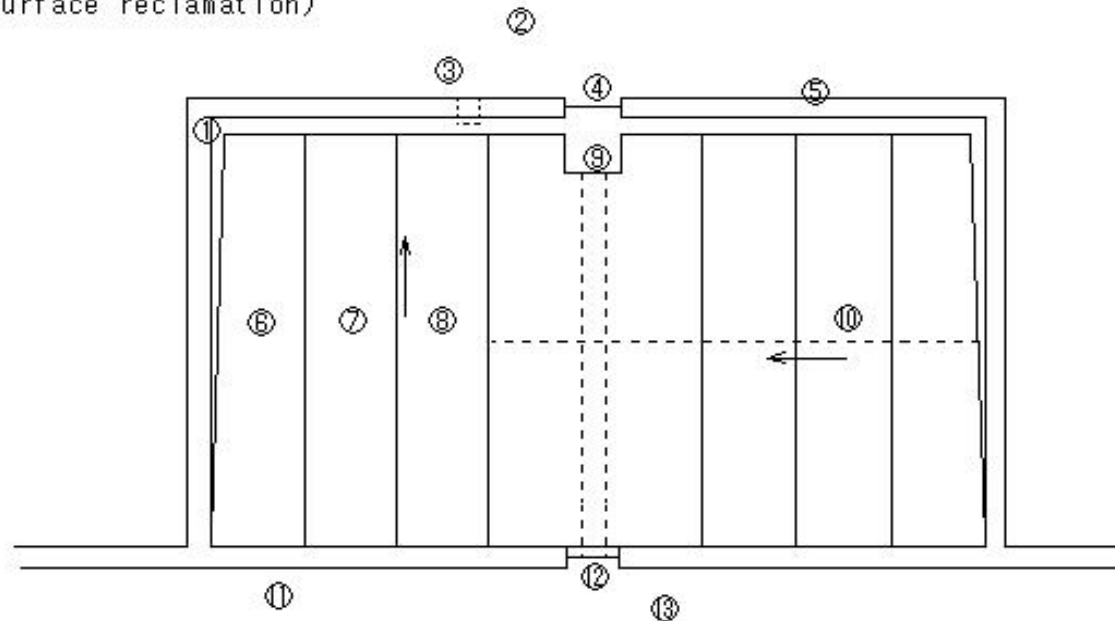
water surface-contact with air
Channel slope - current velocity - gravity flow

(I401)Sea bottom reclamation (Sea surface reclamation)

(I401)Sea bottom reclamation (Sea surface reclamation)

Sea bottom reclamation (Sea surface reclamation)

- ① Place with the tide
- ② Sea surface
- ③ Tide stop gate
- ④ Drain gate
- ⑤ Levee
- ⑥ Irrigation channel
- ⑦ Drainage channel
- ⑧ Irrigation channel
- ⑨ Reservoir
- ⑩ Drainage channel
- ⑪ Levee
- ⑫ Hindland drainage gate
- ⑬ Land

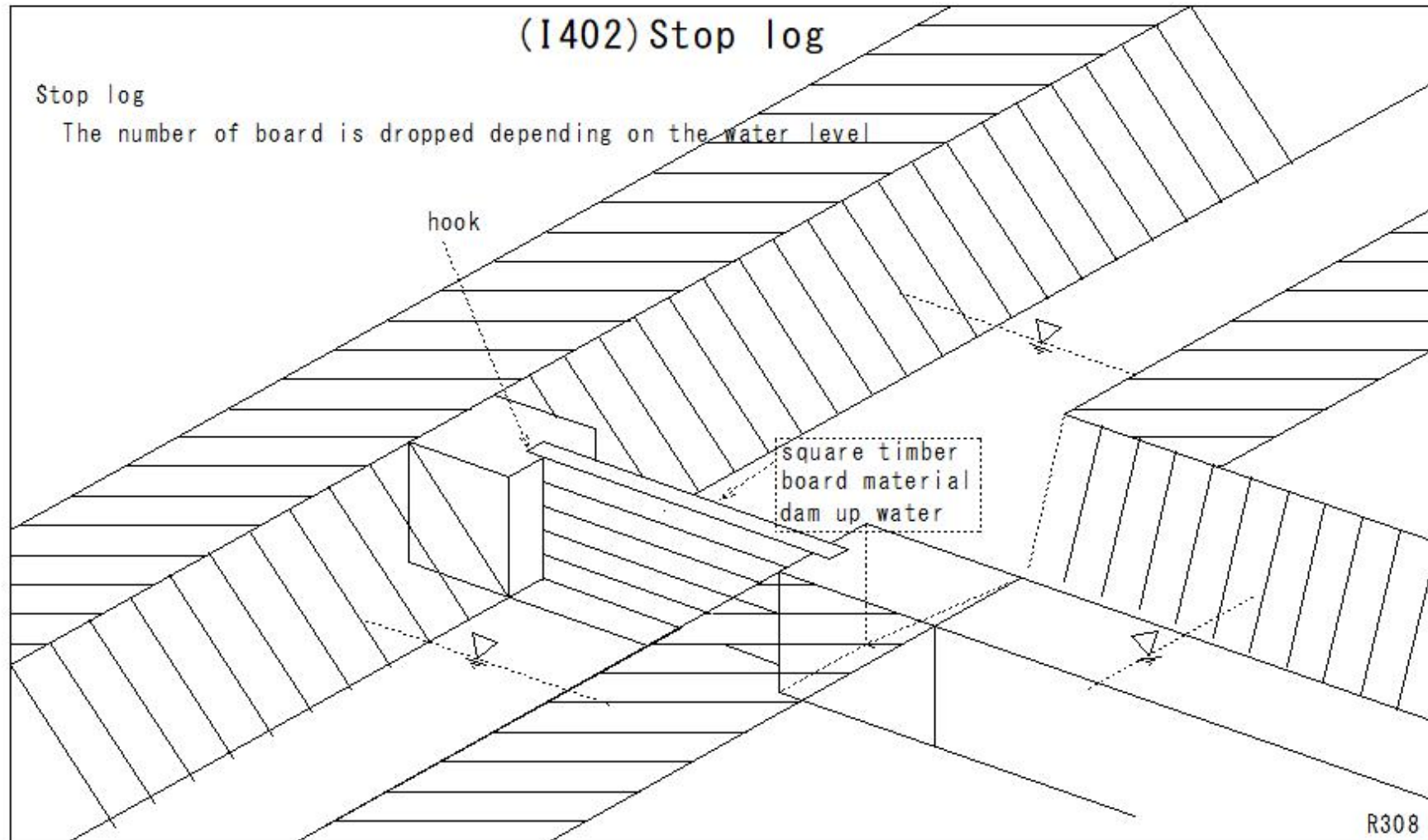


Sea surface reclamation is the process of dividing the sea or wetlands with levees or other structures, draining the water, and turning them into land.

Purpose: Turn the water surface into land and use it for farmland, urban development, etc.

Method: Surround the sea or wetlands with levees, drain the water, bring in soil, etc., and turn the water surface into land.

(I402)Stop log



(I403)Estuary improvement

(I403)Estuary improvement

Sand control

Near the river mouth

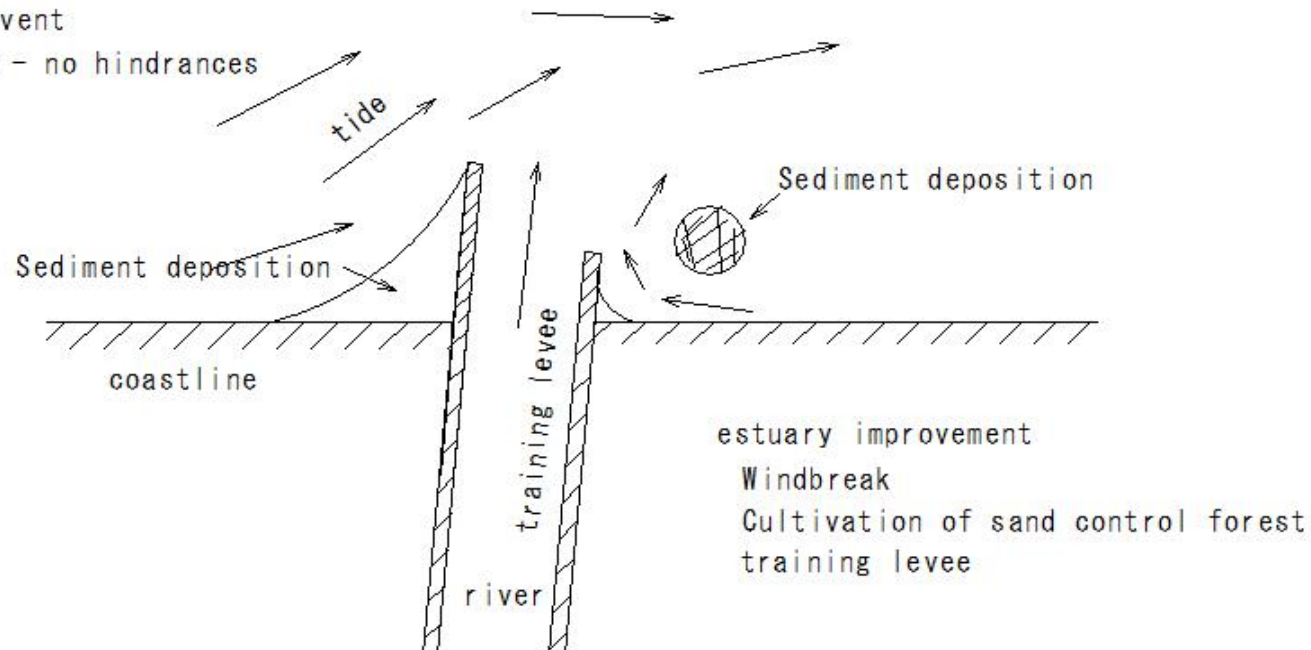
river quicksand

drifting sand on the coast

flying sand

Blockage - prevent

ship transport - no hindrances

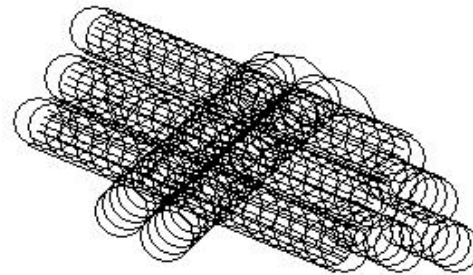
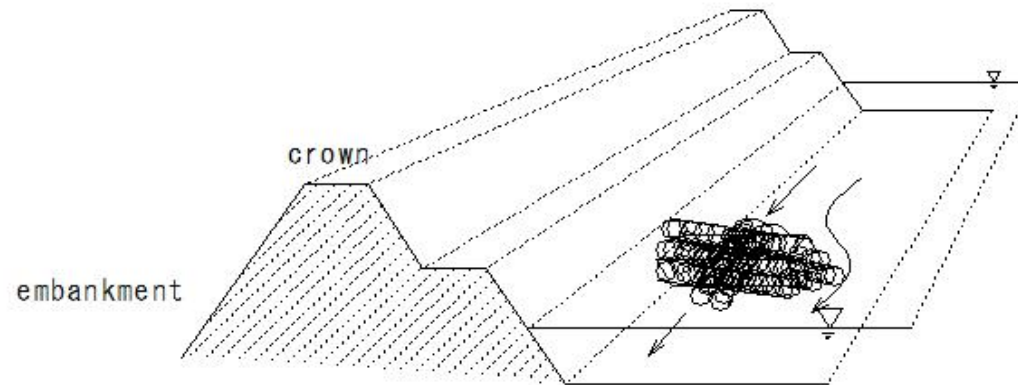


R309

(I404)Semi-permeable groin -wire cylinder masonry work(gabion)

(I404) Semi-permeable groin -wire cylinder masonry work(gabion)

Semi-permeable groin -wire cylinder masonry work(gabion)



Semi-permeable groin
wire cylinder masonry work(gabion)

R310

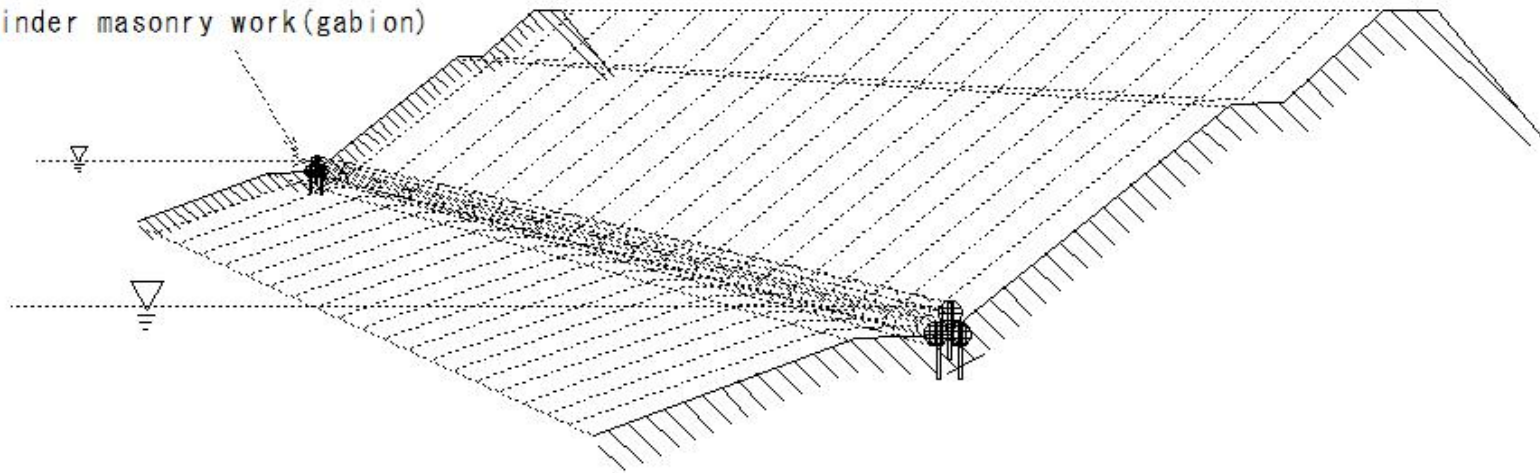
(I405)Semi-permeable groin -wire cylinder masonry work(gabion)

(I405) Semi-permeable groin -wire cylinder masonry work(gabion)

Semi-permeable groin -slope foot protection

slope foot protection

wire cylinder masonry work(gabion)



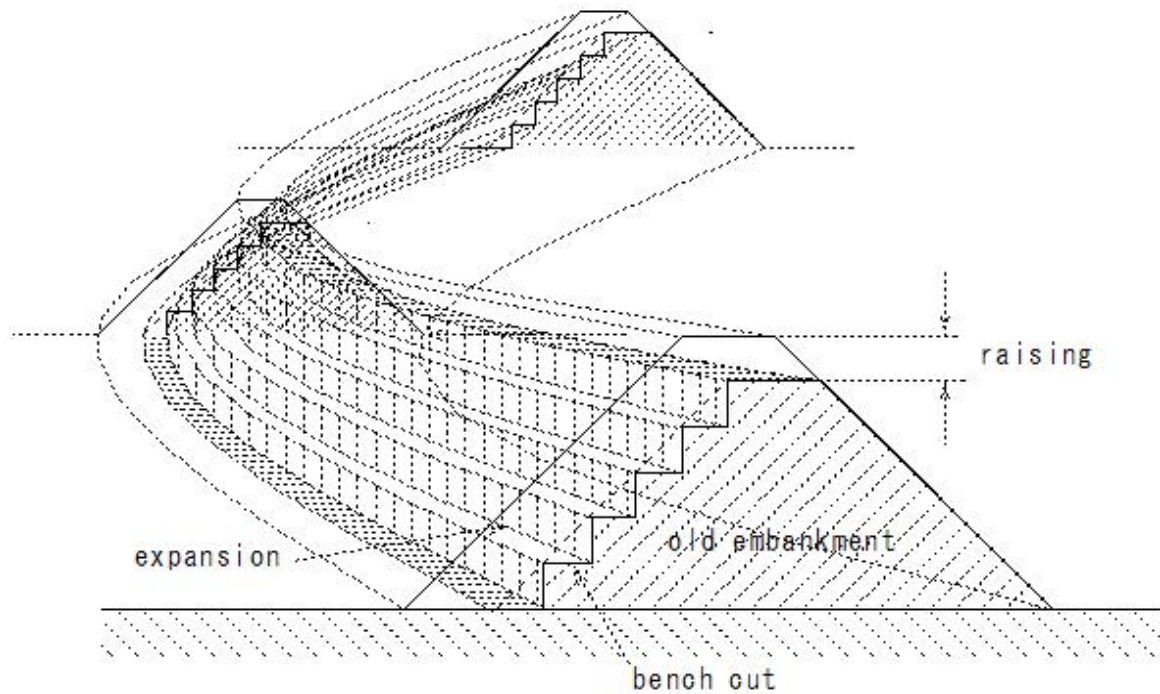
R311

(I406)Embankment(raising)

(I406) Embankment (raising)

Raising

Embankment crown increases



R312

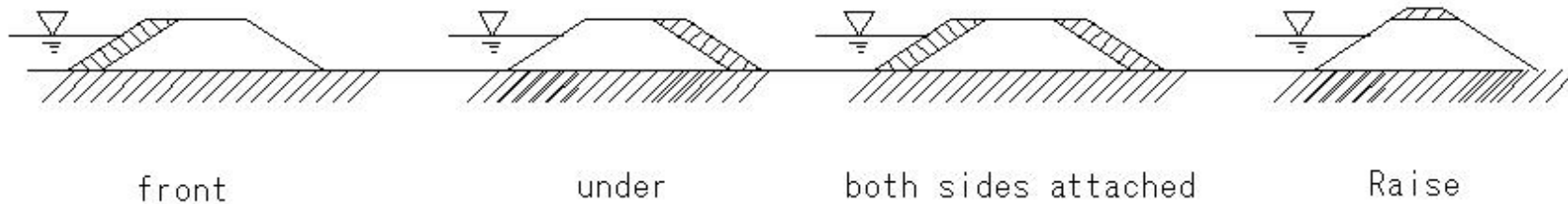
(I407)Embankment(raising)

(I407) Embankment (raising)

Levee - High - Soft - Raised

Settling part - raising

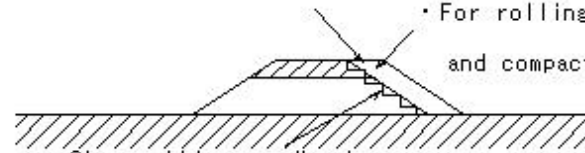
levee widening



- Walling embankment to existing embankment

- Walling embankment

- For rolling compaction, make the layer thin and compact it sufficiently.



- Step cutting - adhesion

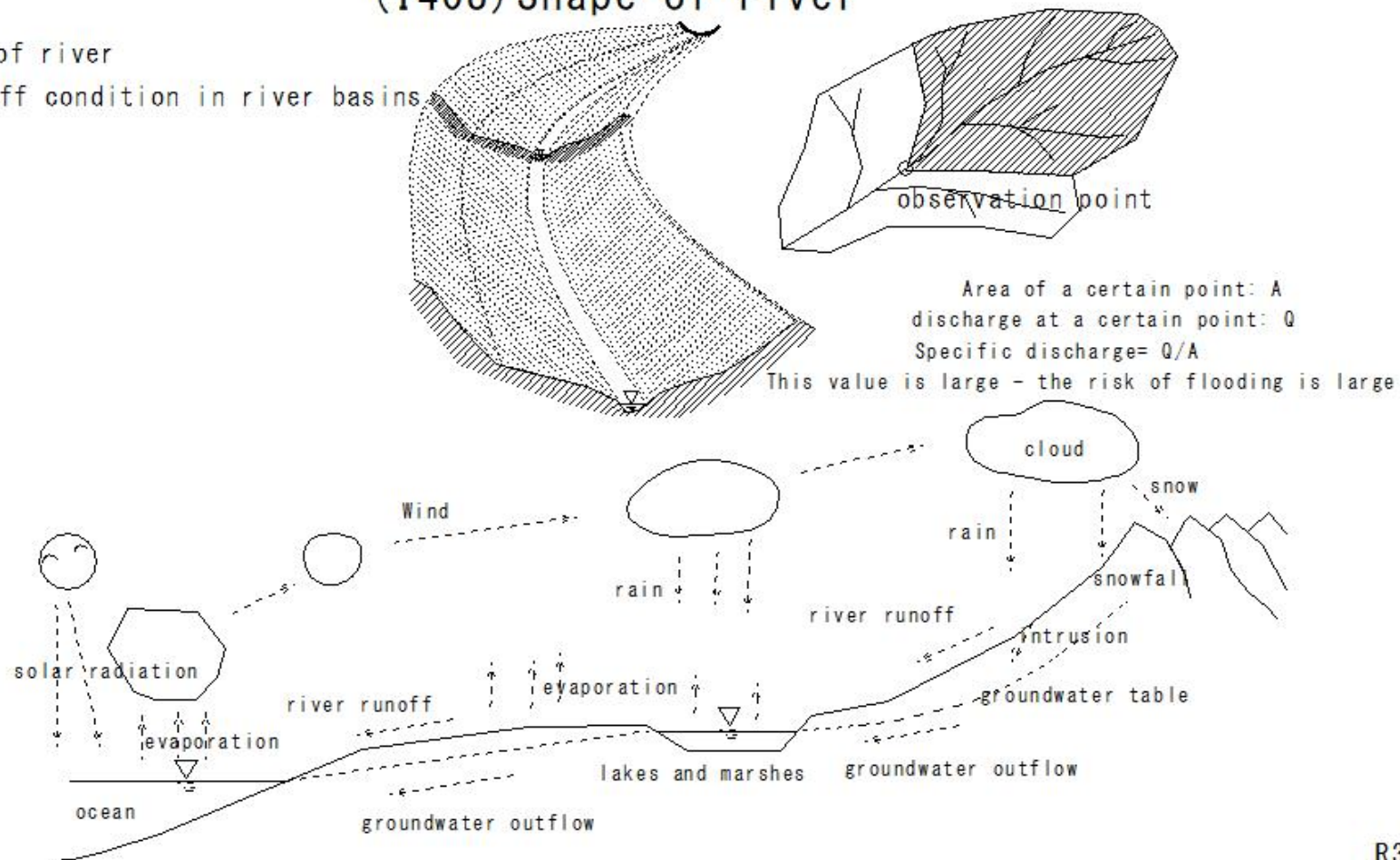
- Soft ground - whole embankment - Settlement

(I408)Shape of river

(I408) Shape of river

Shape of river

Runoff condition in river basins



R314

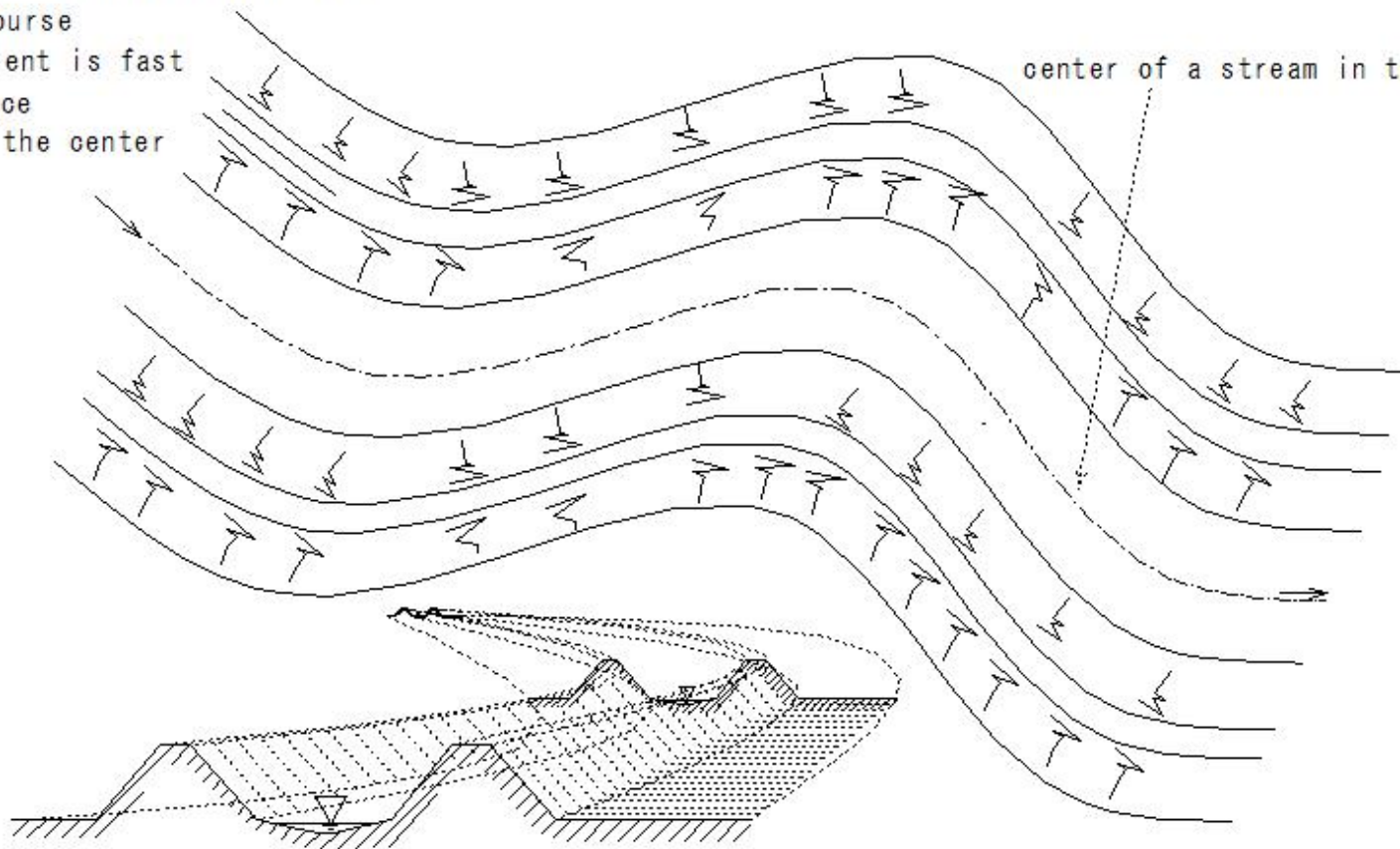
(I409)Center of stream in the river

(I409)Center of stream in the river

Center of a stream in the river

water course
the current is fast
deep place
connect the center

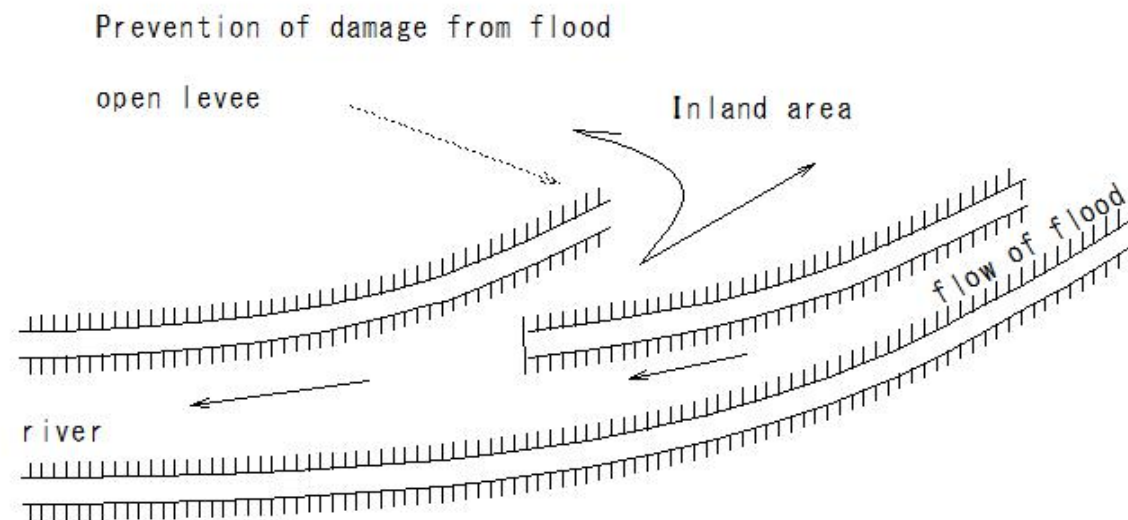
center of a stream in the river



R315

(I410)Open levee

(I410) open levee

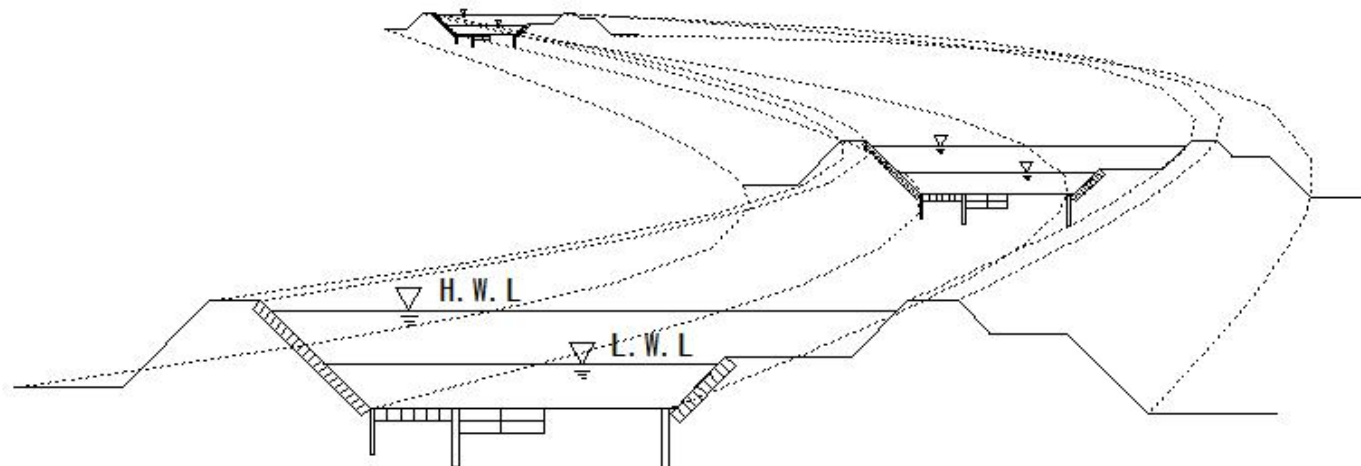


(I411)River improvement

(I411)River improvement

River improvement

- ①River improvement refers to construction work to prevent disasters such as floods and high tides and improve rivers.
- ②It includes various measures to ensure the flow capacity of rivers, such as building sand banks and digging riverbeds.

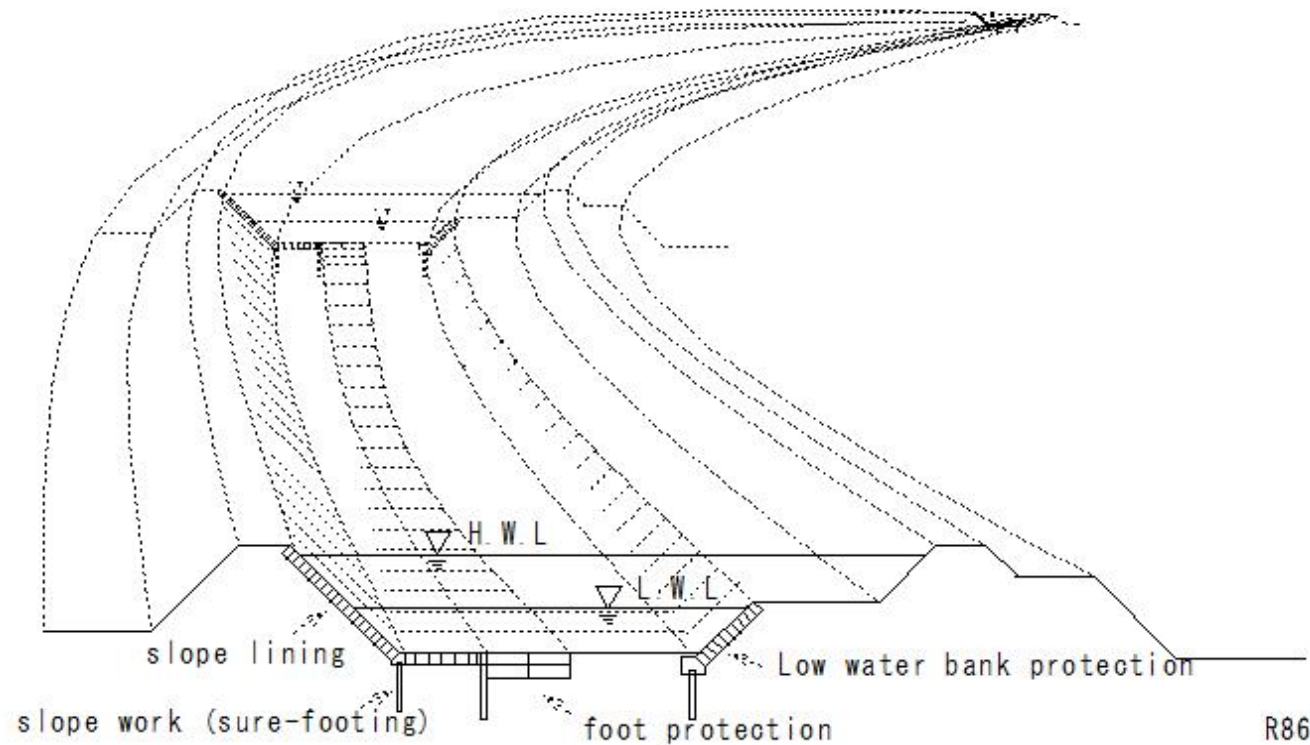


(I412)River administer

(I412)River administer

River administer

- ① A river administrator is a person who makes plans for flood control, water use, and environmental improvement of rivers, and who carries out construction and maintenance.



R86

(I413)River works

River works

High water construction

River channel repair work

Bank protection/groin

Water control work

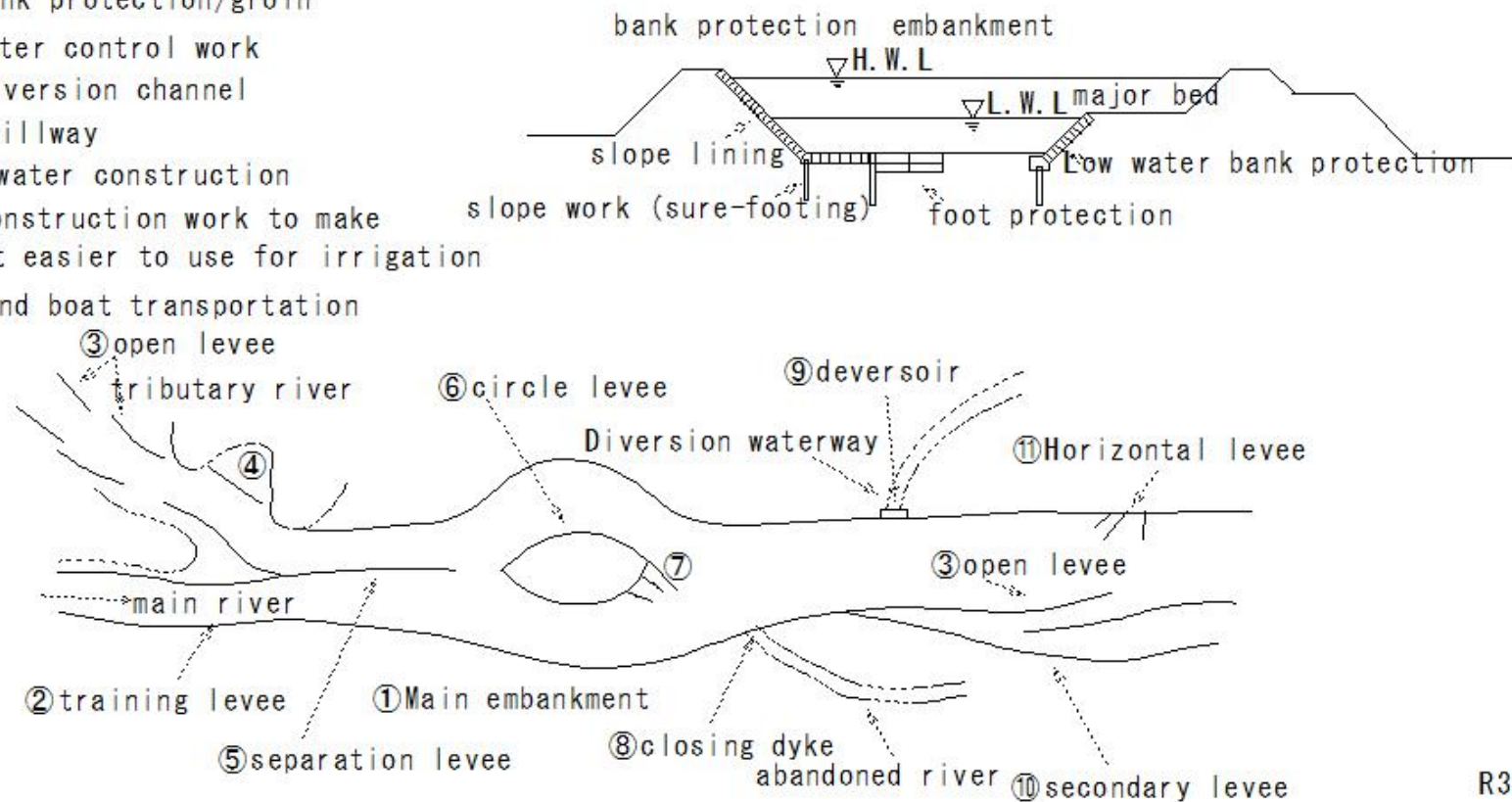
diversion channel

Spillway

low water construction

Construction work to make
it easier to use for irrigation

and boat transportation

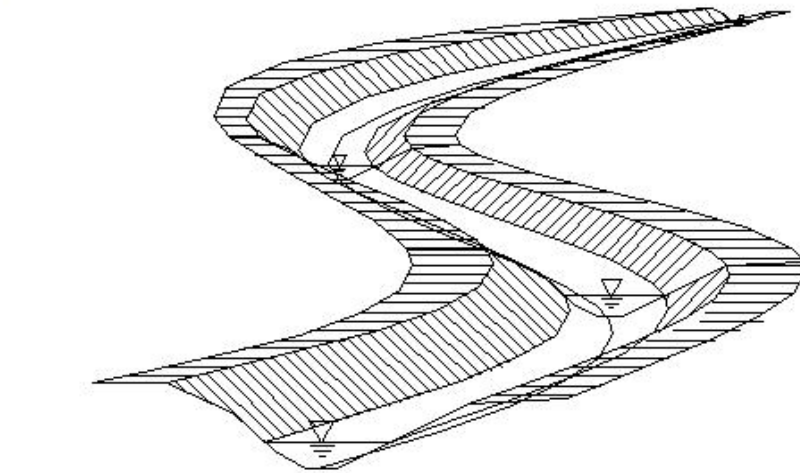


R323

(I414)Equilibrated grade of river

(I414)Equilibrated grade of river

Equilibrated grade of river



equilibrated grade of river

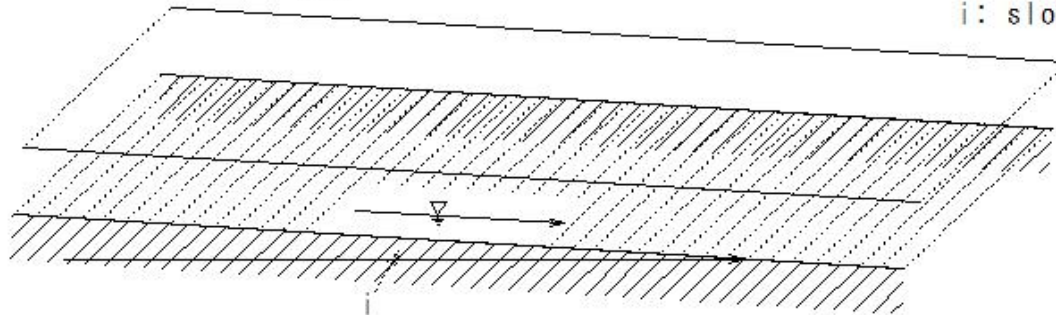
$$v = C\sqrt{Ri}$$

v: flow velocity

C: runoff coefficient

R: hydraulic radius

i: slope of river bed



(I415)Graded condition of river

(I415)Graded condition of river

Graded condition of river

carrying operation

Solvent: Dissolving and flowing in water

Floating current: floating and flowing in water

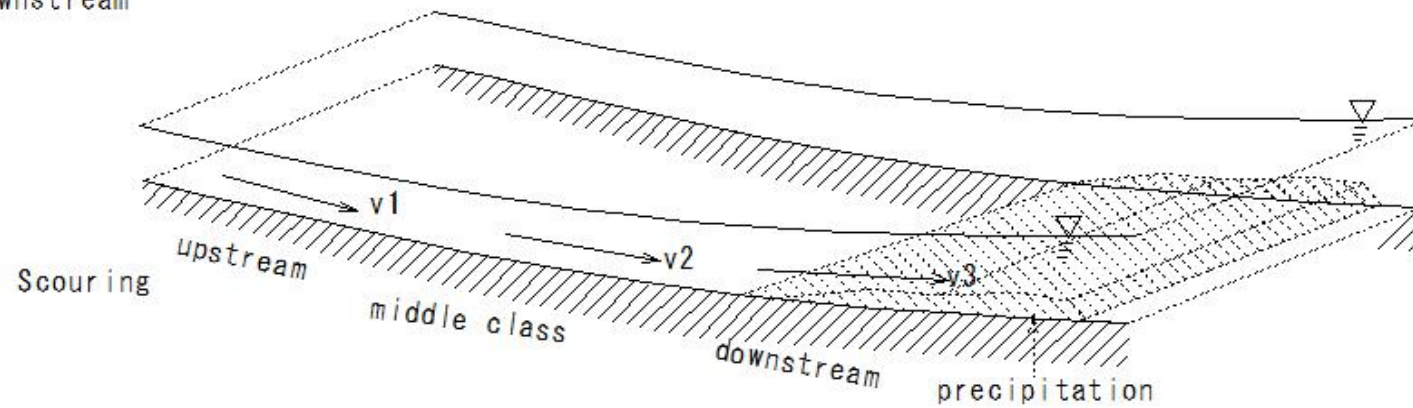
Sweep: Flowing by rolling on the river bed

river

erosion effect

Sediment grains

flow downstream



I379

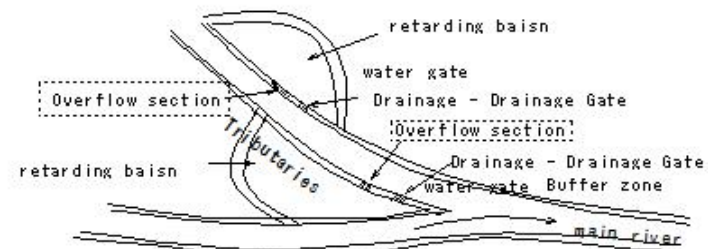
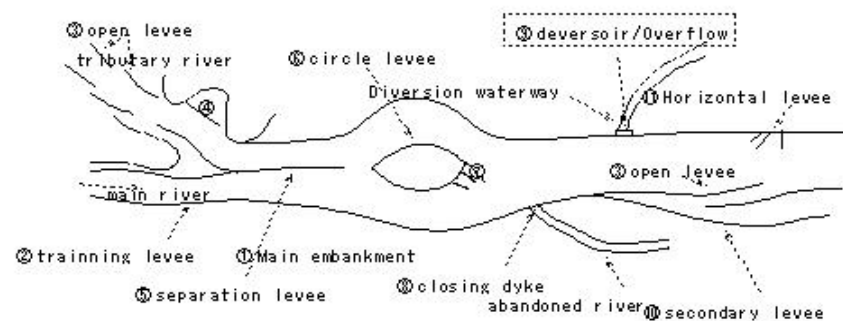
R290

(I416)River Law

(I416)River Law

River Law

- ① Prevent the occurrence of disasters caused by floods, tsunamis, high tides, etc.
- ② Rivers are used appropriately.
- ③ The normal function of flowing water is maintained.
- ④ River environment is improved and protected.
- ⑤ Comprehensive management.
- ⑥ Contribute to the conservation and development of the nation's land.
- ⑦ Maintain public safety and promote public welfare.



(I417)Water supply(activated carbon method)

(I417)Water supply(activated carbon method)

Water supply

Activated carbon method

Water purification method for drinking water

Odor

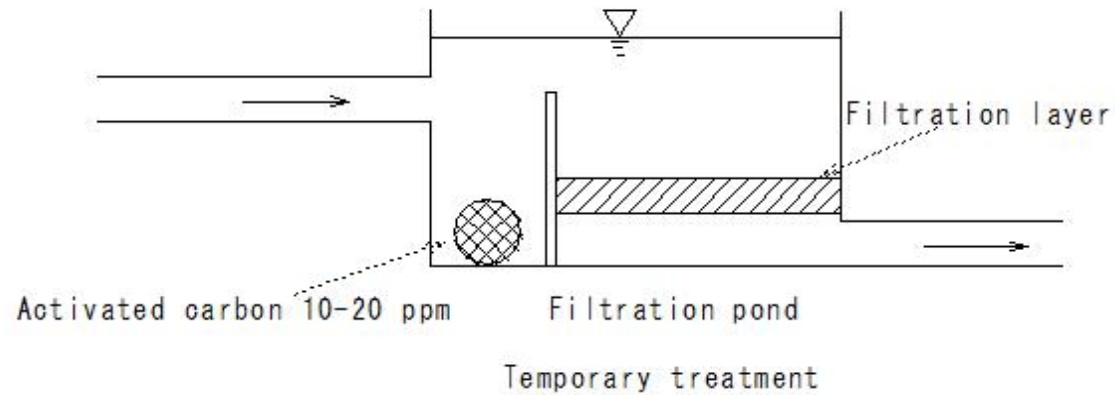
Color

Synthetic detergent

Removing radioactive substances

Uses activated carbon

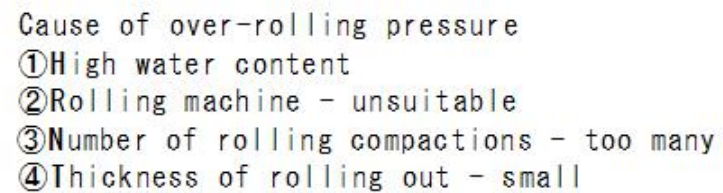
Combined with ozone treatment



W226

W229

(I418) Embankment (over compaction)



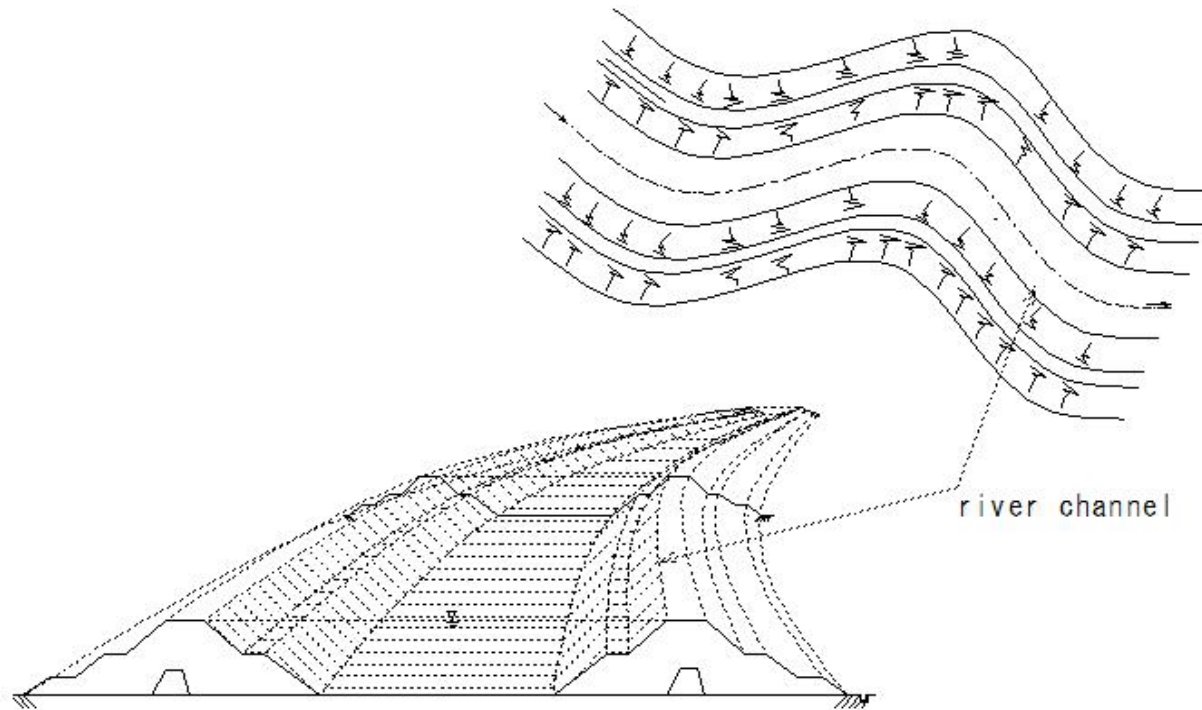
R326

(I419)River channel

(I419)River channel

River channel

water course through which river water flows



R327

(I420)River channel improvement

(I420)River channel improvement

River channel improvement

Flood prevention

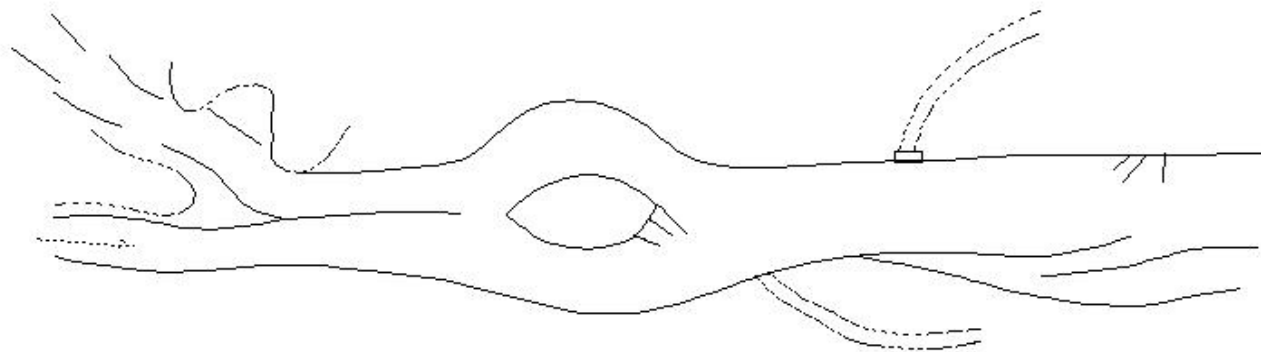
river channel improvement

High water construction

river channel improvement

High water control work

low water construction



R328

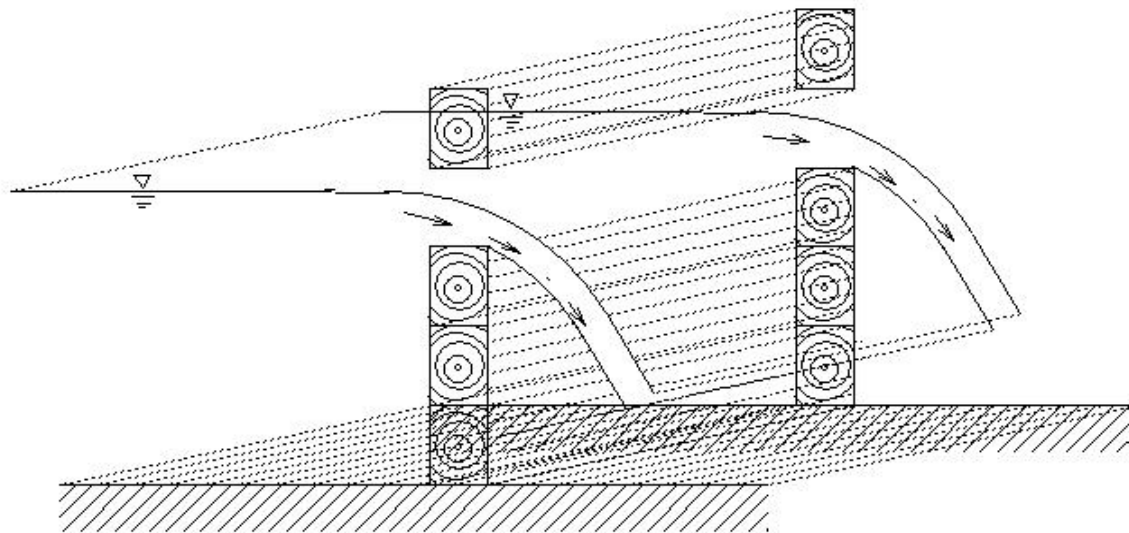
(I421)Movable weir(stop log)

(I421)Movable weir(stop log)

Movable weir

①stop log

adjust discharge

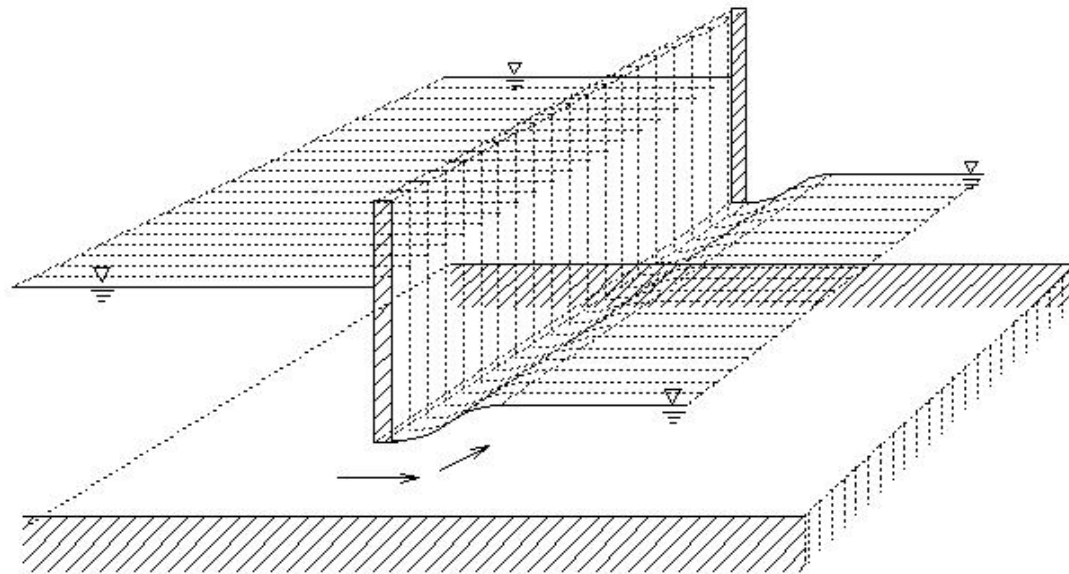


①stop log

(I422)Movable weir(Sluice gate)

(I422)Movable weir(Sluice gate)

Movable weir
adjust discharge



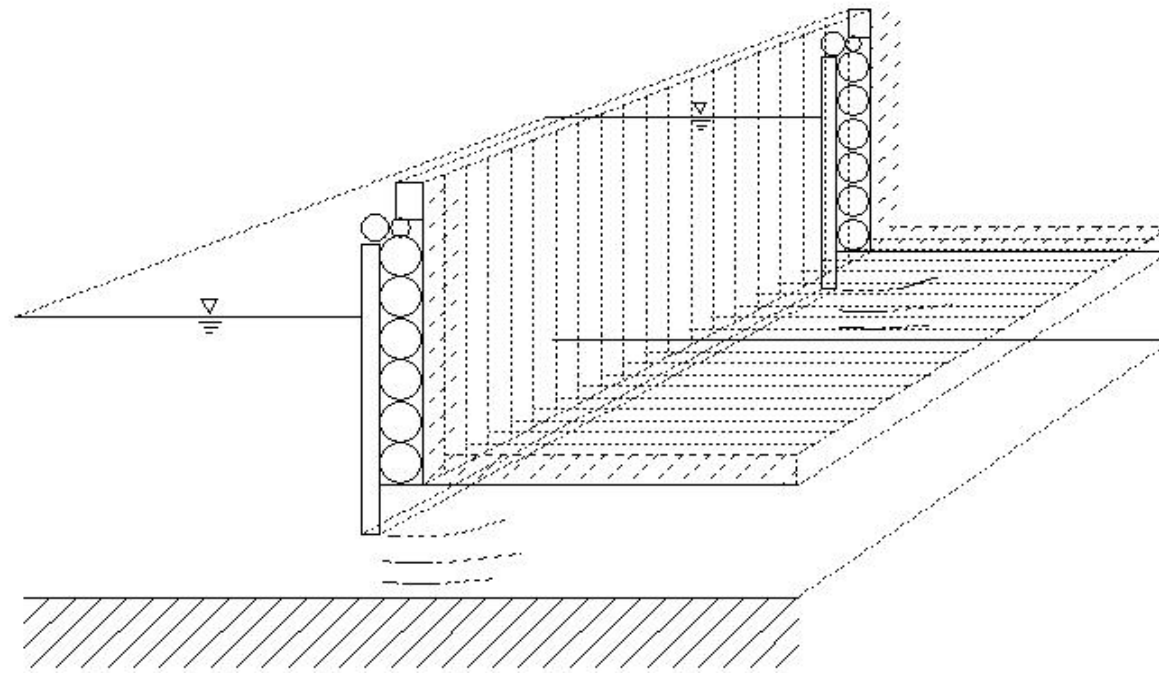
②Sluice gate

R330

(I423)Movable weir(Stoney Weir)

(I423)Movable weir(Stoney Weir)

Movable weir
adjust discharge
③ Stoney Weir



③ Stoney Weir

R331

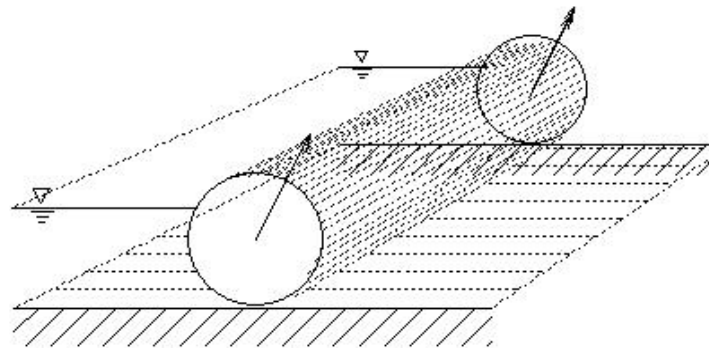
(I424)Movable weir(Rolling gate)

(I424)Movable weir(Rolling gate)

Movable weir
adjust discharge

④Rolling gate

Don't let the water overflow



④Rolling gate

(I425)Movable weir(Tentergate)

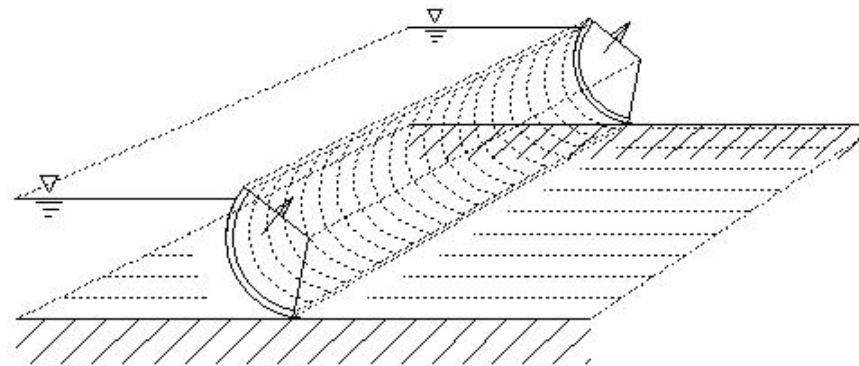
(I425)Movable weir(Tentergate)

Movable weir

adjust discharge

Don't let the water overflow

⑤Tentergate

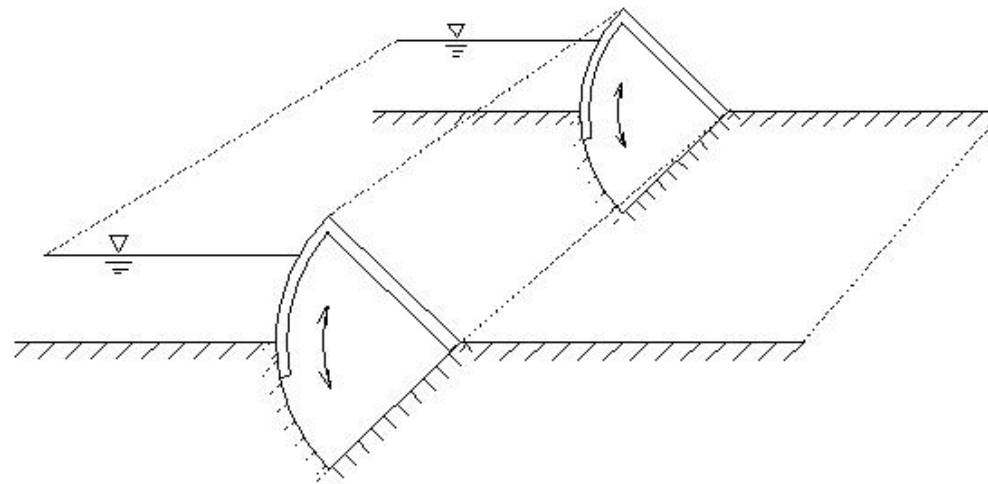


④Rolling gate

(I426)Movable weir(Drum gate)

(I426) Movable weir (Drum gate)

Movable weir
adjust discharge
⑥Drum gate



⑥Drum gate

(I427)Movable weir(Overturning weir)

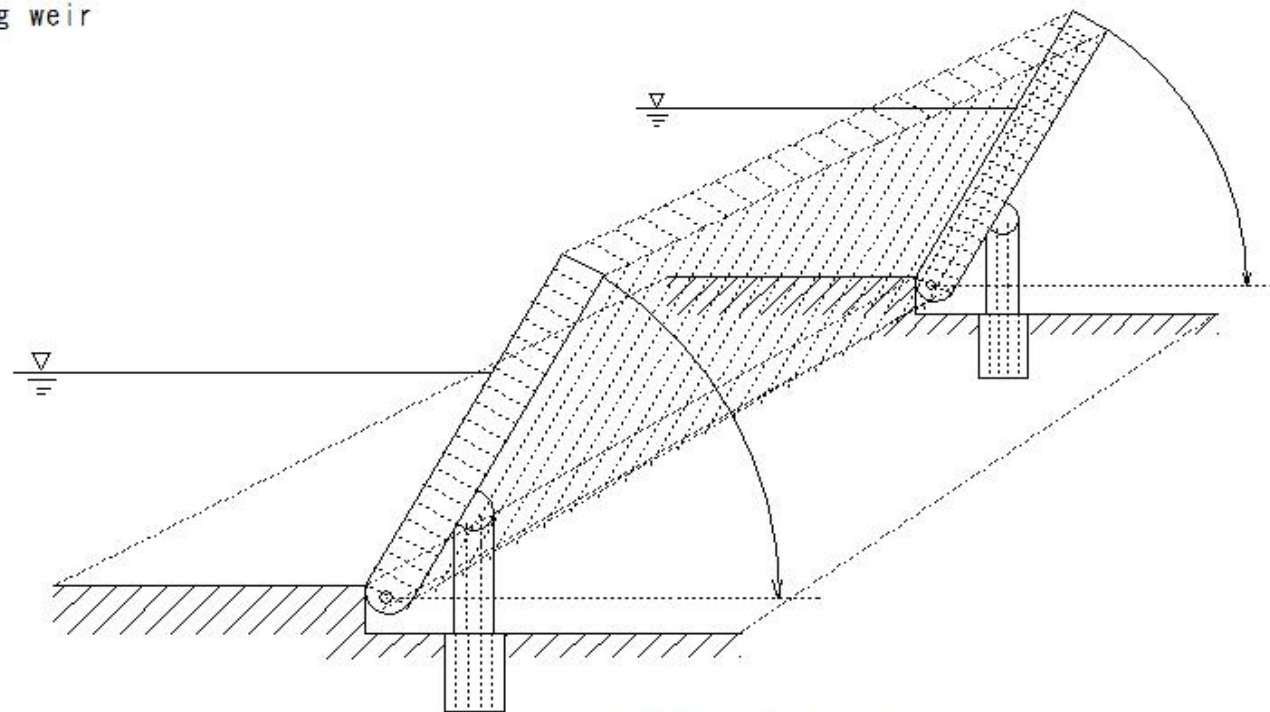
(I427)Movable weir (Overturning weir)

Movable weir

adjust discharge

Don't let the water overflow

⑦Overturning weir



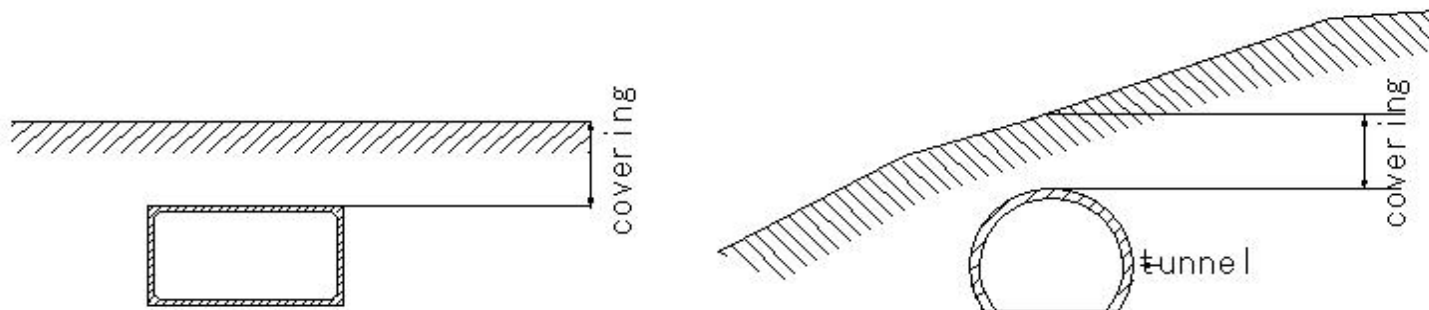
⑦Overturning weir

R335

(I428)Cover

(I428) Covering

Covering
Thickness from structure to ground



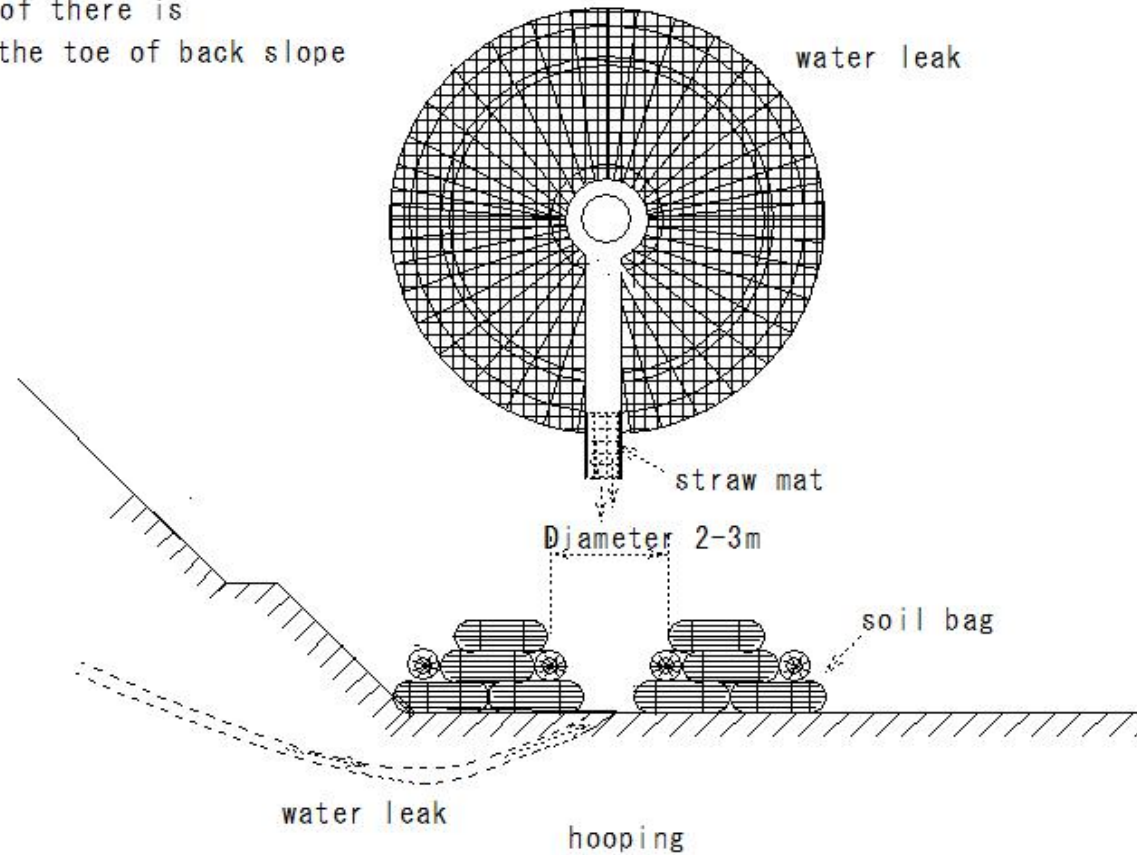
E510

(I429) Embankment-drainage method (hooping)

(I429) Embankment-drainage method (hooping)

Hooping

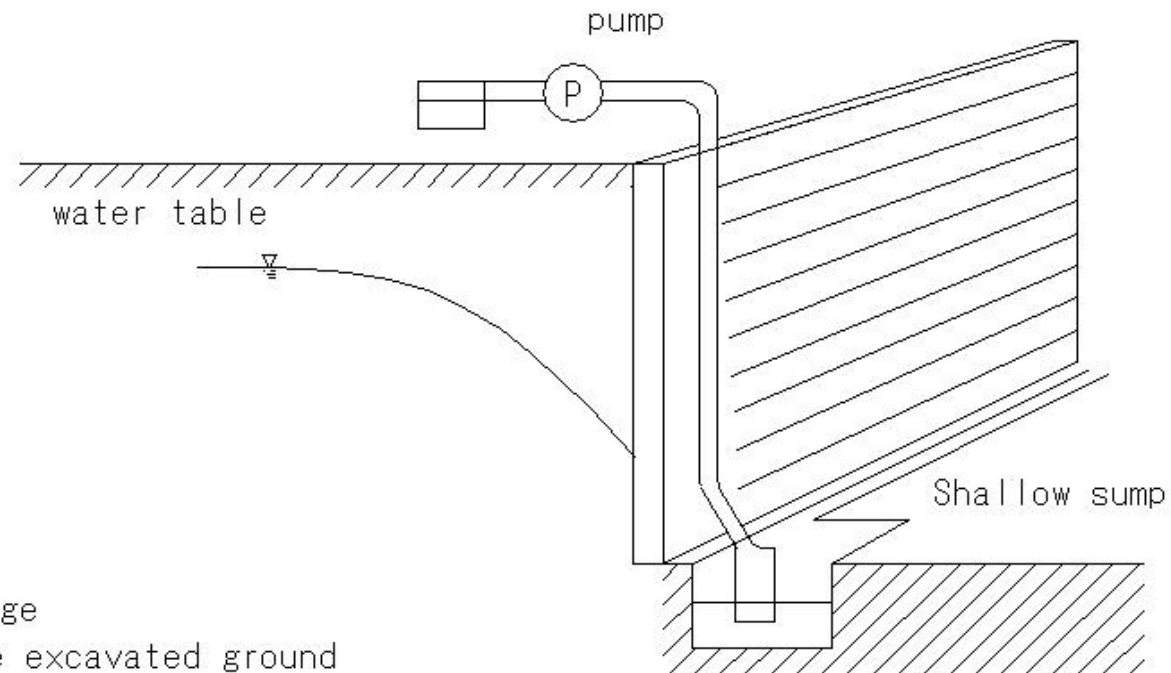
Drainage method case of there is
water leakage from the toe of back slope



R336

(I430) Drainage method

(I430) Drainage method



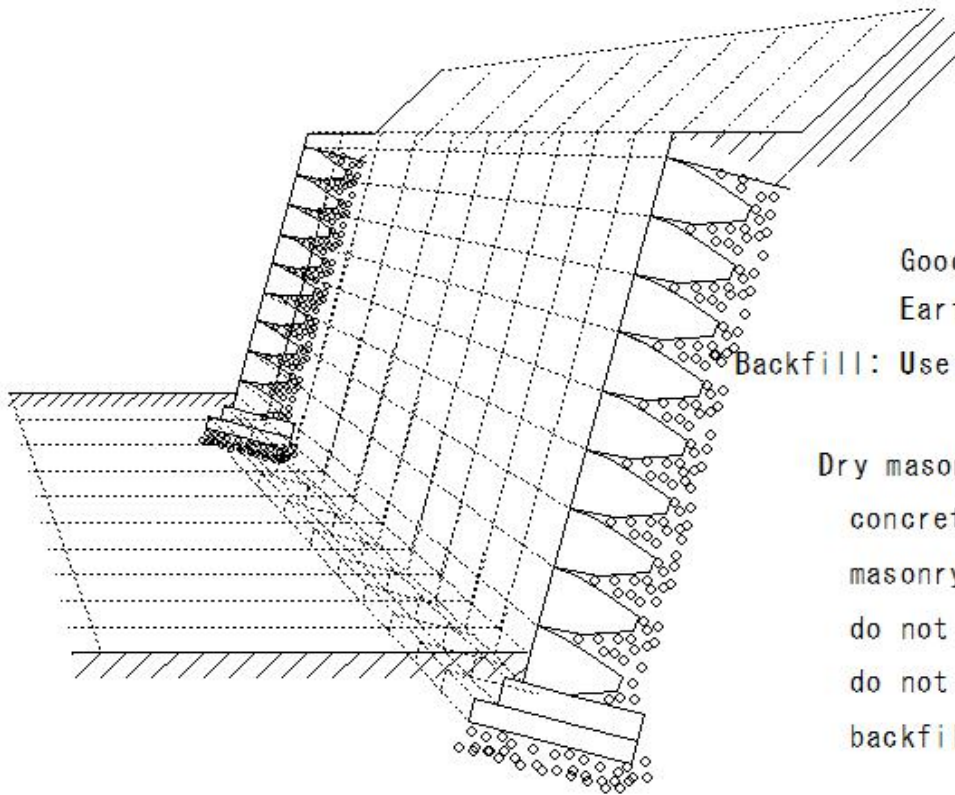
Drainage method

① Shallow sump drainage

- The bottom of the excavated ground
- Collect water by gravity
- Pump up and drain accumulated water using a pump
- Excavation in shallow ground where the amount of spring water is relatively small

(I431)Masonry (dry masonry)

(I431)Masonry (dry masonry)



Good drainage

Earth pressure does not increase

Backfill: Use cobble stone instead of concrete

Dry masonry

concrete block

masonry

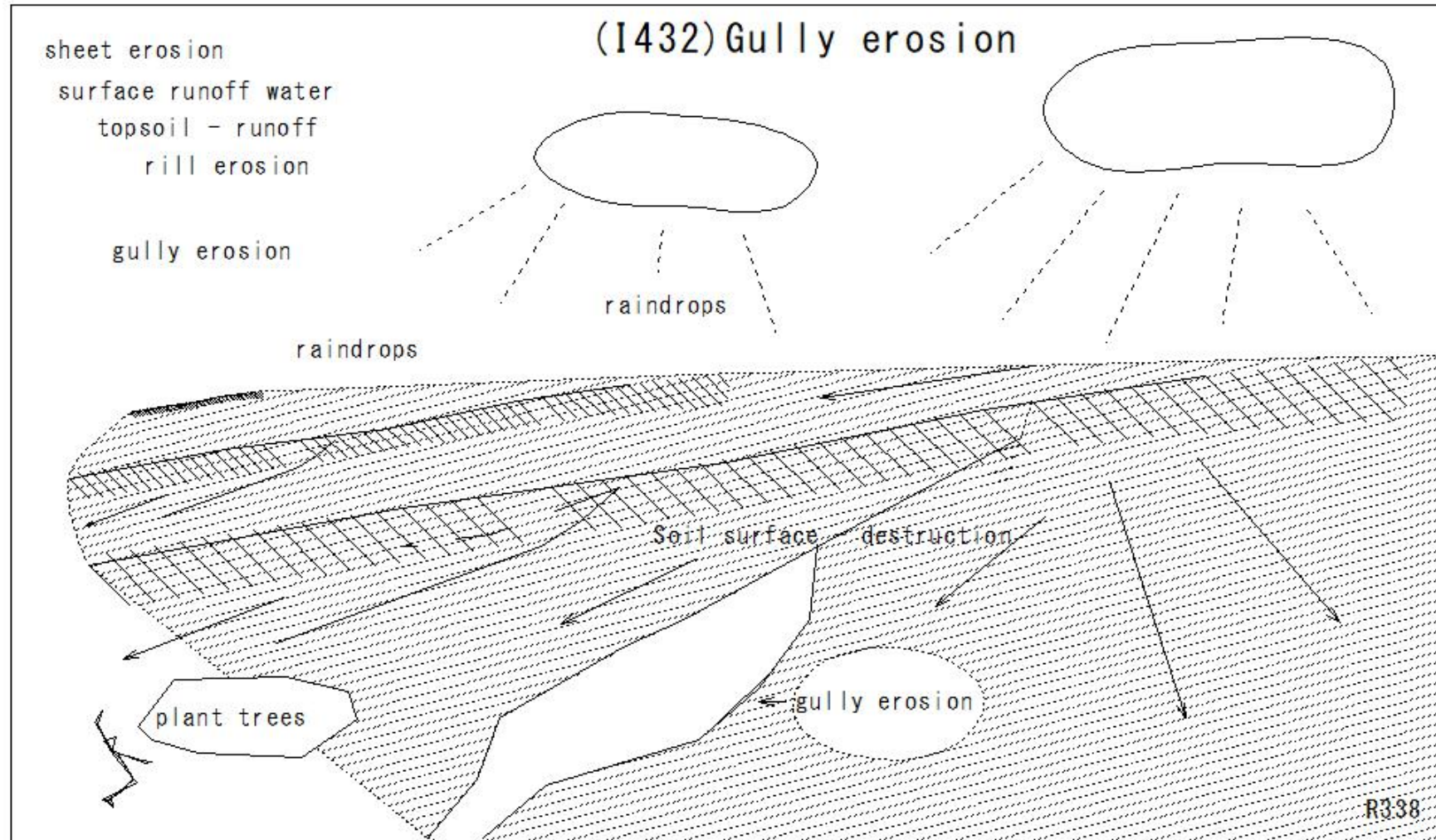
do not use mortar or concrete

do not use mortar for joints

backfill - cobblestone

R337

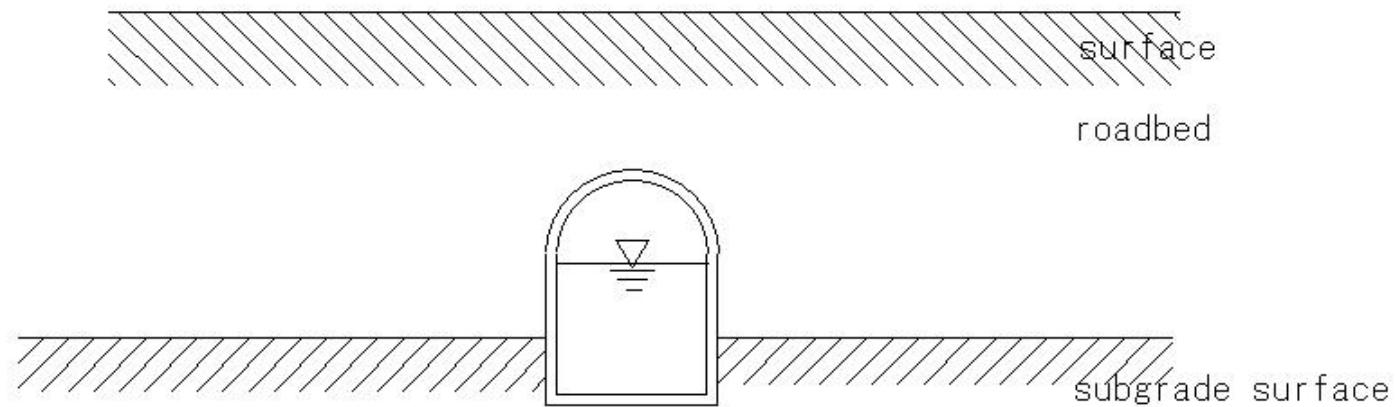
(I432)Gully erosion



(I433)Culvert

(I433) Culvert

Culvert



a kind of open channel

pipe

box culvert

(I434)Irrigation methods

(I434) Irrigation methods

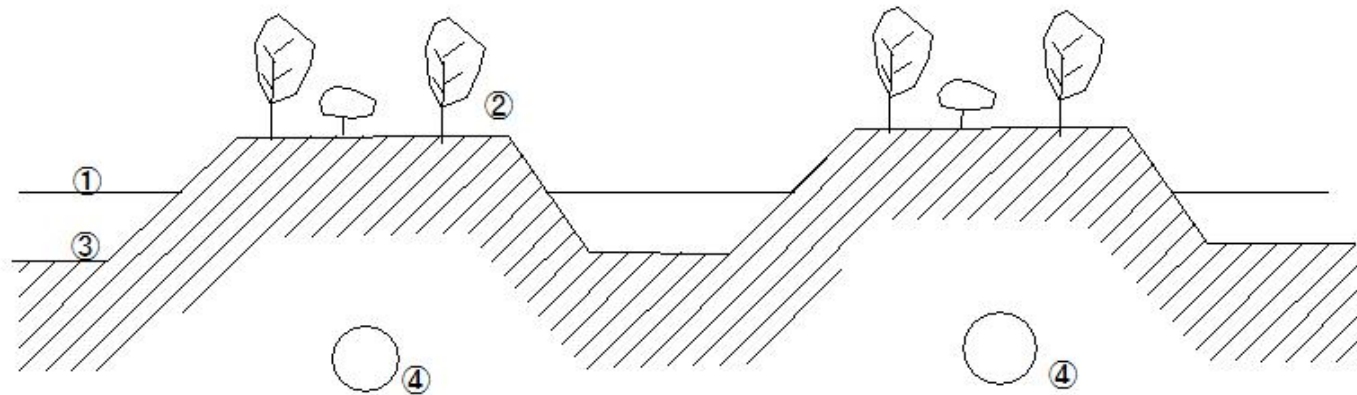
Irrigation methods

- ① Sewage
- ② Bed (1-3m wide or more)
- ③ Ditch (40-45cm deep, 1-2m wide)
- ④ Connecting drainage pipe

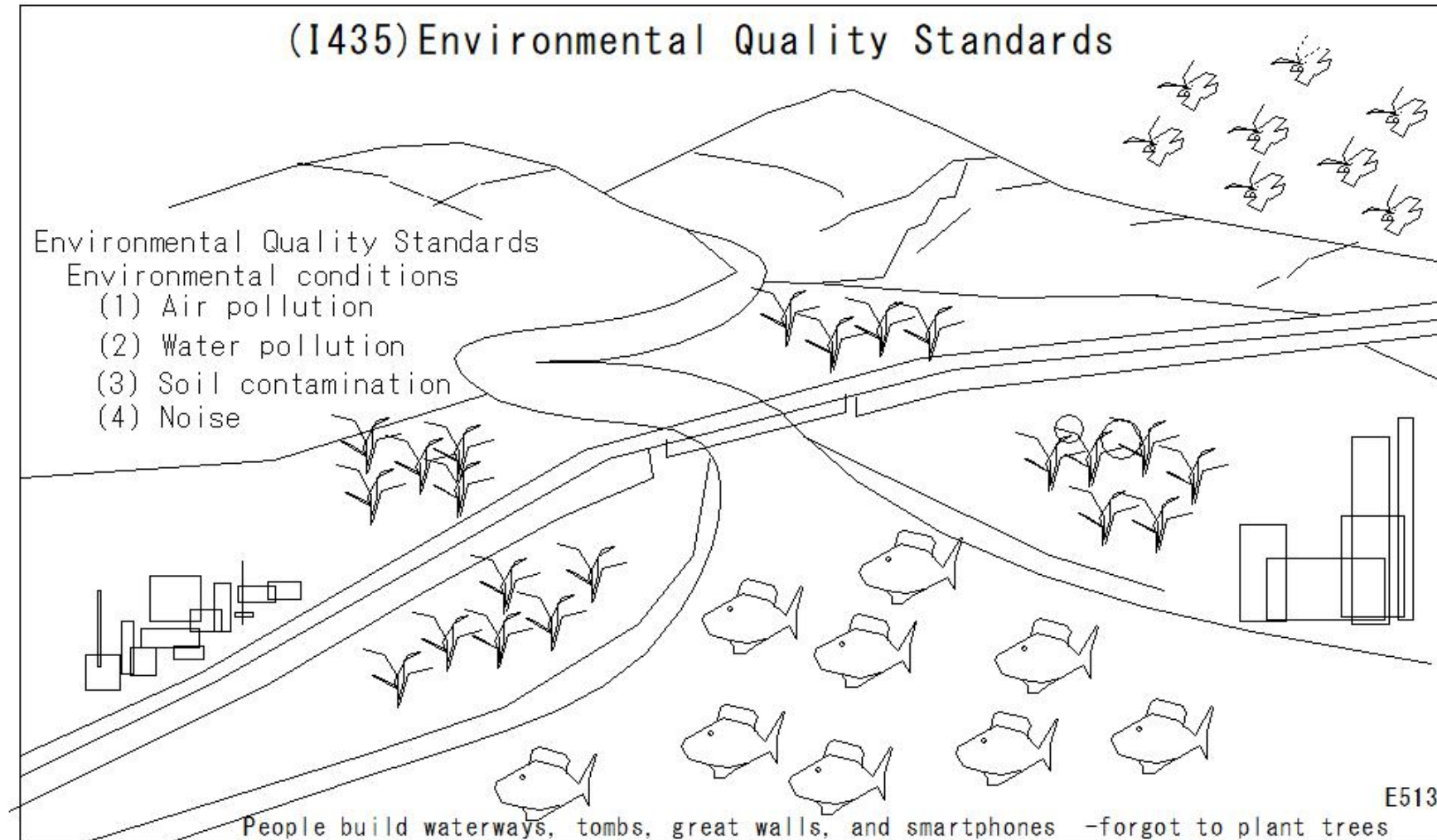
Sewage treatment

Direct sewage to the field and treat it

Collect seepage water



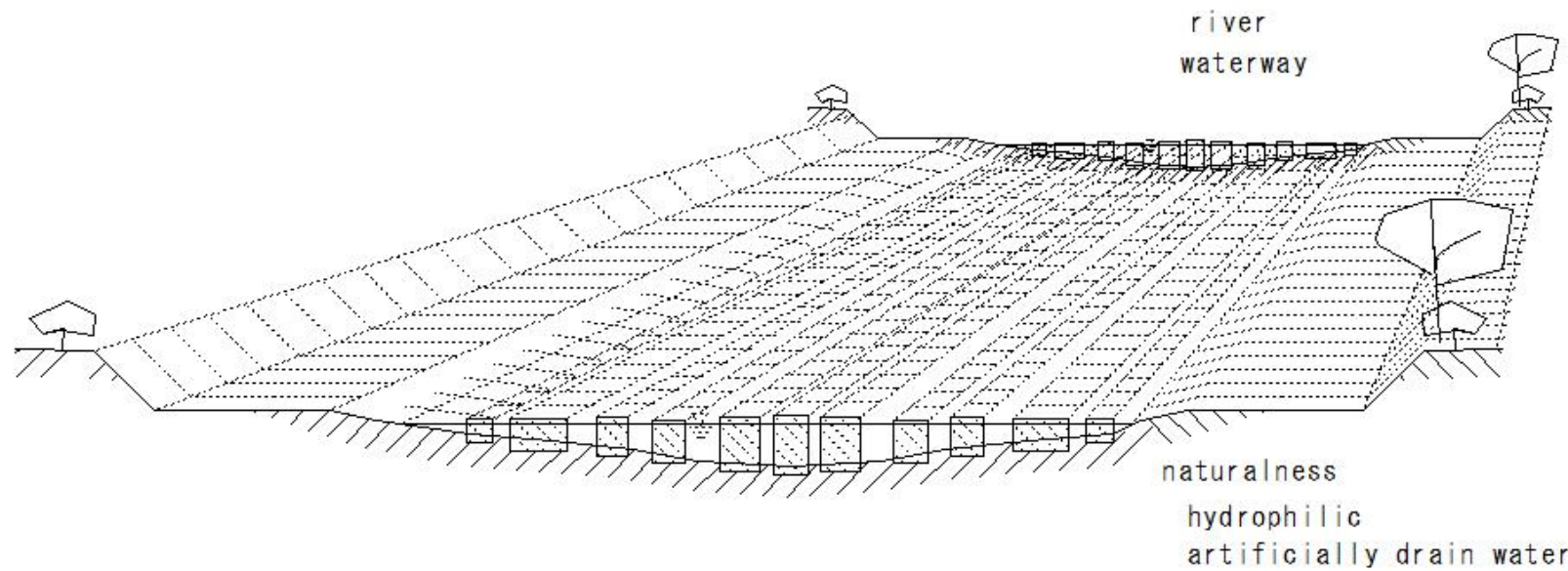
(I435)Environmental Quality Standards



(I436)Environment irrigation water

(I436)Environment irrigation water

environment irrigation water



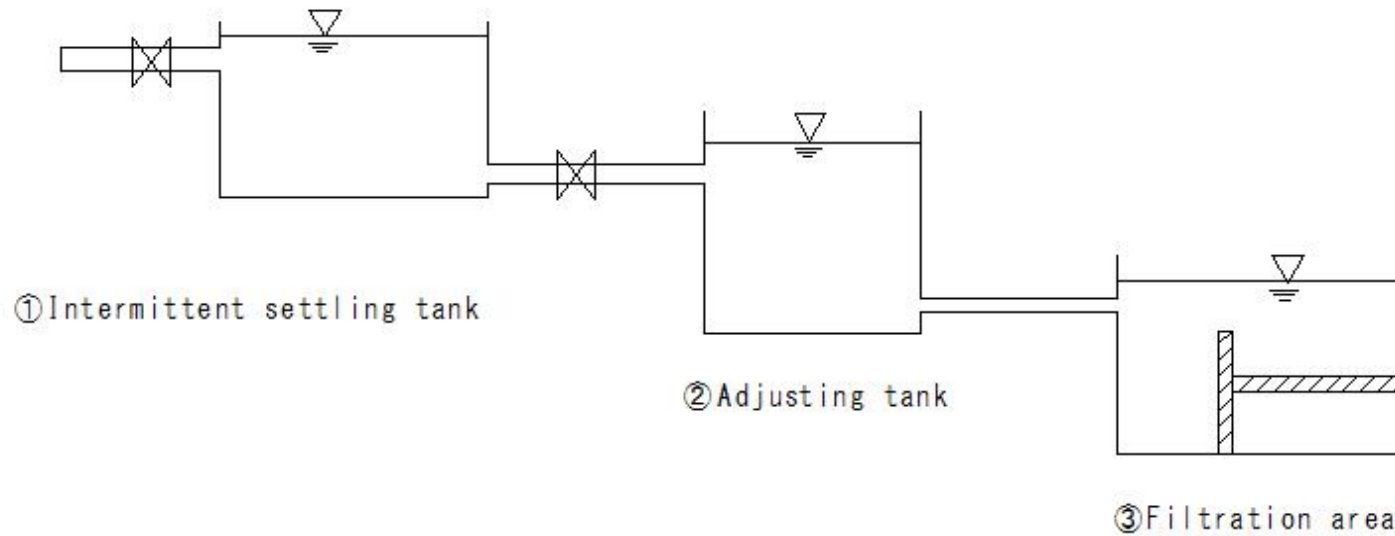
R341

(I437)Intermittent settling tank

(I437)Intermittent settling tank

Intermediate flow settling basin

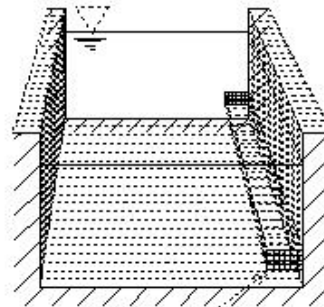
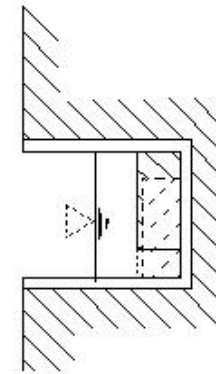
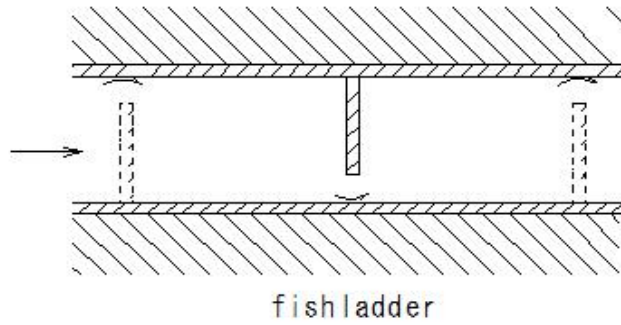
In water purification and sewage treatment, this equipment separates solids contained in wastewater by settling them.



(I438)Fishladder

(I438)Fishladder

Fish aisle



Eel aisle

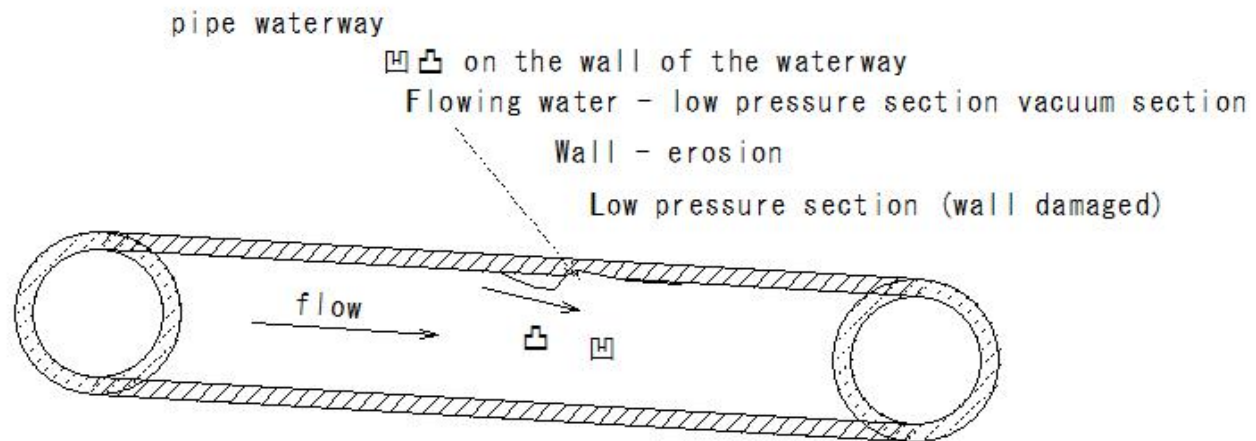
R345

(I439) Cavitation

(I439) Cavitation

Cavitation

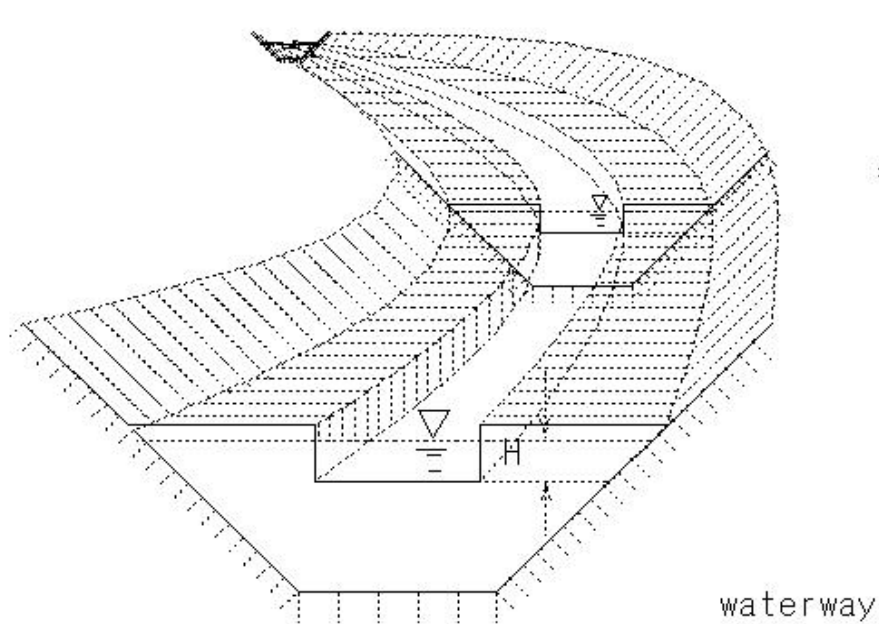
Power plant



(I440)Weir(notch)

(I440) Weir (notch)

Notch

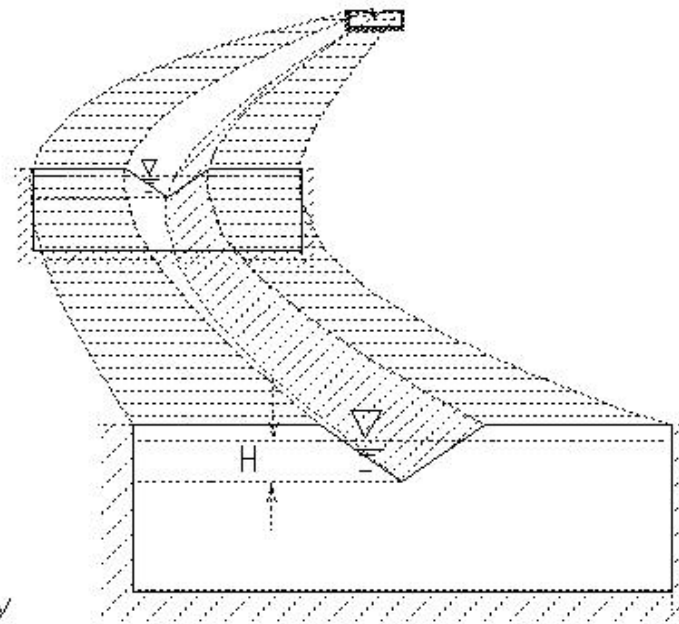


square shape - cut out

Overflow water depth measurement - discharge

Square shape - square weir

H: Overflow water depth

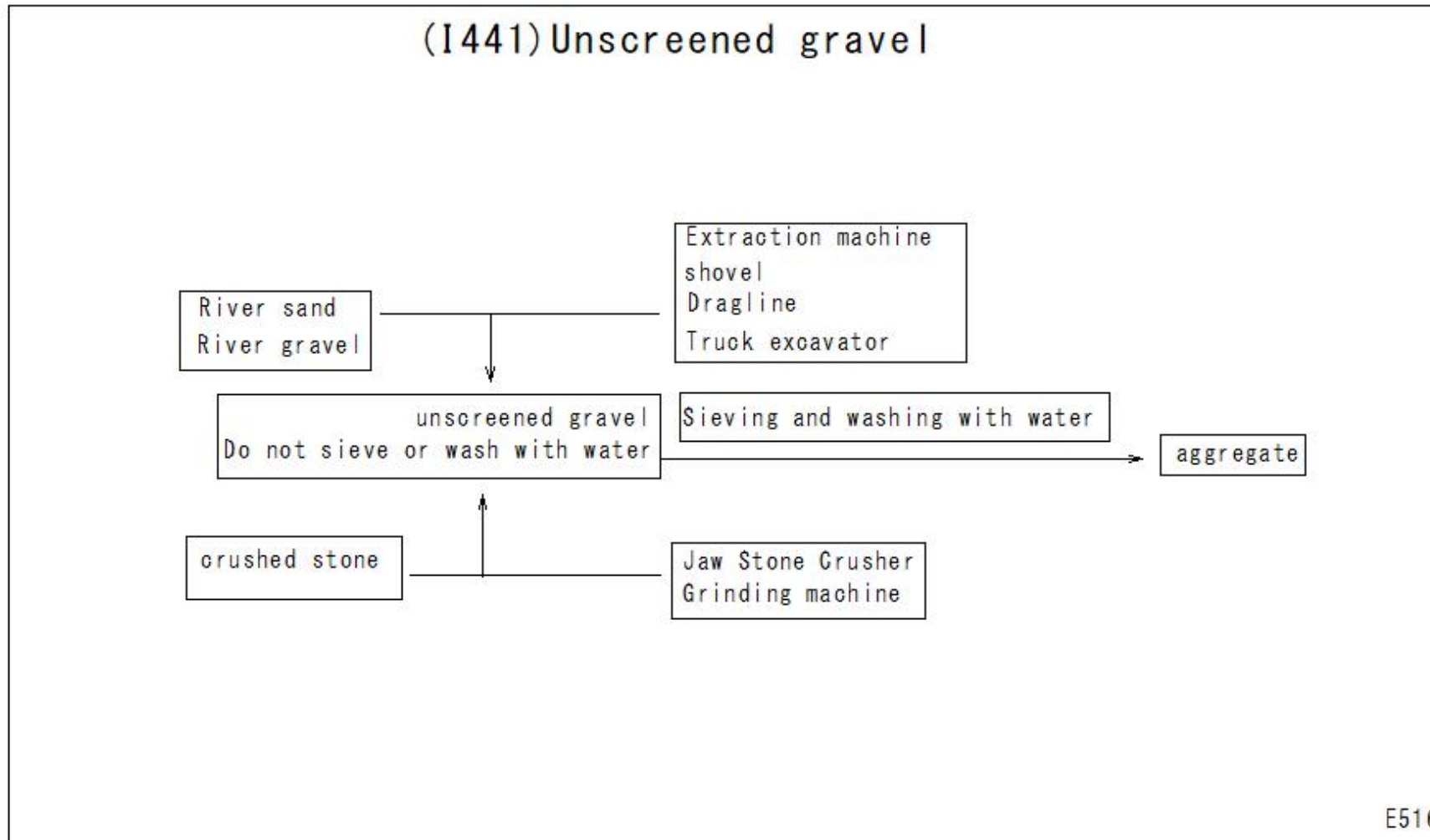


Triangular shape - cut out

Triangular shape - triangular dam

R346

(I441)Unscreened gravel



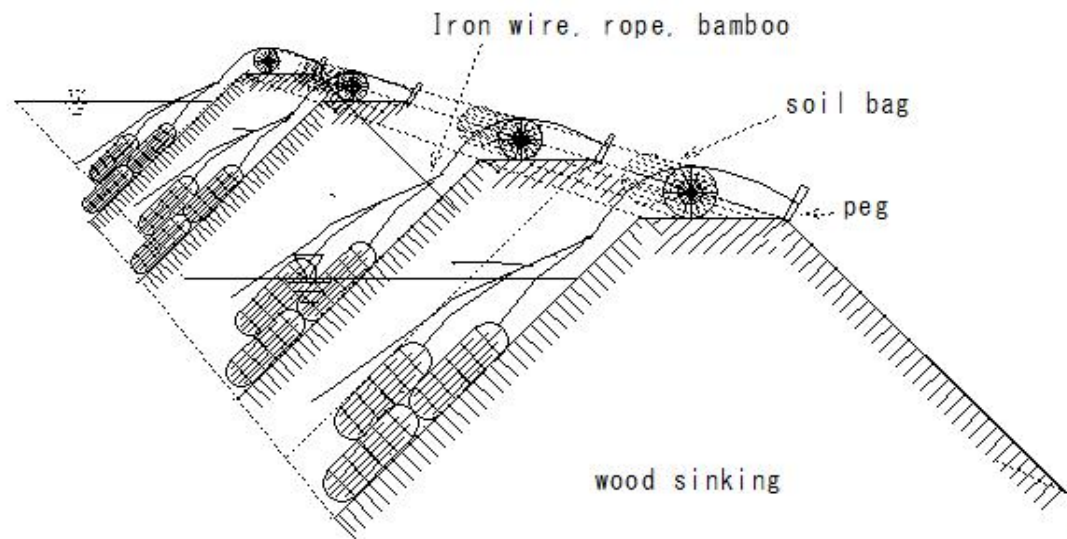
(I442)Embankment (wood sinking)

(I442)Embankment (wood sinking)

wood sinking

River embankment collapse prevention method

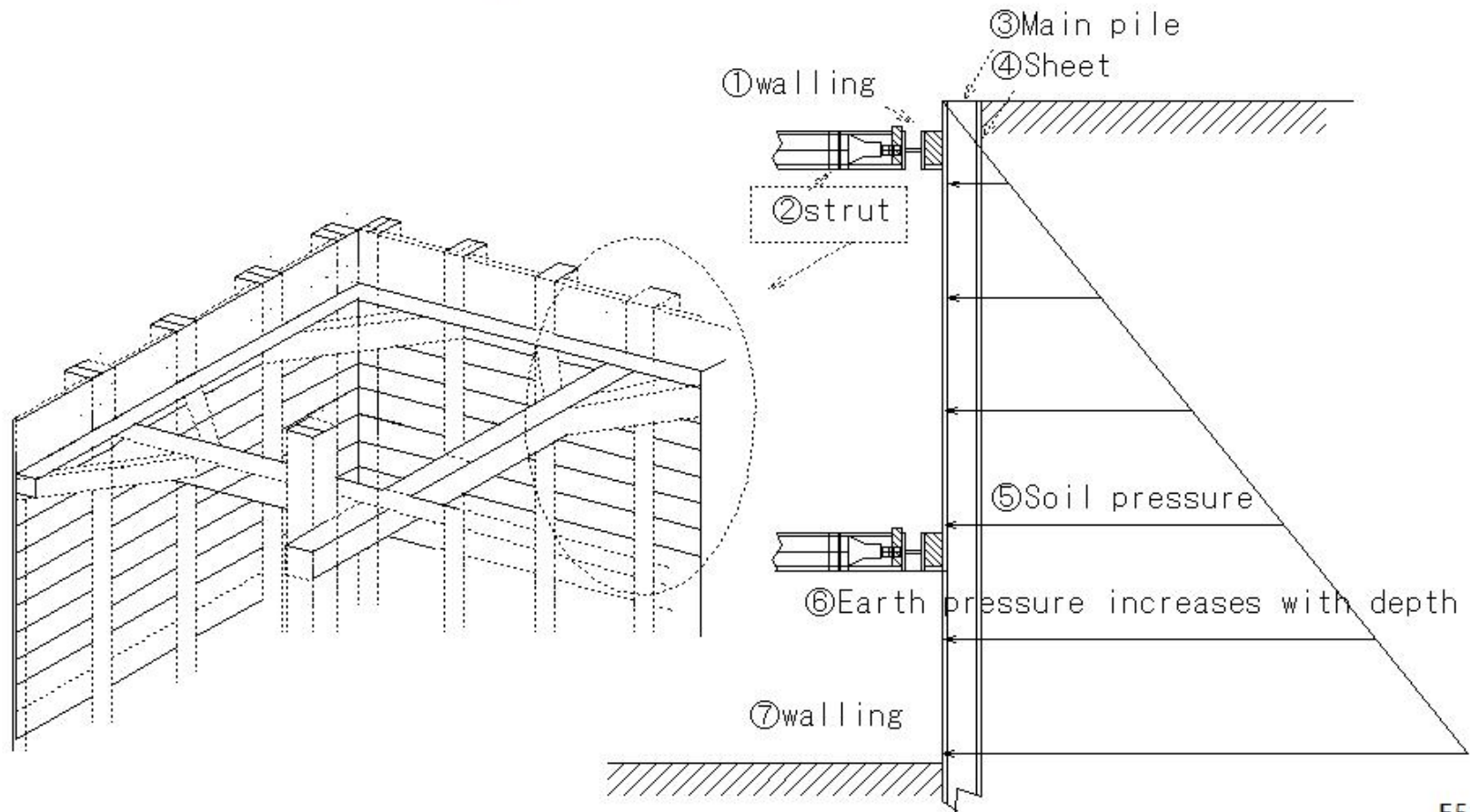
slope protection



R340

(I443)Strut

(I443) Strut



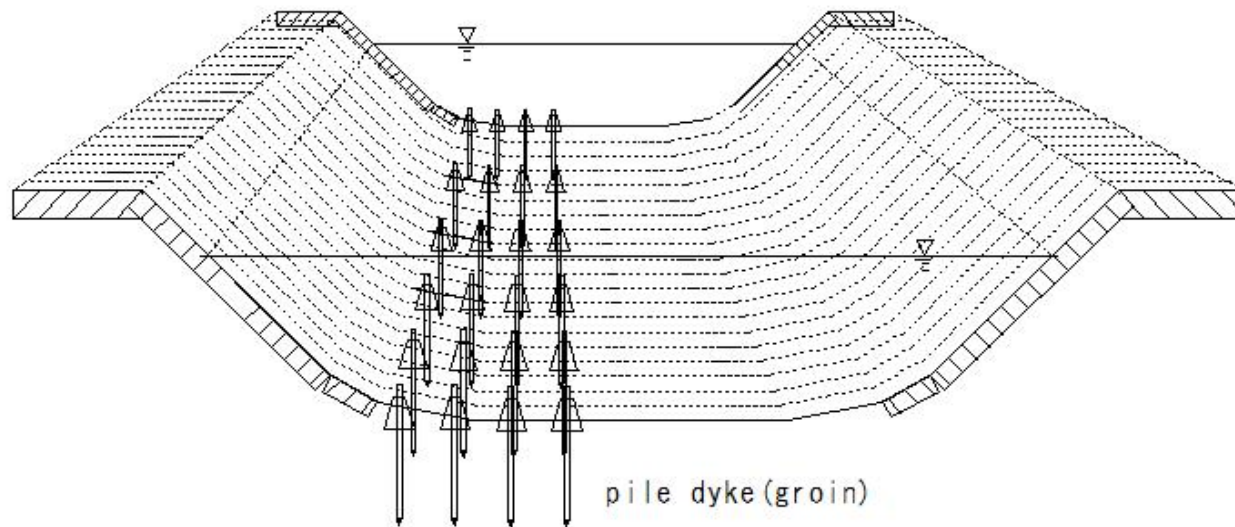
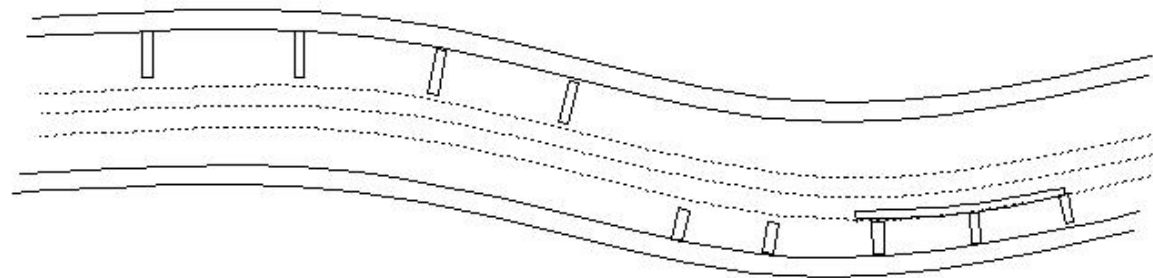
(I444)Pile dyke(groin)

Pile dyke(groin)

wooden pile

reinforced concrete piles

(I444)Pile dyke(groin)

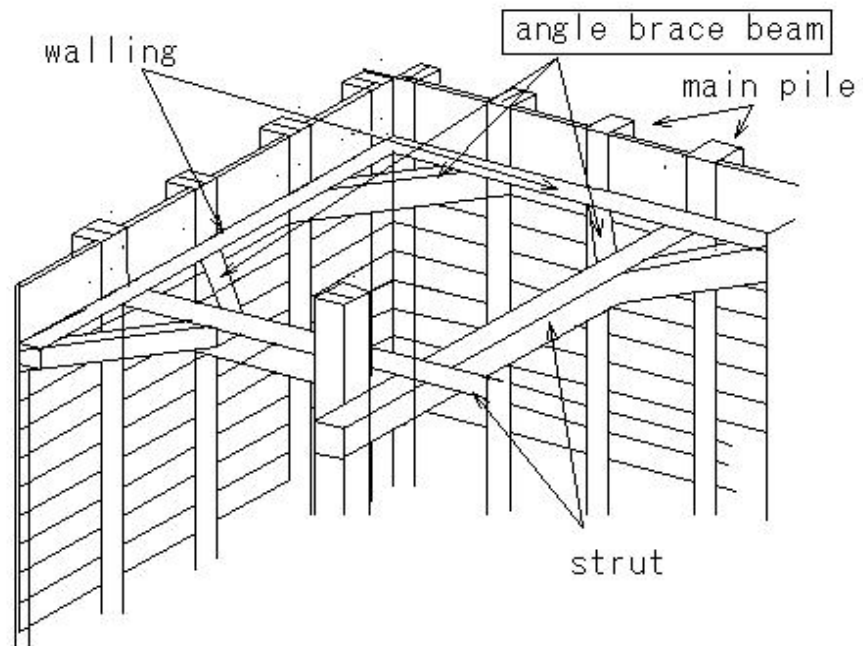


pile dyke(groin)

R347

(I445)Angle brace

(I445) Angle brace

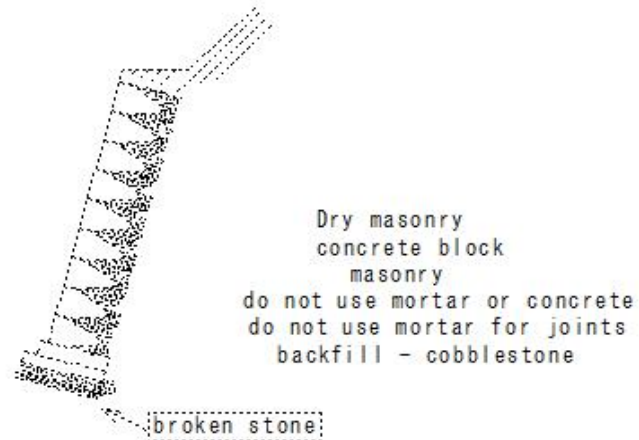
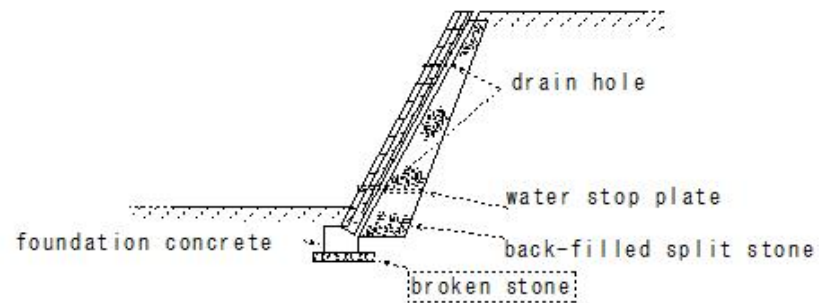


Earth retaining wall method

E602

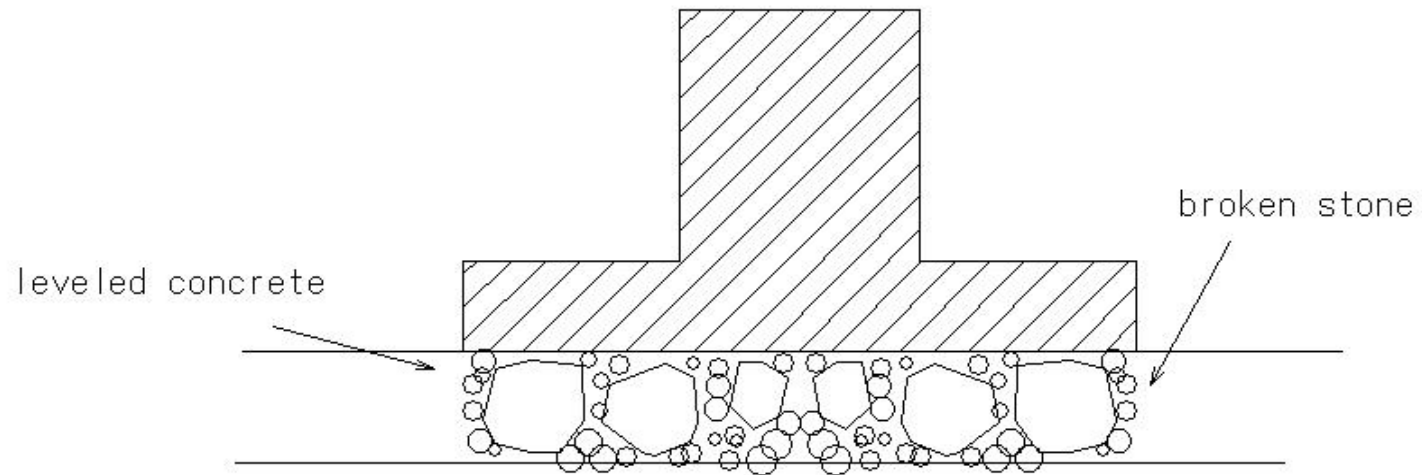
(I446)Broken stone

(I446)Broken stone



(I447)Broken stone foundation

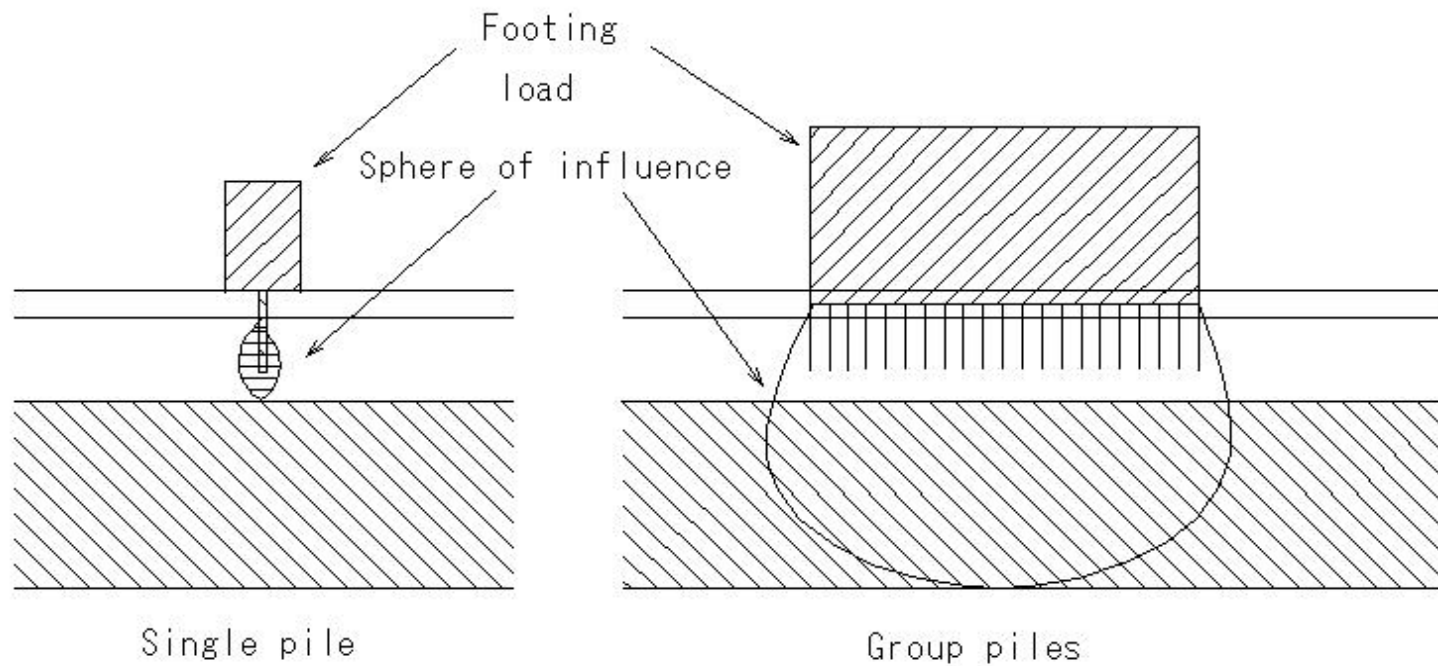
(I447)Broken stone foundation



F227

(I448)Group of piles

(I448)Group of piles

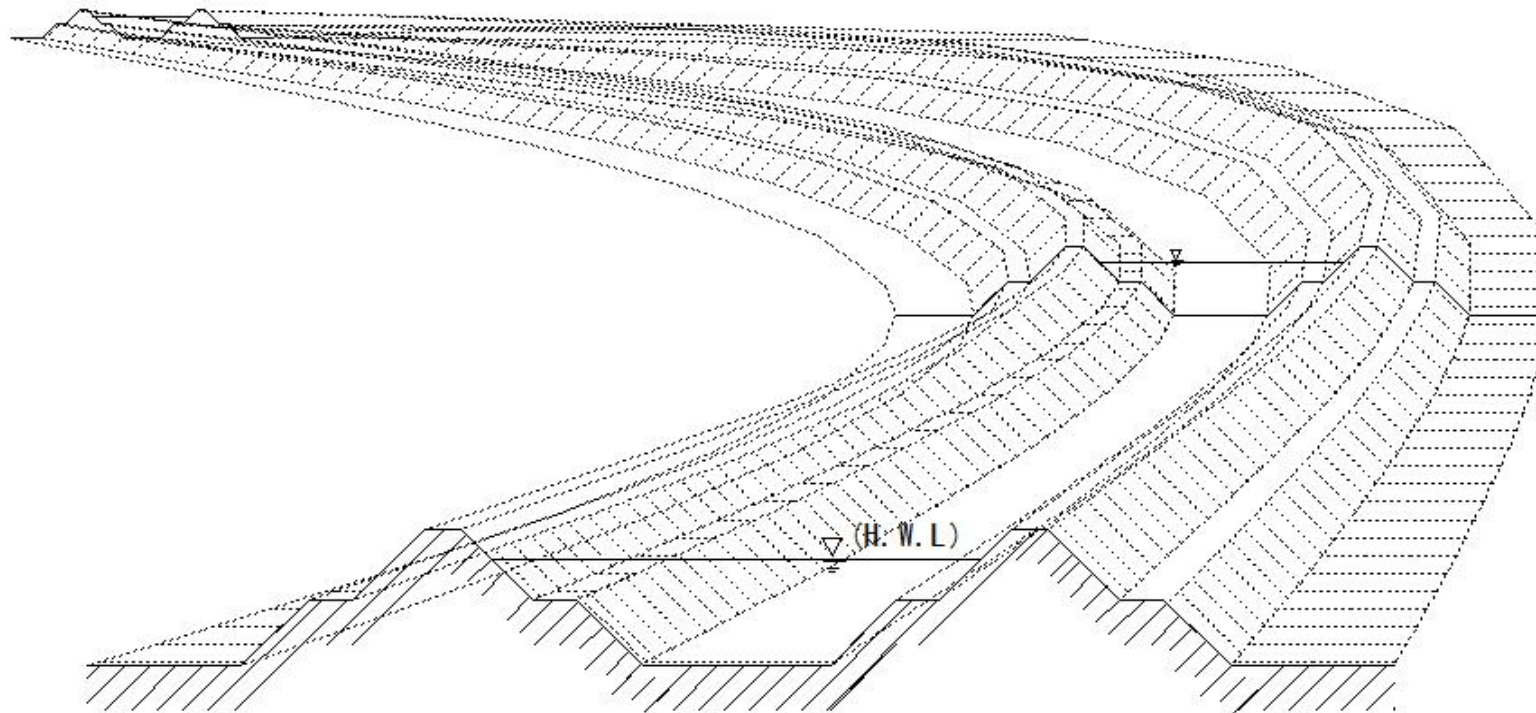


Pile spacing Pile diameter 2.5 times or less

F228

(I449)Estimated high-water level,Designed high water level (H.W.L)

(I449)Estimated high-water level,Designed high water level (H. W. L)



estimated high-water level
Designed high water level (H. W. L)

R350

(I450) Estimated high-water discharge, design high-water discharge

design high-water discharge

-
- The diagram illustrates a river system with a main channel and several tributaries. The main channel flows from left to right. At the far left, an inflow of 8500 is shown. The channel then enters a 'flood storage basin' where the flow is labeled '0'. After exiting the basin, the flow is 8500. A 'tributary river' joins from the top, adding 1000 to the flow, making it 10000. Another 'tributary river' joins from the top further downstream, adding 1500 to the flow, making it 11500. A third 'tributary river' joins from the bottom, adding 500 to the flow, making it 12000. Finally, a 'spillway (flood-way)' branches off to the bottom right, carrying away 3000, leaving a final outflow of 8500 at the far right. The background is filled with diagonal dashed lines.

(I451)Design flood discharge

(I451)Design flood discharge

Design flood discharge

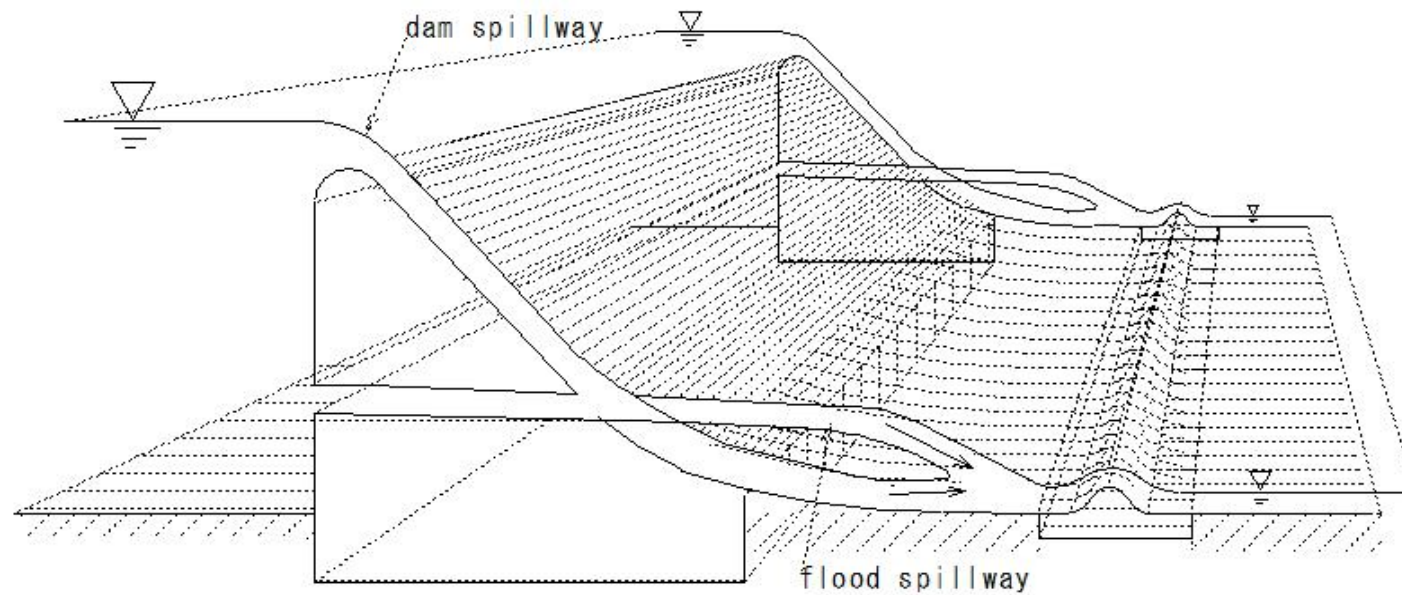
dam design

Concrete dam: once every 100 years

Field flood discharge once every 200 years

design flood discharge

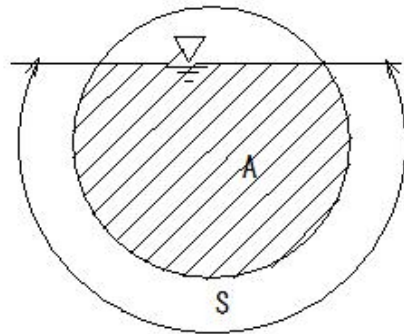
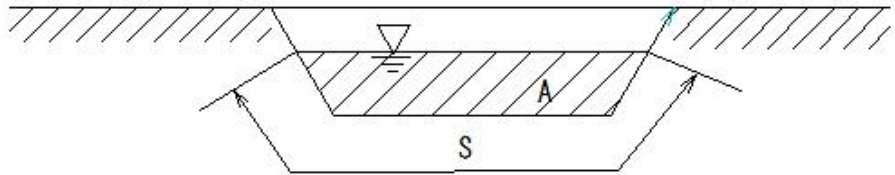
Designed for safe flow



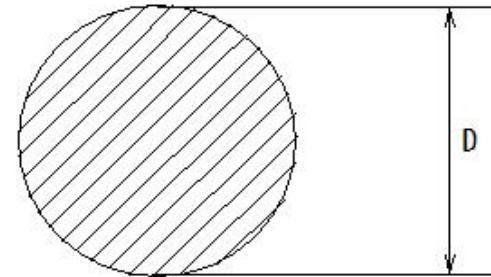
R352

(I452)Hydraulic radius

(I452)Hydraulic radius



open channel



$$R = A/S = (\pi D^2/4) / (\pi D) = D/4$$

pipeline

Cross-sectional area of flow: A

Hydraulic radius: R

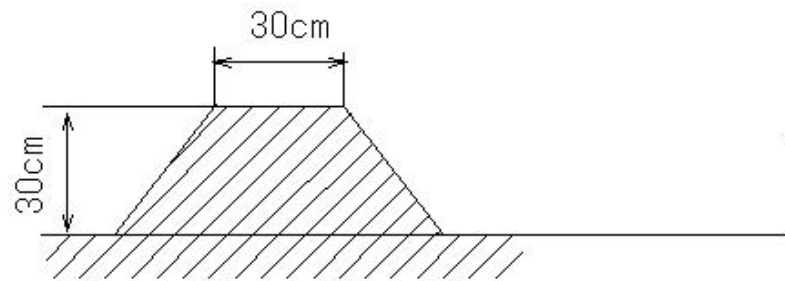
$$R = A/S$$

Wetted perimeter: S

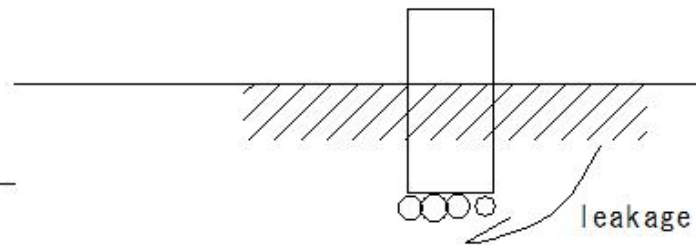
(I453)Border

(I453) Border

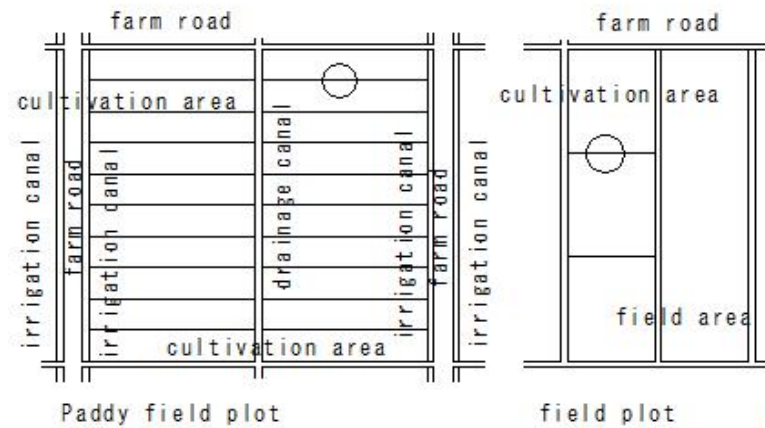
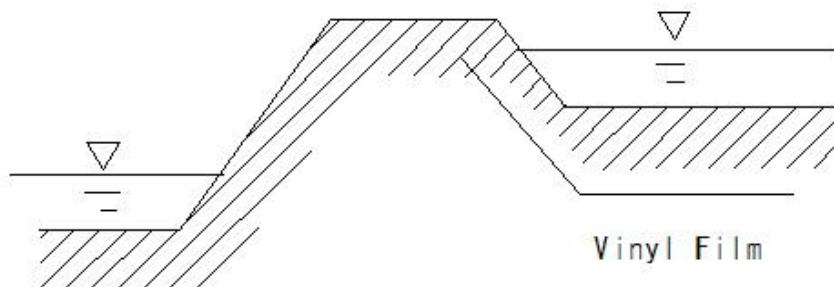
temporary border



concrete border



border with drops



(I454)Torrent control works

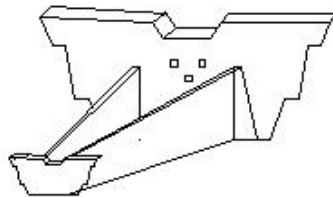
(I454)Torrent control works

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

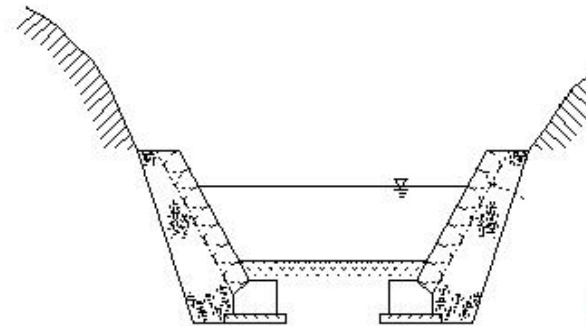


groin



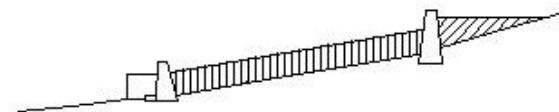
S128

watercourse



S67

S145



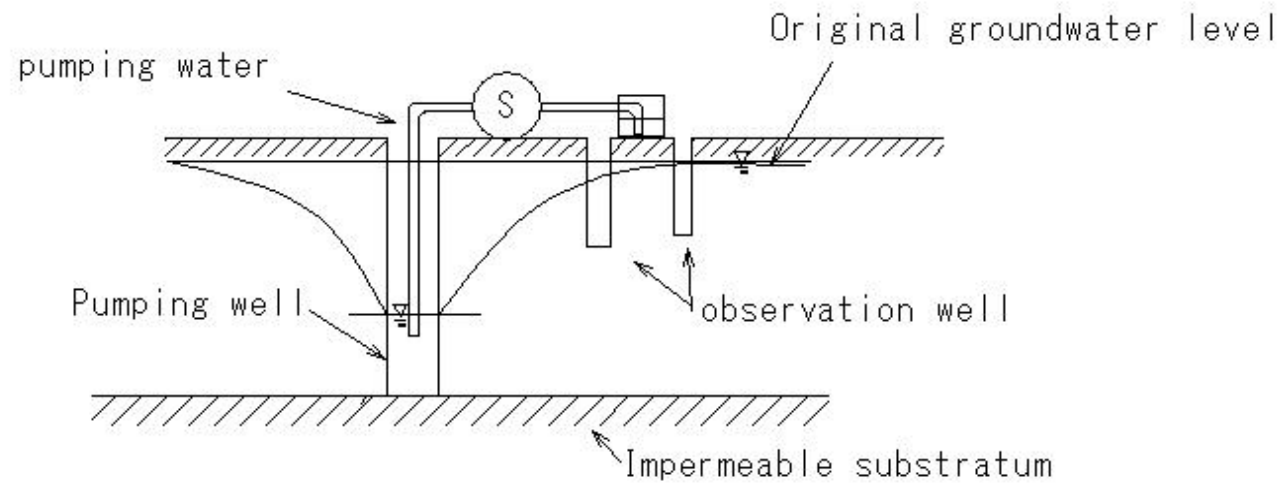
S142

S181

(I455)Field permeability test

(I455)Field permeability test

Field permeability test



E525

(I456)Water supply(Elevated tank)

(I456)Water supply(Elevated tank)

Water supply

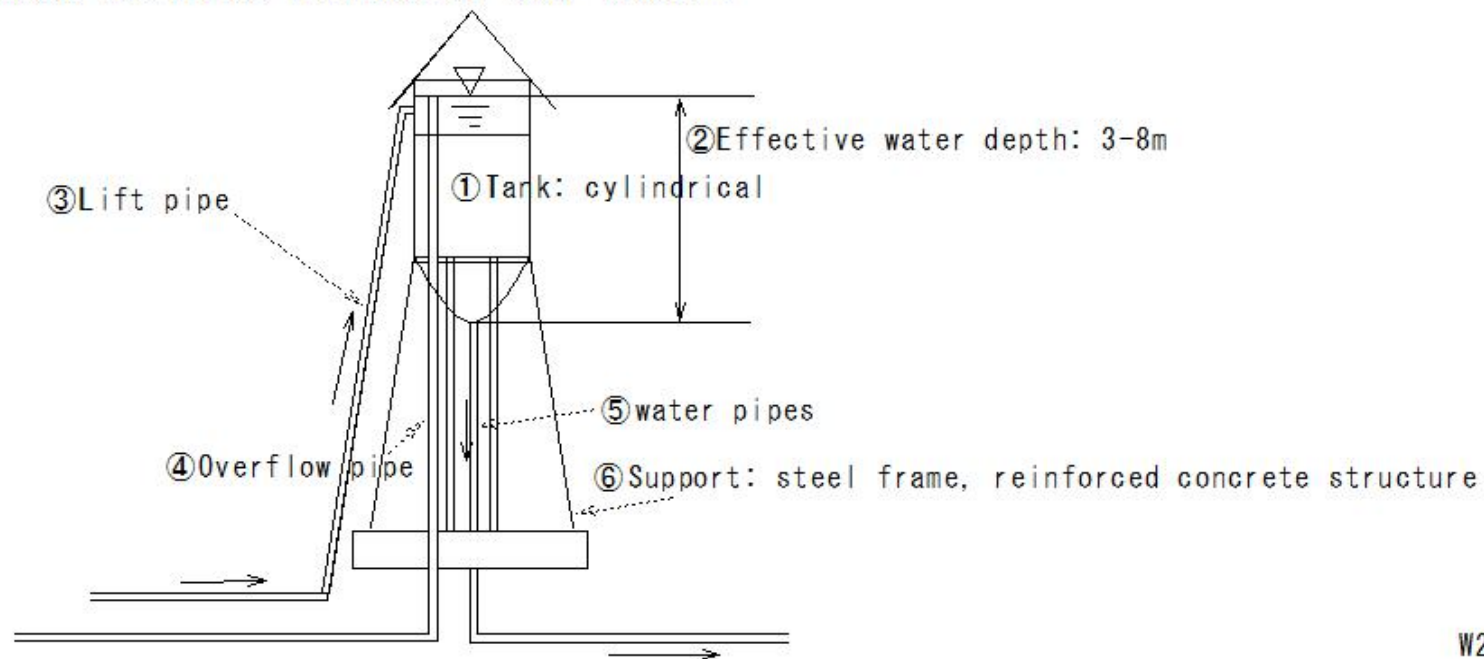
Elevated tank

Residential complexes

Small-scale water distribution area – drainage pond – when high places are not available

A water tank (tank) with an artificially high water level is provided with a pump,

Water supply facilities with natural water pressure



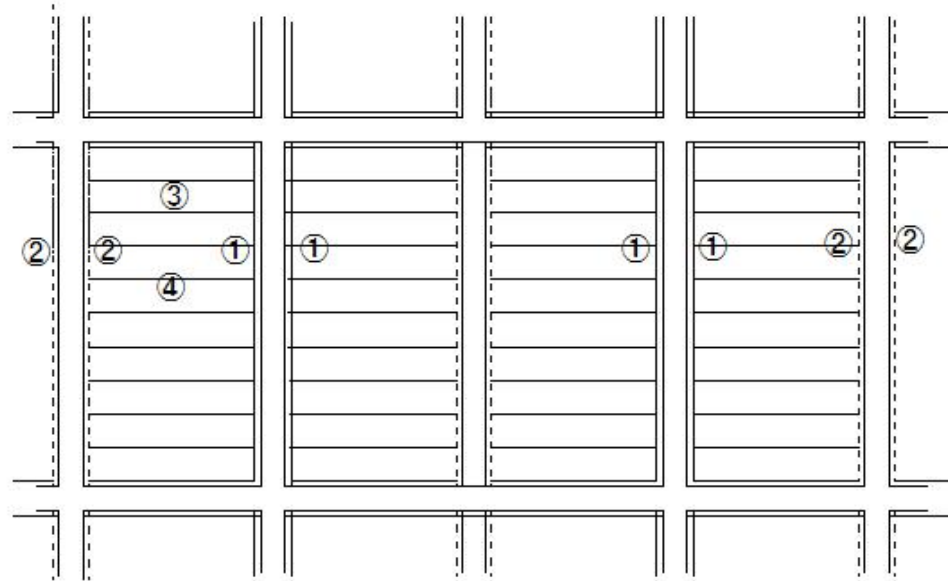
W234

(I457)Field division(Cultivated area)

(I457)Field division(Cultivated area)

Field division(Cultivated area)

- ① Small irrigation canal
- ② Small drainage canal
- ③ Field division(Cultivated area)
- ④ Ridge
- ⑤ Cultivated road



Cultivated areas are plots that are divided into smaller areas by ridges. Cultivated areas are the smallest unit of cultivation, and are plots that allow for efficient work management and appropriate irrigation and drainage management.

(I458)Flood control

(I458)Flood control

Flood control

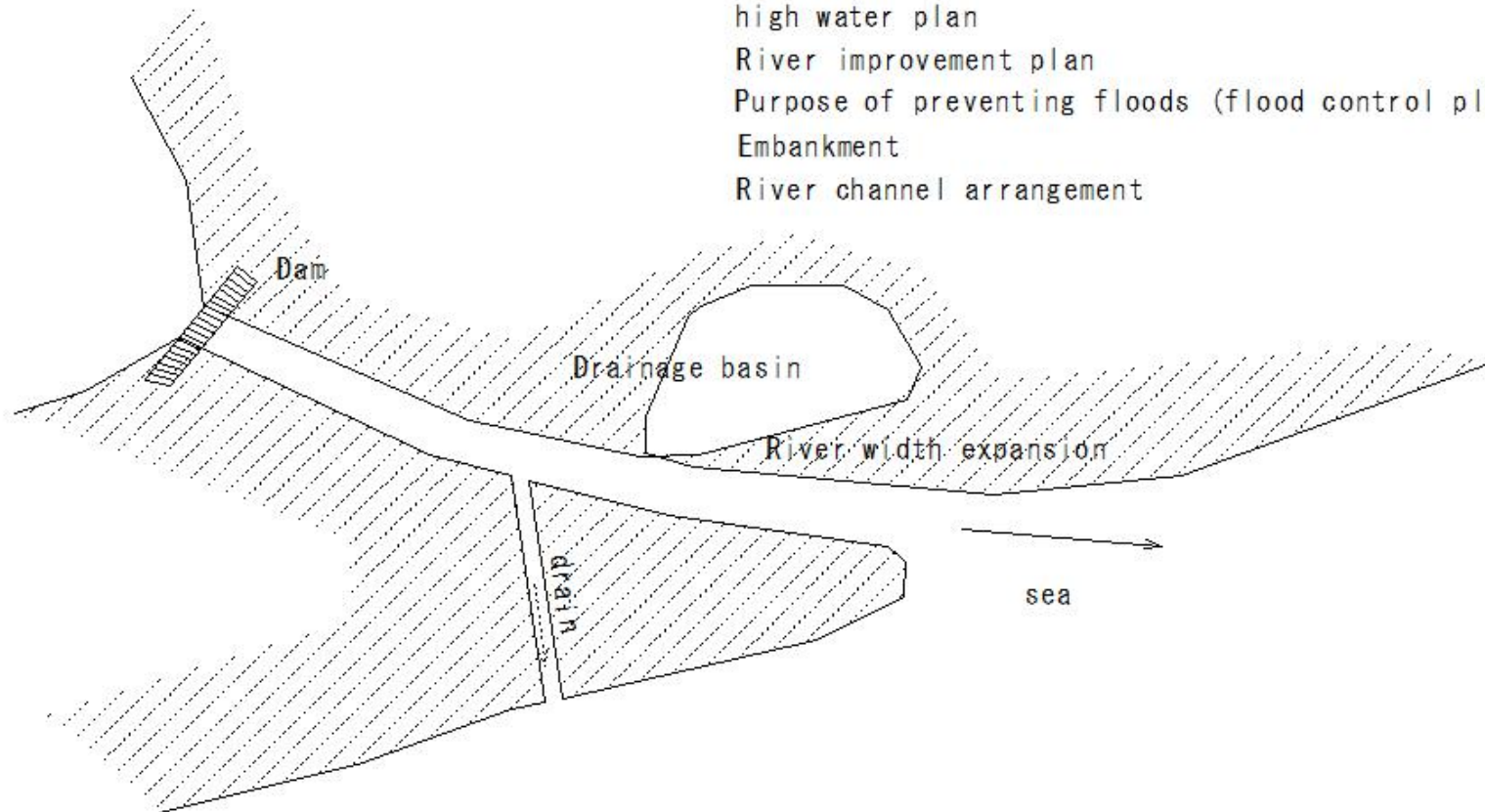
high water plan

River improvement plan

Purpose of preventing floods (flood control plan)

Embankment

River channel arrangement



R354

(I459)Flood protection works

(I459)Flood protection works

Flood protection works

Construction work to prevent flooding

- river channel improvement work
- embankment

River channel arrangement

Flood prevention

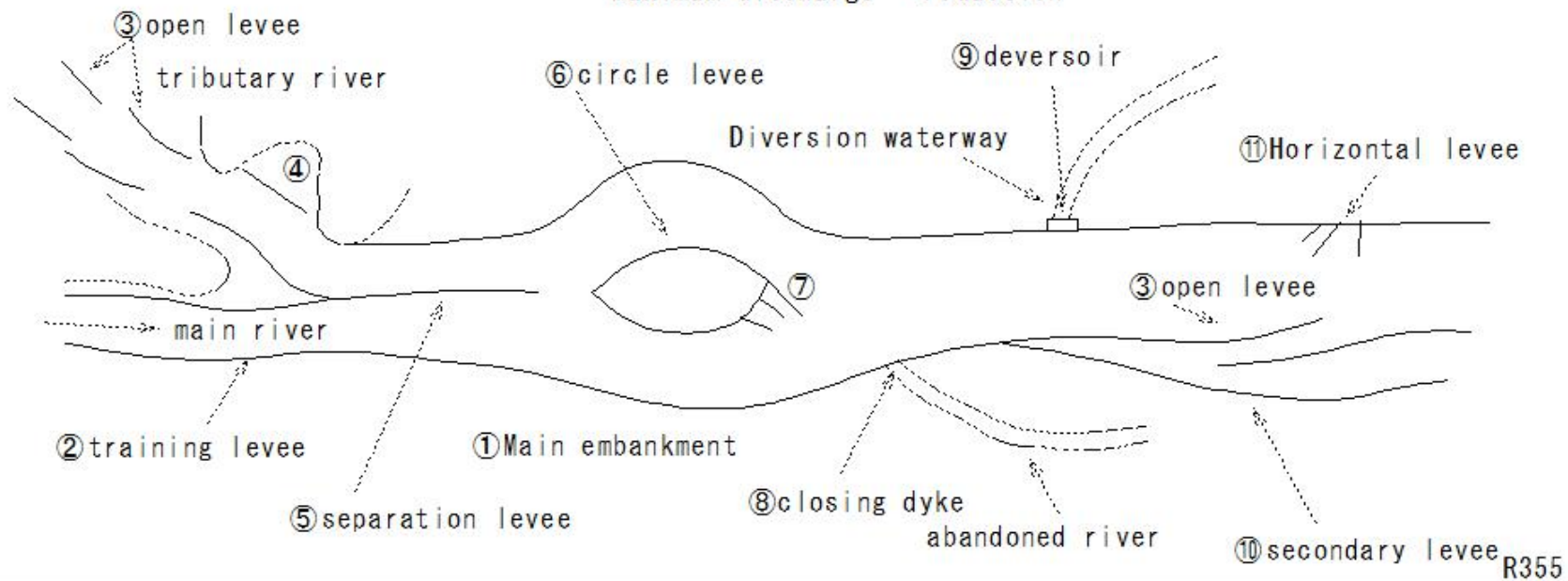
- Flood control method

flood storage basin(Reservoir pond)

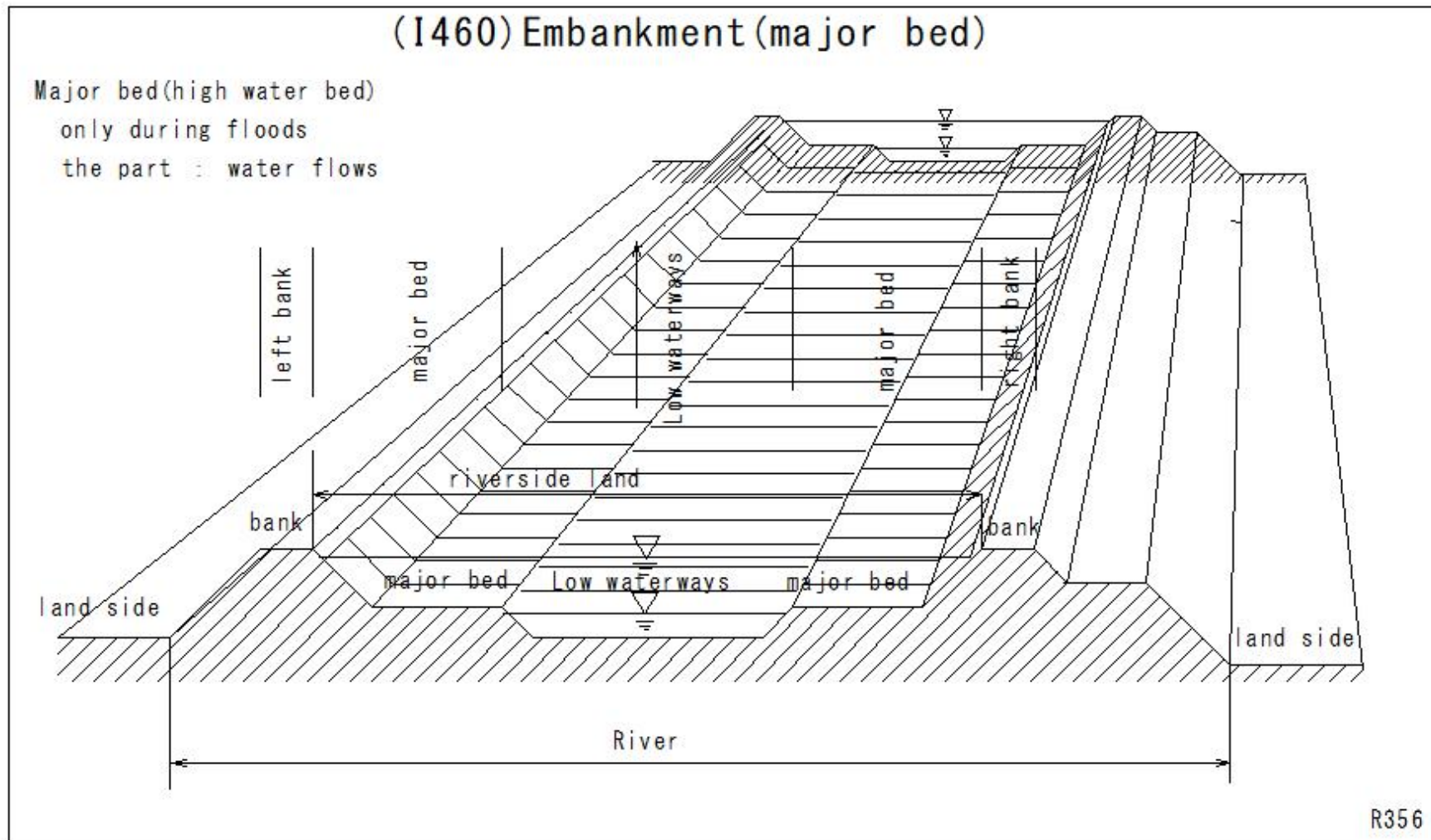
dam-Reservoir

Part of the flood - water storage

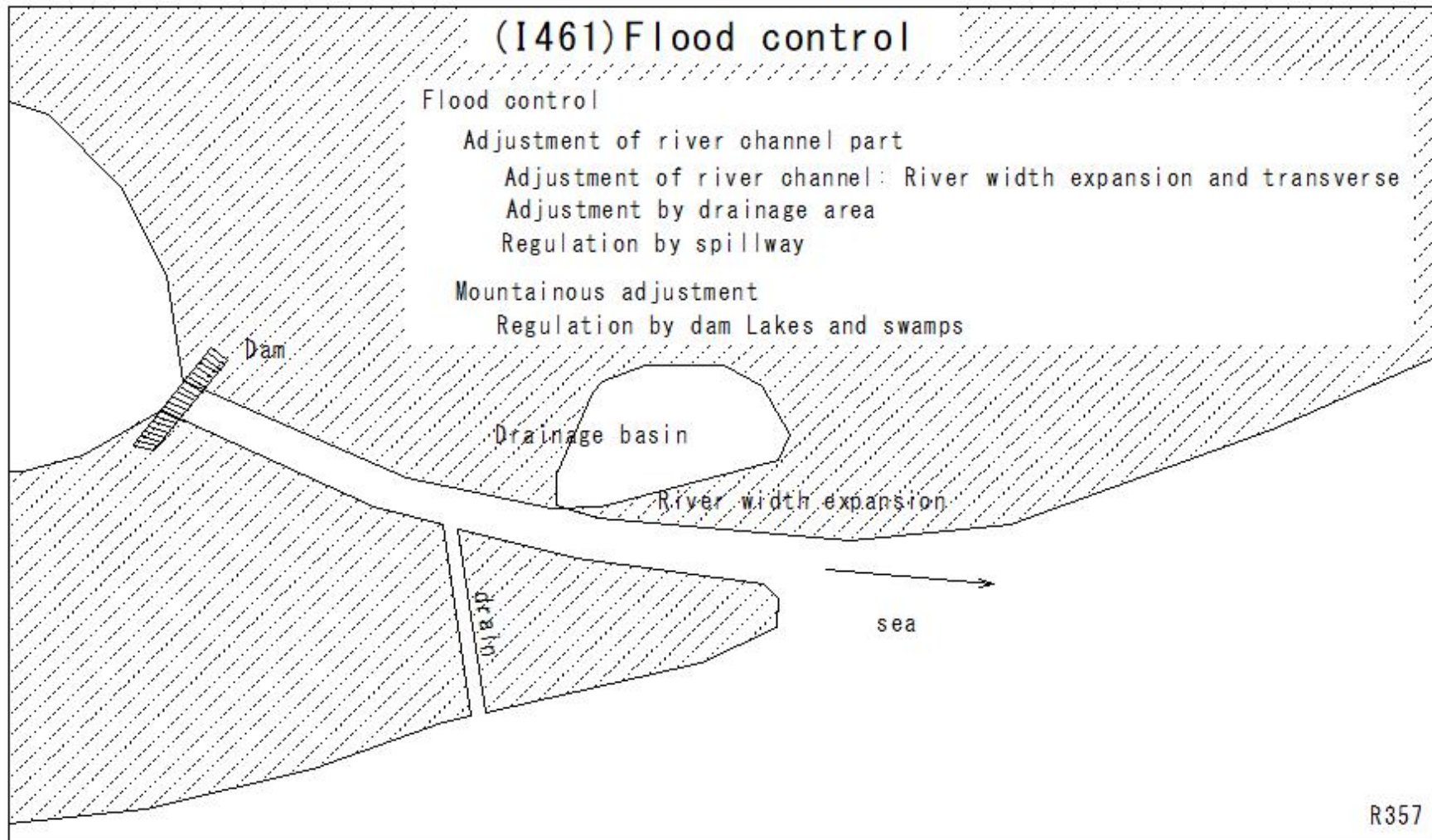
Maximum discharge - reduction



(I460) Embankment(major bed)



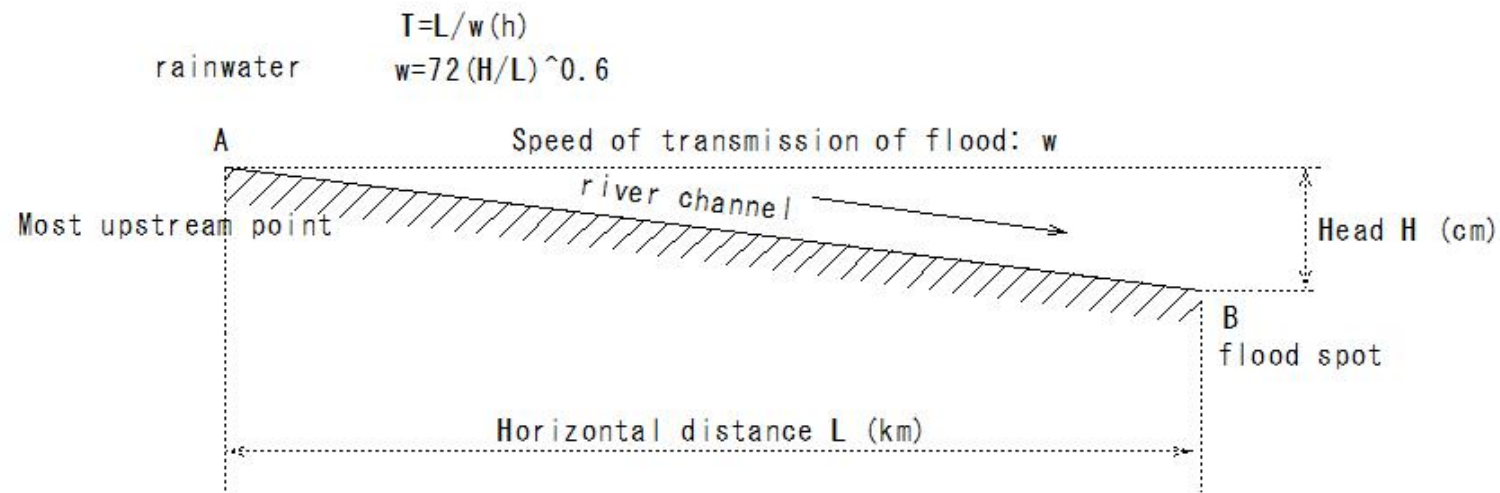
(I461)Flood control



(I462)Time of concentration of flood

(I462)Time of concentration of flood

Time of concentration of flood: T



(I463)Broad-crested weir

(I463)Broad-crested weir

Broad-crested weir

velocity head

wide width

discharge Q

$$Q = CBH\sqrt{2g(H_o - H)}$$

C : flow coefficient

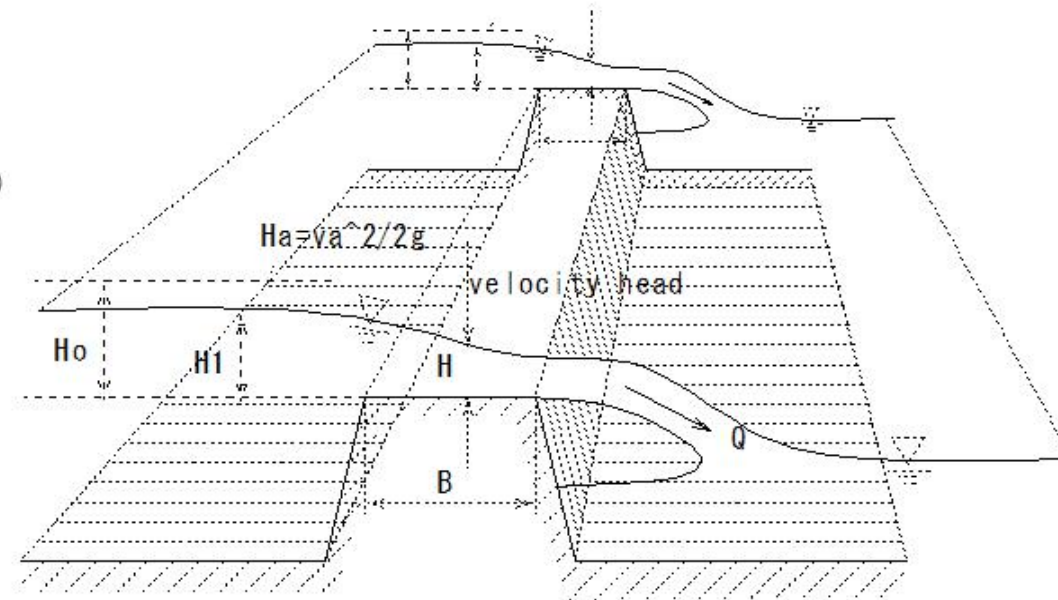
B : Weir width

H : Depth of water at crest

g : gravitational acceleration

H_o : Overflow head ($H_1 + v_a^2/2g$)

v_a : Approach flow velocity

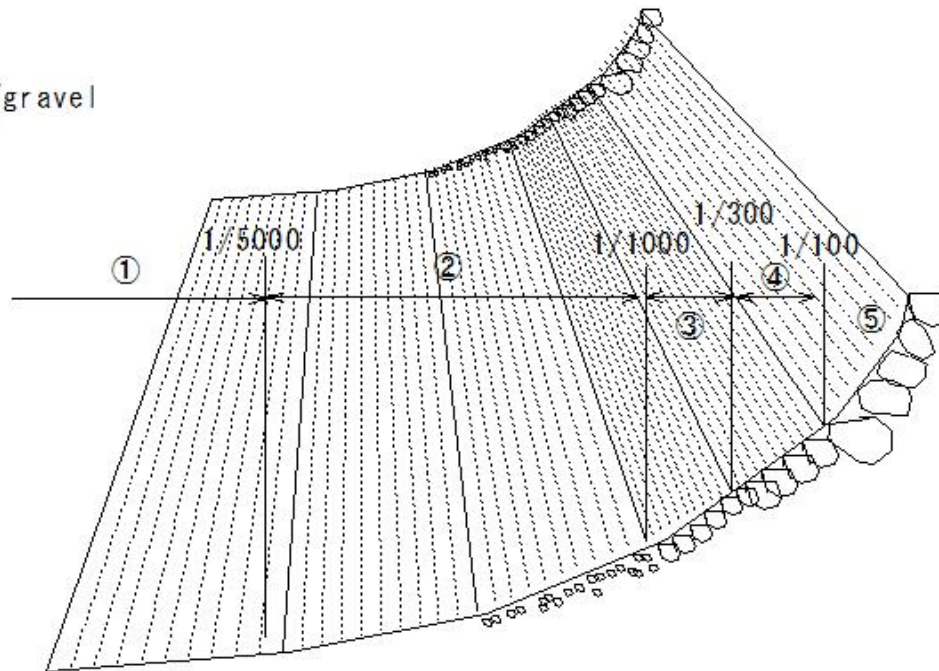


(I464)Gradient(Grade)

(I464)Gradient (Grade)

Gradient (Grade)

- ① Fine sand or silt
- ② Sand
- ③ Gravel
- ④ Large boulders/gravel
- ⑤ Boulders



Gradient (Grade)

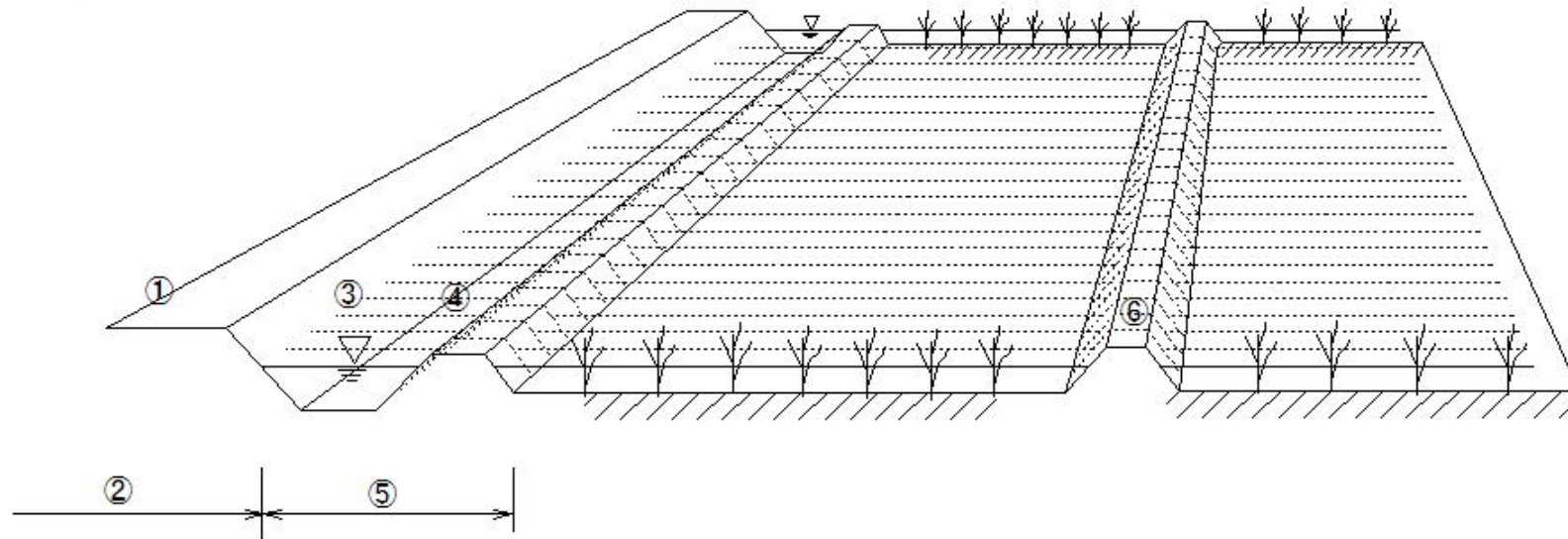
(I465)Ditch(Ditch-side border)

(I465)Ditch(Ditch-side border)

Ditch(Ditch-side border)

Part of the ridge. Mud piled up on the border between rice paddies.

- ① Farm road
- ② Land for farm road
- ③ Small irrigation canal
- ④ Ditch
- ⑤ Land for canal
- ⑥ Ridge

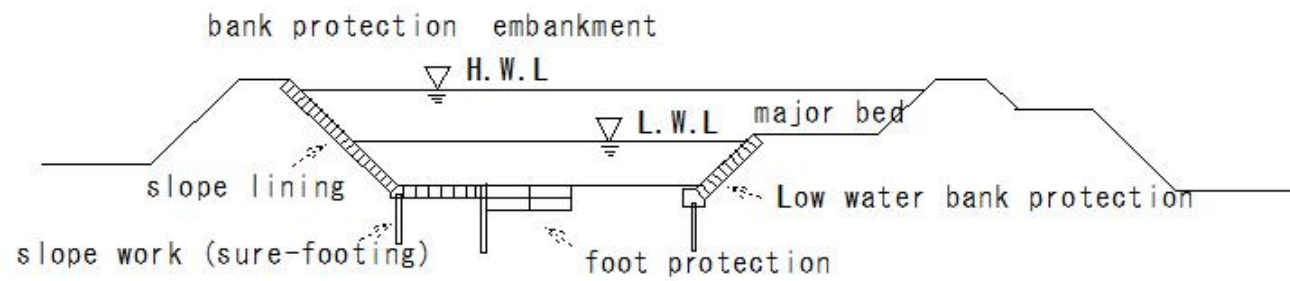


(I466)Bank protection

(I466)Bank protection

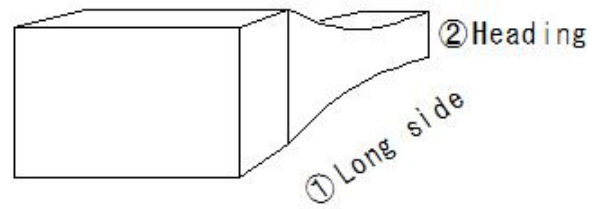
Bank protection

Types of bank protection



(I467)Heading

(I467) Heading

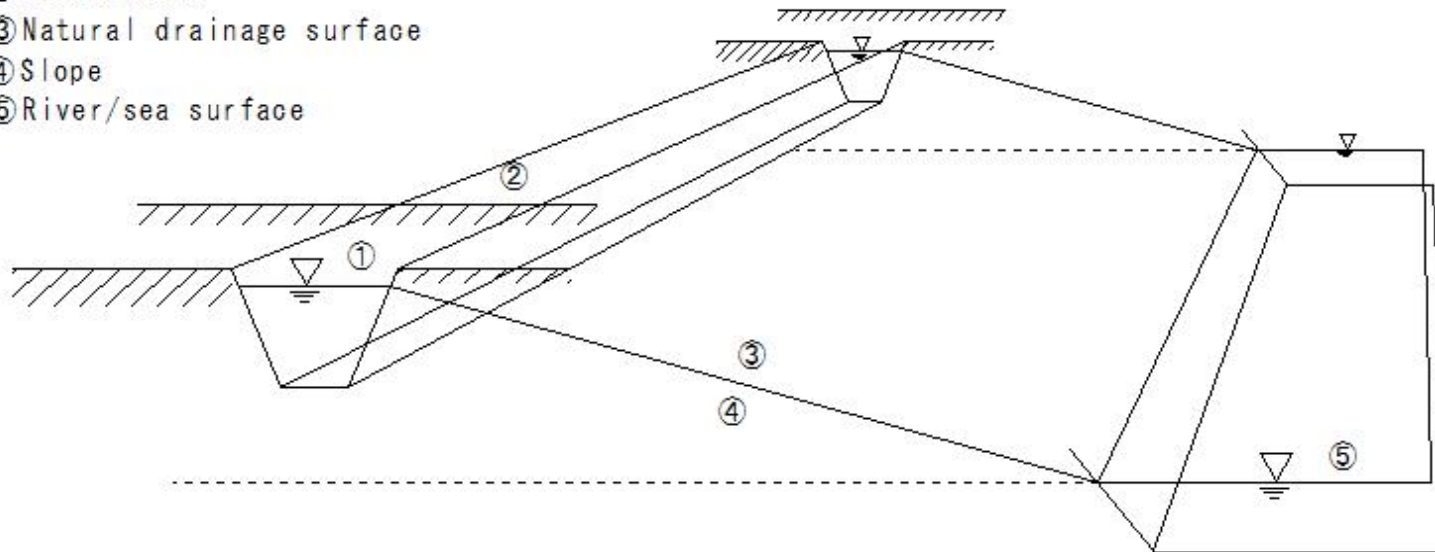


(I468)Lake bottom or marsh bottom

(I468)Lake bottom or marsh bottom

Lake bottom or marsh bottom

- ① Main drainage channel
- ② Lake bottom
- ③ Natural drainage surface
- ④ Slope
- ⑤ River/sea surface



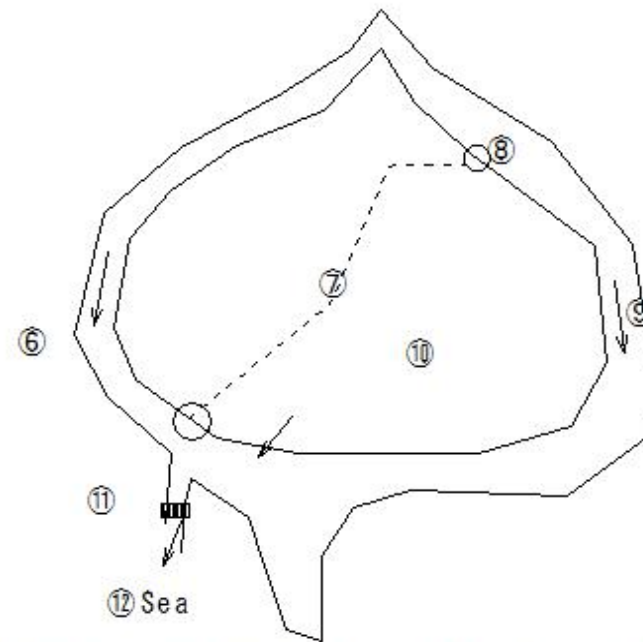
Relationship between reclamation by natural drainage channel method

(I469)Lake bottom or marsh bottom

(I469)Lake bottom or marsh bottom

Lake bottom or marsh bottom

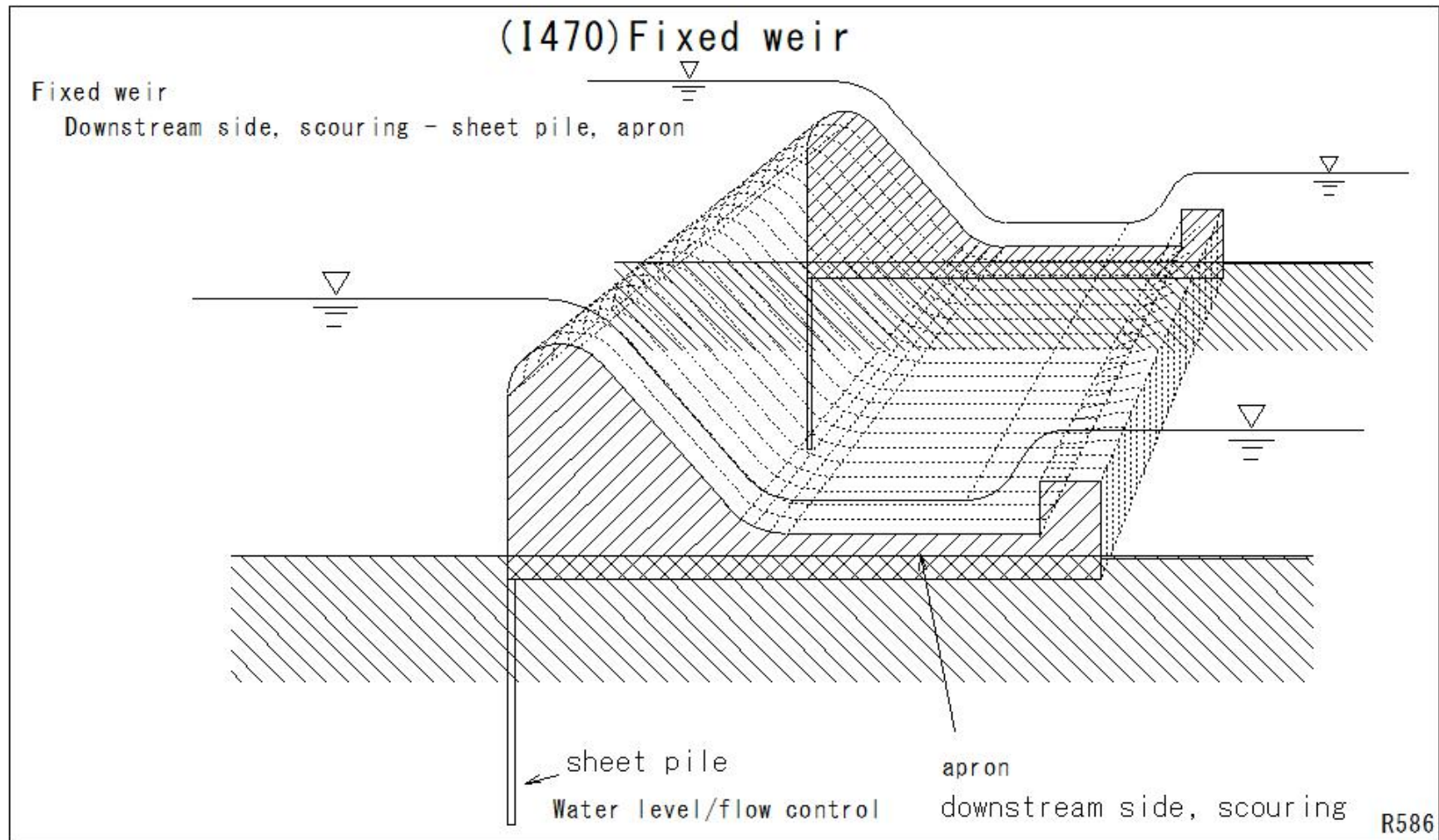
- ⑥ Receiving channel
- ⑦ Drainage channel
- ⑧ Pump
- ⑨ Receiving channel
- ⑩ Adjusting reservoir
- ⑪ Floodgate



図形がありません

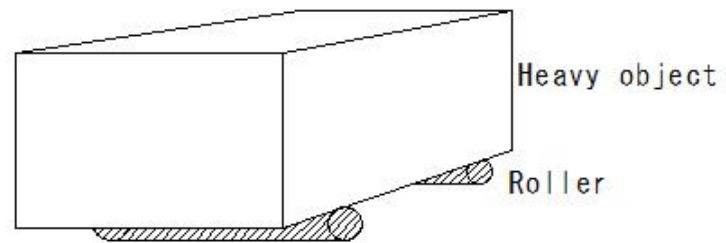
Method using a receiving channel and drainage pump

(I470)Fixed weir



(I471)Roller

(I471)Roller



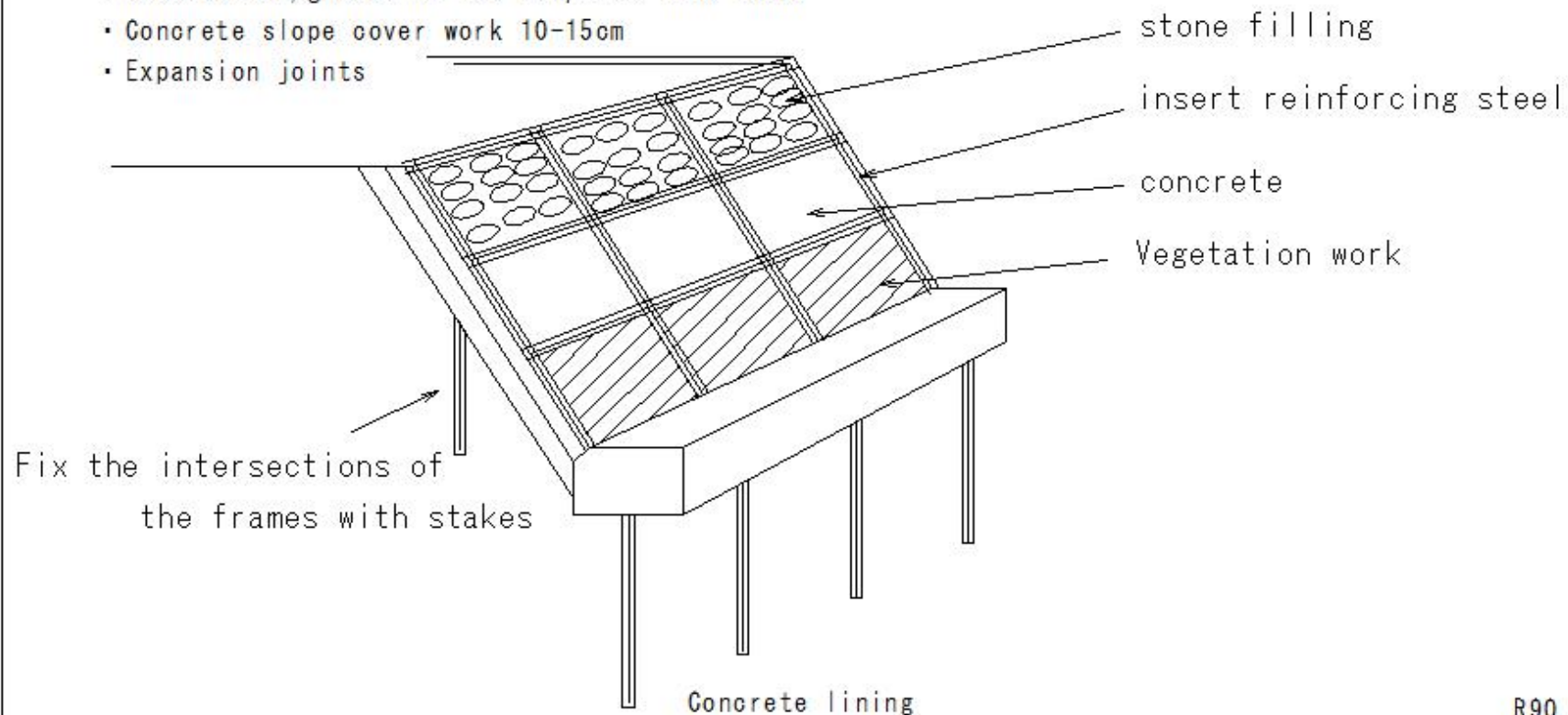
(I472)Concrete pitching

(I472)Construction of Slope lining work(Concrete lining)

Construction of Slope lining work

④Concrete lining

- Cobblestone/gravel on the slope 10-15cm thick
- Concrete slope cover work 10-15cm
- Expansion joints

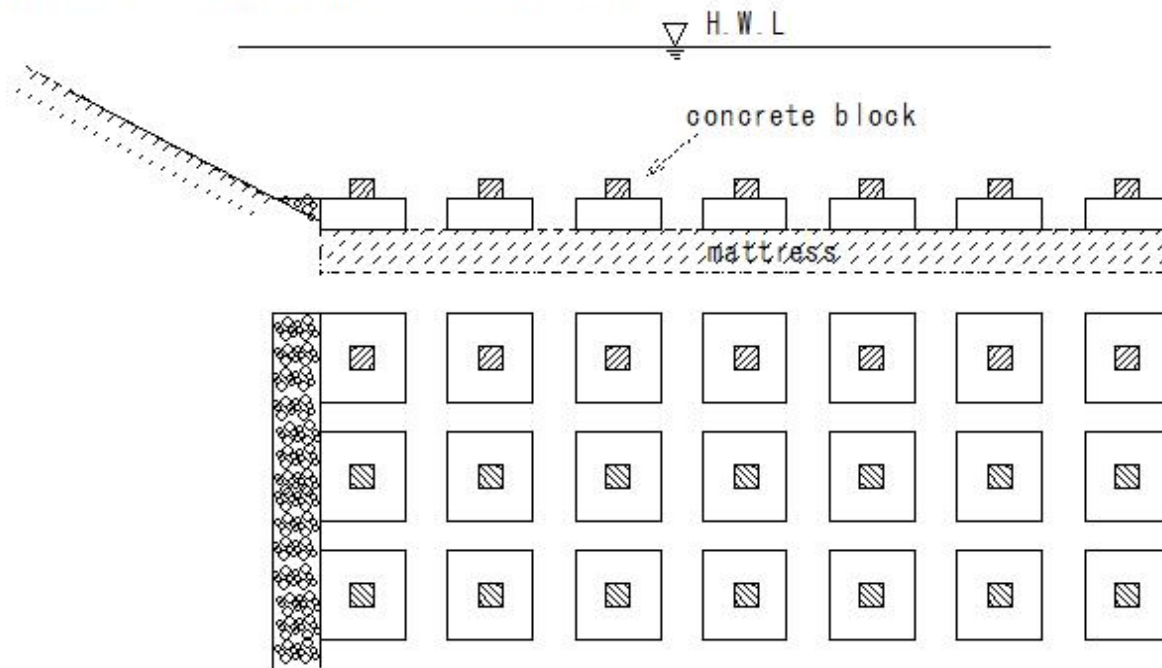


(I473)Groyne (concrete block groyne)

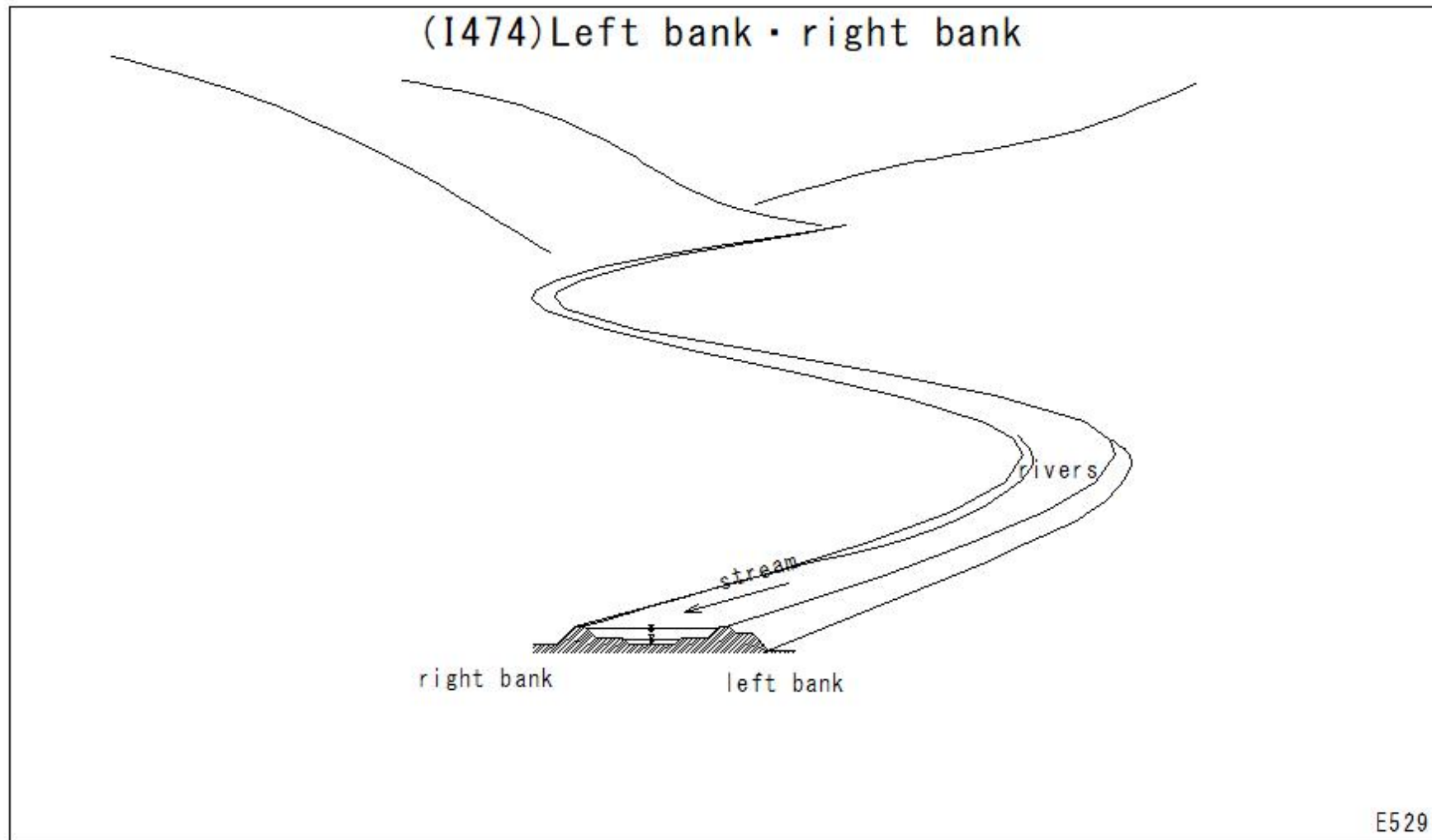
(I473)Groyne (concrete block groyne)

Concrete block groyne

- type of groyne
- Riverbank erosion prevention
- Suitable for rapid rivers
- Arrange large square blocks on the mattress



(I474)Left bankright bank



(I475) Surge-tank

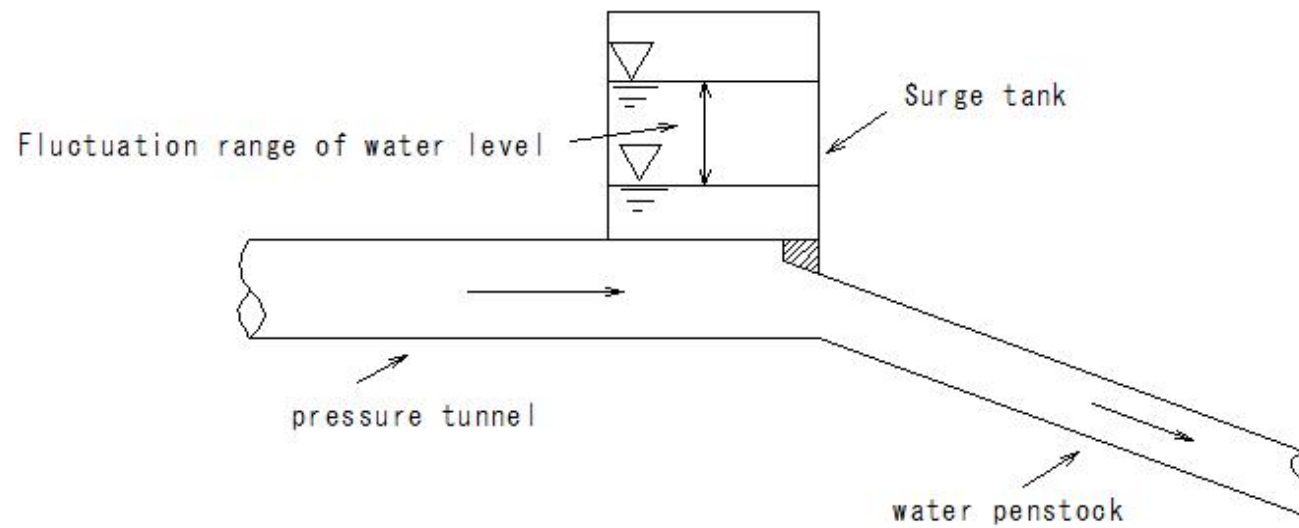
(I475) Surge-tank

Surge-tank

Dam waterway power plant

- Reducing water hammer pressure in penstocks
- Absorbs fluctuations in water pressure

Fluctuation range of water level

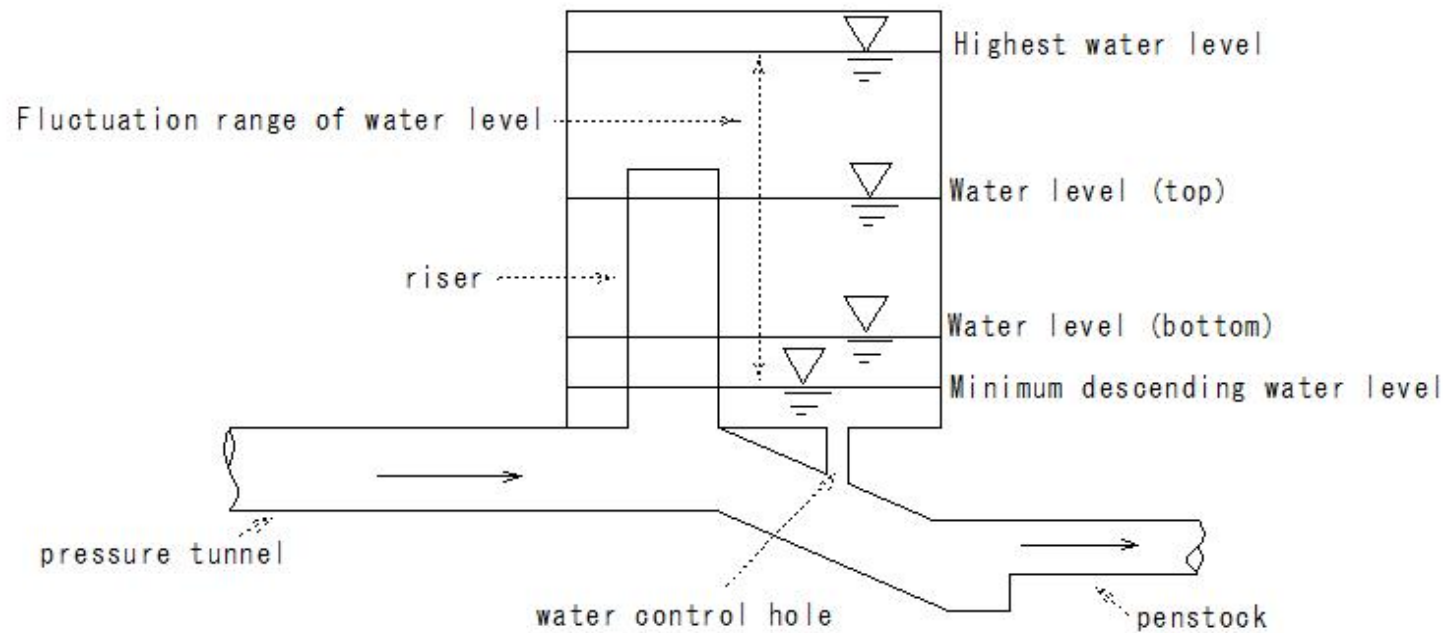


(I476) Differential surge-tank

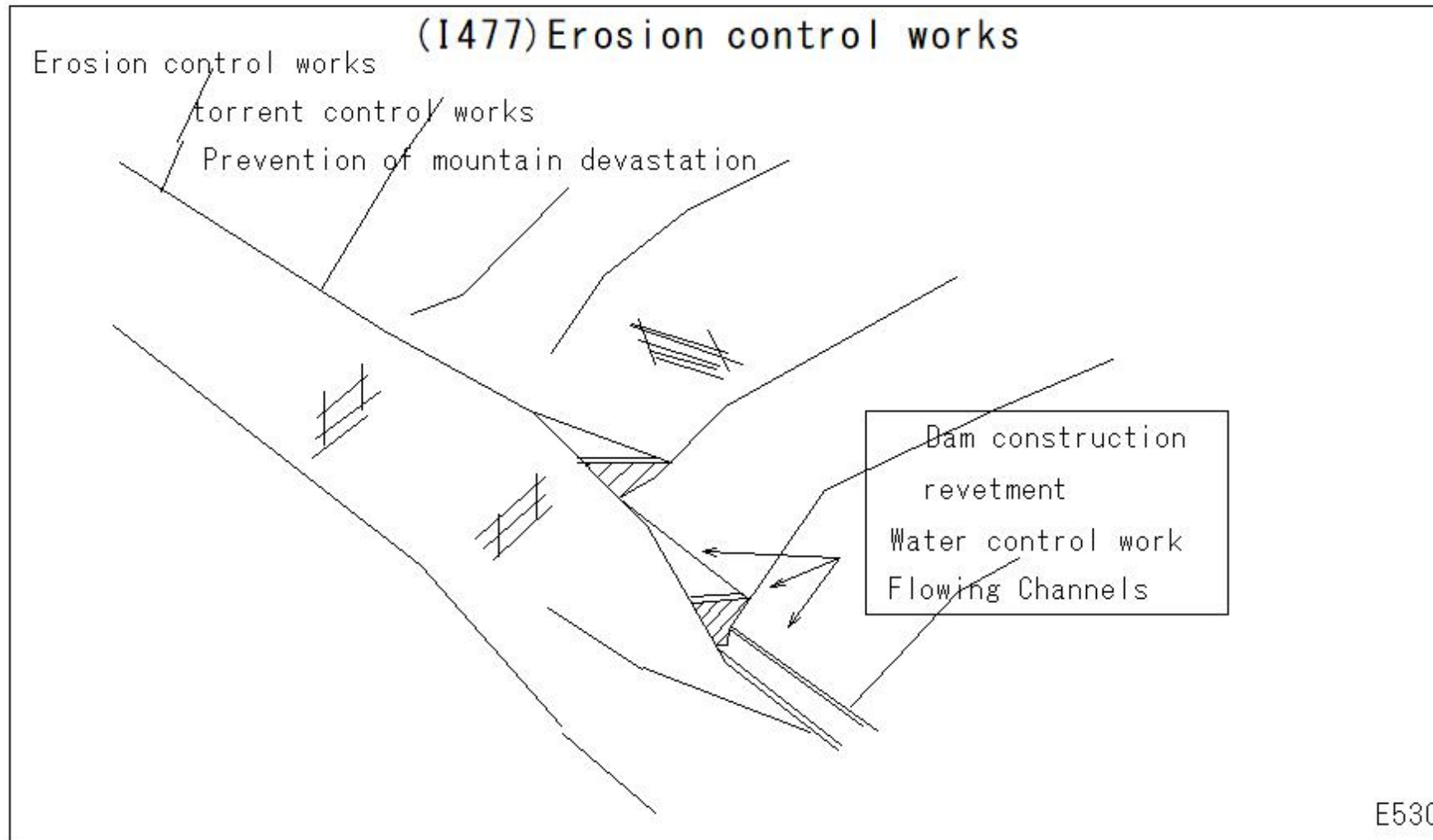
(I476) Differential surge-tank

differential surge tank

- the load suddenly changes, the water level inside the riser changes suddenly.
equilibrium within a short time



(I477)Erosion control works



(I478)Triangular weir

(I478)Triangular weir

Triangular weir

Overflow section

Water flow cross section

triangular weir

discharge: Q

$$Q = 8/15 C \tan \theta / 2 \times (\sqrt{2g} \cdot H^{5/2})$$

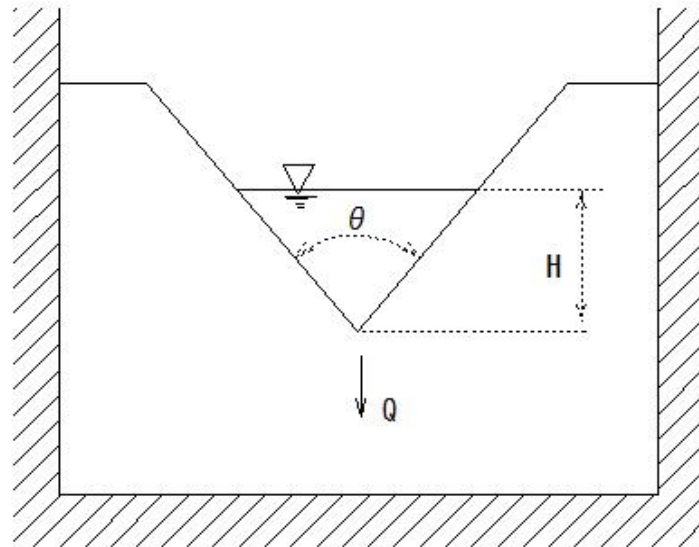
C : discharge coefficient

g : gravitational acceleration

H : Overflow water depth

discharge-a little

Accurate flow measurement

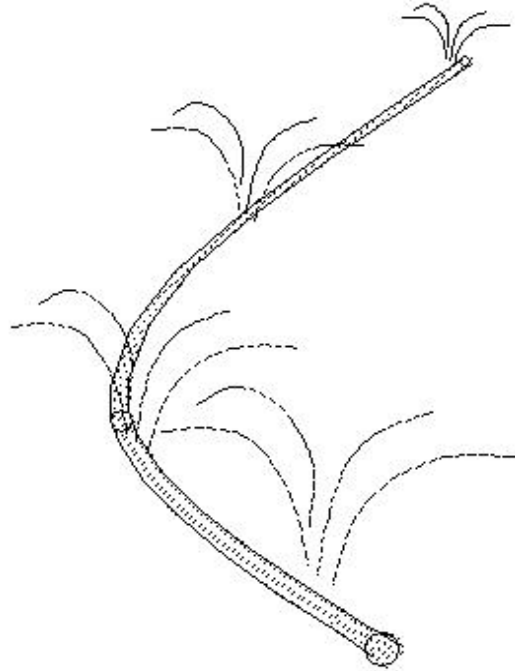


(1479) Spray irrigation

(1479) Spray irrigation

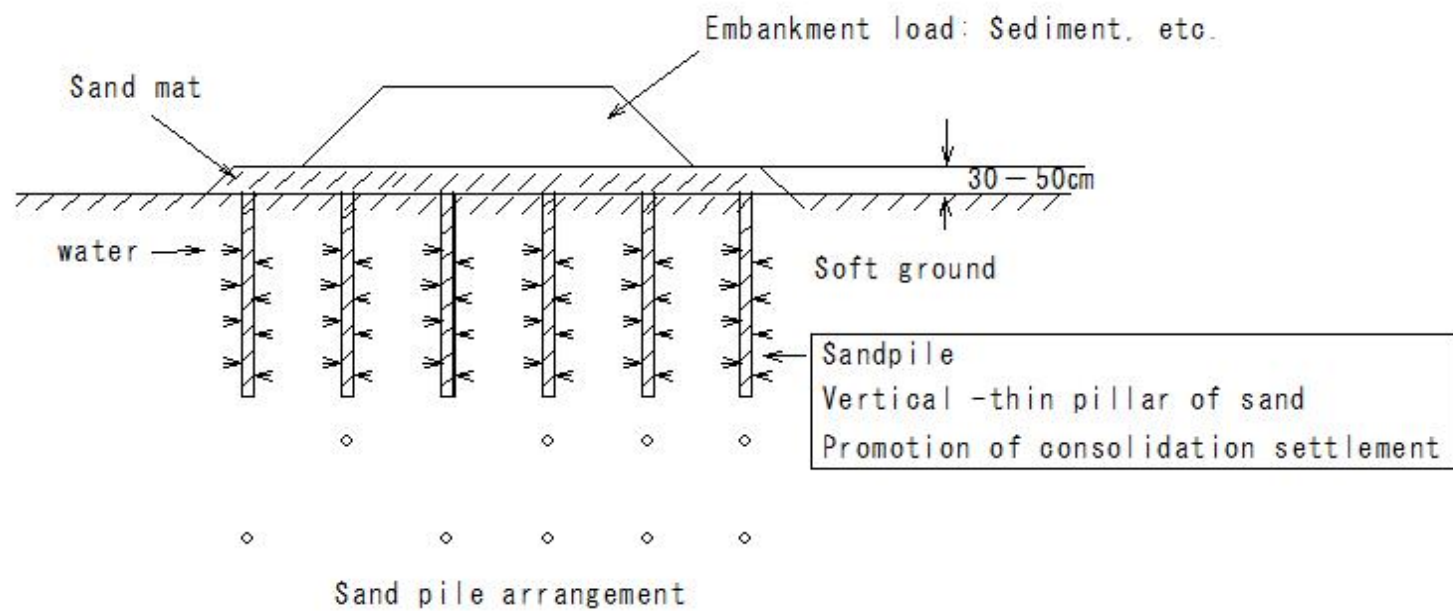
Spray irrigation

- ① A method of irrigation that uses water pressure to spray water in a mist from nozzles or sprinklers
- ② A method of irrigation that provides water to farmland or orchards

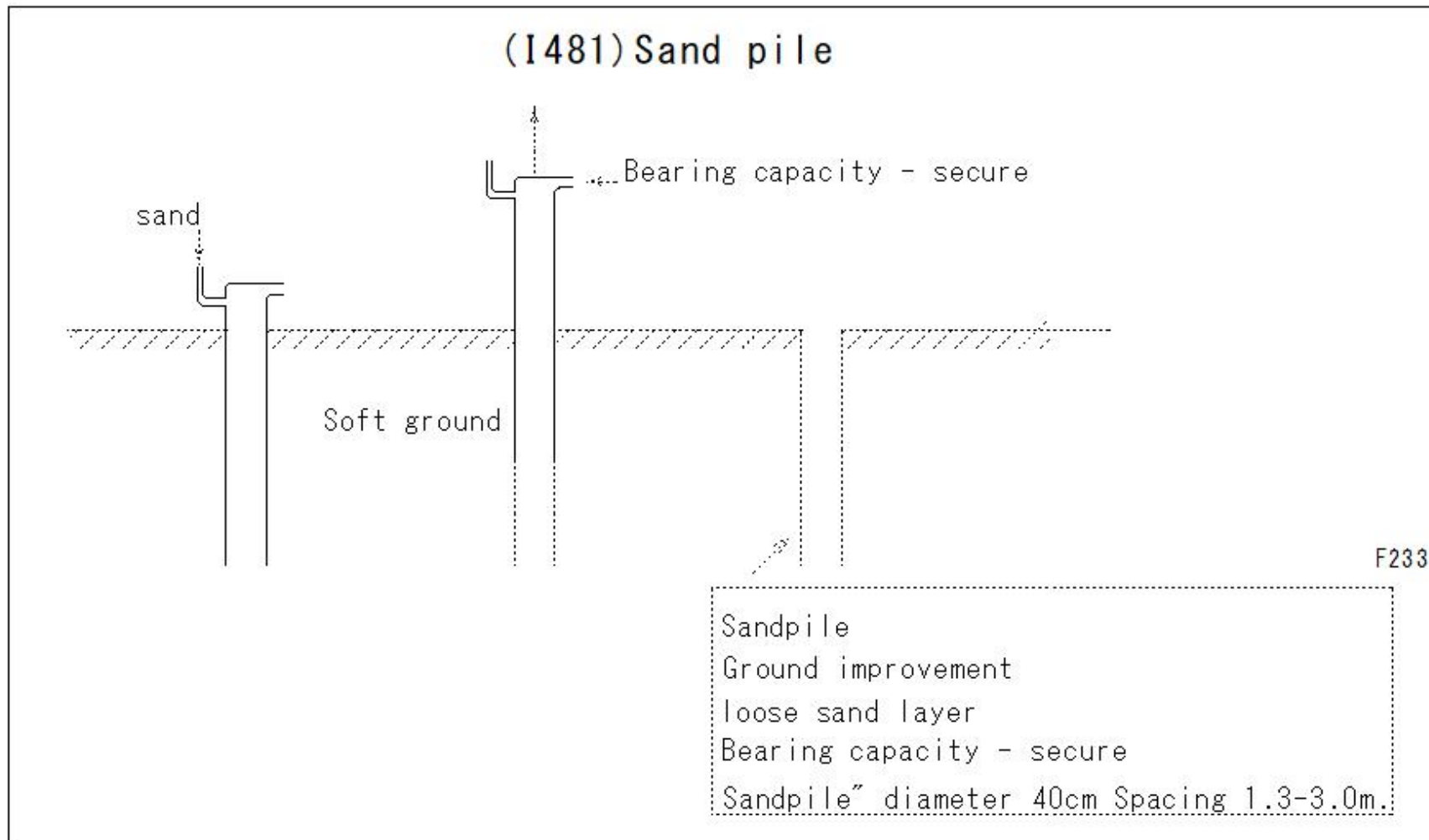


(I480)Sand drain method

(I480)Sand drain method



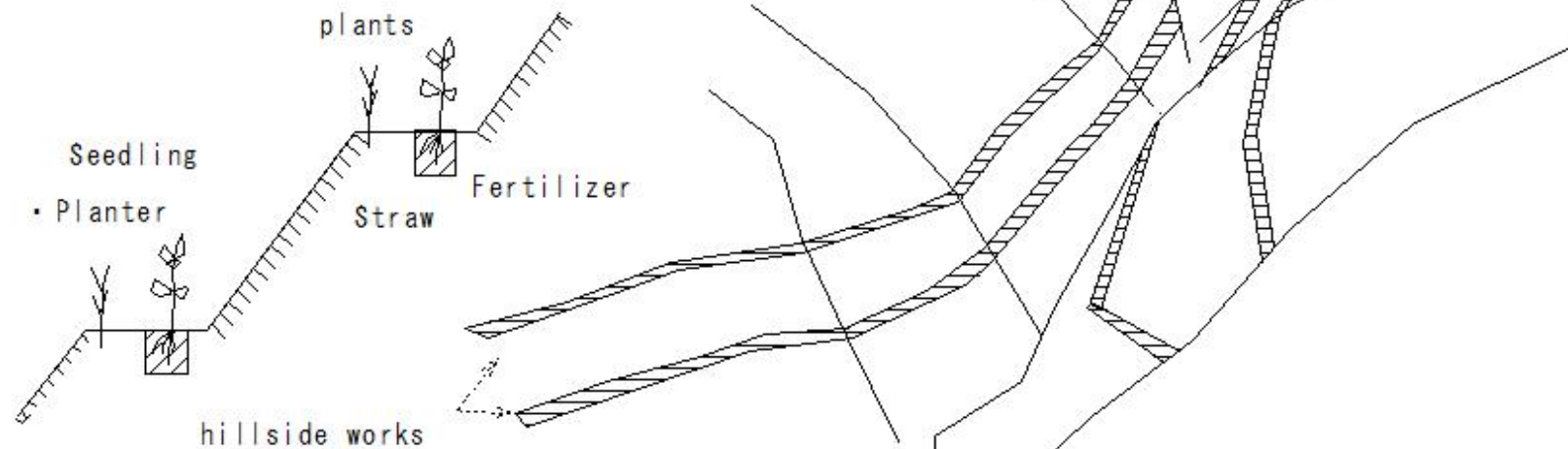
(I481) Sand pile



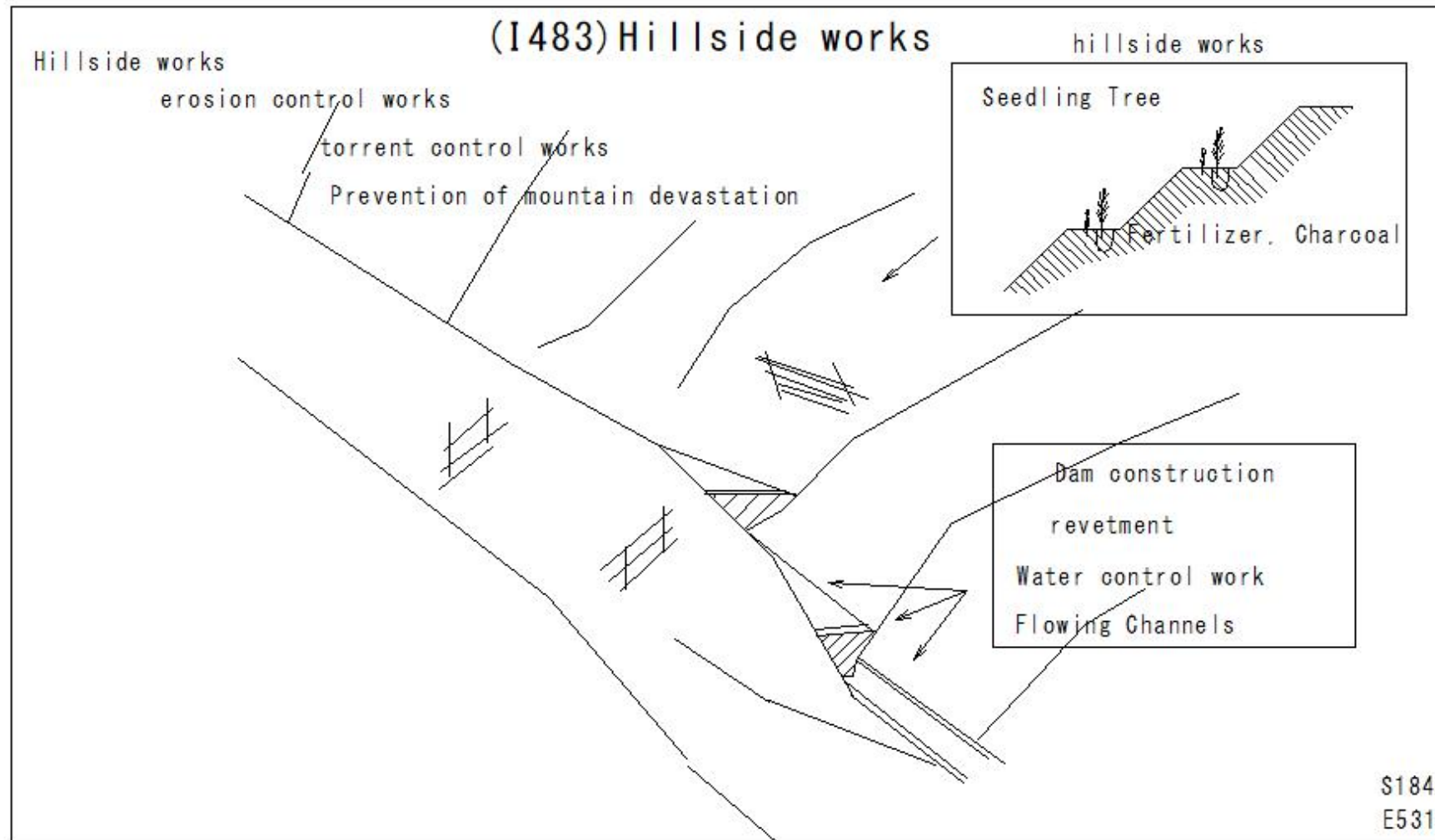
(1482) Hillside works

hillside works

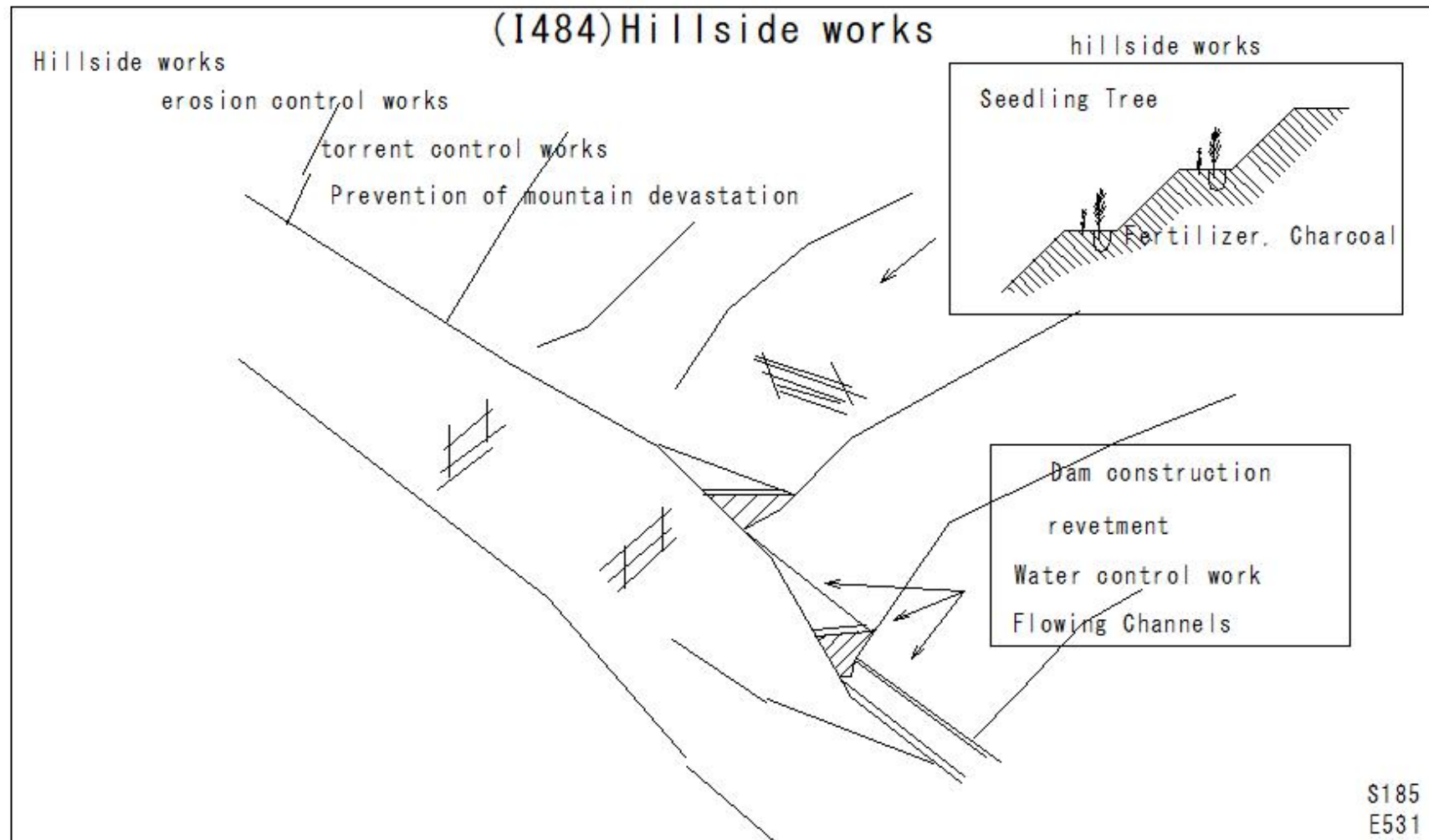
- Cut the mountainside into steps
- Preventing mountainside collapse by planting drainage structures and seedlings
- Mountainside slope cutting work
- Mountainside coating work
- Preventing mountainside collapse by planting drainage structures and seedlings



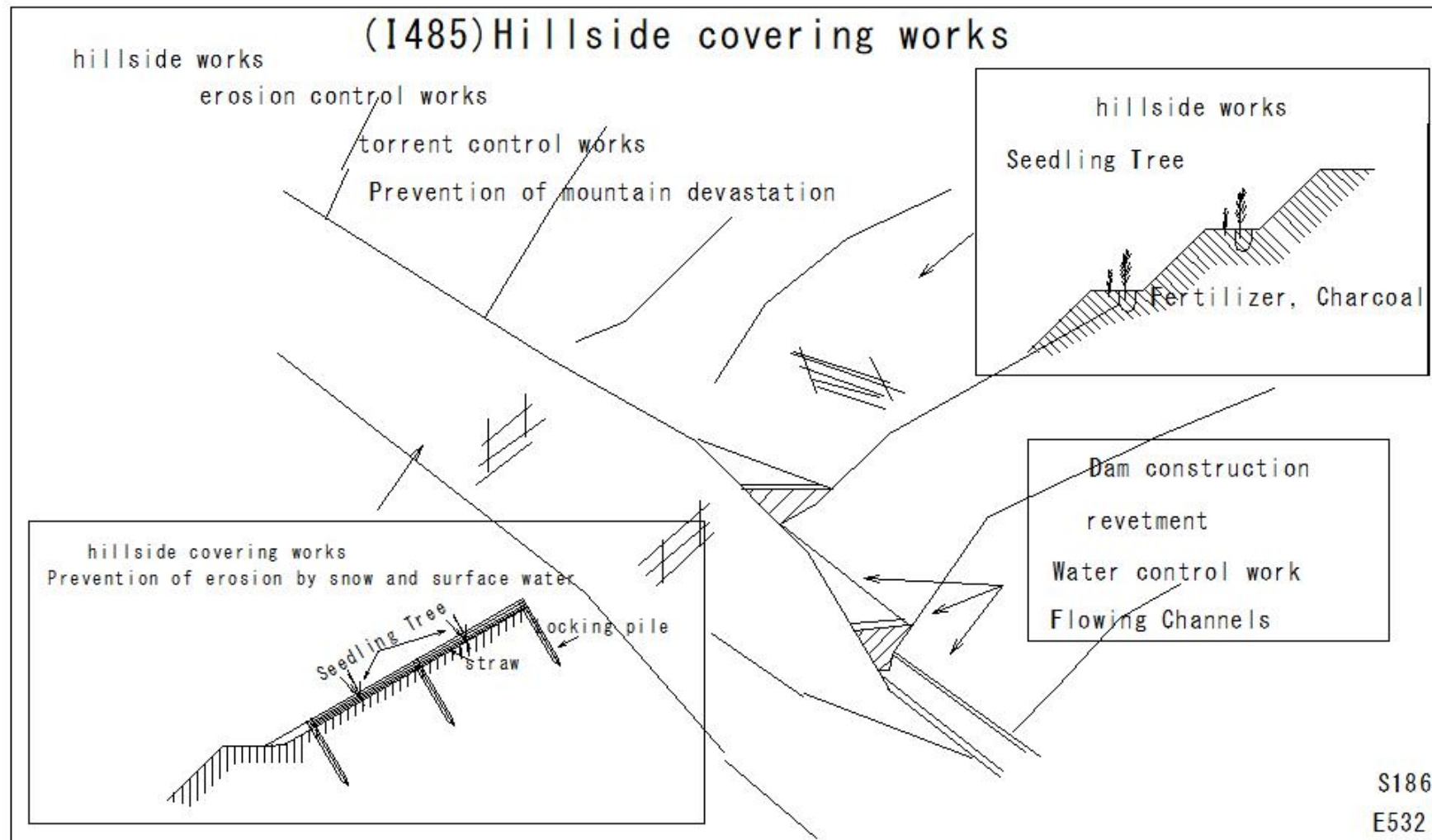
(I483)Hillside works



(I484) Mountainside slope cutter



(I485)Hillside covering works



(I486) Square weir

(I486) Square weir

Square weir

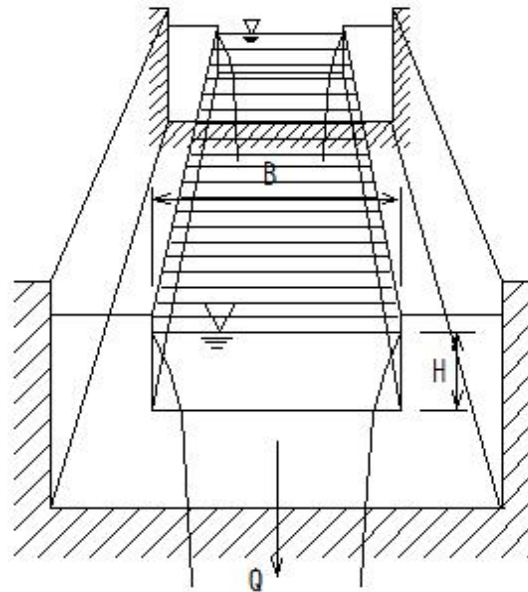
$$Q = CBH^{3/2}$$

C: Discharge coefficient

B: Cross-sectional width of water passage

H: Overflow depth

Q: Discharge



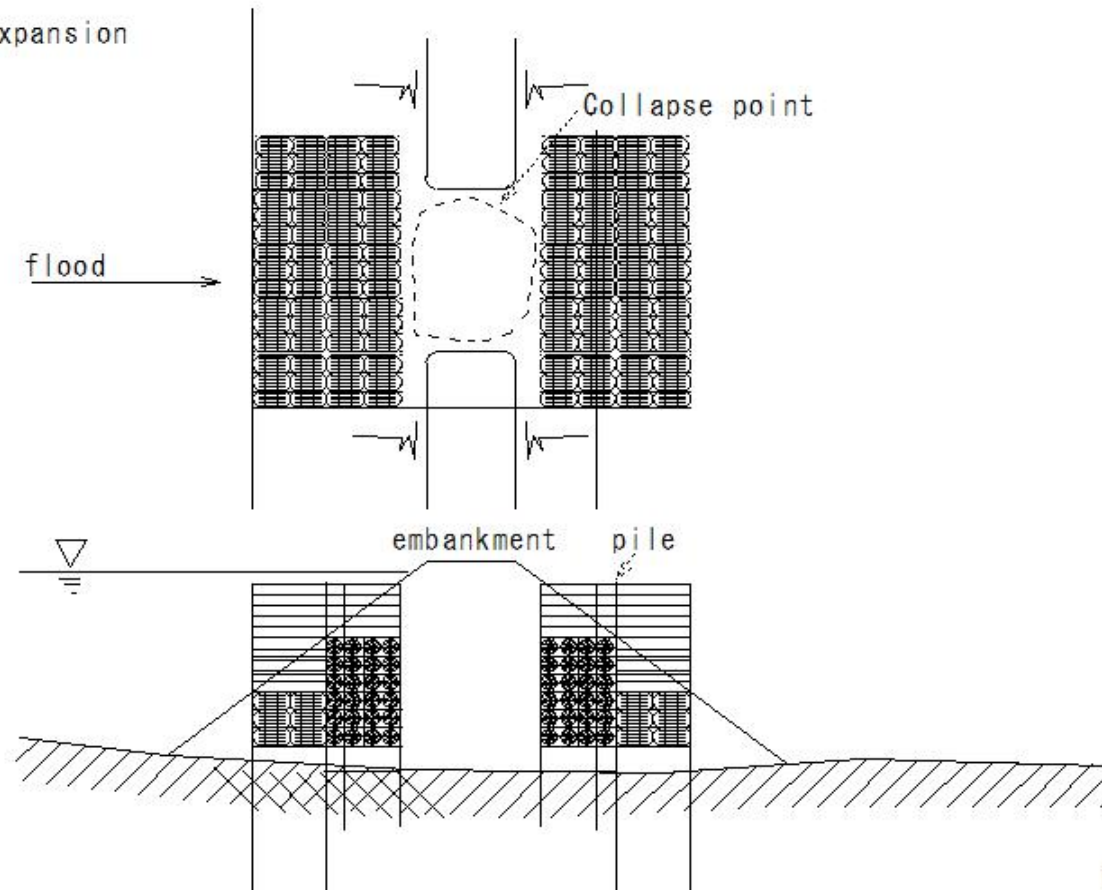
(I487)Levee burst prevention (hurdle work)

(I487)Levee burst prevention (hurdle work)

Hurdle work(soil bag)

Levee burst - prevention of expansion

Emergency measure



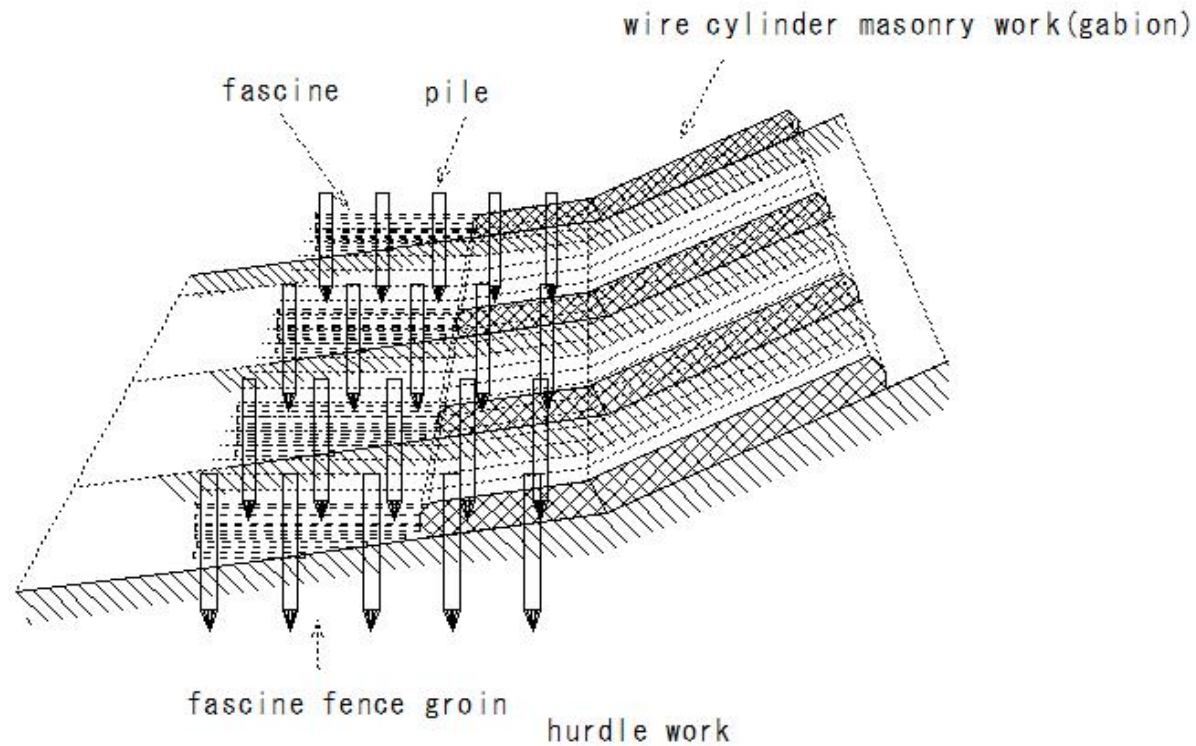
R535

(I488)Hurdle work(bank protection work)

(I488)Hurdle work(bank protection work)

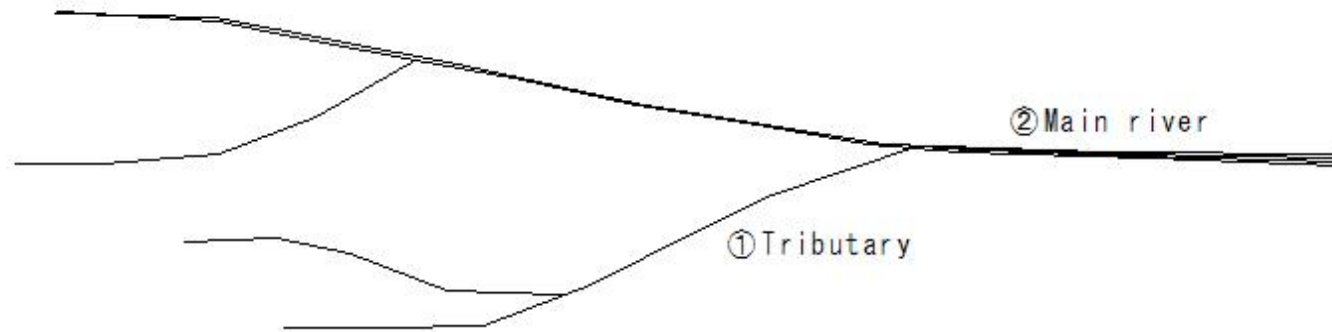
Hurdle work(bank protection work)

- Weaken the flow
- Prevention of scouring



(I489)Tributary

(I489)Tributary



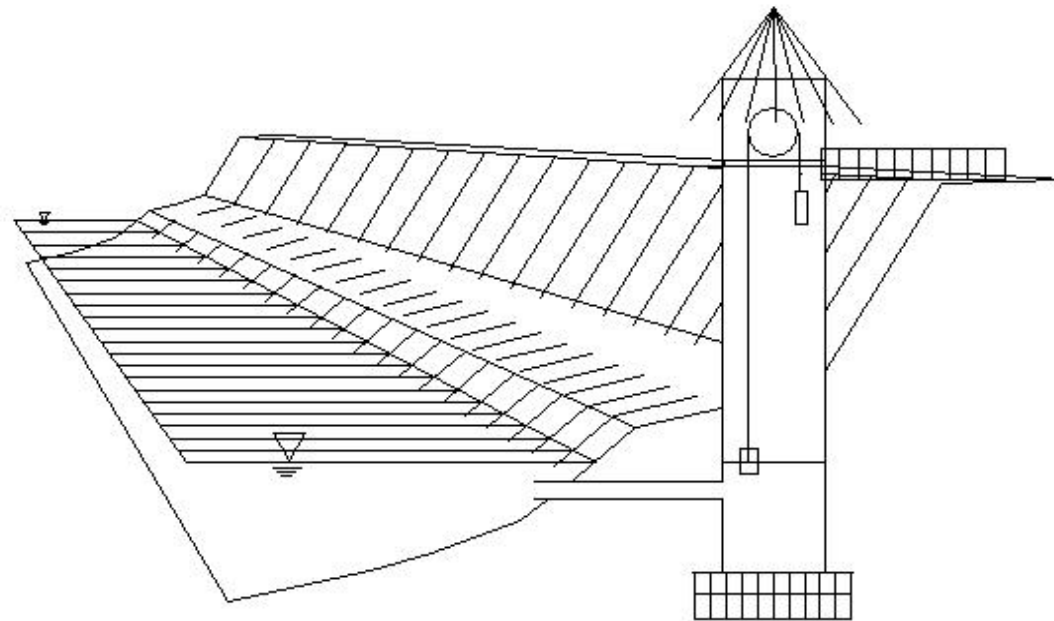
(I490)Automatic water gauge

(I490)Automatic water gauge

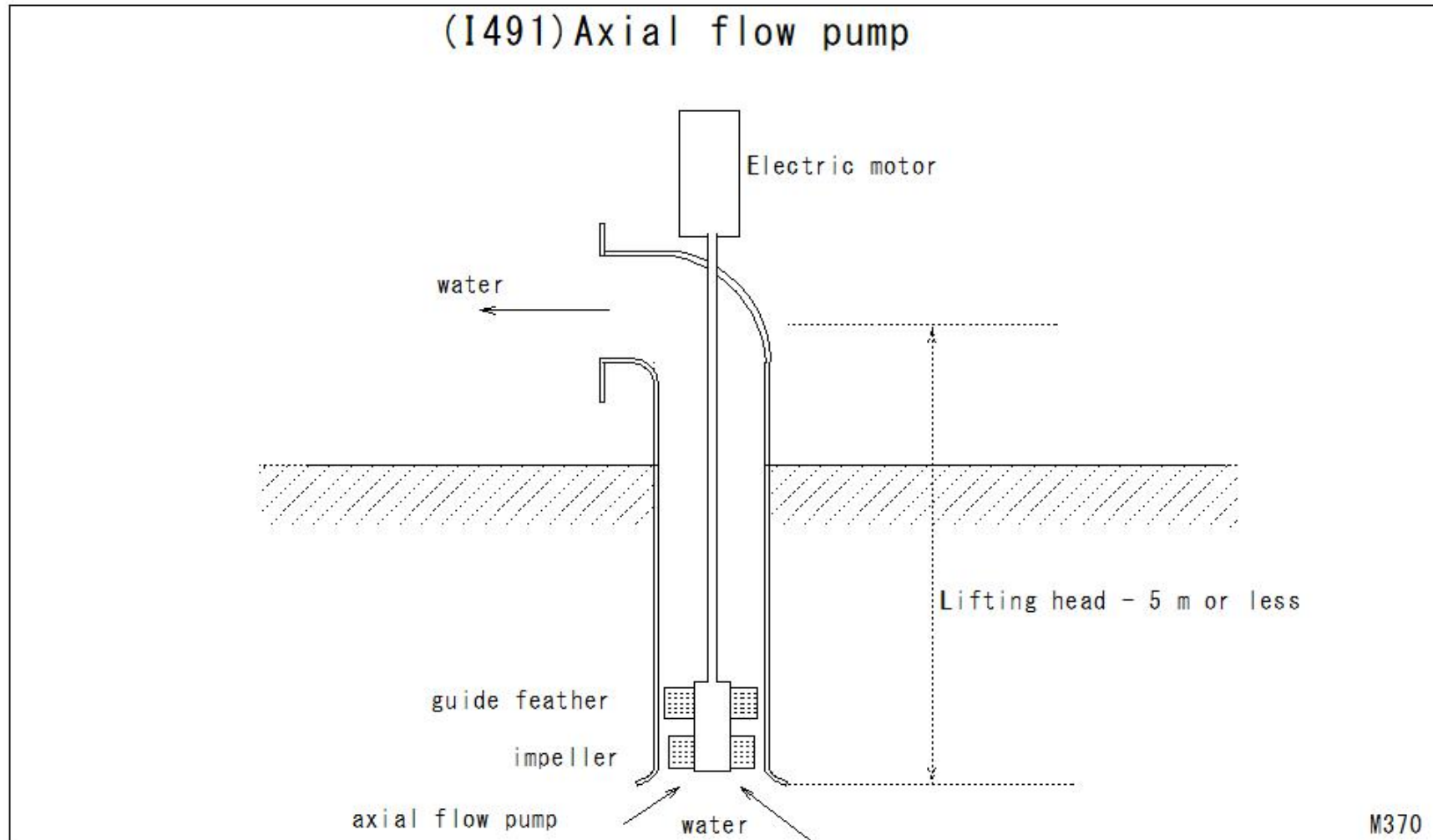
Automatic water gauge

An "automatic water gauge" is a device that automatically records changes in water level.

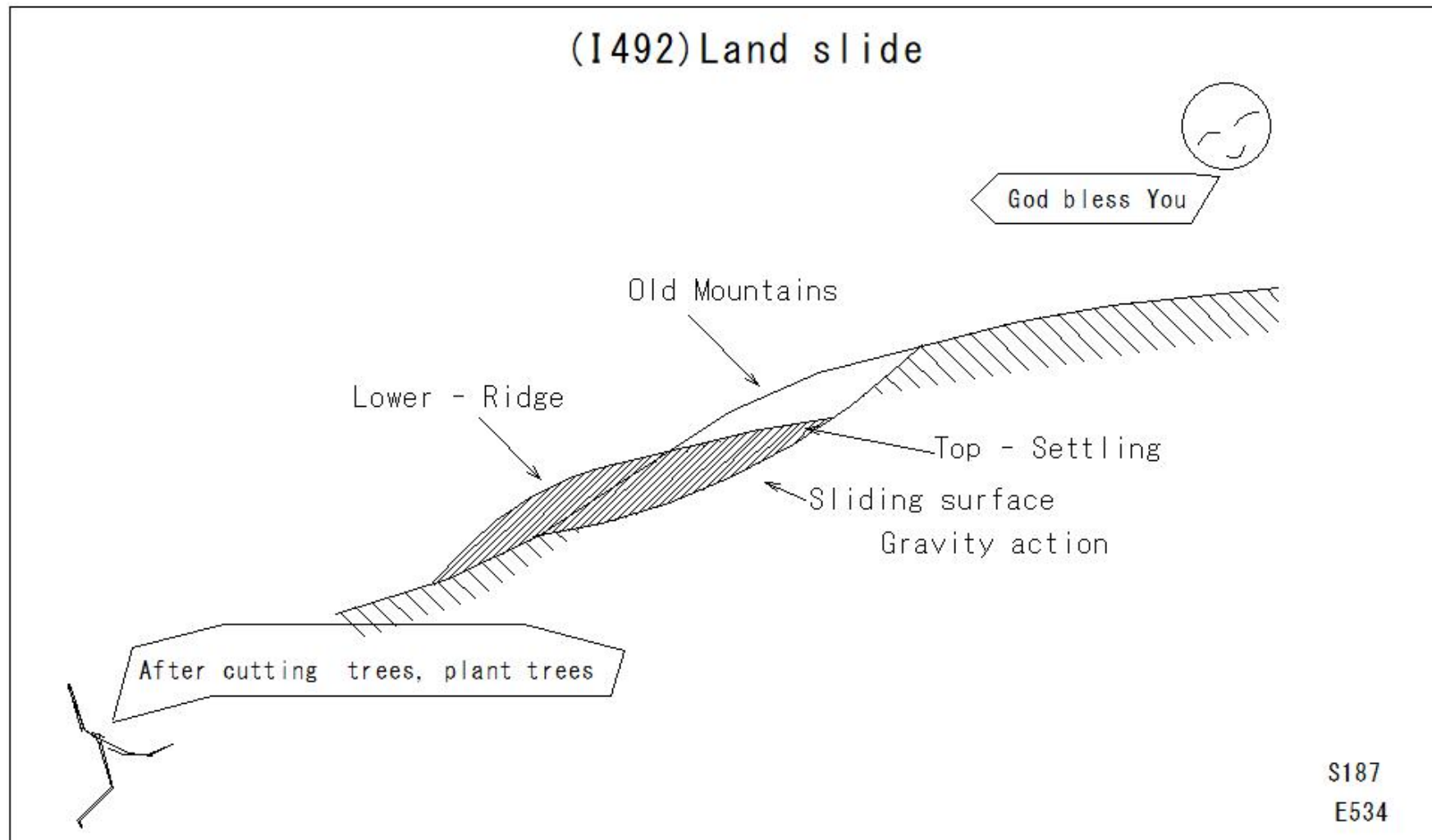
- ① Automatic recording device
- ② Observation well
- ③ Float



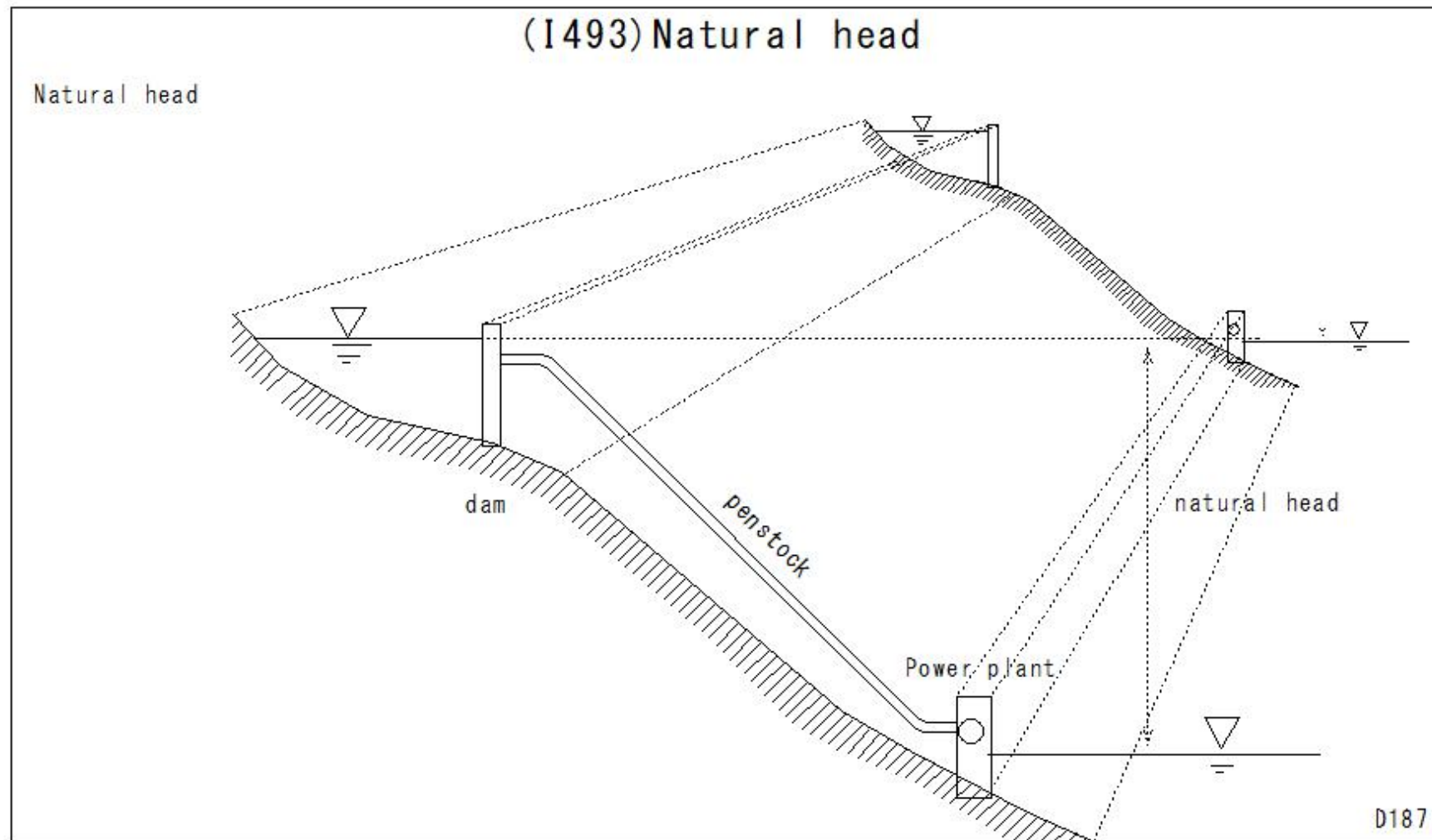
(I491)Axial flow pump



(I492)Land slide



(I493) Natural head



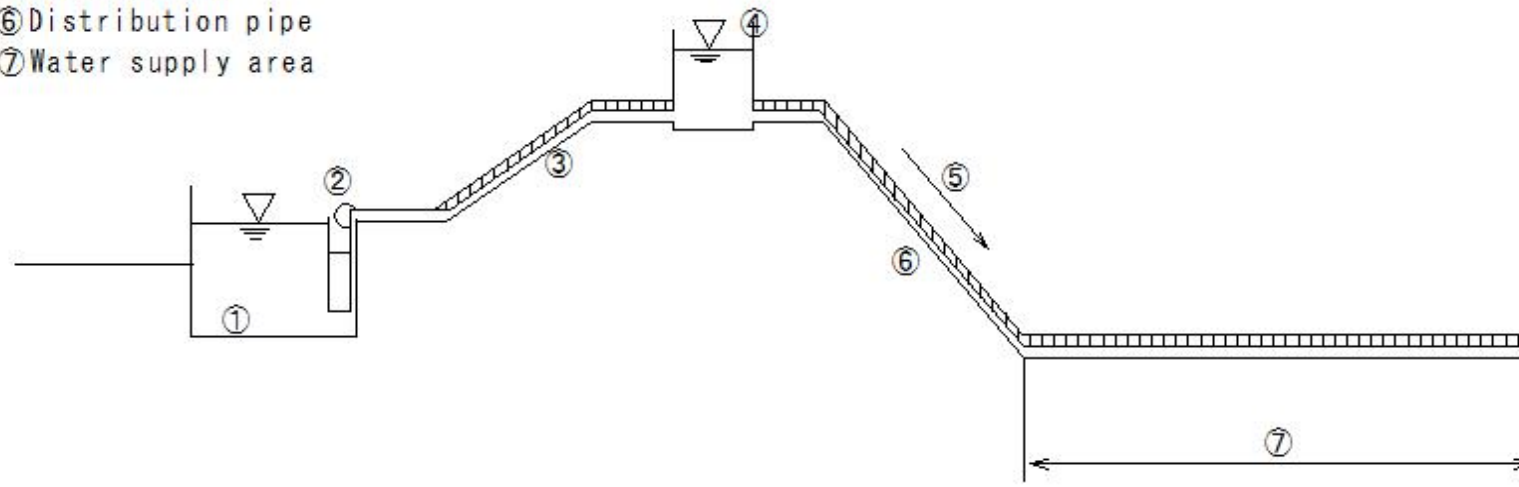
(I494)Natural drainage system

(I494)Natural drainage system

Natural drainage system

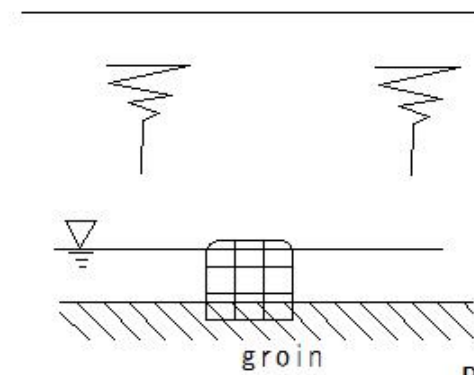
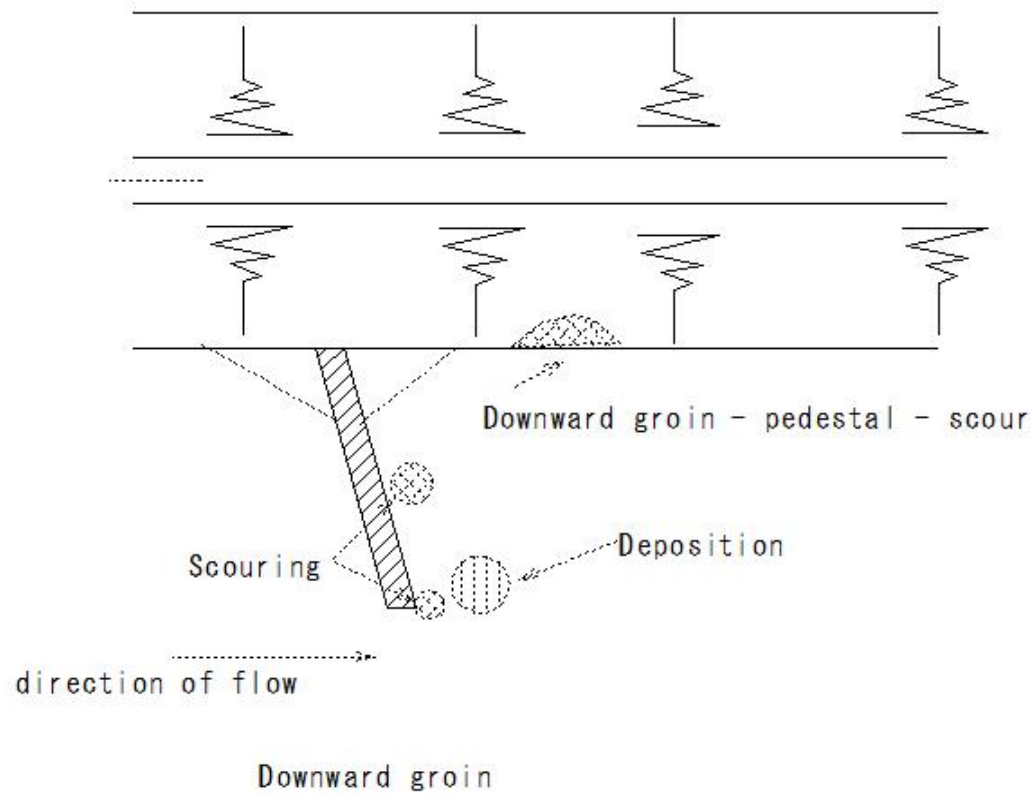
The natural flow distribution system is a method of distributing water by setting up a distribution reservoir on high ground and using the difference in elevation to allow

- ① Water purification plant
- ② Water pump
- ③ Water pipe
- ④ Distribution reservoir
- ⑤ Natural flow
- ⑥ Distribution pipe
- ⑦ Water supply area



(I495)Downward groin

(I495)Downward groin



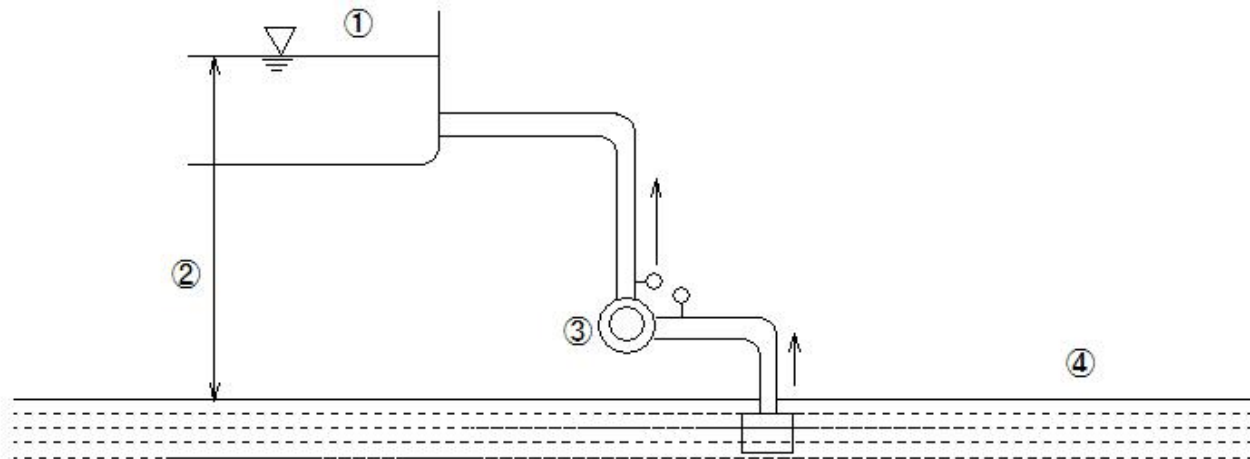
R441

(I496)Gross pump head

(I496)Gross pump head

Gross pump head

- ① Discharge water level
- ② Actual head
- ③ Pump
- ④ Suction water level



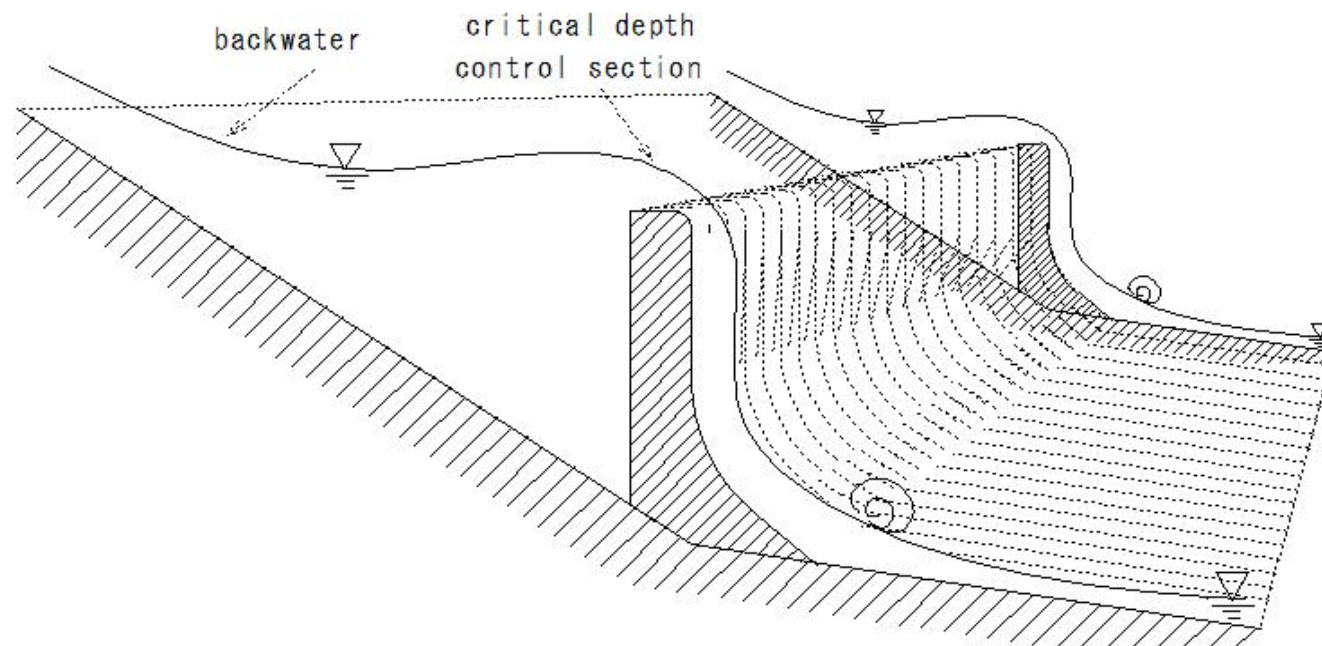
(I497)Control section

(I497)Control section

Control section : The dominant cross section appears
at the top of the weir.

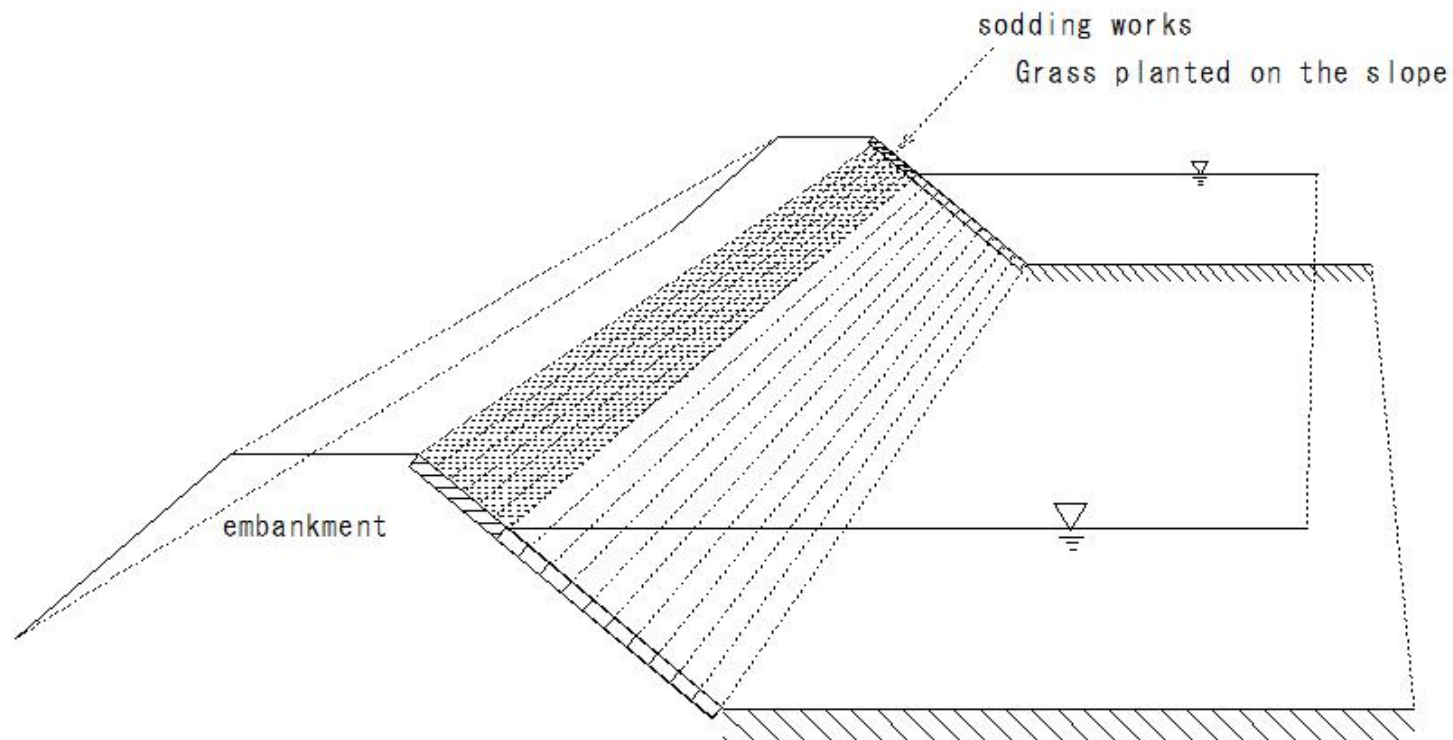
Governing the flow conditions in an open channel

Serves as the starting point for calculating drainage curves.



(I498)Bank protection(sodding works)

(I498)Bank protection(sodding works)



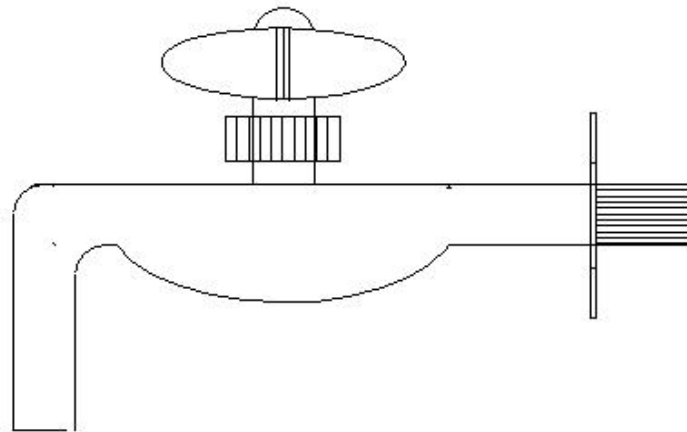
R460

(I499)Self closing tap

(I499)Self closing tap

Self closing tap

A self-closing faucet is a faucet that starts water flowing when you press the handle or lever once and stops automatically after a certain period of time or when you release the handle.



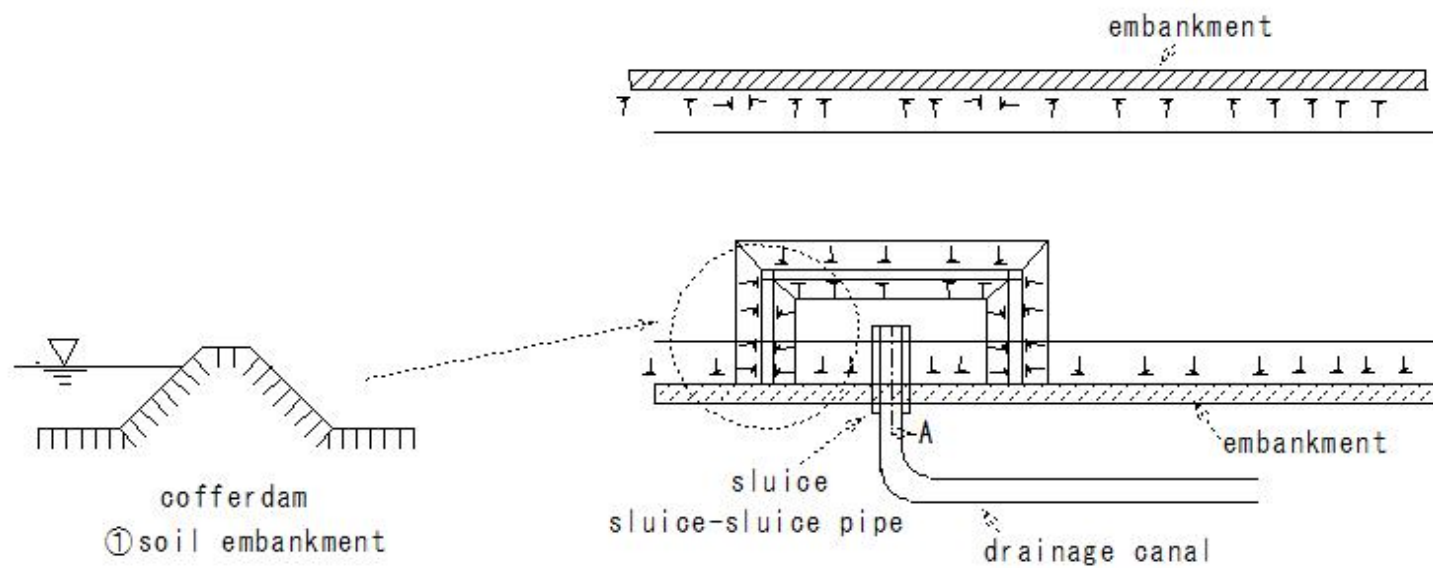
(I500)Cofferdam

(I500) Cofferd dam

Cofferdam

river construction

① soil embankment



(I501)Closing dyke

(I501)Closing dyke

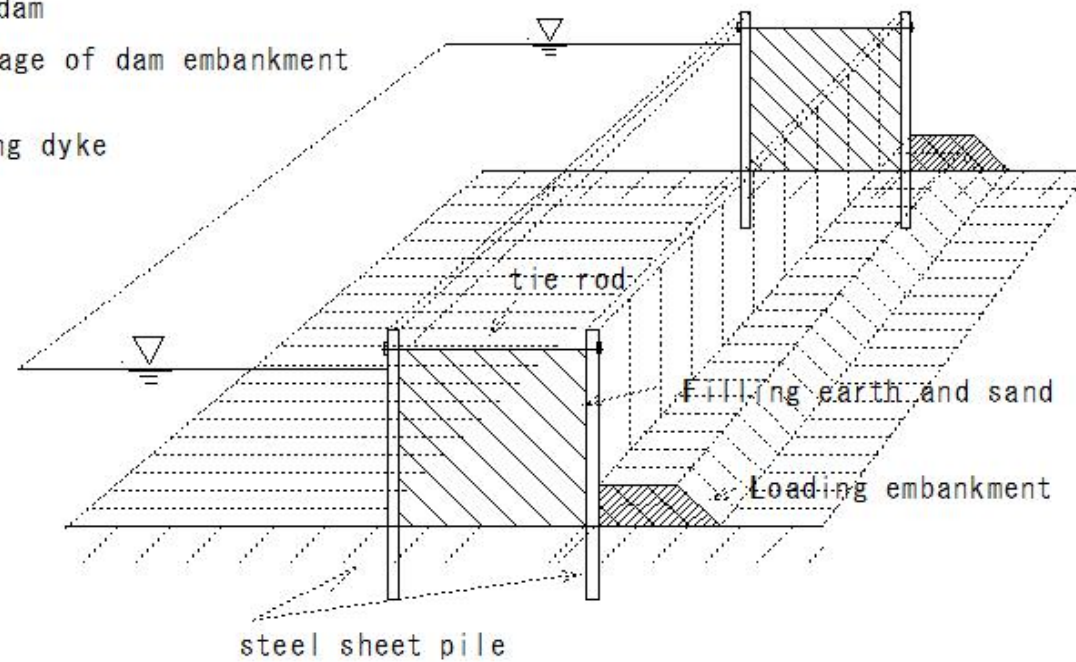
Closing dyke

Changing the waterway

Tributary river cofferdam

Purpose of water stoppage of dam embankment
river cross section

Steel sheet pile closing dyke



(I502)Wire cylinder(gabion)

(I502)Wire cylinder (gabion) losing dyke

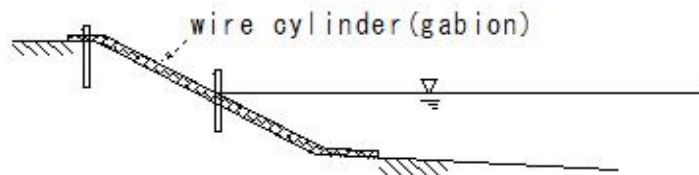
Wire cylinder(gabion)

sluice gate by purpose

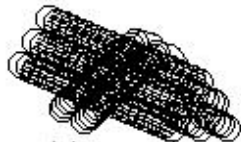
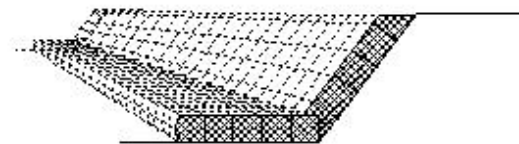
Prevention of outflow due to spring water

bank protection

fill with broken stones



wire cylinder masonry work(gabion)



Semi-permeable groin
wire cylinder masonry work(gabion)

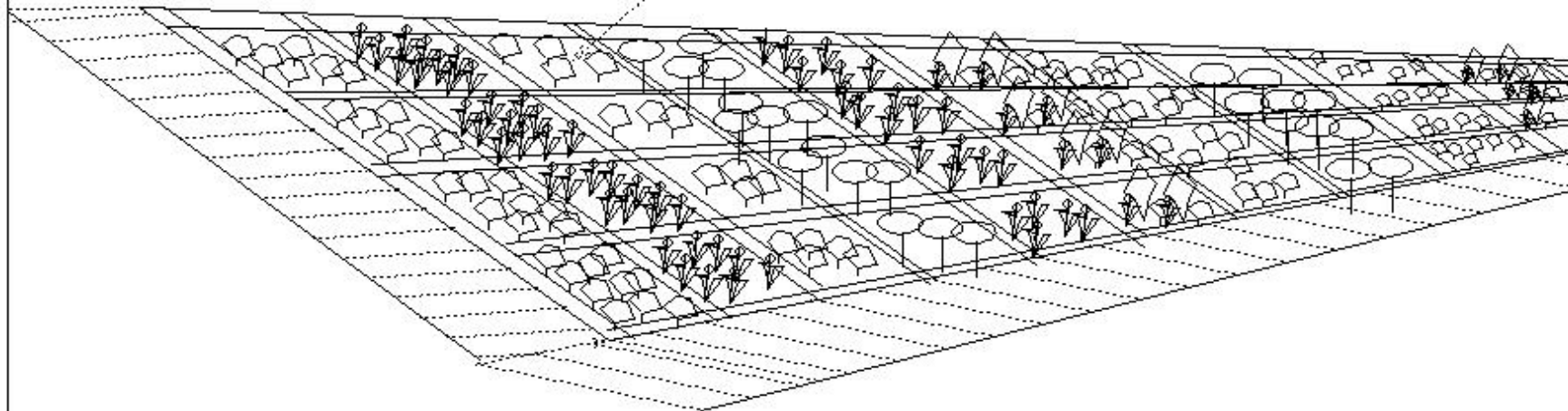
iron wire
Cobblestone/split stone
cylindrical basket
cobblestone
fill with broken stones

(I503)Wire cylinder(gabion)

(I503)Plantable bank protection

Greening block bank protection

bank protection slope
greening
inside-cavity
soil
plant - growth



R367

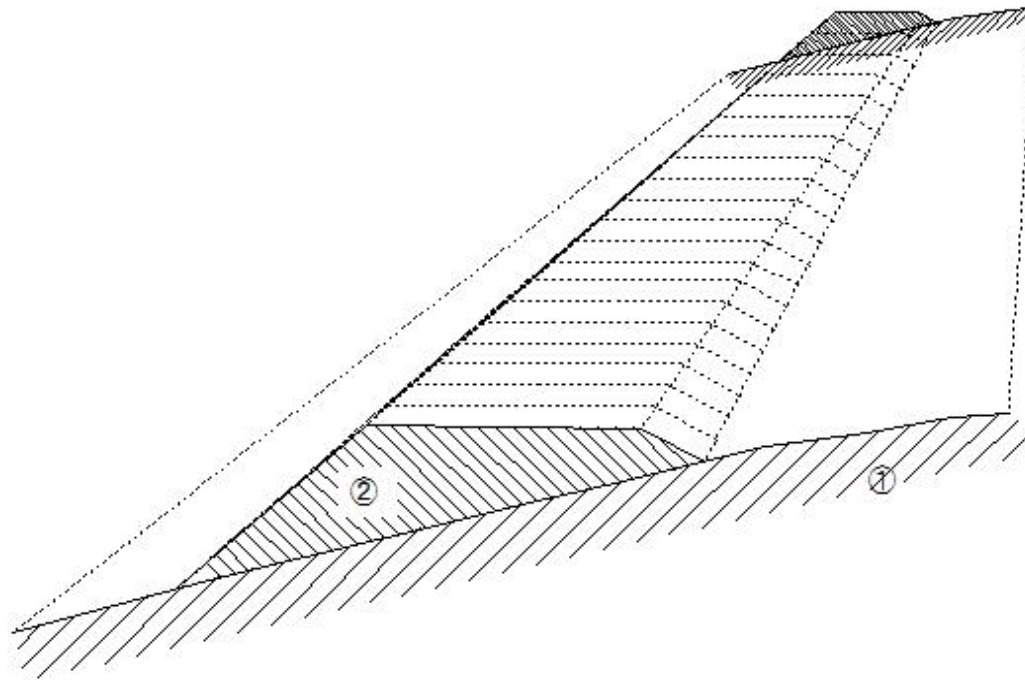
(I504) Natural ground

(I504) Natural ground

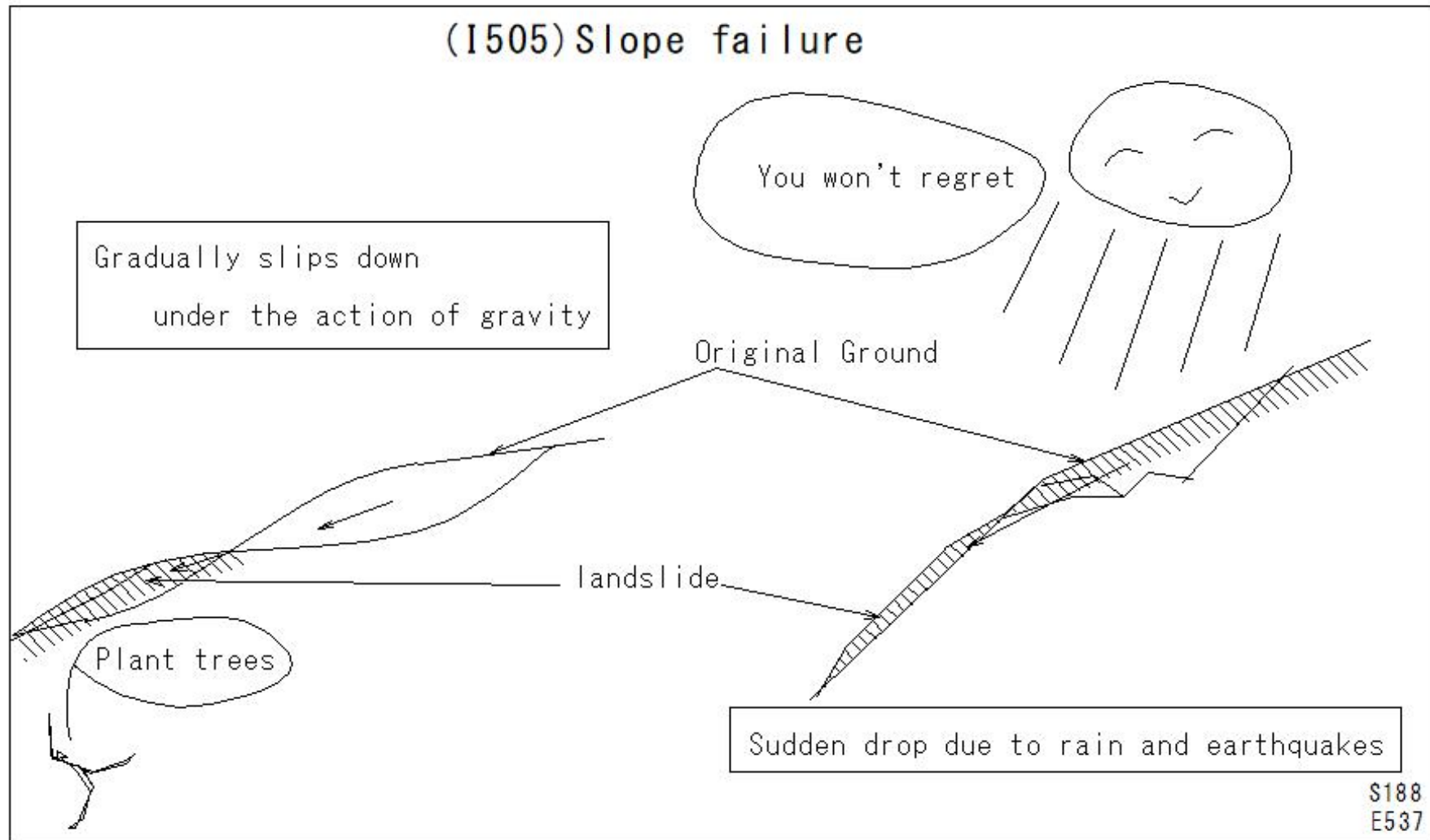
Natural Ground

① Ground

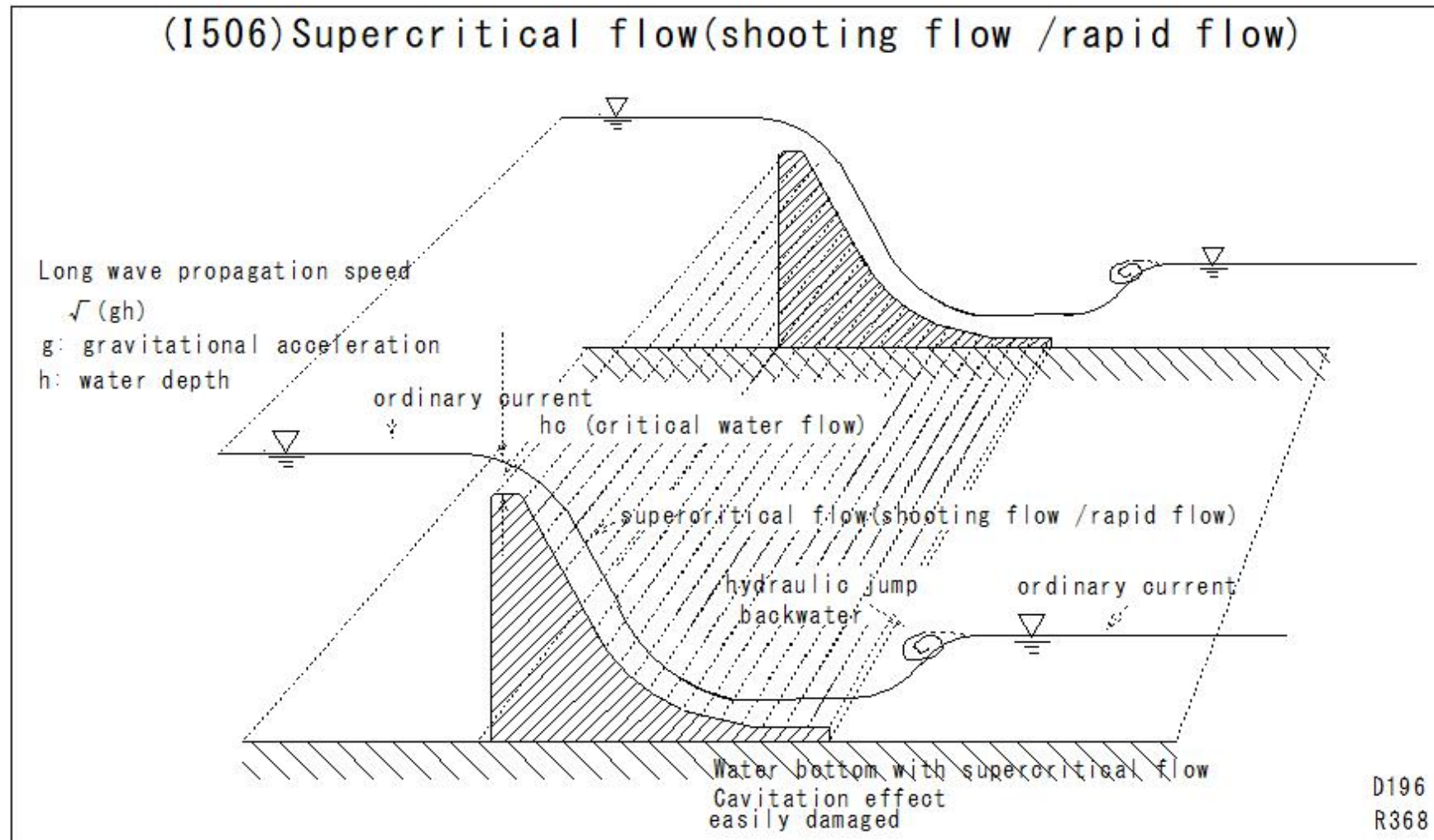
② Embankment



(I505) Slope failure



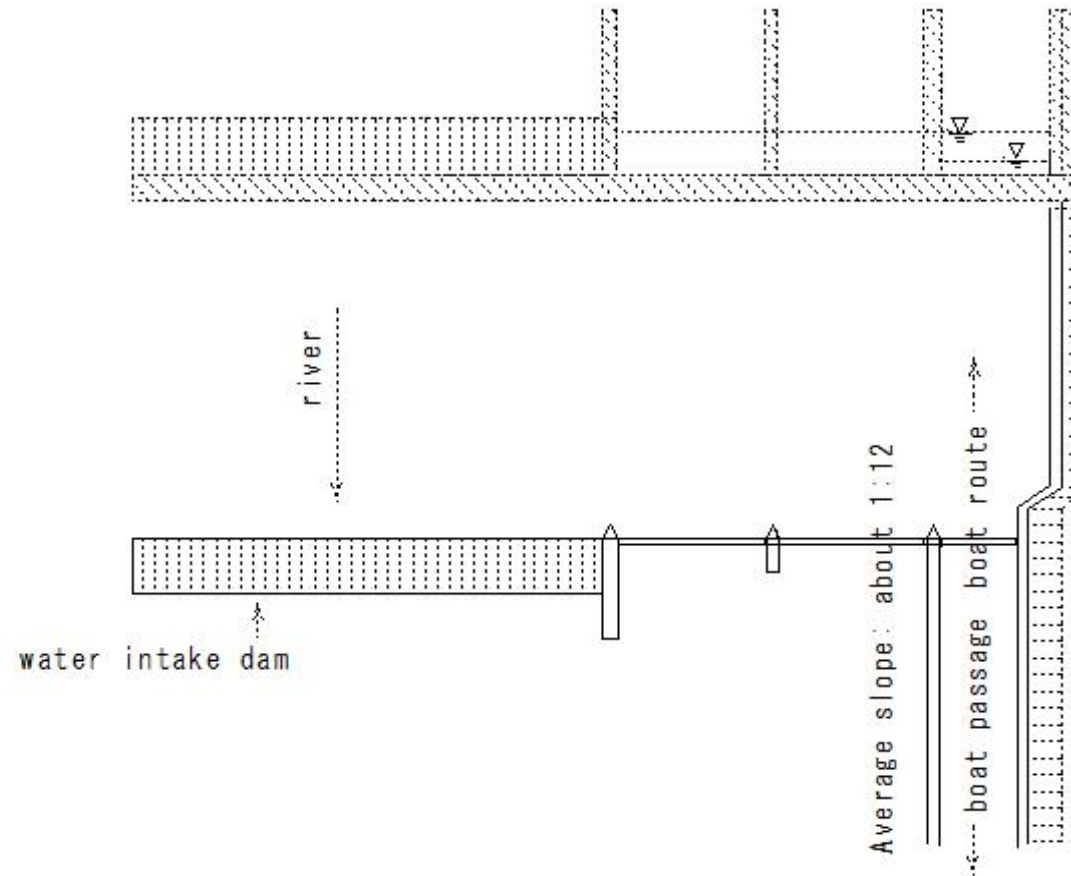
(I506) Supercritical flow (shooting flow / rapid flow)



(I507)Boat way

(I507) Boat way

boat way



R369

(I508) Catchment well (Drainage well)

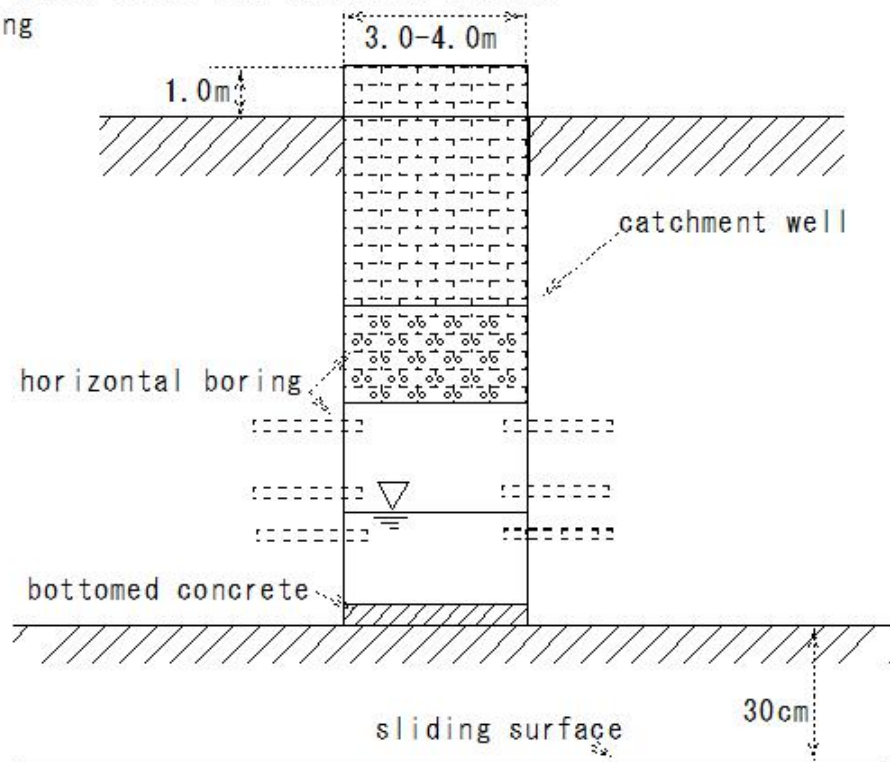
(I508) Catchment well

Catchment well

Landslide surface

a well collects water above the landslide surface

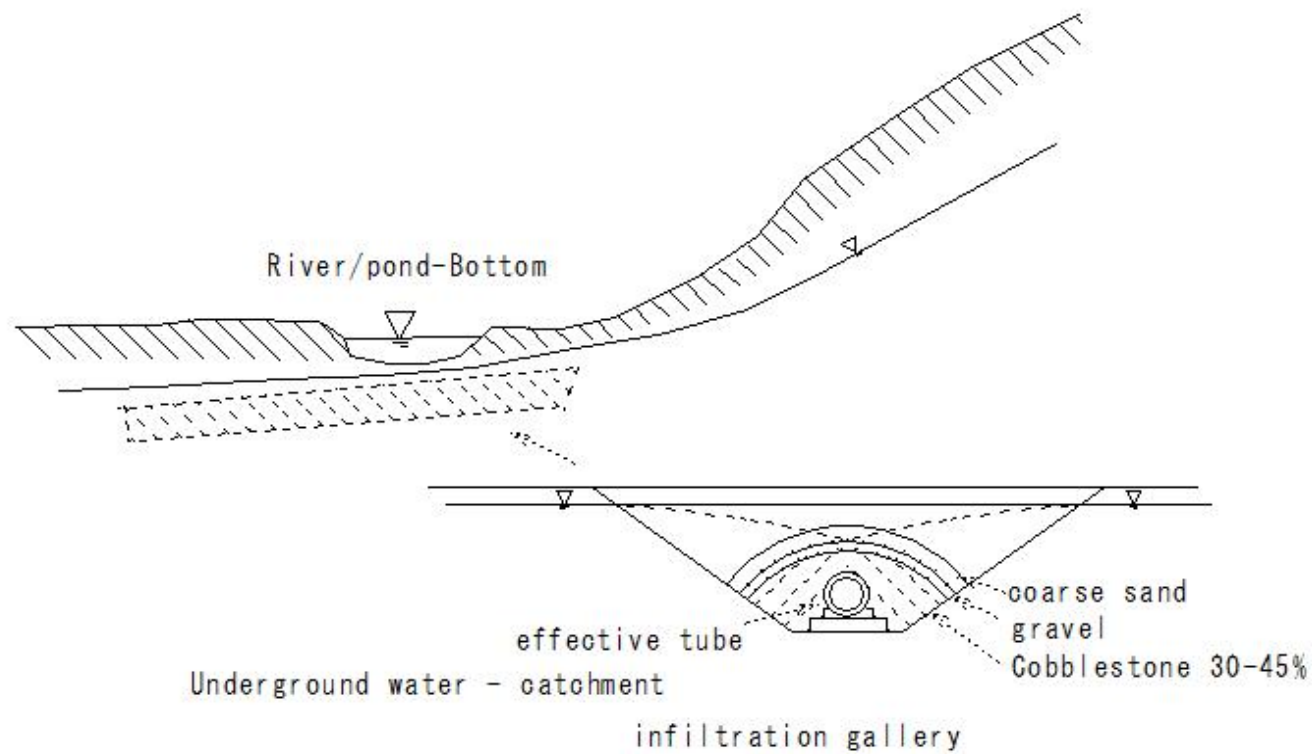
horizontal boring



(I509)Infiltration gallery

(I509) Infiltration gallery

Infiltration gallery



S190

(I510)Free outflow

(I510)Free outflow

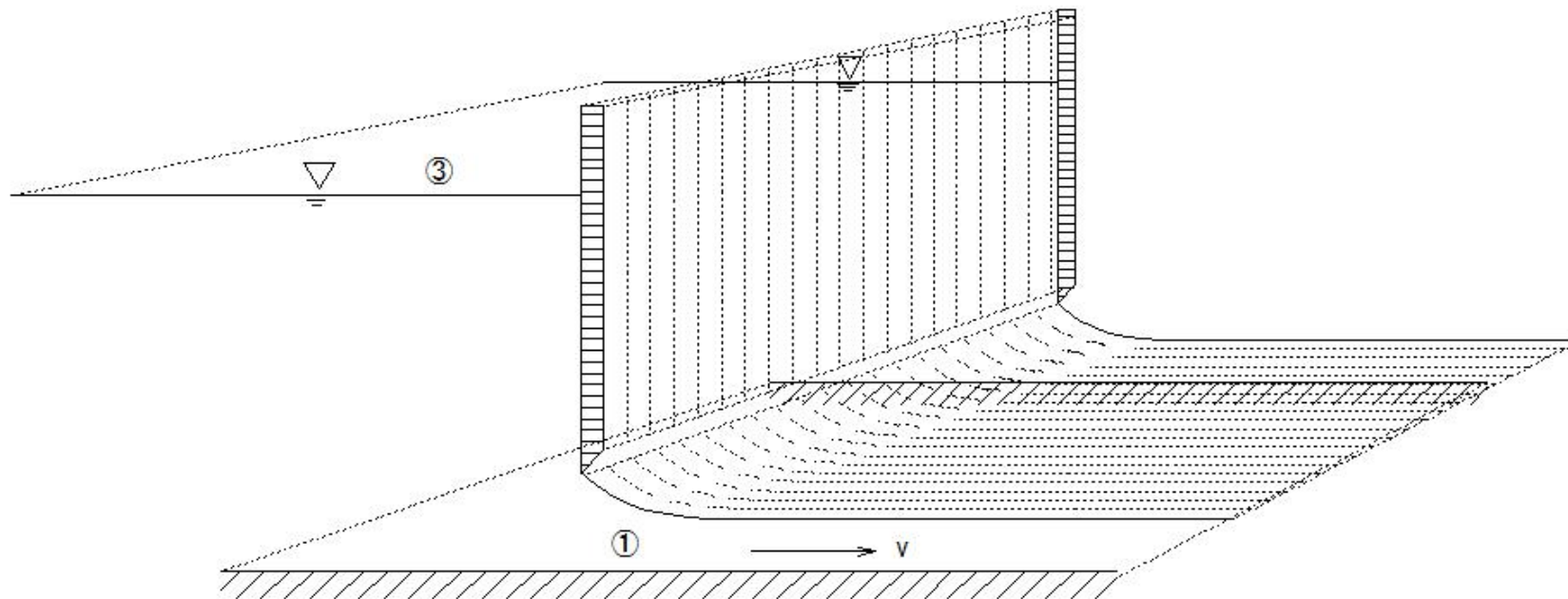
Runoff not controlled by downstream conditions

① Supercritical flow

② Horizontal

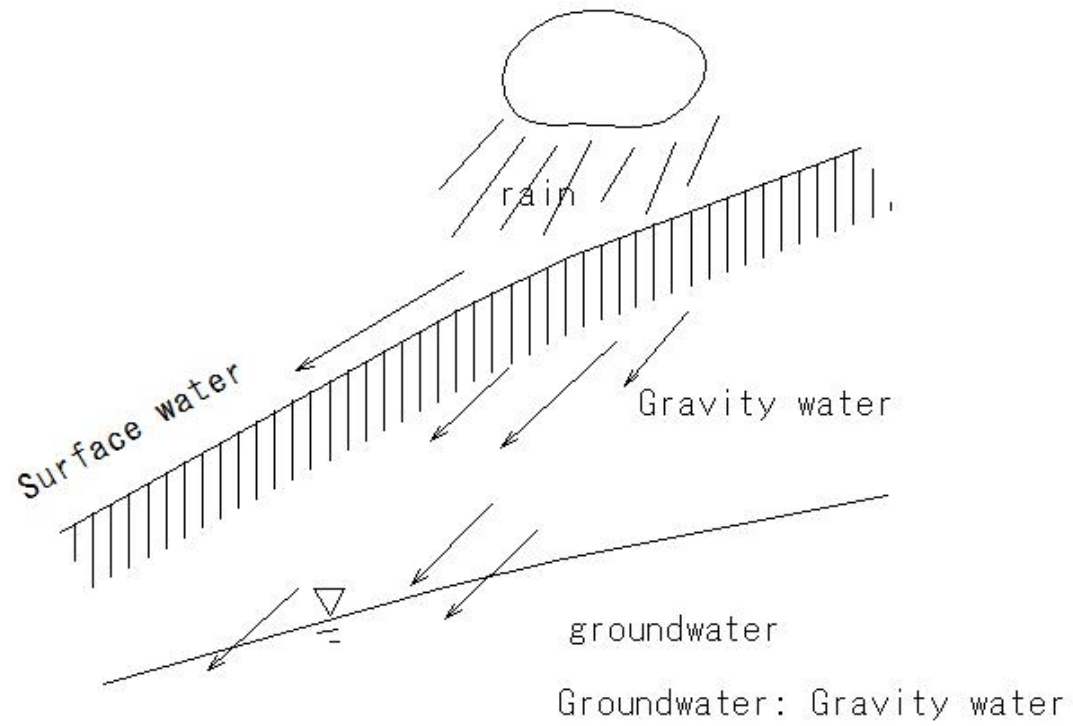
③ Free outflow from the sluice gate

Water bottom with supercritical flow (shooting flow / rapid flow)



(I511)Gravity water

(I511)Gravity water

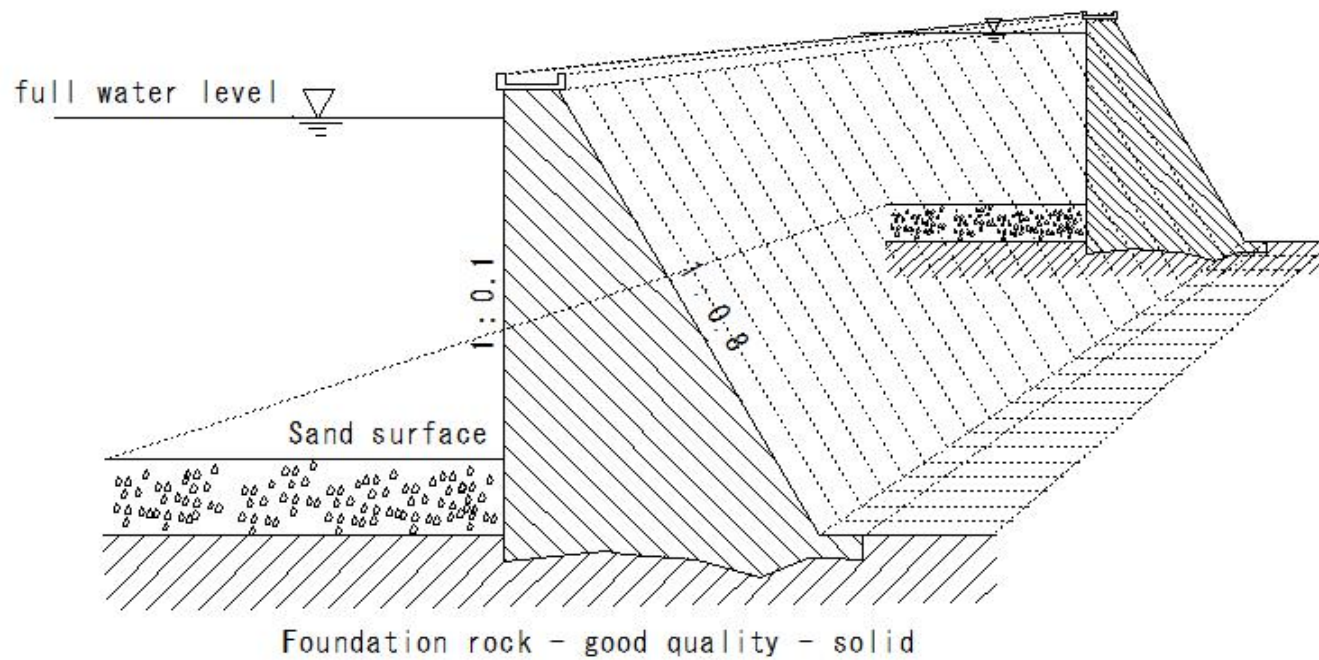


(I512)Gravity dam

(I512)Gravity dam

Gravity dam

- Concrete weight of the dam body
- Water pressure: Withstands external forces
- Foundation rock - good quality - solid



(I513)Water-intake

(I513) Water-intake

water intake

Taking water for a purpose from a source

source

river
lake
reservoir

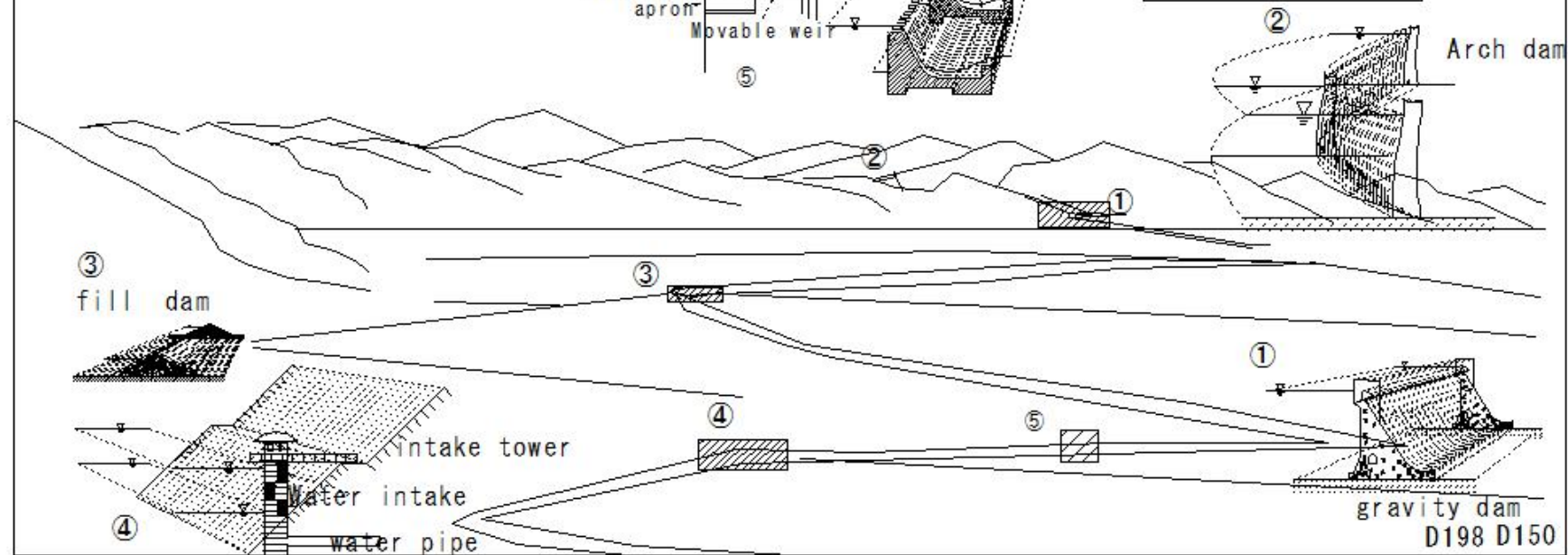
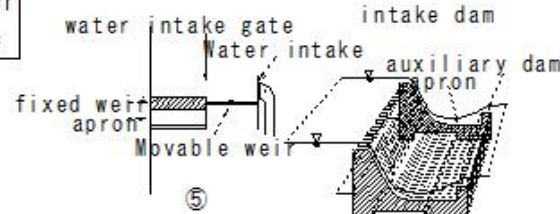
water intake dam
water intake tower
water intake gate

Water intake

waterway

purpose use

Power plant
water supply
industrial water
irrigation water



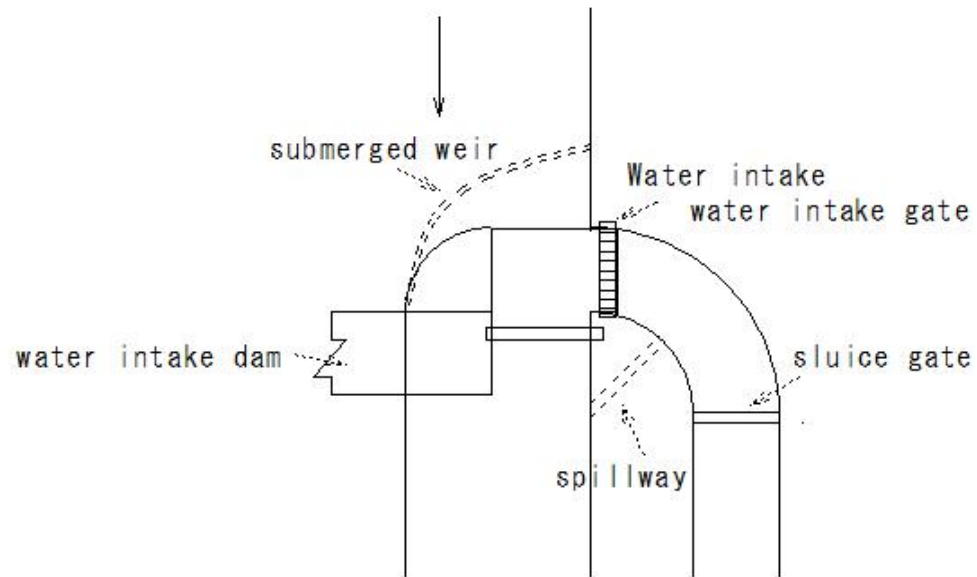
D198 D150

(I514)Intake

(I514) Intake

Intake

An inlet that introduces water from a river, lake, or reservoir into a waterway



D199
r372

(I515)Intake dam

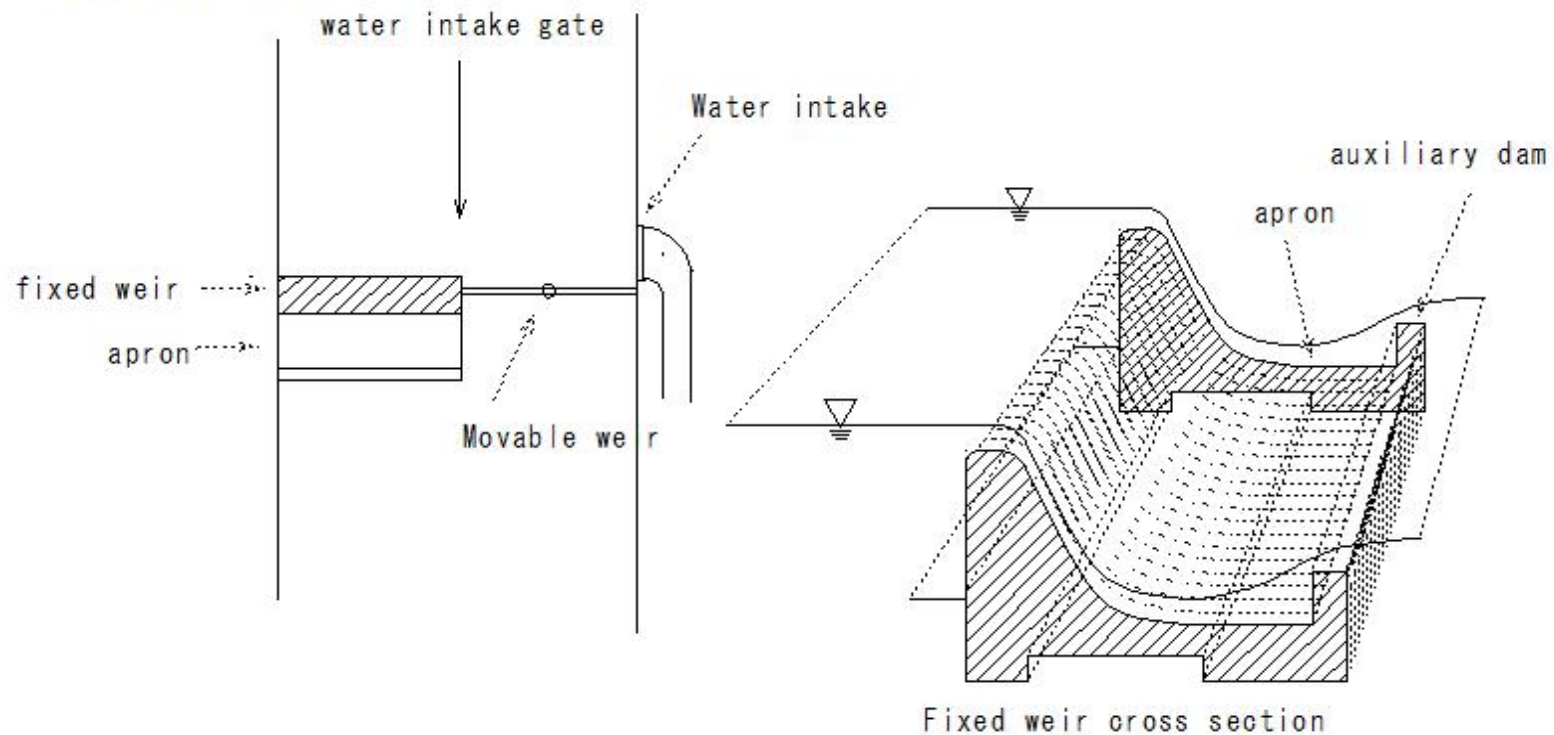
(I515) Intake dam

Intake dam

Dams to make it easier to introduce river water into waterways

A dam is an overflow-shaped weir.

Combined with mobile weir



D200
r373

(I516) Intake dam

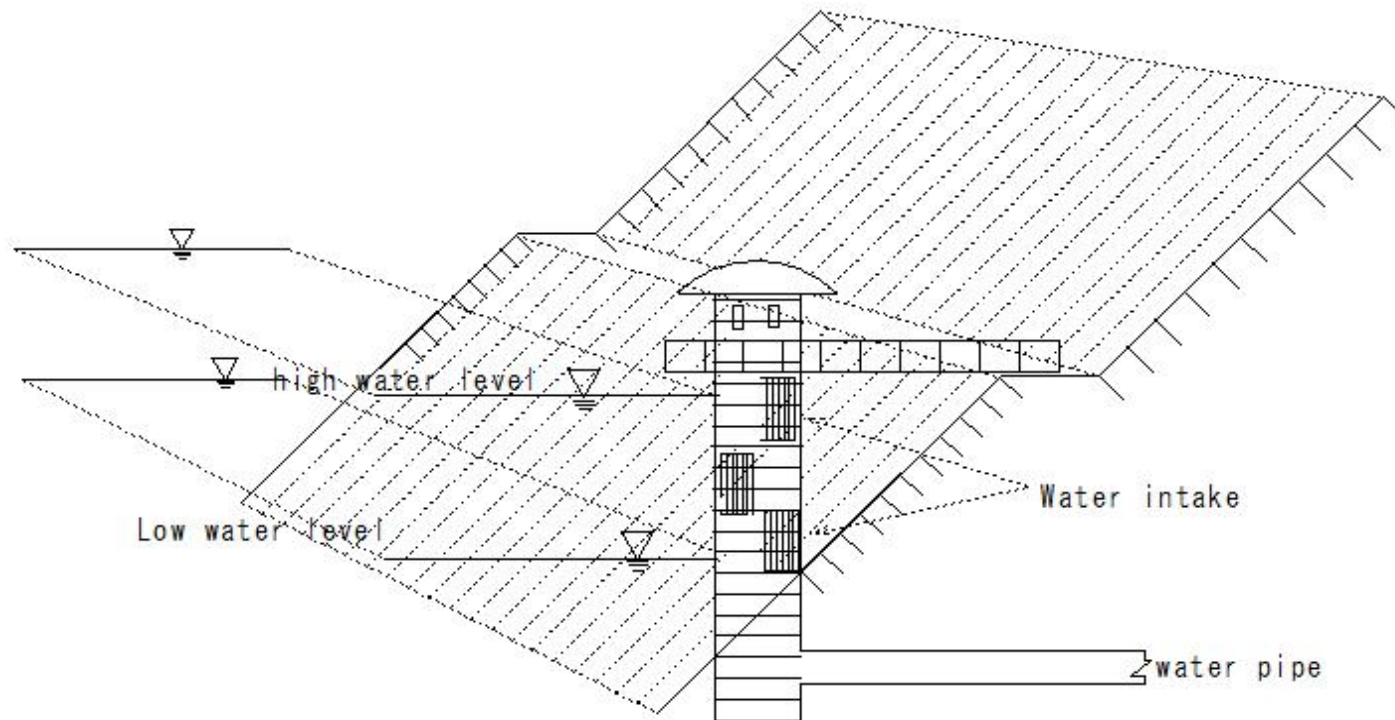
(I516) Intake dam

Intake tower

Tower for taking water at any depth from rivers, lakes, and reservoirs

A tower built underwater

Various water intakes are provided to accommodate changes in water level.



D201
r374

(I517)Circular society

(I517)Circular society

Circular society(Recycling-oriented society)

① Pavement using recycled materials

Low-noise pavement

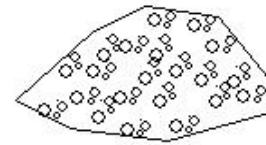
② Construction sludge used as embankment material

③ Concrete structures
(recycled aggregate)

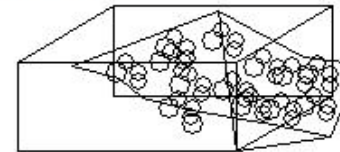
④ Construction sludge

⑤ Recycling facilities

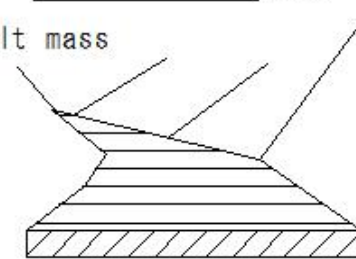
Earth and sand generated during construction



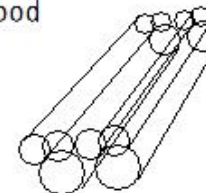
Concrete block: Used as recycled aggregate, etc.



Asphalt mass

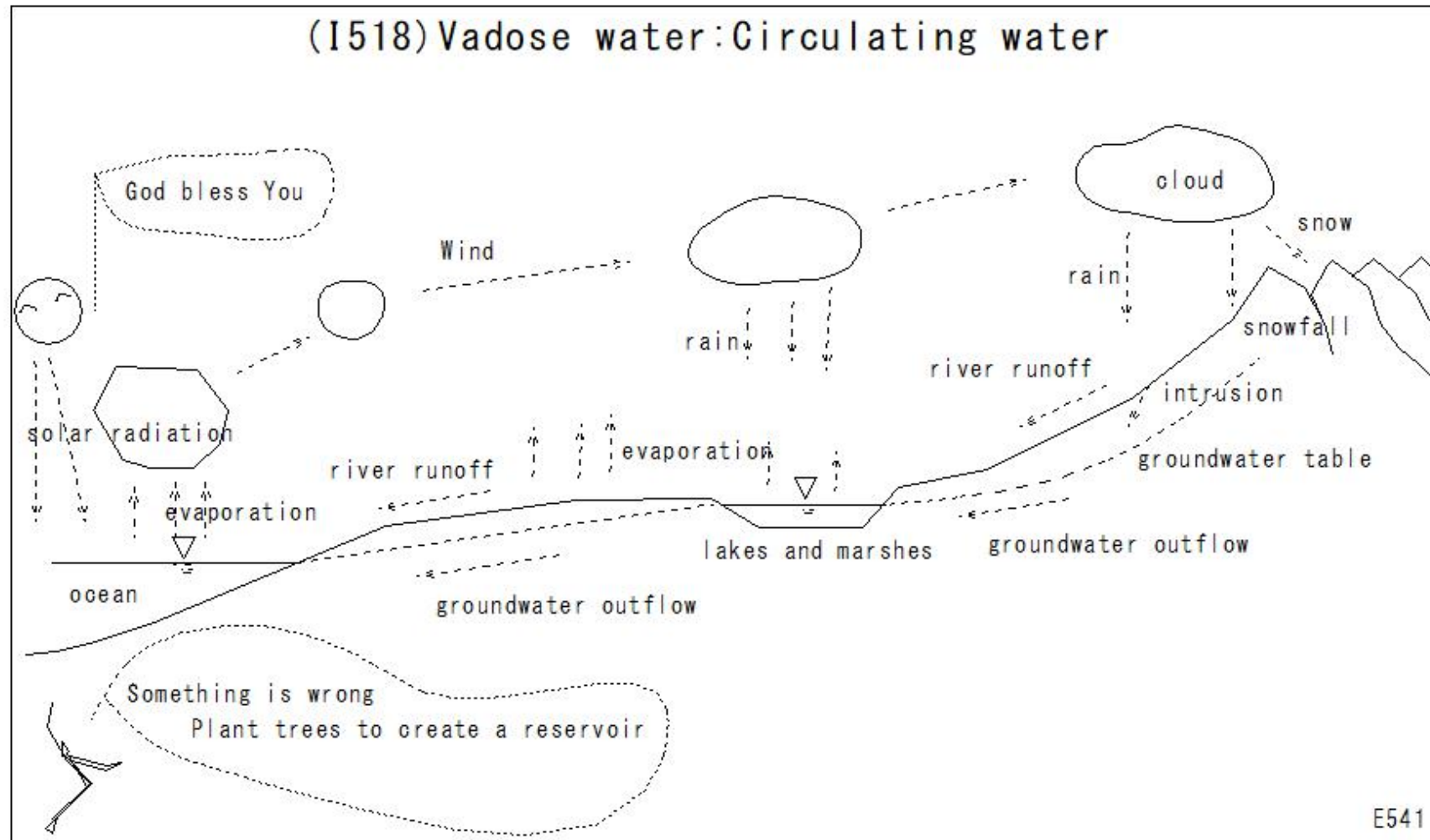


Wood



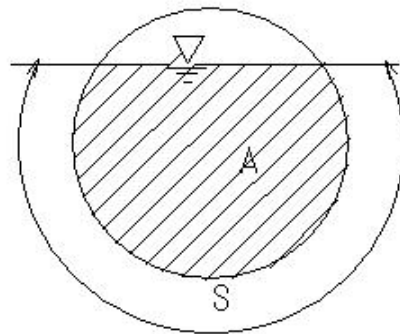
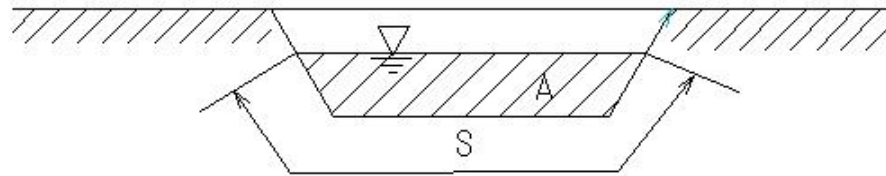
CM939

(I518)Vadose water:Circulating water

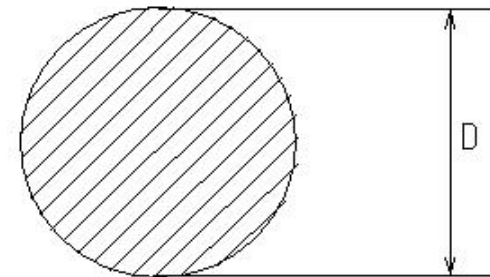


(I519)Wetted perimeter

(I519)Wetted perimeter



open channel



$$R = A/S = (\pi D^2/4) / (\pi D) = D/4$$

pipeline

Cross-sectional area of flow: A

Hydraulic radius: R

$$R = A/S$$

Wetted perimeter: S

D206
E521

(I520)Water supply (clean water(Purified water))

(I520)Water supply (clean water(Purified water))

Water supply

clean water(Purified water)

Raw water → Passes water quality standards → Purification

Raw water → Water pipe(Water conveyance pipes) → [Purification (chemical sedimentation →
[Rapid filtration → Disinfection])]

→ To water reservoir

clean water(Purified water)

Raw water → Water pipe(Water conveyance pipes) → [Purification
[(normal sedimentation(plain precipitation) → Slow filtration → Disinfection)]

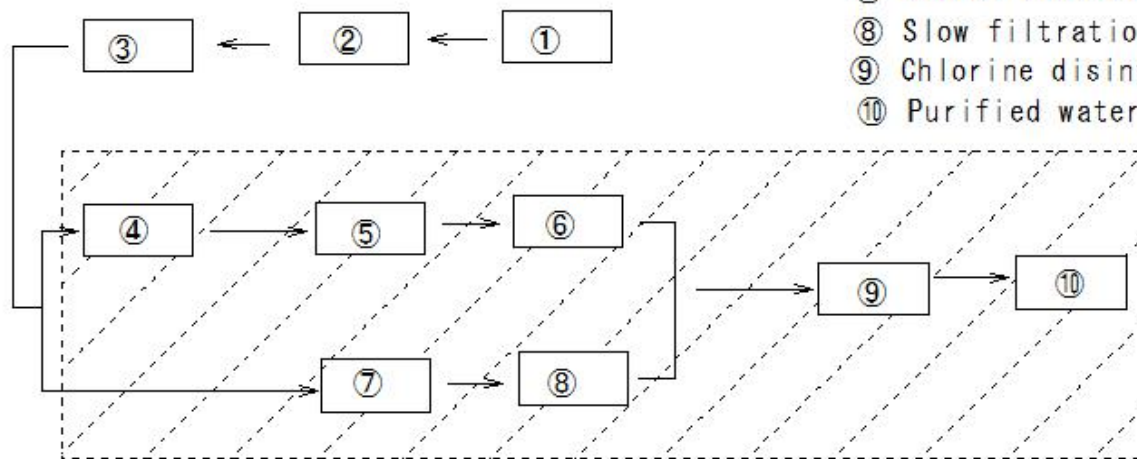
→ To water reservoir

(I521)Water supply (purification plant)

(I521)Water supply (purification plant)

Water supply
purification plant

- ① Raw water
- ② Water conveyance pipe
- ③ Receiving well
- ④ Coagulation pond
- ⑤ Chemical sedimentation pond
- ⑥ Rapid filtration pond
- ⑦ Normal sedimentation
- ⑧ Slow filtration pond
- ⑨ Chlorine disinfection
- ⑩ Purified water pond



purification plant

(I522)Intercepting drain

(I522) intercepting drain

Intercepting drain
contour

parallel waterways

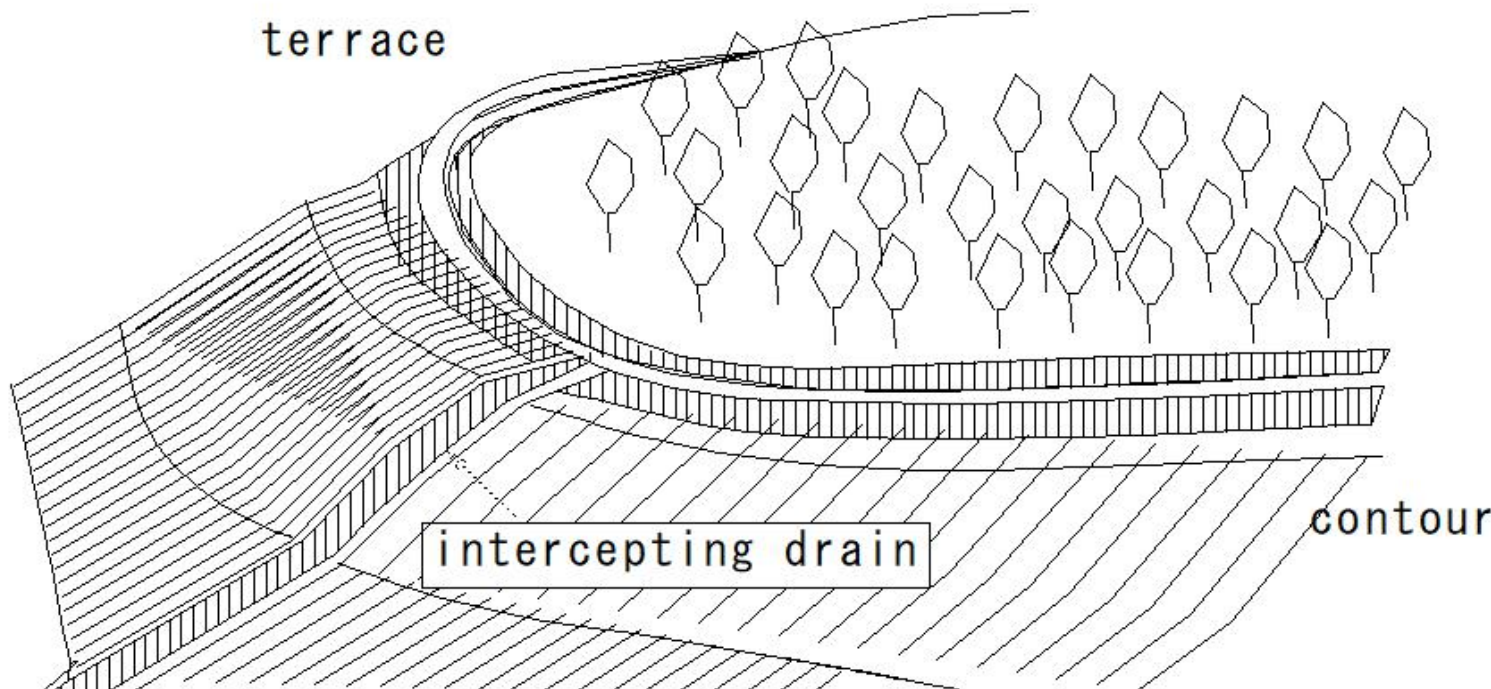
Eliminate water from the upper part

terrace

intercepting drain

contour

R380



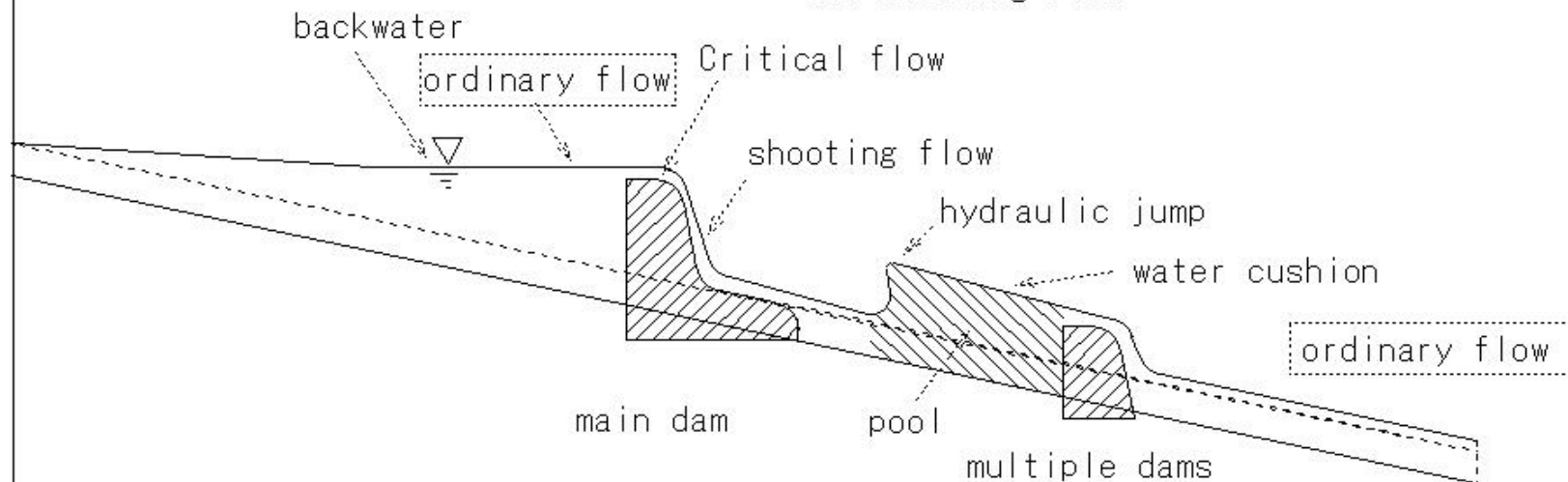
(I523) Ordinary flow

(I523) Ordinary flow

Type of water flow

hydraulic jump and backwater

Critical flow: the boundary between ordinary flow and shooting flow



ordinary flow - Critical flow - shooting flow - hydraulic jump - ordinary flow

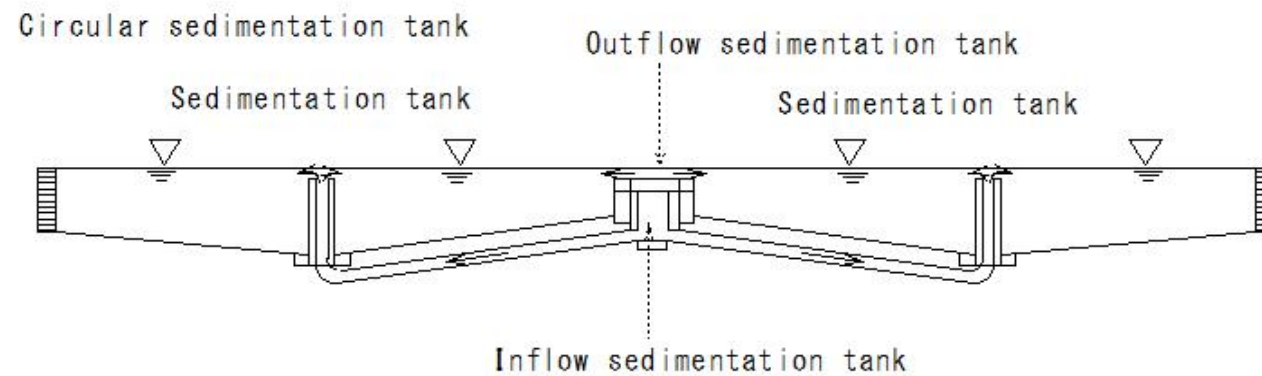
(I524)Water supply (continuous flow setting basin)

(I524)Water supply (continuous flow setting basin)

Water supply

continuous flow setting basin

A type of sedimentation tank for water purification



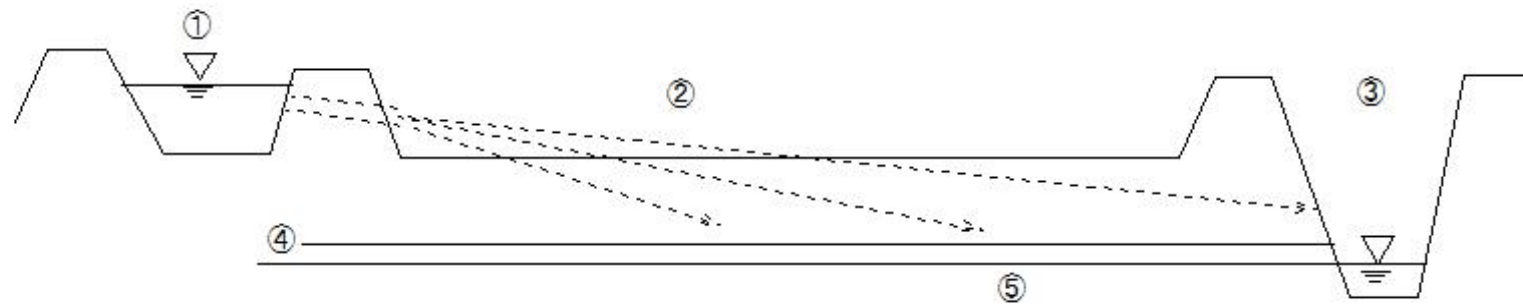
A type of sedimentation tank for water purification

(I525)Salt Exclusion

(I525) Salt Exclusion

Salt Exclusion

- ① Fresh water
- ② Salinity below 3%
- ③ Salt removal tank
- ④ Groundwater level (below 50cm)
- ⑤ Underground drainage pipe

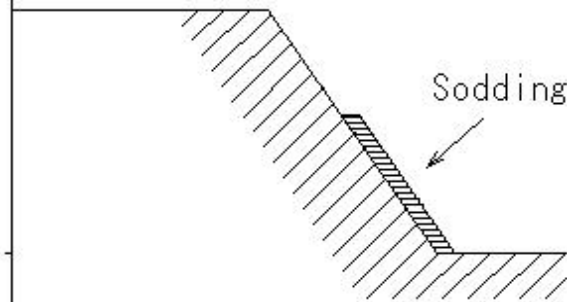


Salt removal is the process of washing away excess salt from the soil, mainly in agricultural land, and neutralizing the salt with soil conditioners.

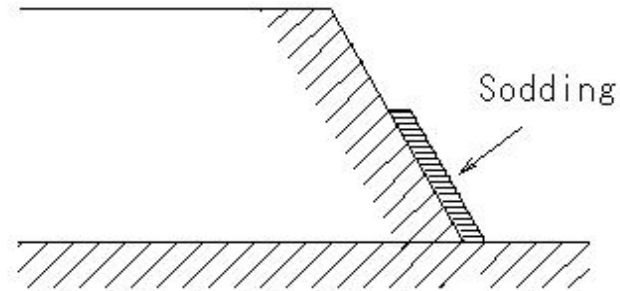
(I526)Planted slope protection:Vegetation engineering

(I526)Planted slope protection:Vegetation engineering

Slope protector



Cut



Embankment

S191

E543

(I527)River (cut-off)

(I527)River (cut-off)

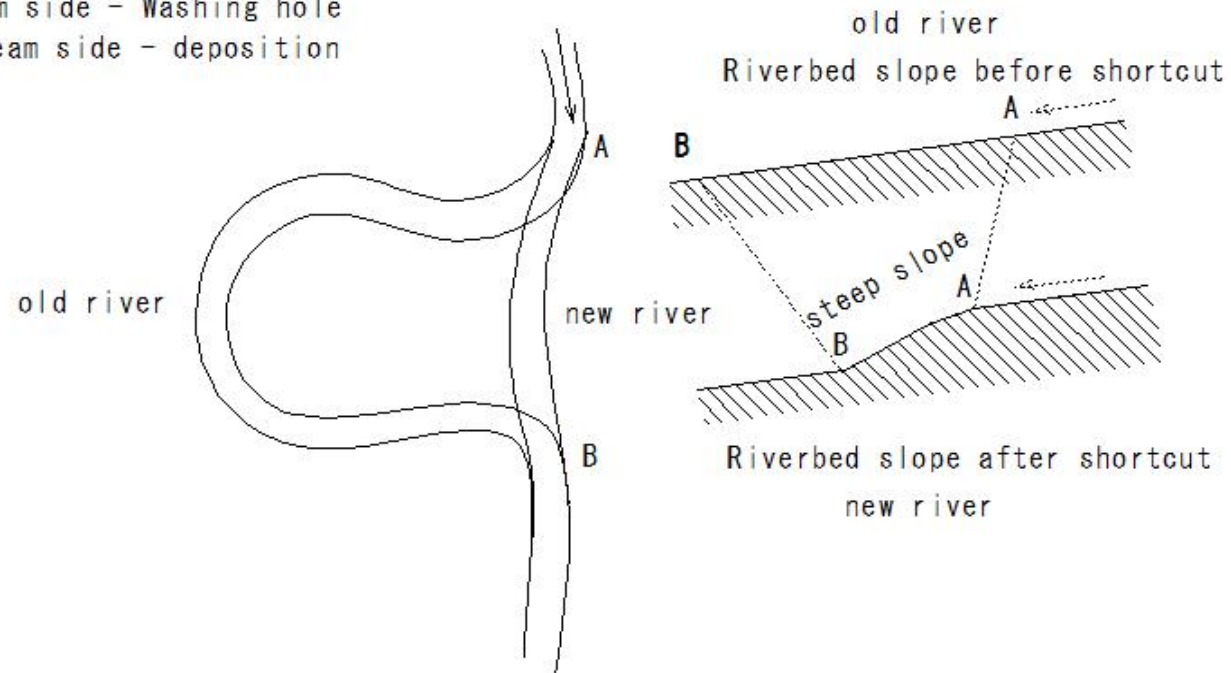
Shortcut

Flow capacity - increase

short and connected

Upstream side - Washing hole

Downstream side - deposition



(I528)Silt layer

(I528) Silt layer

Silt layer

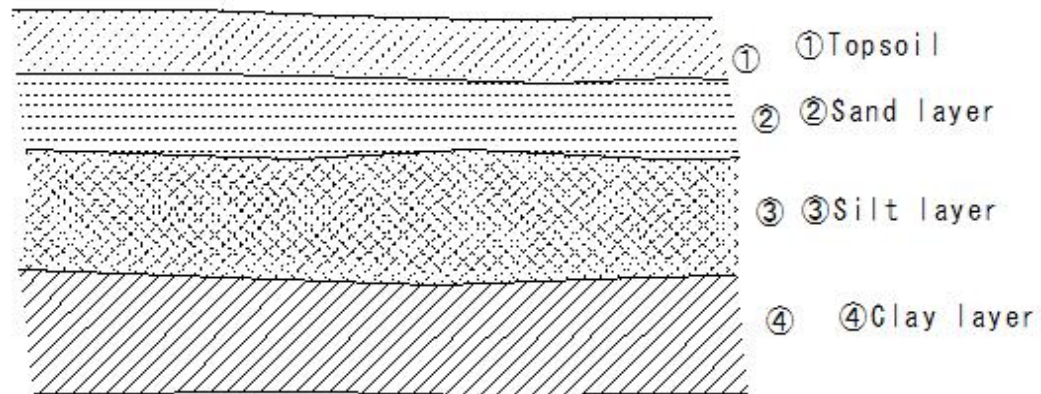
Disadvantages of silt layers

Low frictional resistance

Low compressibility

Easy to flow

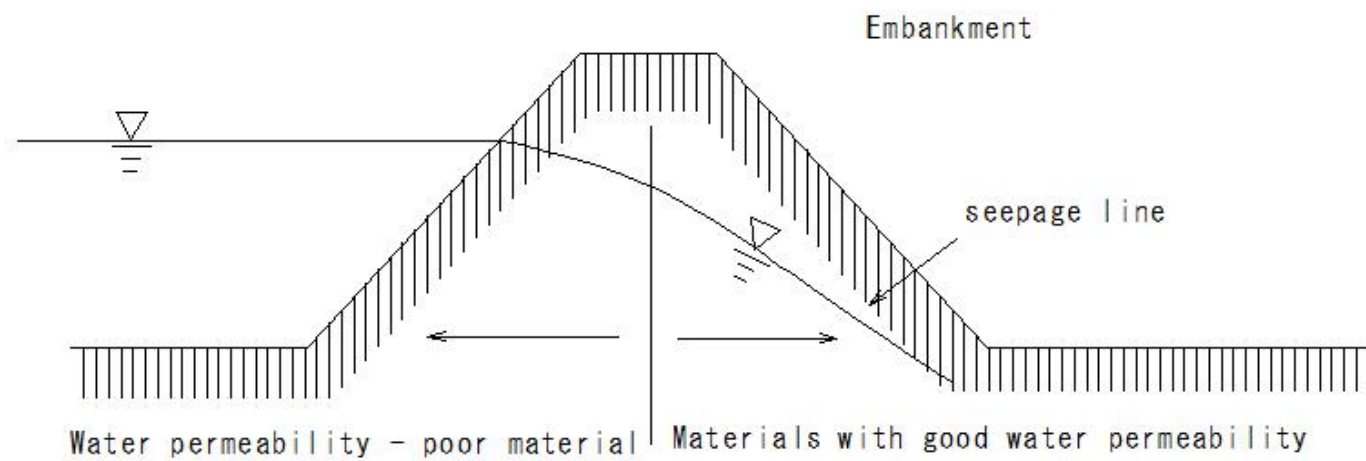
High capillary action



Examples of strata

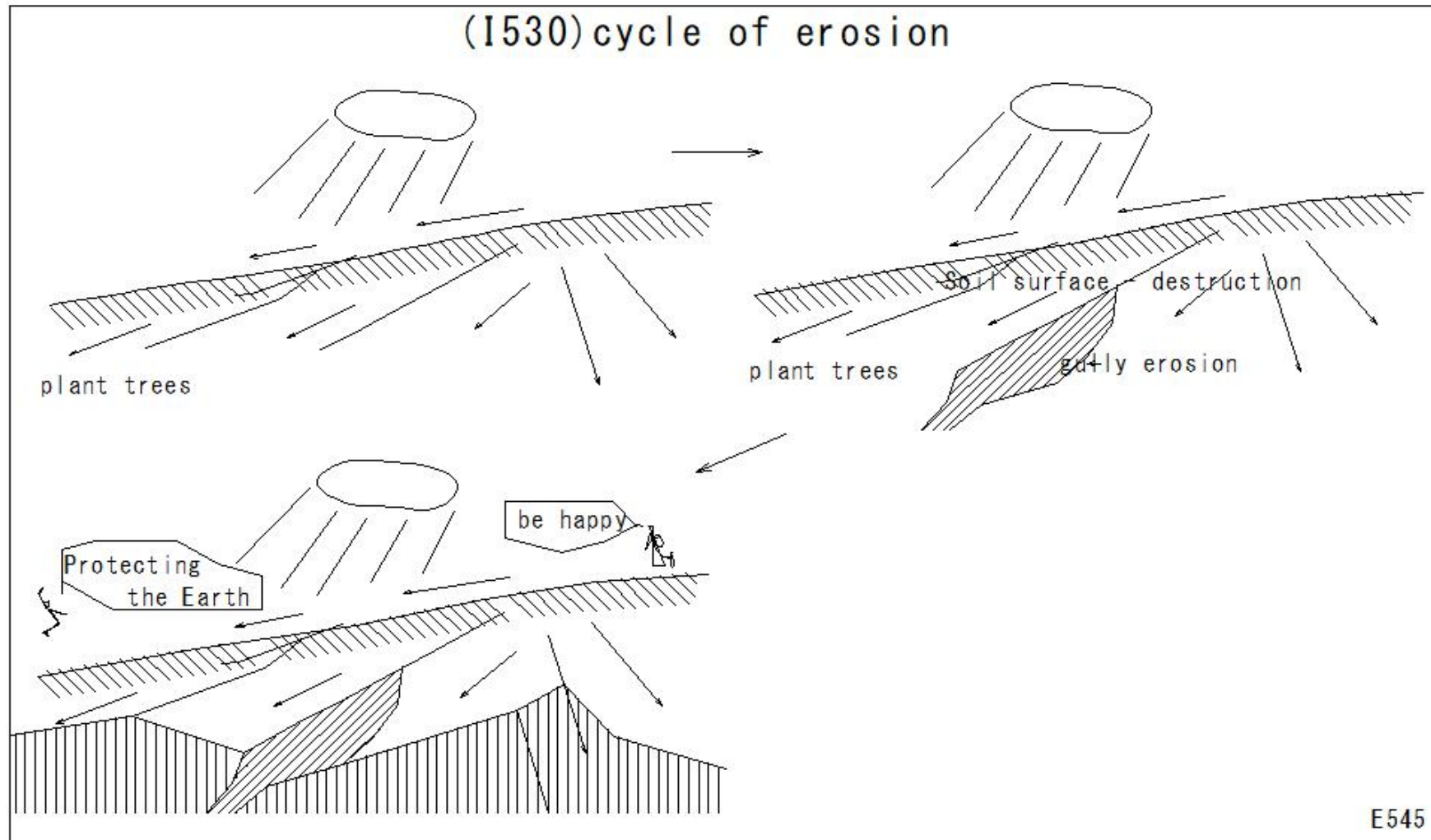
(I529) Seepage line: Infiltration line

(I529) Seepage line: Infiltration line



E544

(I530)Cycle of erosion



(I531)Hydraulic pressure

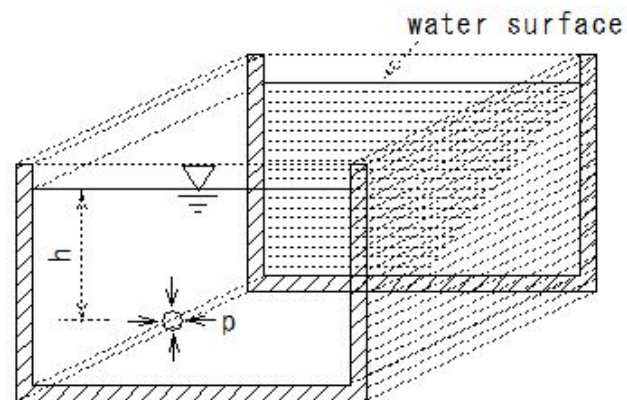
(I531)Hydraulic pressure

Hydraulic pressure

hydraulic pressure $p=wh$

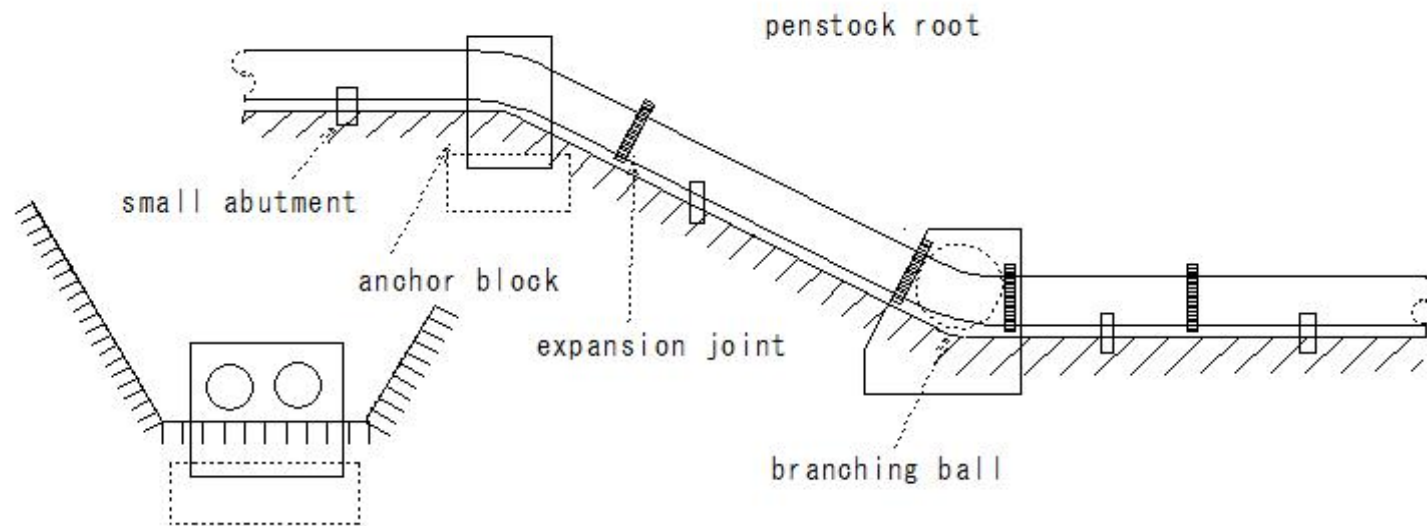
w: unit volume mass of water

h: water depth



(I532)Penstock root

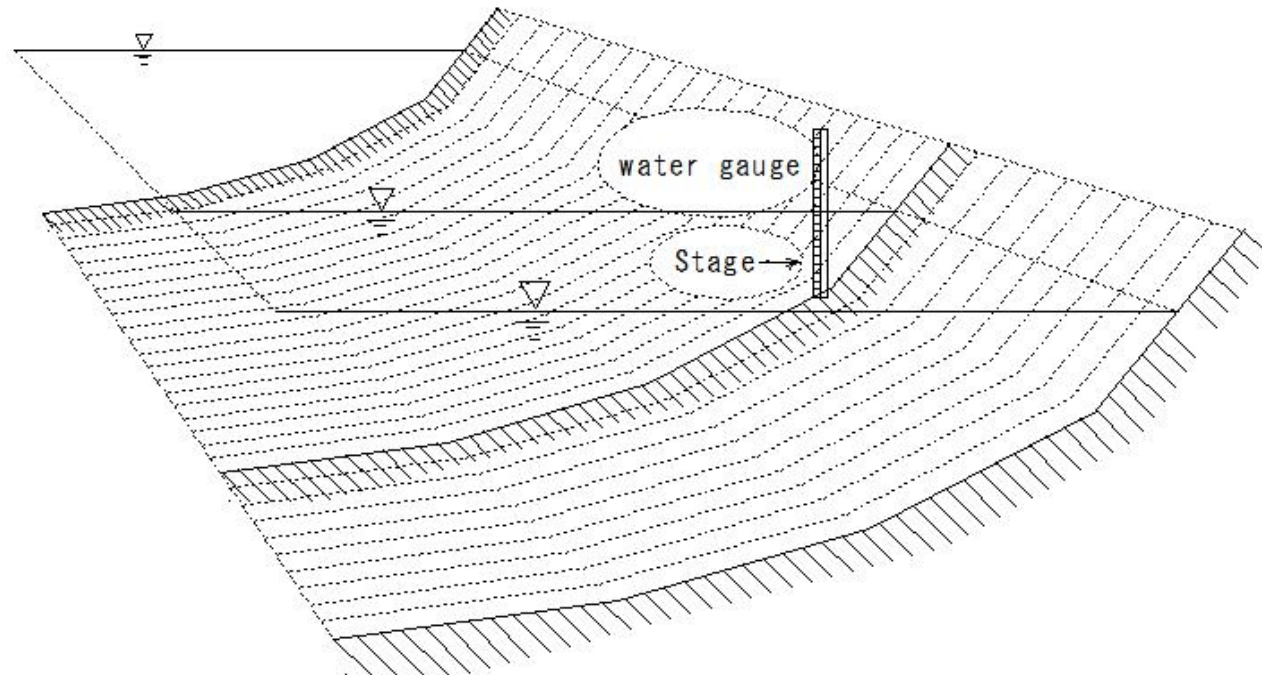
(I532)Penstock root



R384

(I533)Stage(water level)

(I533) Stage (water level)



R385

(I534)Water-level recorder

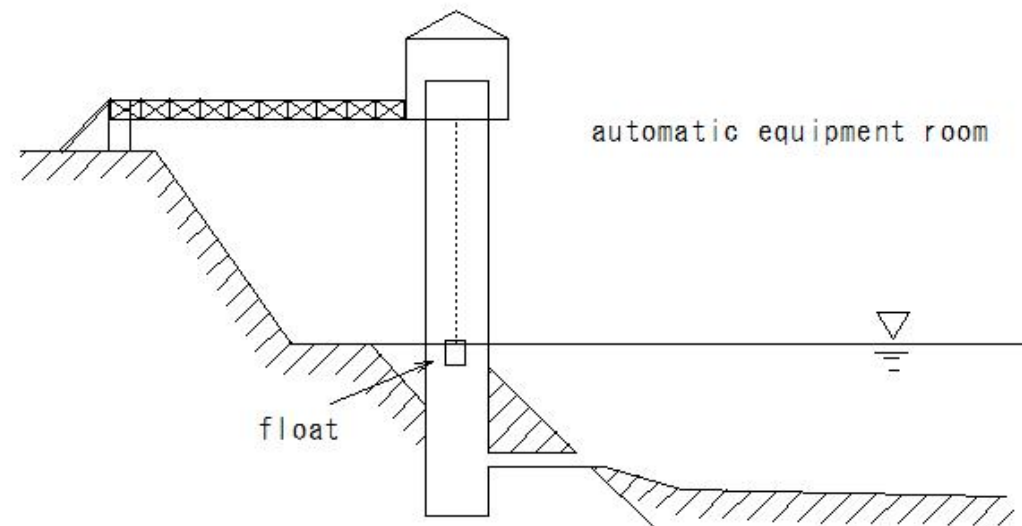
(I534)Water-level recorder

Water-level recorder

water level gauge

instrument for measuring water level

Self-recording water level gauge



D211

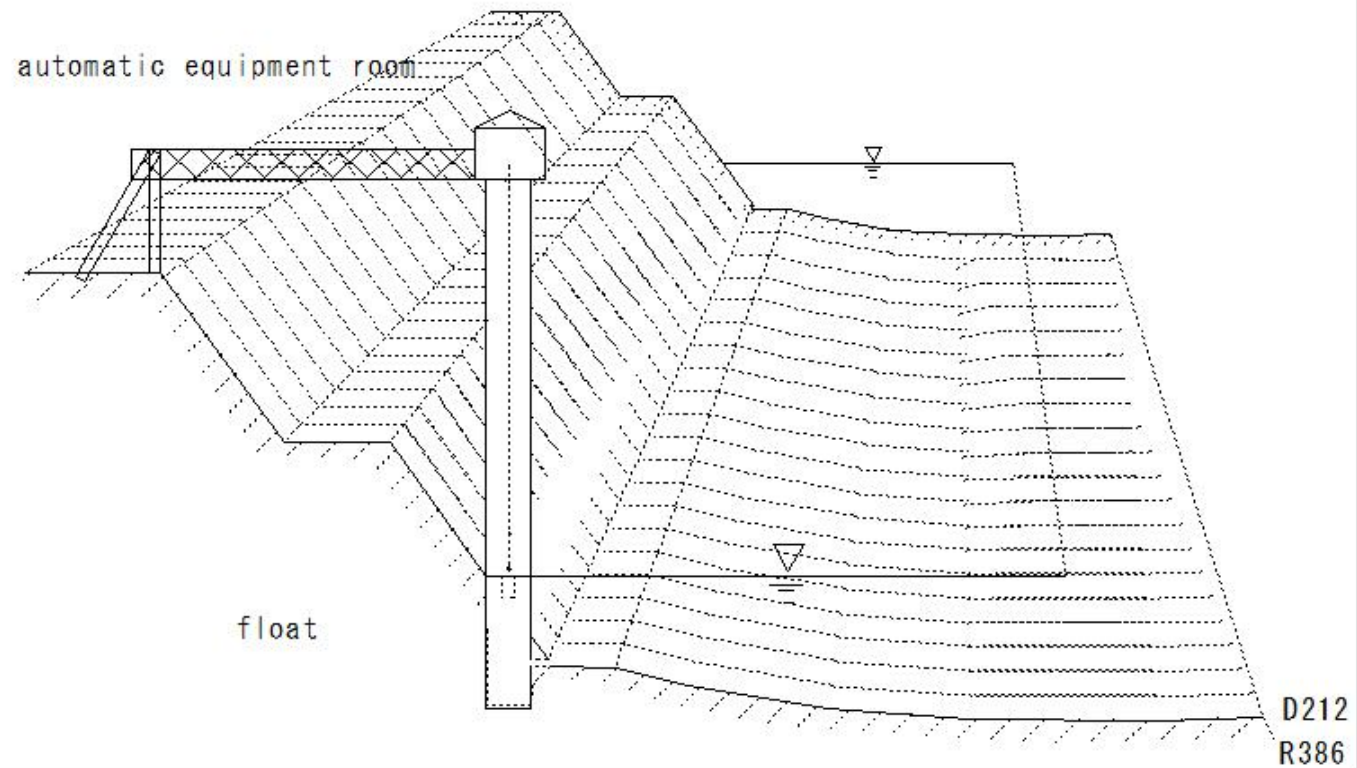
(I535)Water-level recorder

(I535)Water-level recorder

Water-level recorder

instrument for measuring water level

Self-recording water level gauge



(I536)Water hammmmer

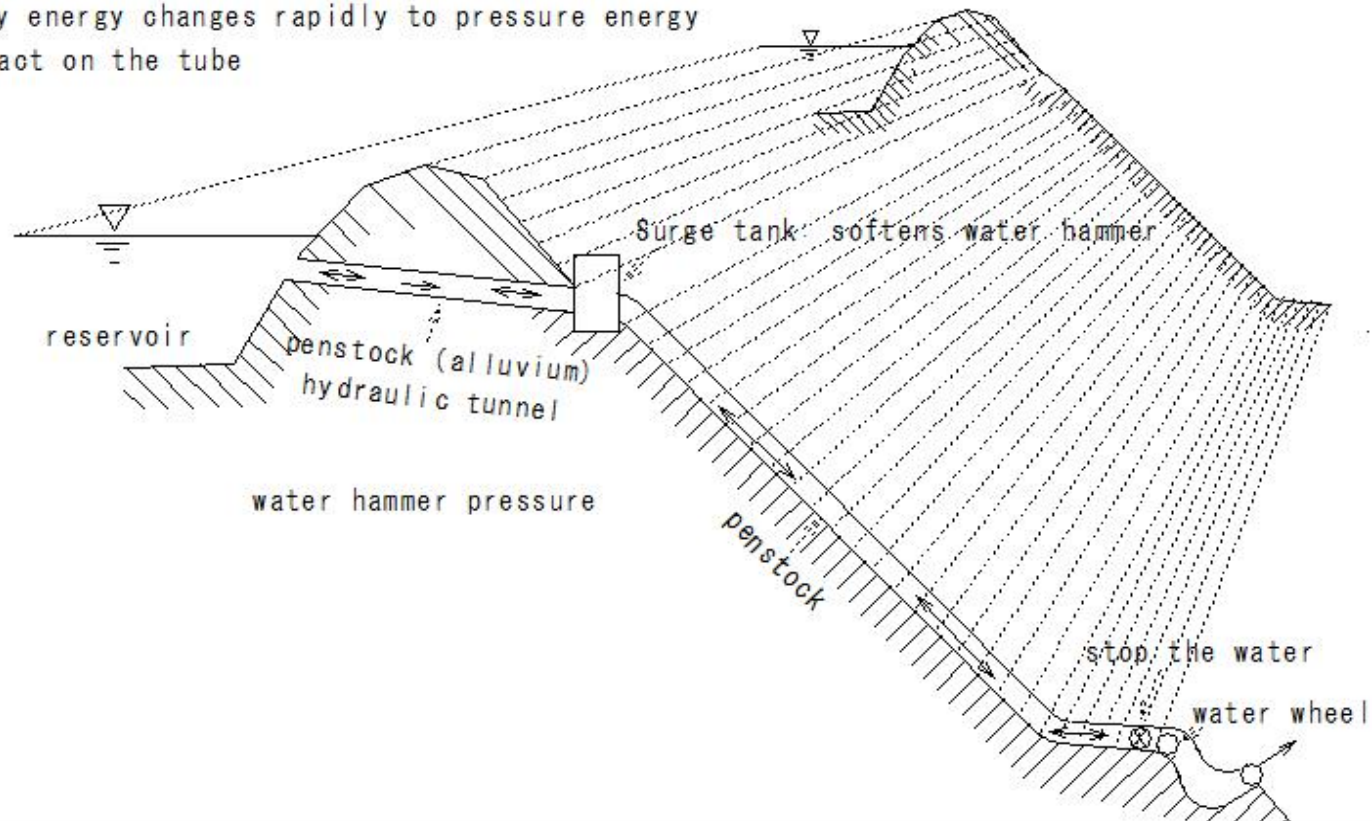
(I536)Water hammer

Water hammer

stop the water suddenly

Velocity energy changes rapidly to pressure energy

big impact on the tube



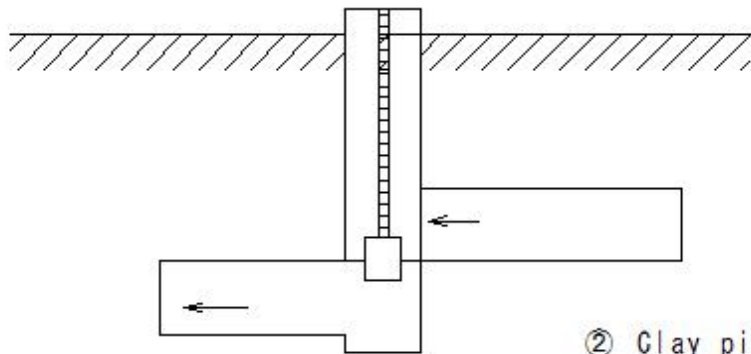
D213

R387

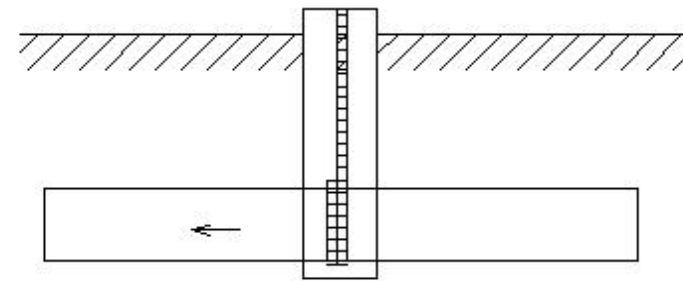
(I537)Relief well(Water gate)

(I537)Relief well(Water gate)

Relief well(Water gate)



① Drop Relief well(Water gate)

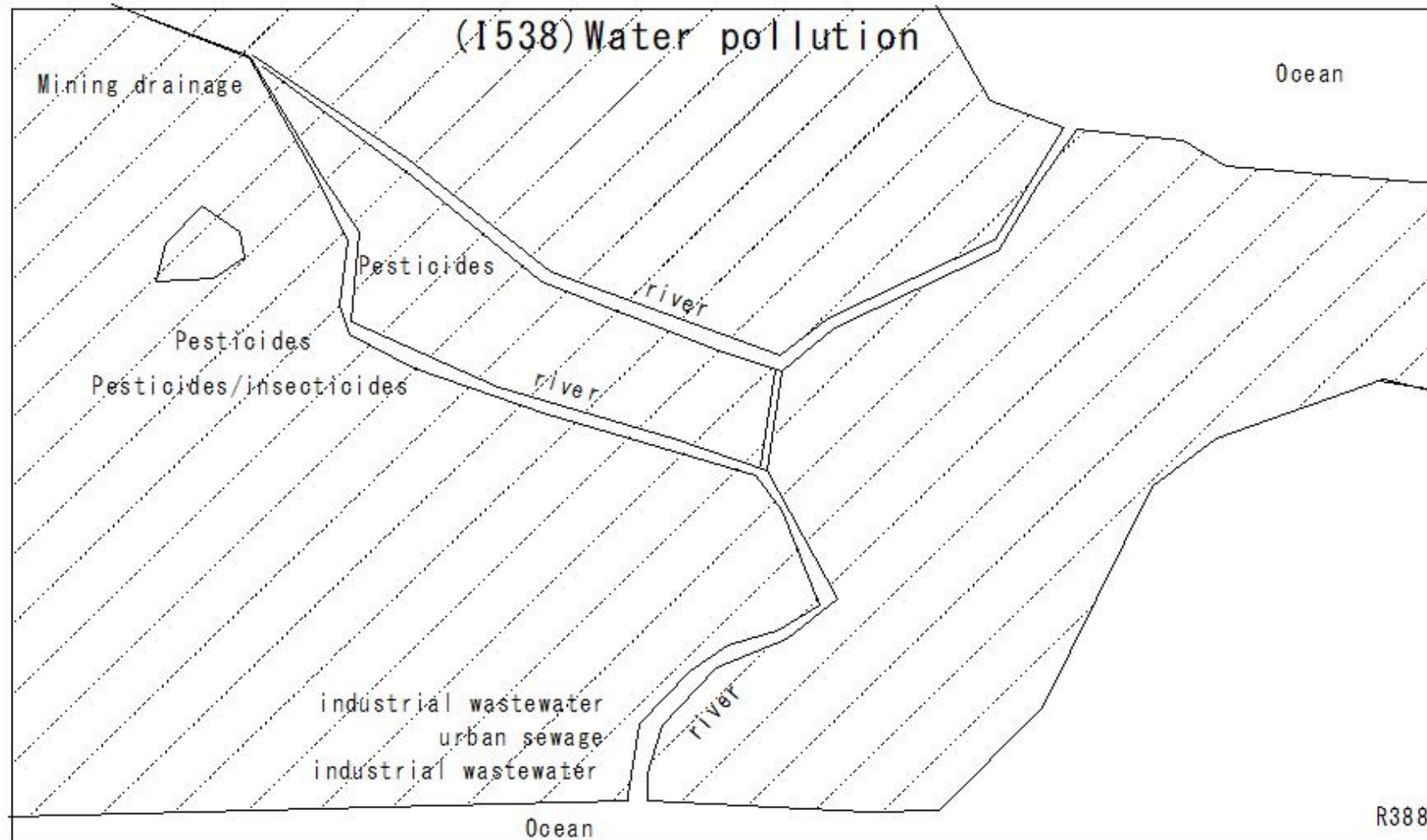


③ Horizontal Relief well(Water gate)

② Clay pipe or concrete pipe

Regulating the flow of water for irrigation etc.

(I538)Water pollution

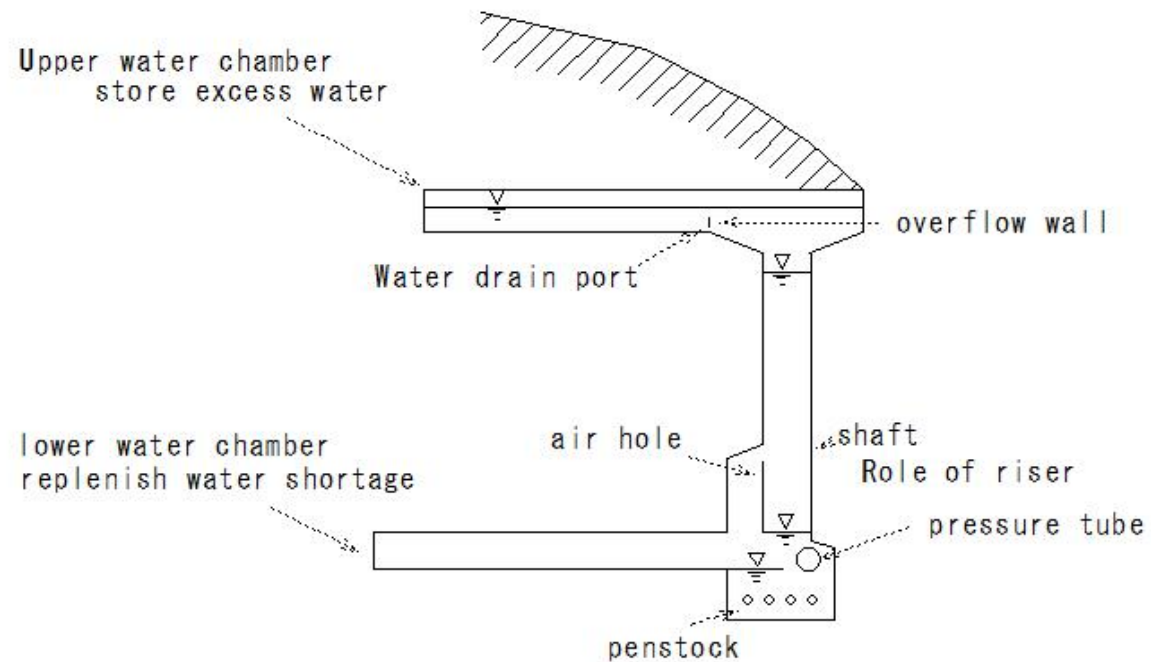


(I539)Chamber surge tank

(I539)Chamber surge tank

Chamber surge tank

- Water hammer pressure gives a large impact to the pressure channel
- Upper and lower water chambers: Absorbs water hammer pressure

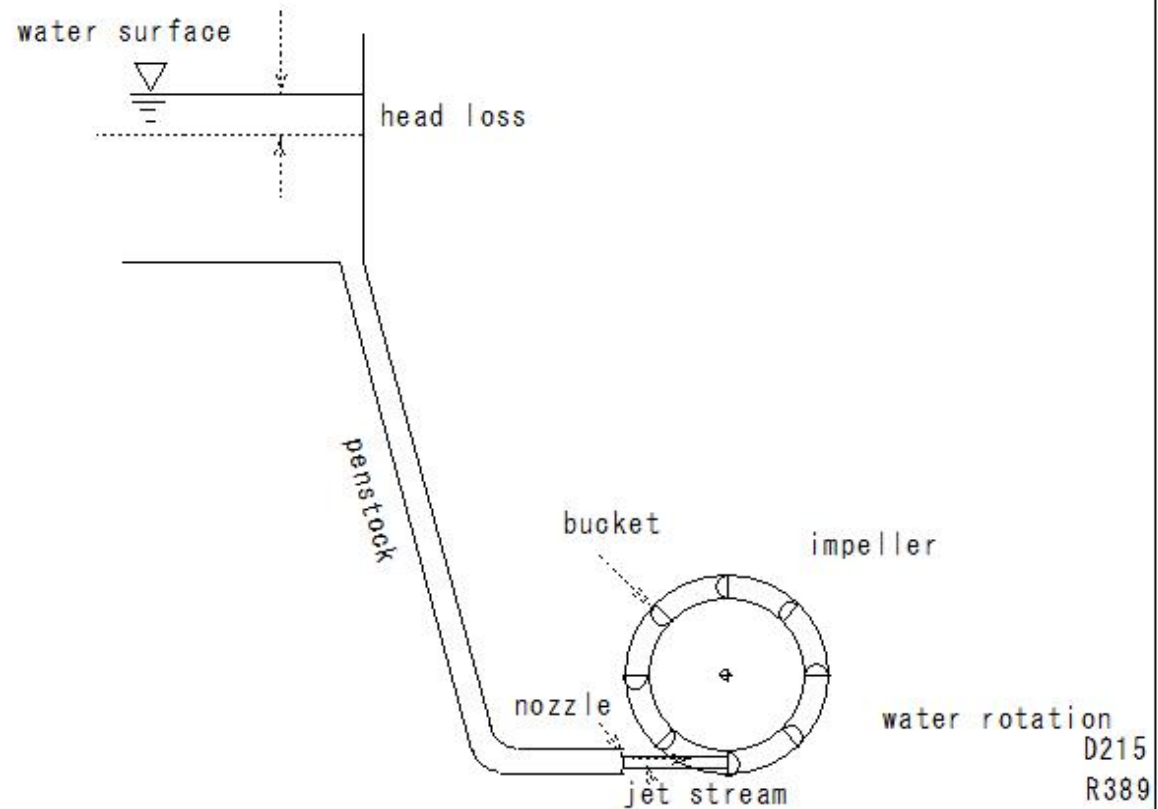


(I540)Hydraulic turbine

(I540)Hydraulic turbine

Hydraulic turbine

Generate electricity by operating a directly connected generator



(I541)Efficiency of hydraulic turbine

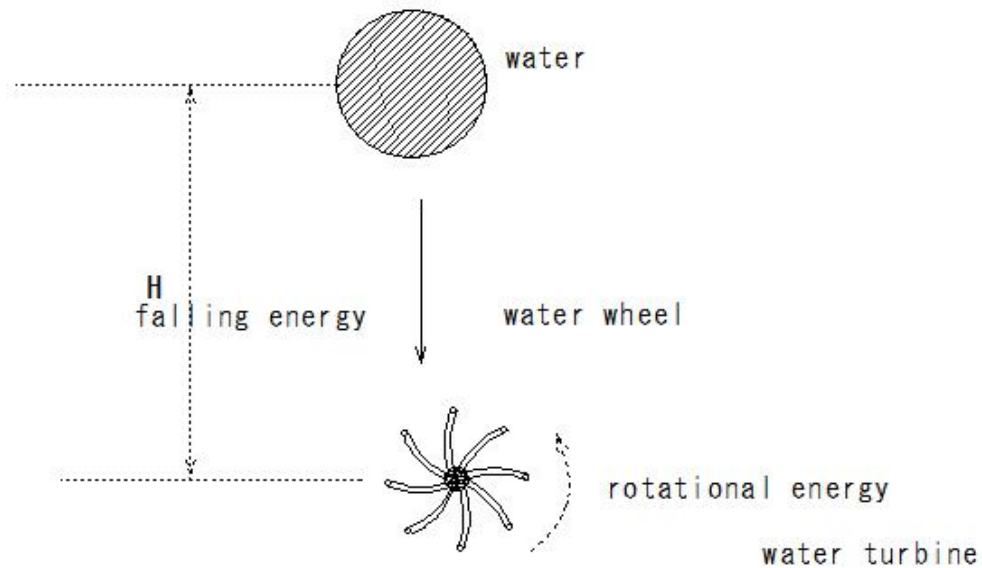
(I541)Efficiency of hydraulic turbine

efficiency of hydraulic turbine

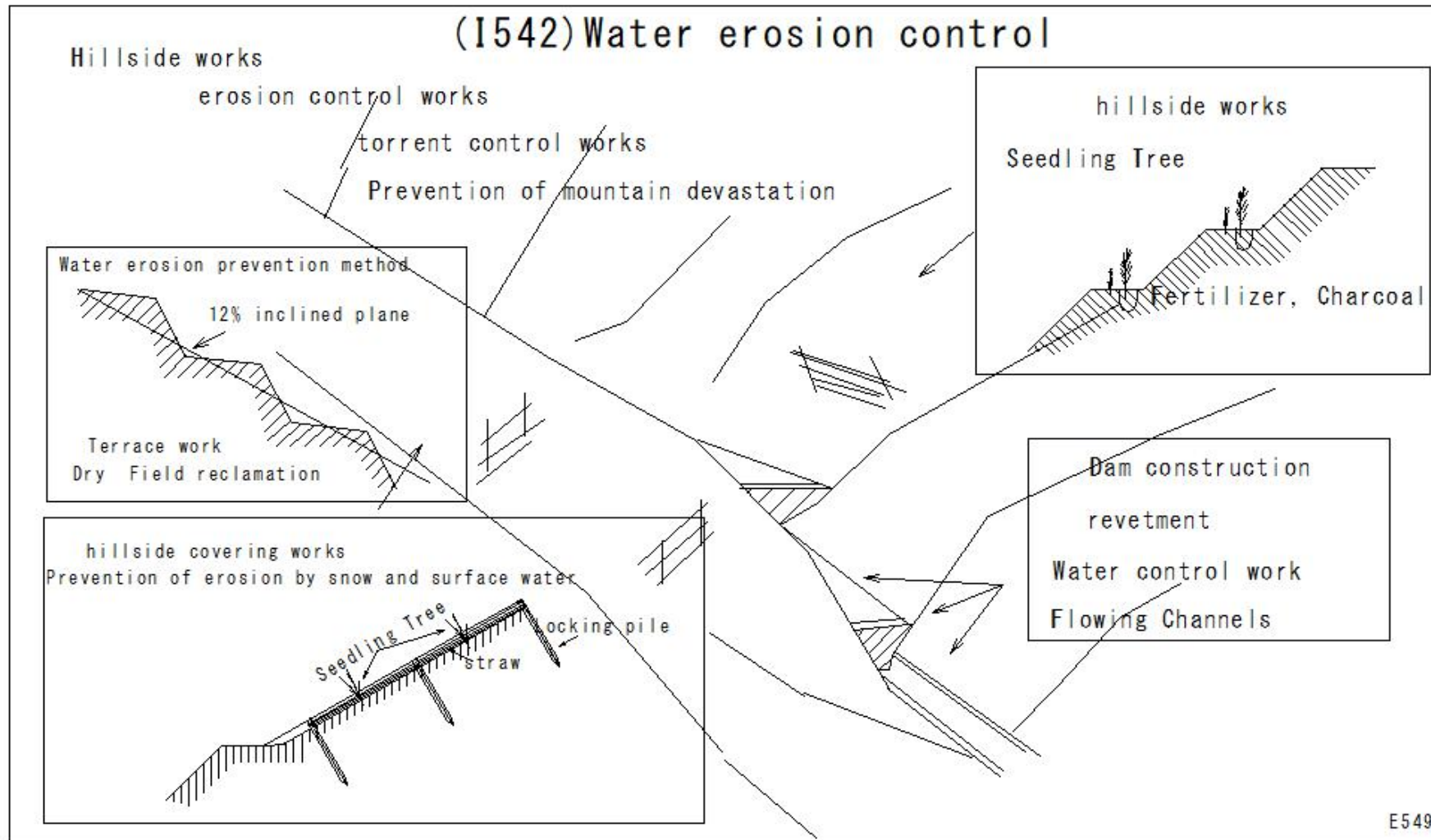
- Water from penstock – water wheel runner – high speed rotation – power generation

water energy rotational energy

Degree – Efficiency of a water wheel



(I542)Water erosion control



(I543)Spur dyke(groin)

(I543) Spur dyke (groin)

spur dyke(groin)

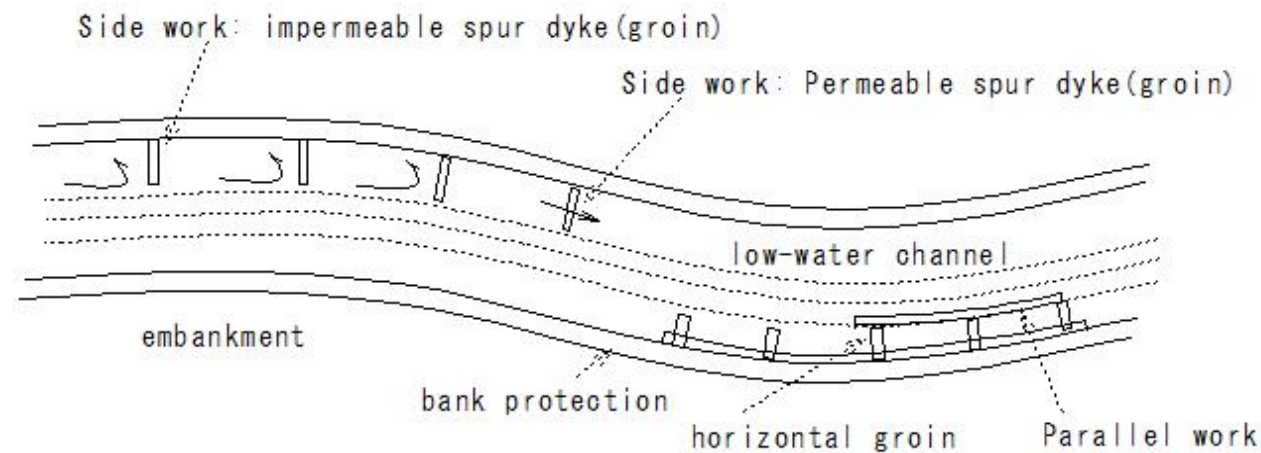
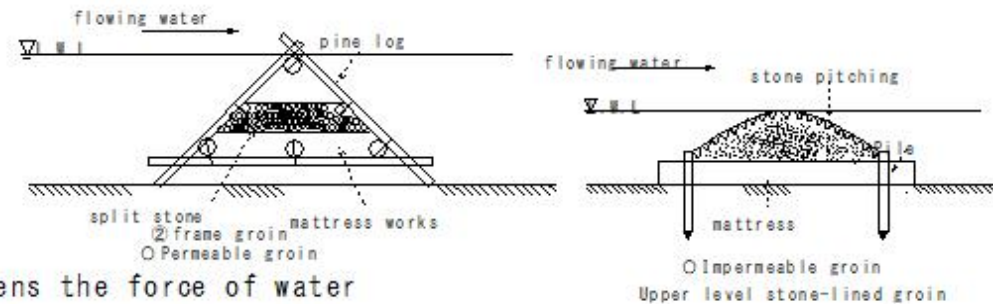
weaken the water force

Regulates flow direction

- Sediment precipitation
- Preventing riverbed scouring
- Stability of low waterways

Permeable spur dyke(groin) : weakens the force of water

Impermeable spur dyke(groin) : water system - overflow



(I544)Gate

(I544) Gate

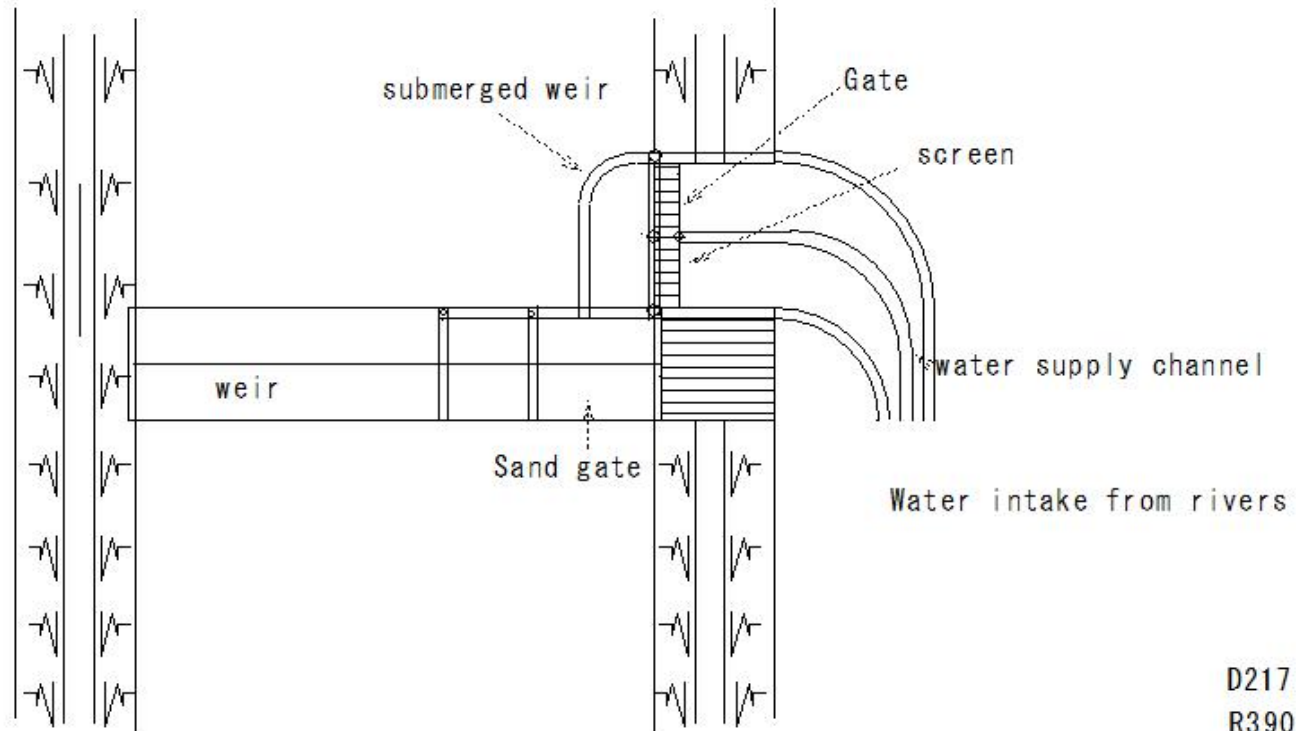
Gate

discharge adjustment

water intake

for ship navigation

Movable doors installed across rivers, canals, and embankments

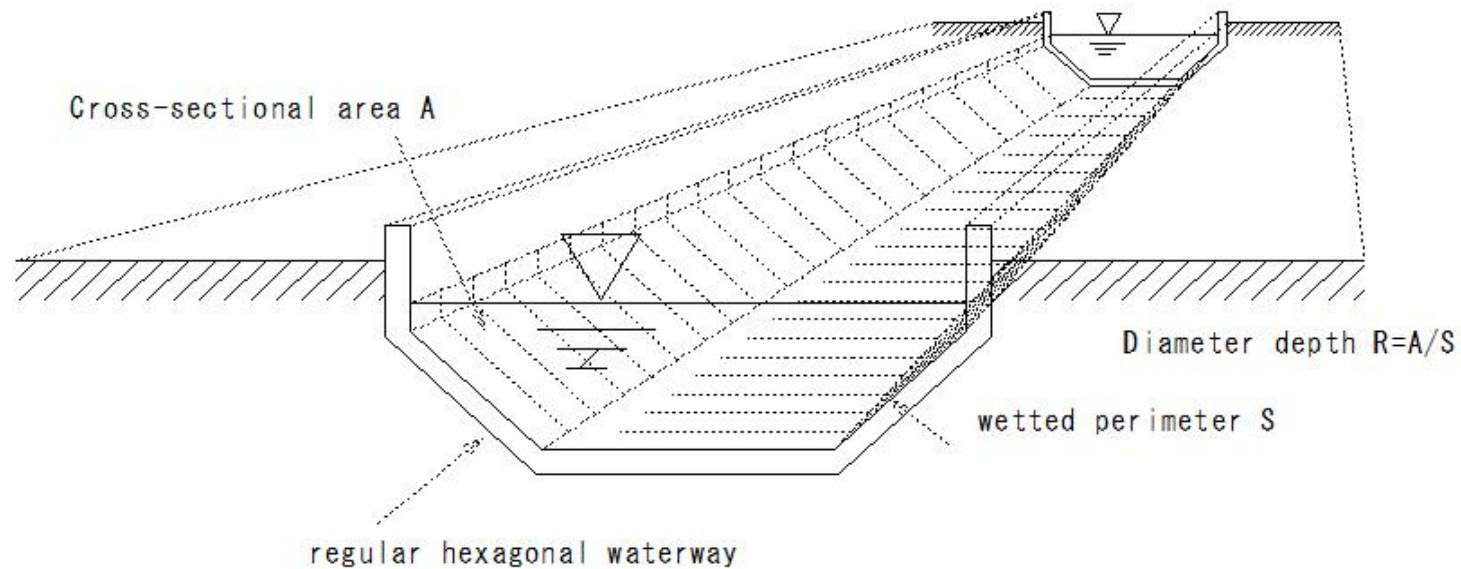


(I545)Best hydraulic cross-section

(I545)Best hydraulic cross-section

Best hydraulic cross-section

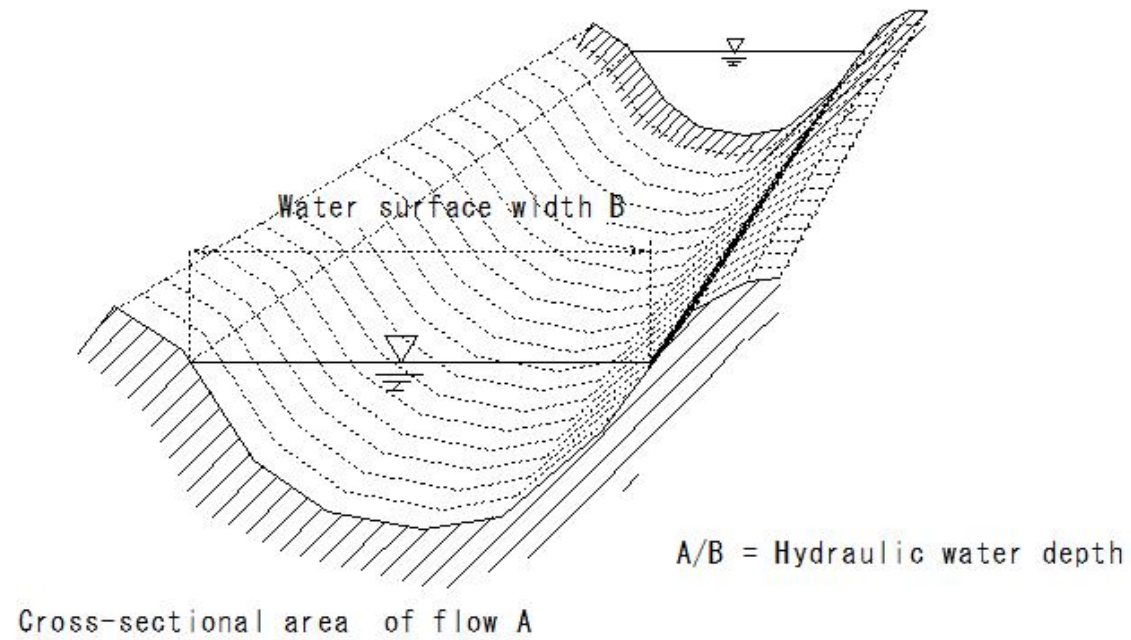
Channel cross section that allows the largest discharge to flow with a certain flow area



(I546)Hydraulic water depth

(I546)Hydraulic water depth

Hydraulic water depth

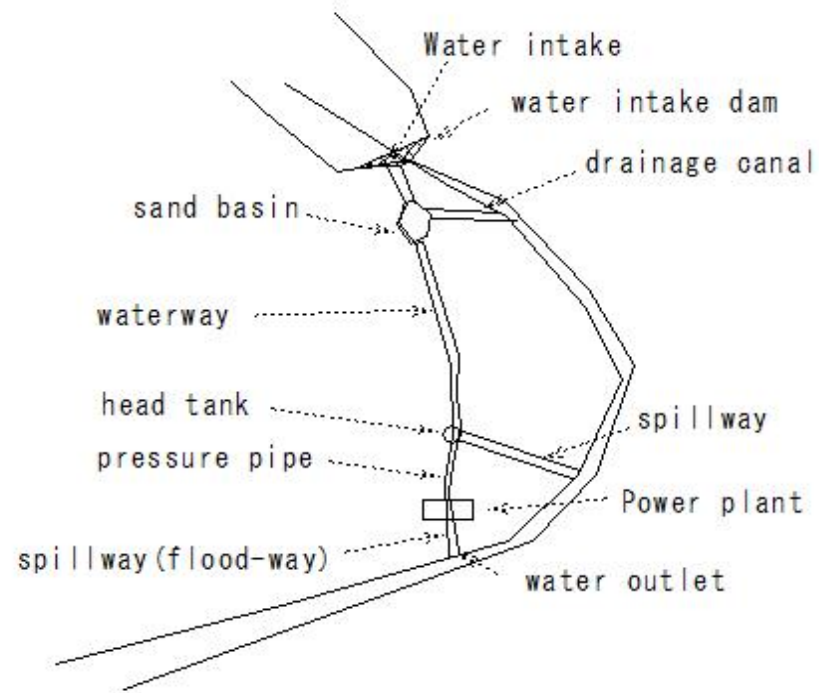


(I547)Conduct type water power

(I547)Conduct type water power

Conduct type water power

Guide river water through a channel to a point where a large head can be obtained.
Generate electricity by dropping it down with a pressure tube



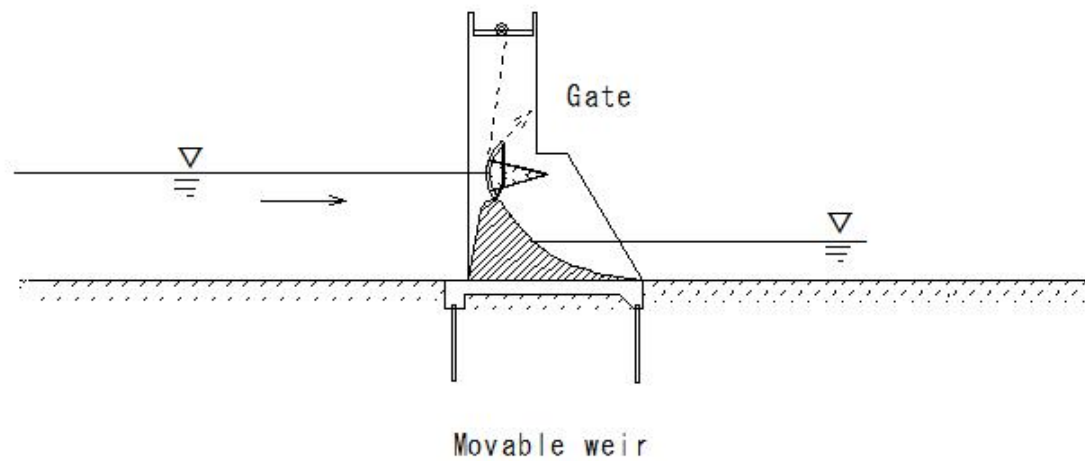
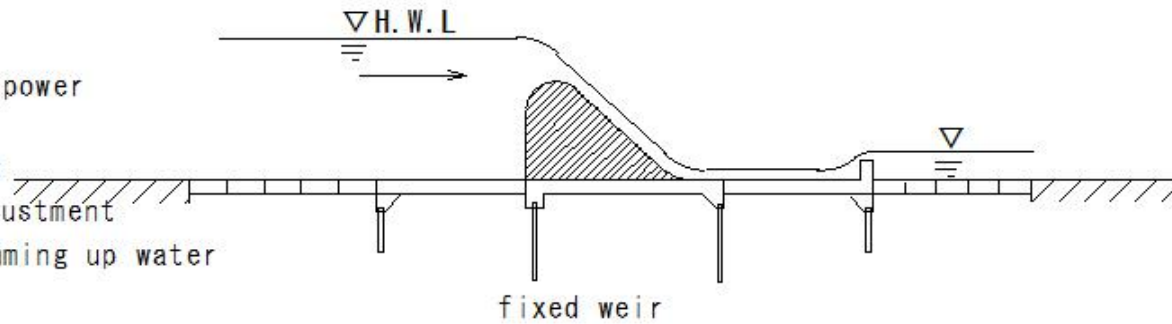
D220
R392

(I548)Weir

(I548)Weir

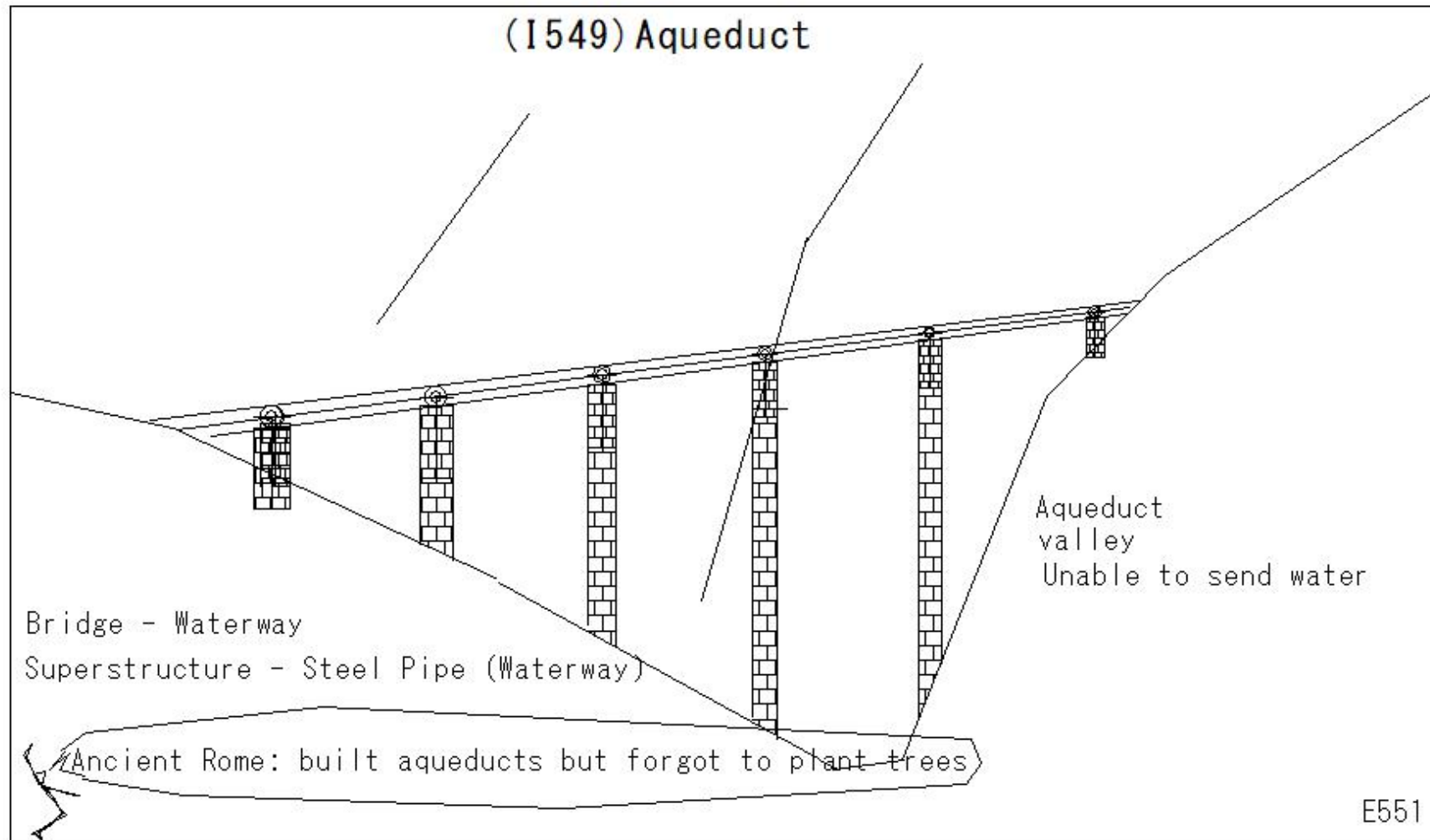
Weir

irrigation
water supply
hydroelectric power
Water intake
boat transport
high water adjustment
Waterway - damming up water



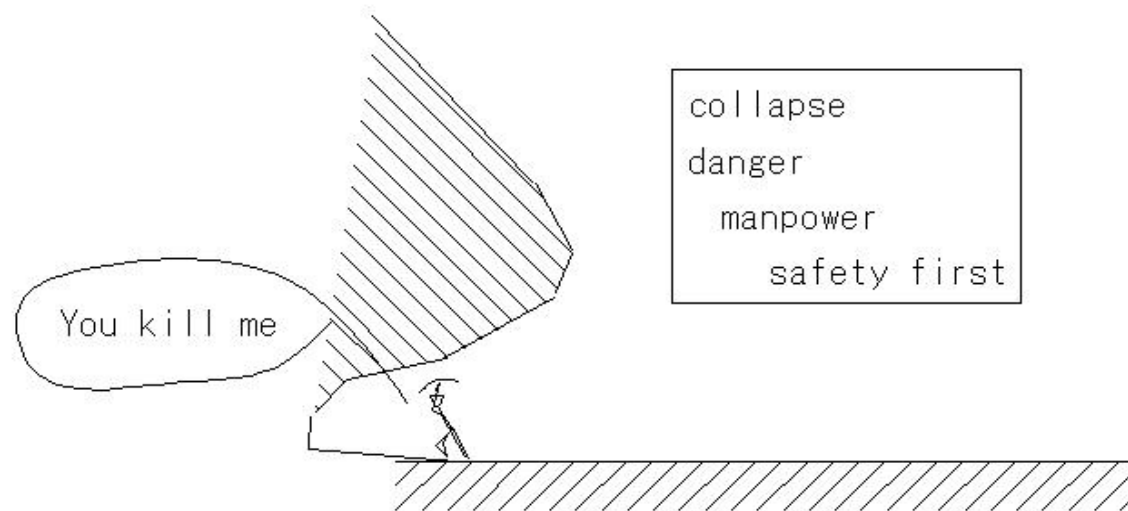
D221
R302

(1549) Aqueduct



(I550)Undermining

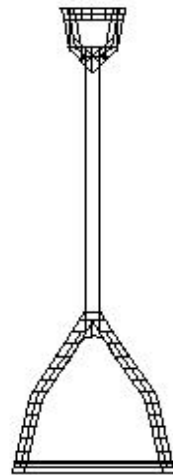
(I550) Undermining



E552

(I551)Scoop

(I551) Scoop



Earthmoving tools

Scooping up sediment

E553

(I552)Rubble-mound breakwater

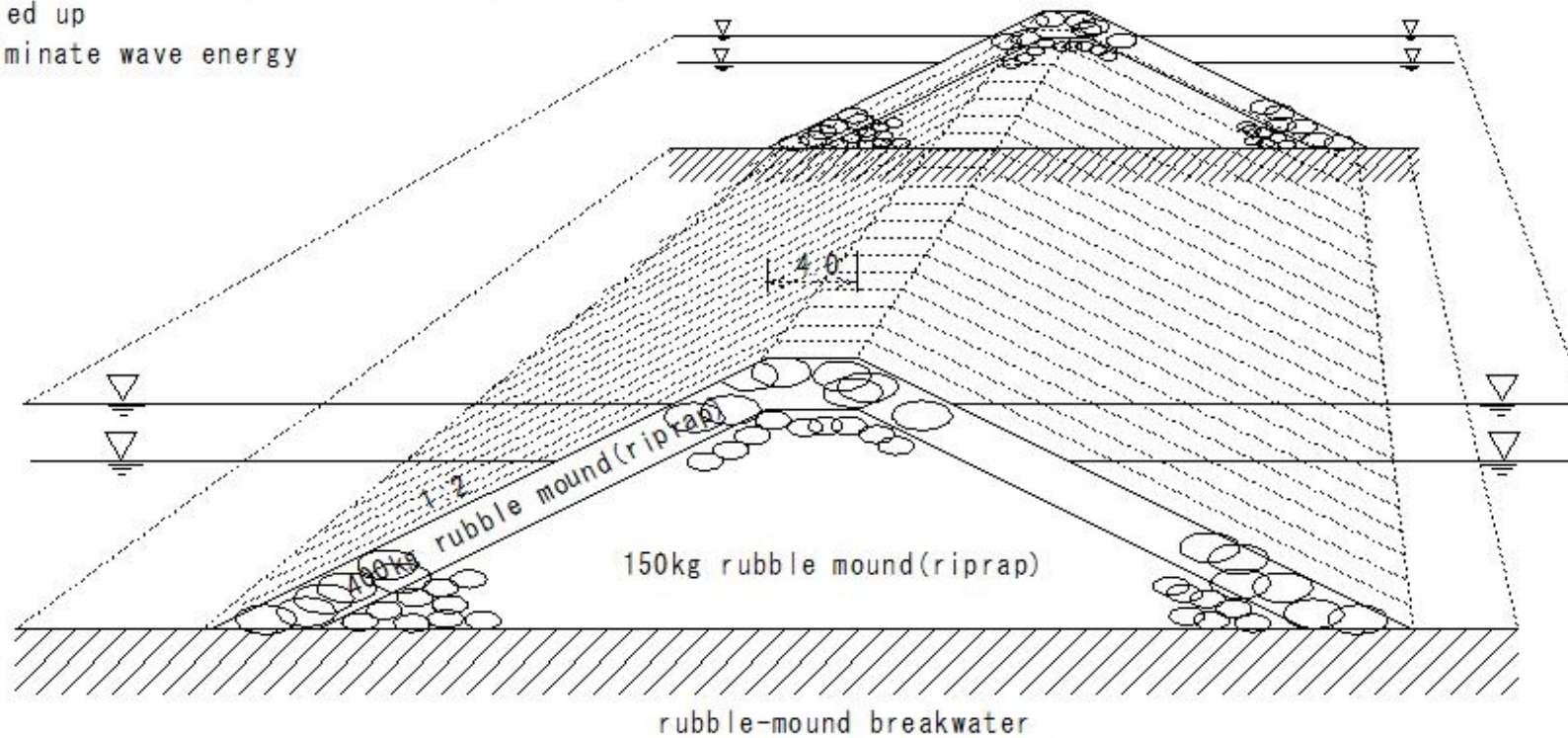
(I552)Rubble-mound breakwater

rubble-mound breakwater

rubble mound(riprap): split stone/tetra pot

piled up

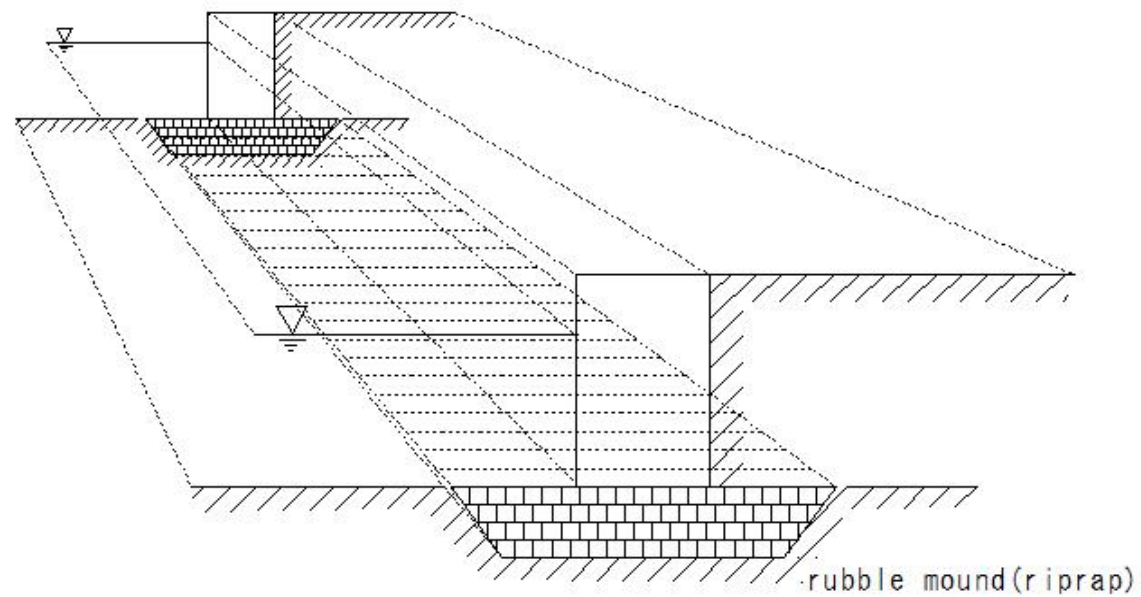
eliminate wave energy



(I553)Riprap work

(I553)Riprap work

Riprap work
breakwater
sand control
training levee
training levee
seawall

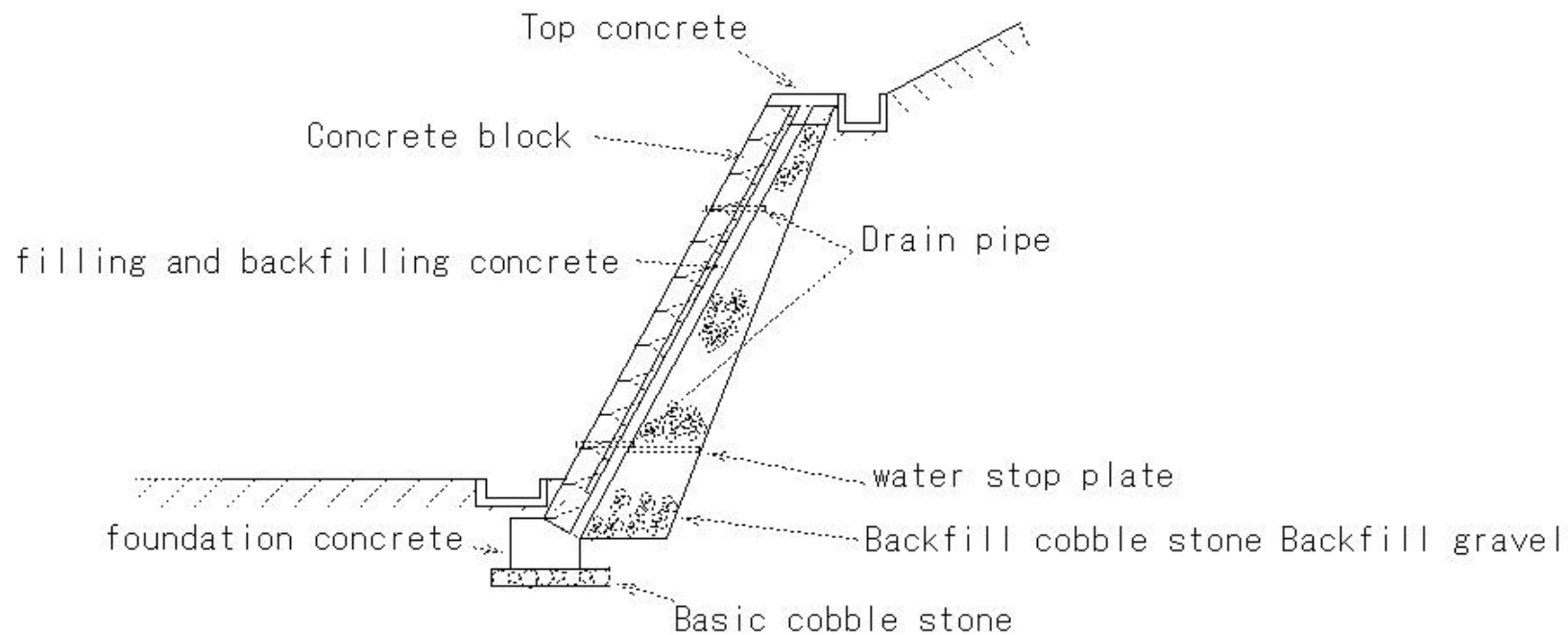


riprap work

(I554)Slope protection-Concrete block masonry

(I554)Slope protection-Concrete block masonry

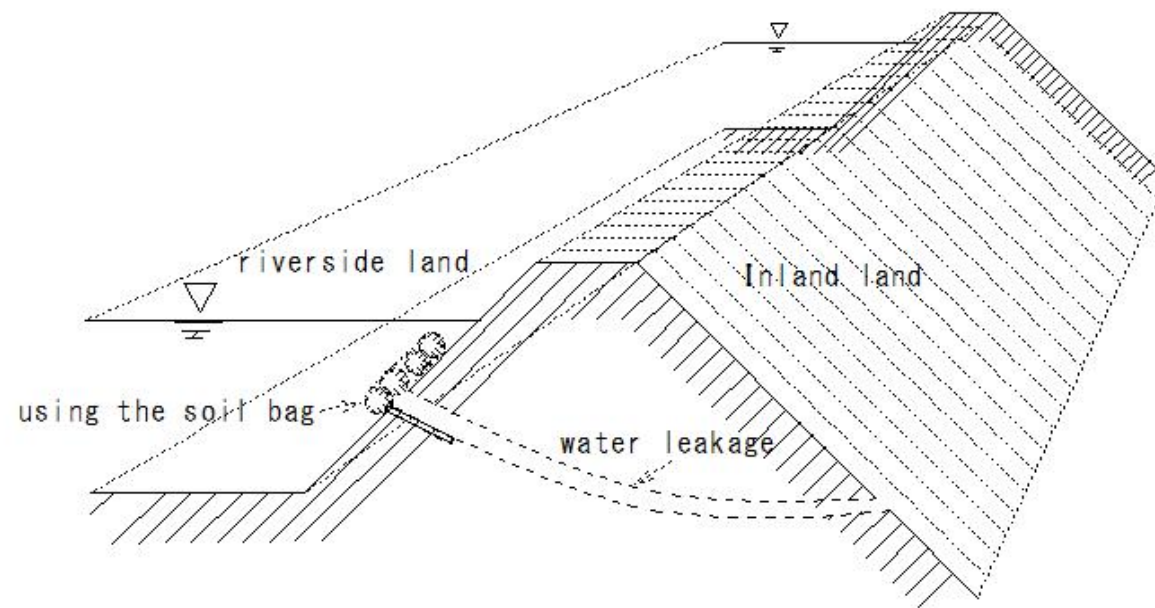
Slope protection
Concrete block masonry



(I555) Preventing water leakage from embankments

(I555) Preventing water leakage from embankments

Preventing water leakage from embankments



R394

(I556)Stoney gate weir

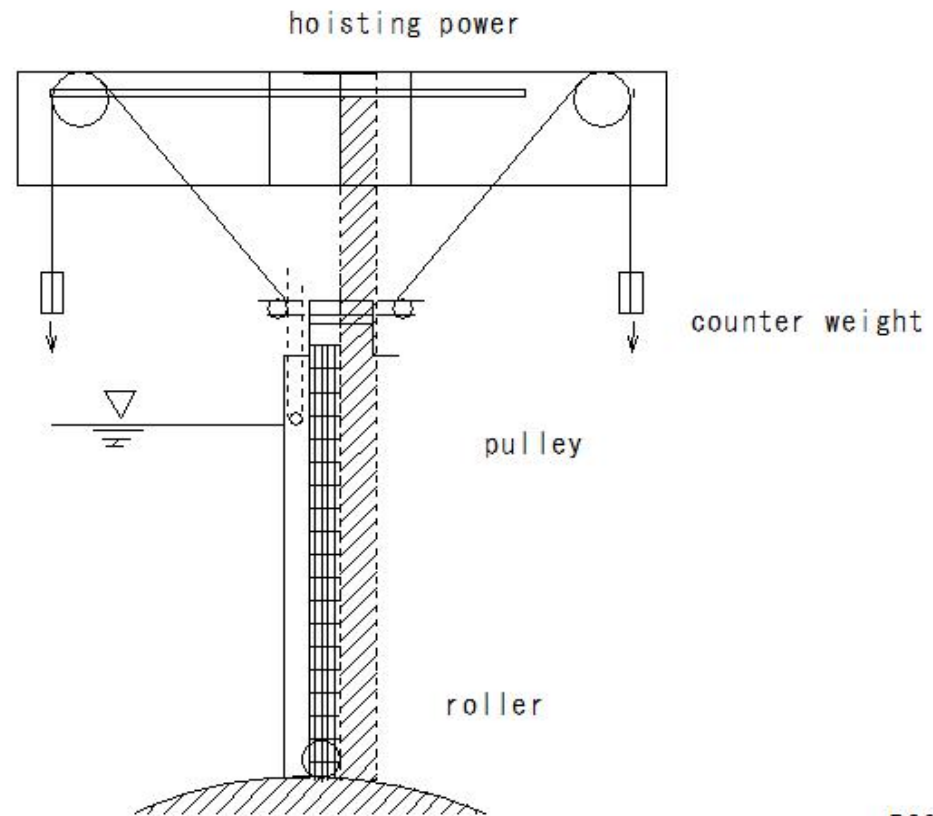
(I556)Stoney gate weir

Stoney gate weir

sluice gate

series of rollers

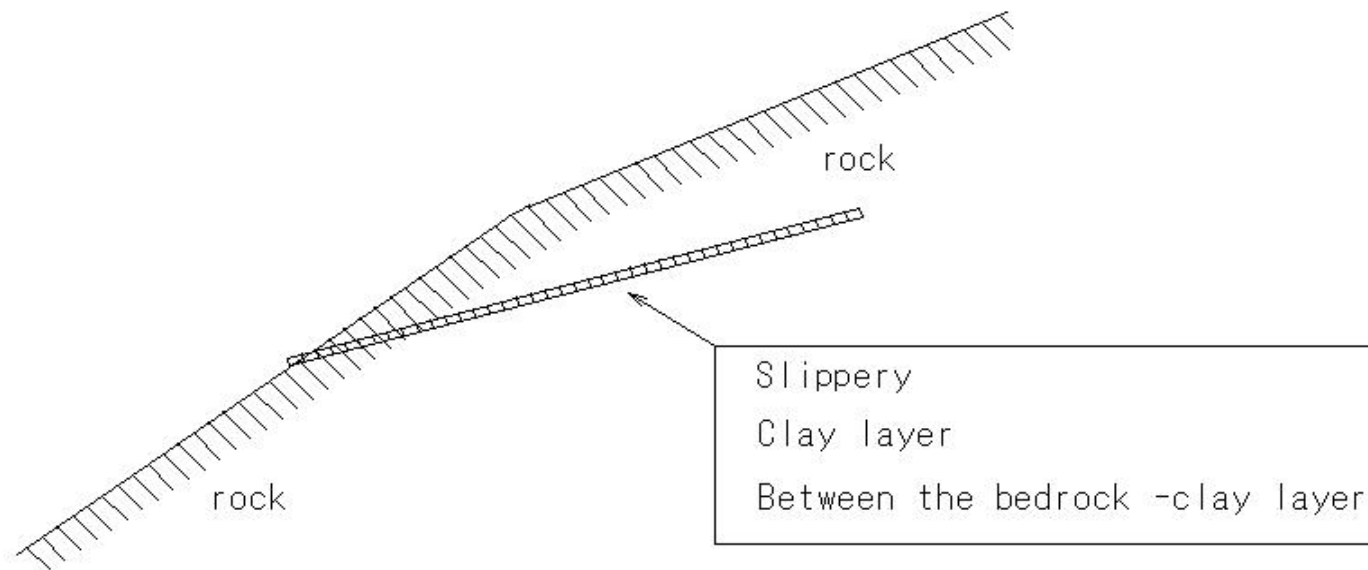
- The top and bottom open and close smoothly.



R395

(I557)Sliding surface

(I557)Sliding surface



S194
E555

(I558)Sewerage(thickner(Sludge scraper))

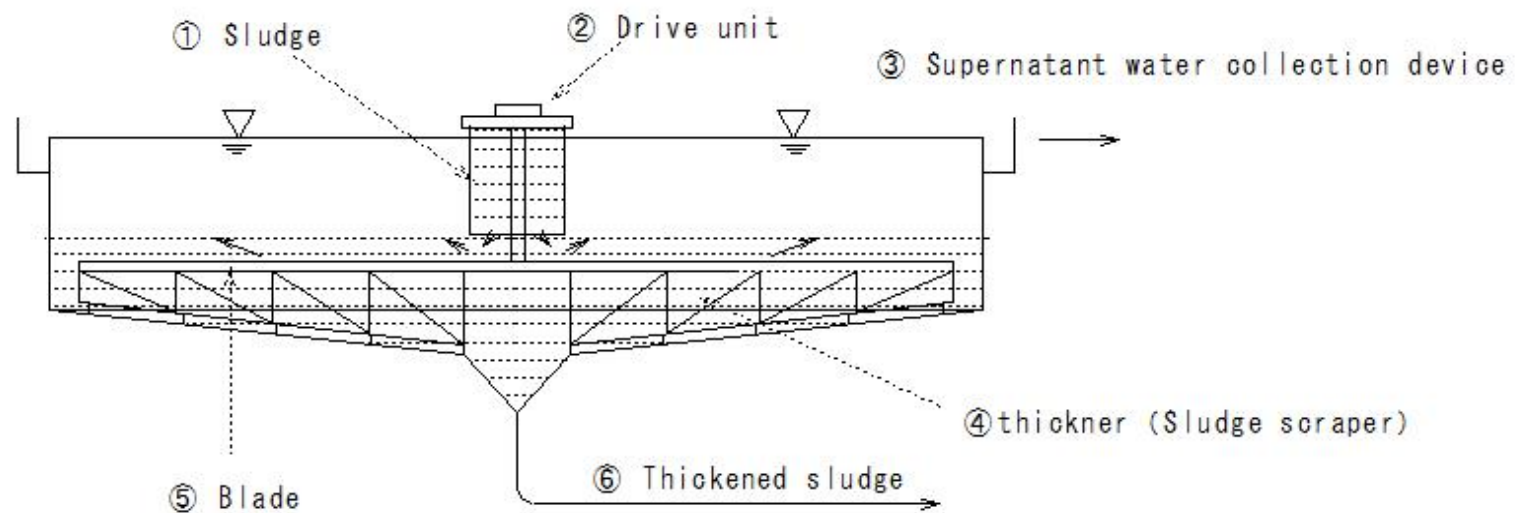
(I558) Sewerage(thickner (Sludge scraper))

Sewerage

thickner (Sludge scraper)

Sewage treatment plant

Machine scrapes and collects settled sludge



thickner (Sludge scraper)

W244

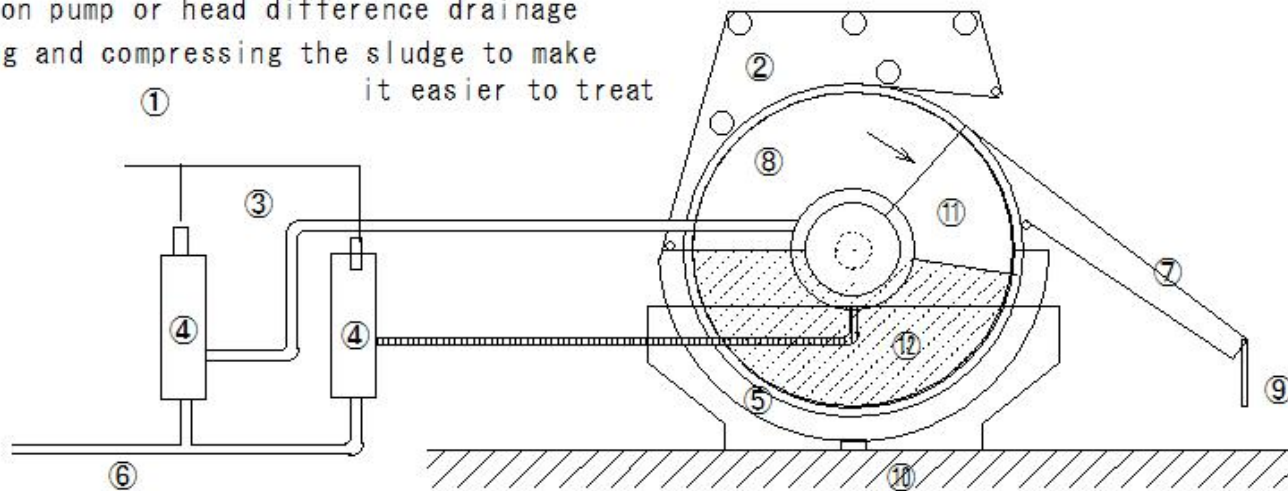
(1559) Sewerage (sludge treatment)

Sewer age

Sludge treatment

The sludge (mud) generated during the sewage treatment process is treated by dehydrating, drying, incinerating, etc.

- ① Vacuum filter
② Compression roller
③ Vacuum pump
④ Vacuum tank
⑤ Sludge
⑥ Distribution pump or head difference drainage
⑦ Dehydrating and compressing the sludge to make it easier to treat
- ⑧ High vacuum
⑨ Cake (dehydrated sludge)
⑩ Vacuum filter
⑪ Stripping normal pressure
⑫ Low vacuum
-
- ① ②



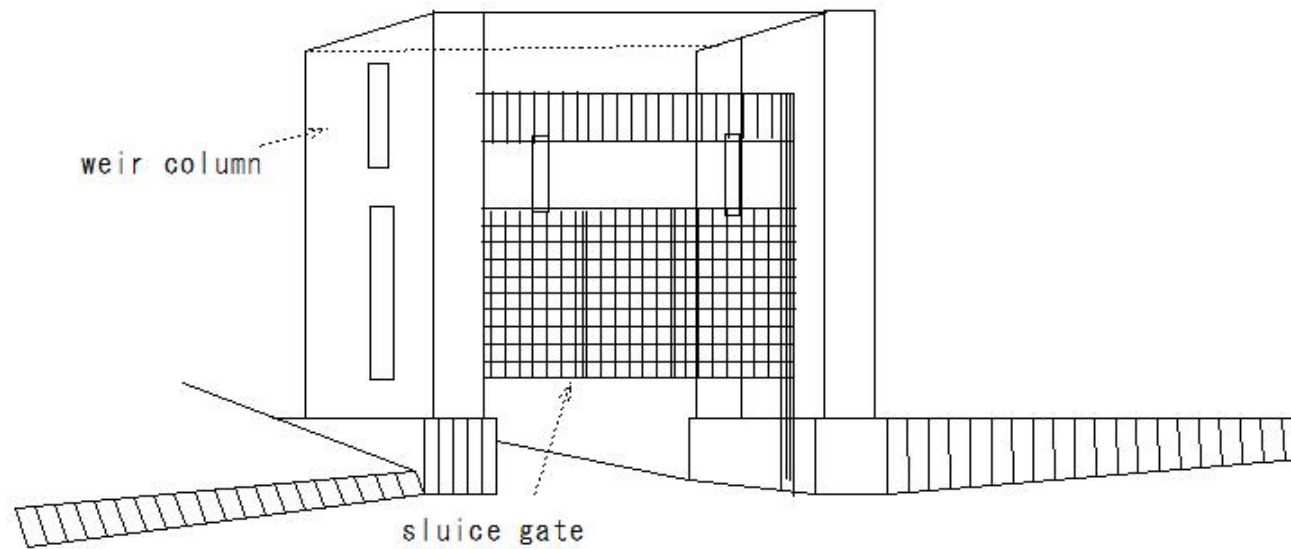
W245

(I560)Sluice gate

(I560)Sluice gate

Sluice gate

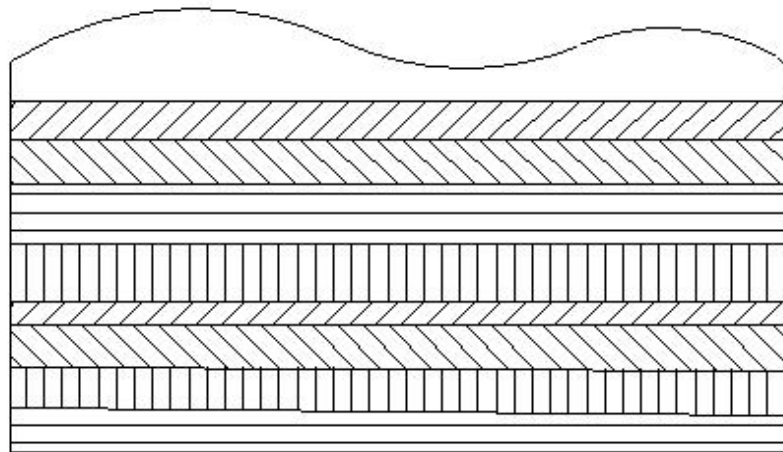
Rectangular gate that can be opened and closed up and down



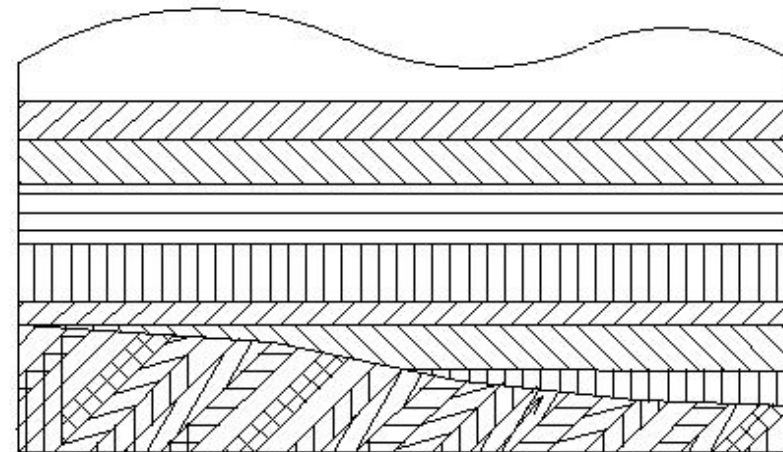
(I561)Conformity

(I561)Conformity

conformity



Inconformity



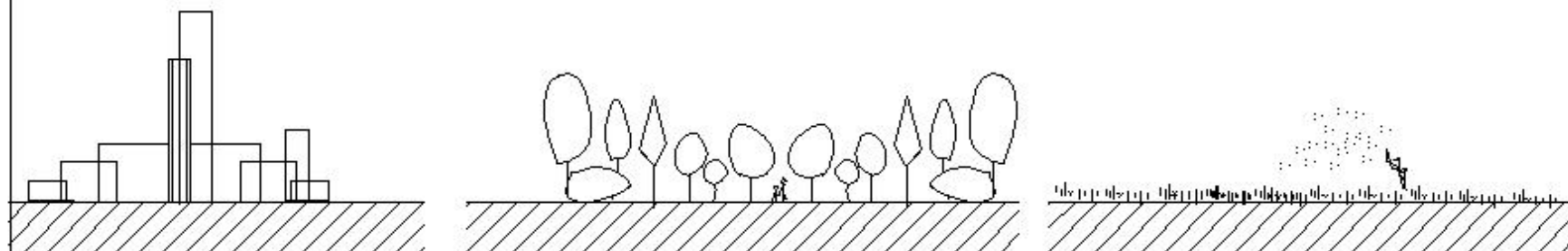
sedimentation
Geo-disaster
Tectonic movements

Basal rubble

E556

(I562)Productive green tract of land

(I562)Productive green tract of land



urban

forest

agricultural land

adjacent to the city

Productive green spaces

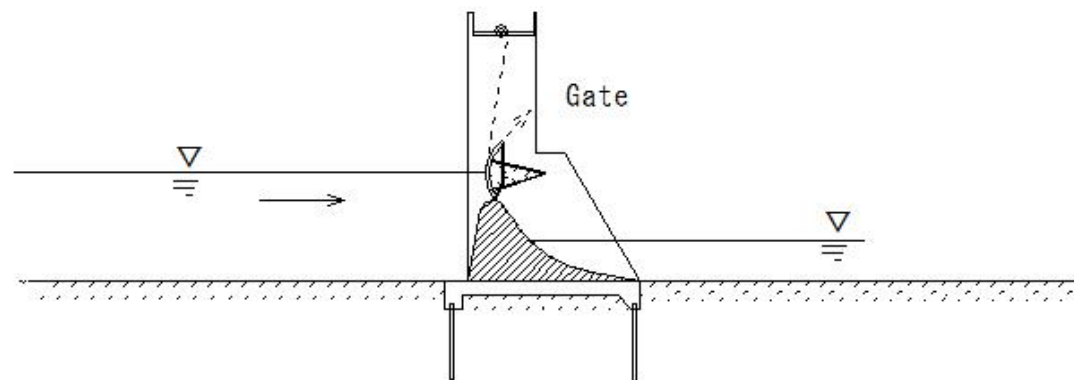
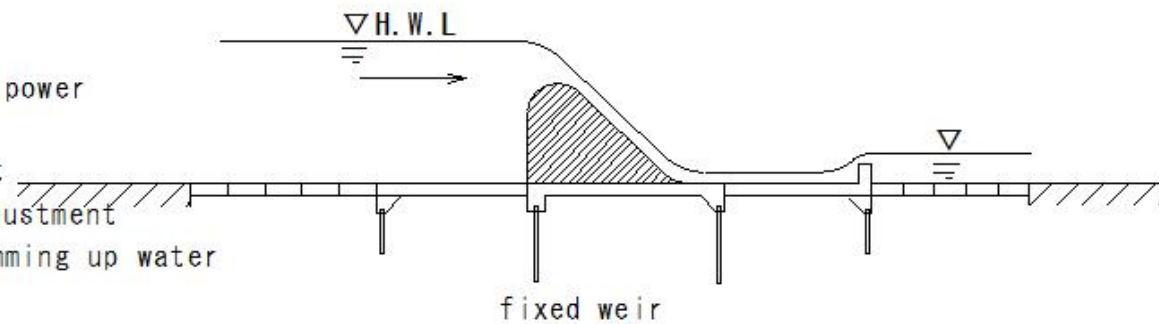
R397

(I563)Weir

(I563) Weir

Weir

irrigation
water supply
hydroelectric power
Water intake
boat transport
high water adjustment
Waterway - damming up water



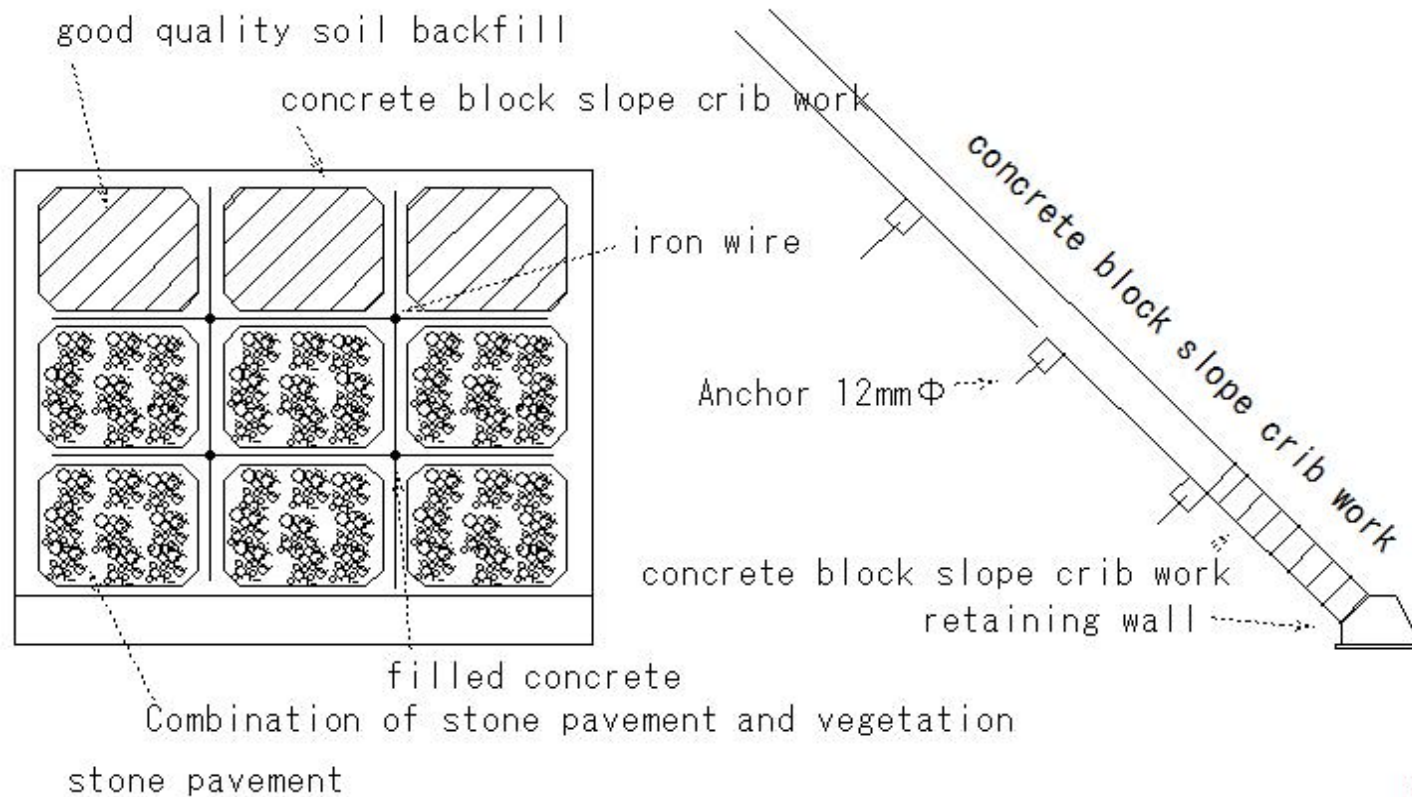
Movable weir

D221
R302

(I564) Slope crib work

(I564) Slope crib work

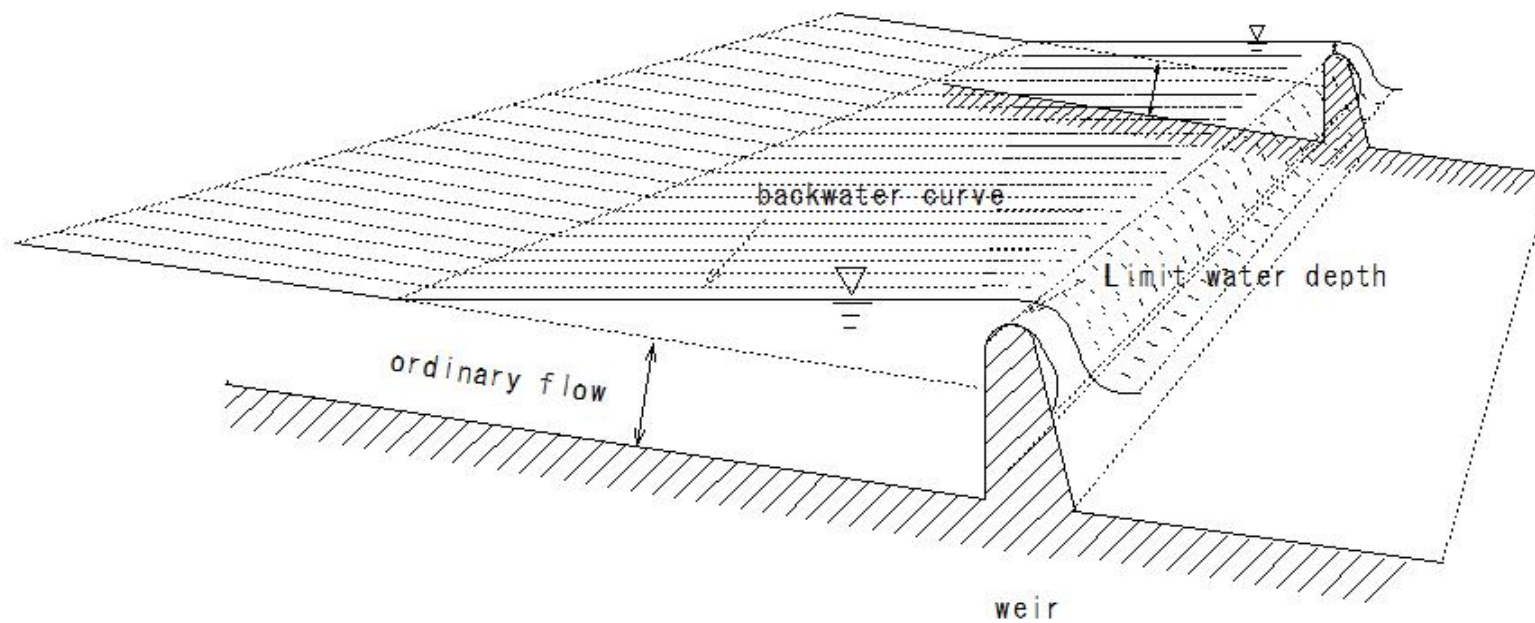
slope crib work



R381

(I565)Backwater curve

(I565)Backwater curve



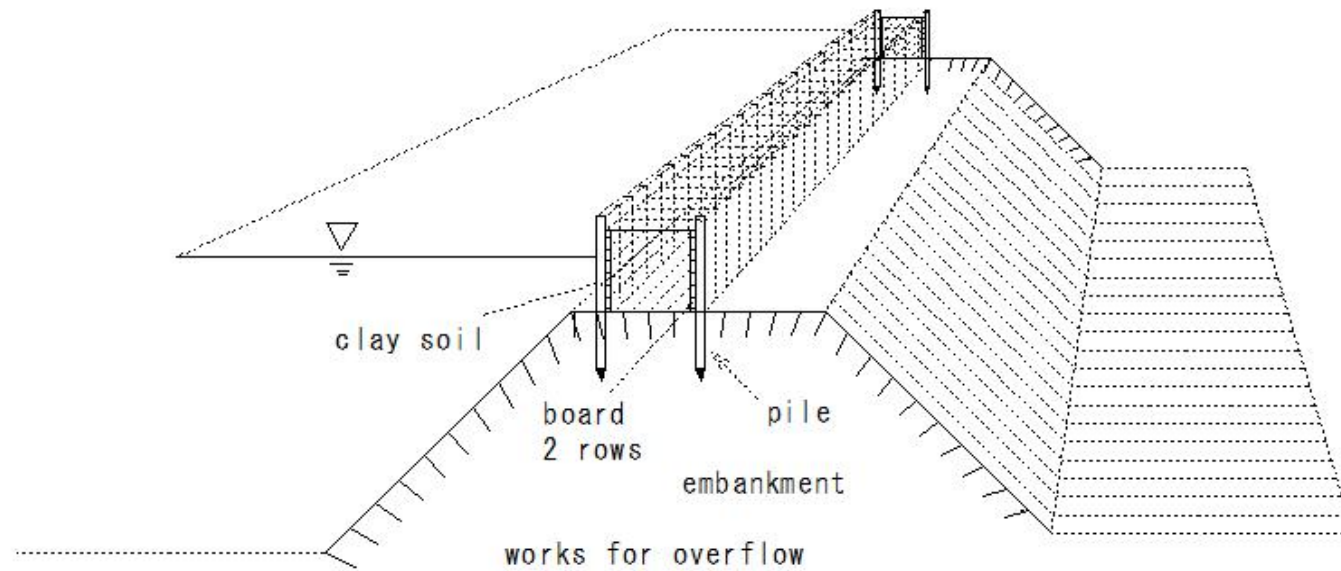
D222
R418

(I566)Works for overflow(board work)

(I566)Works for overflow(board work)

works for overflow(board work)

A type of flood prevention method



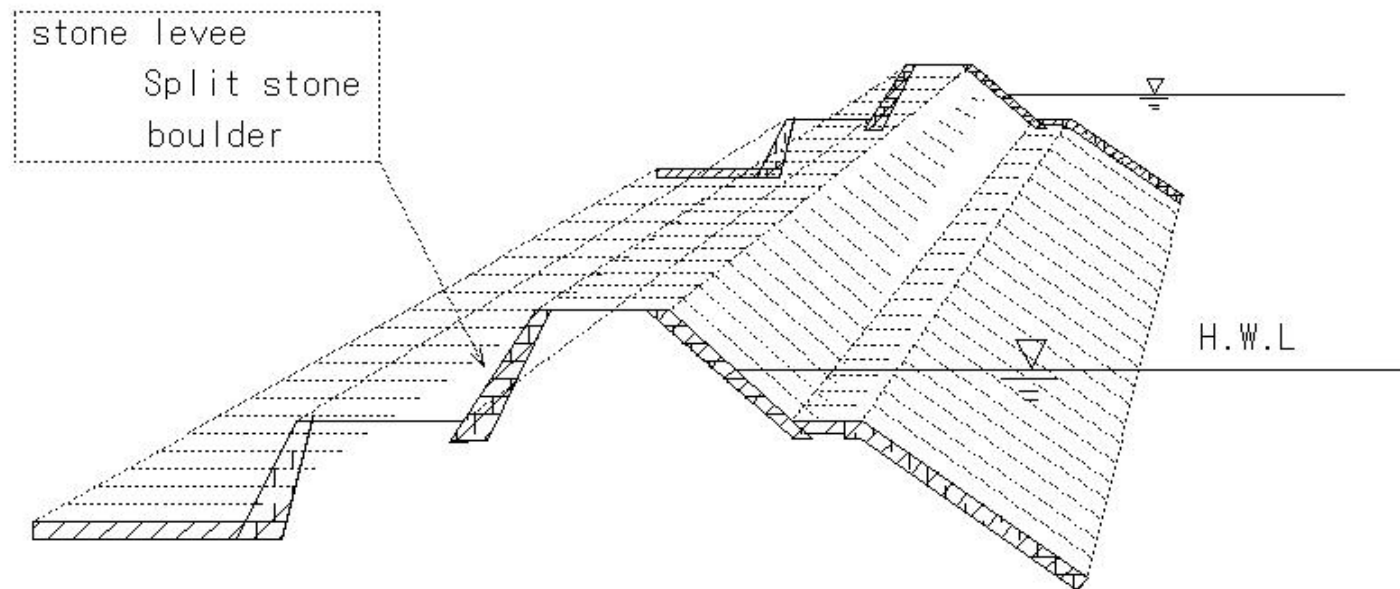
R399

(I567) Stone levee

(I567) Stone levee

Stone levee

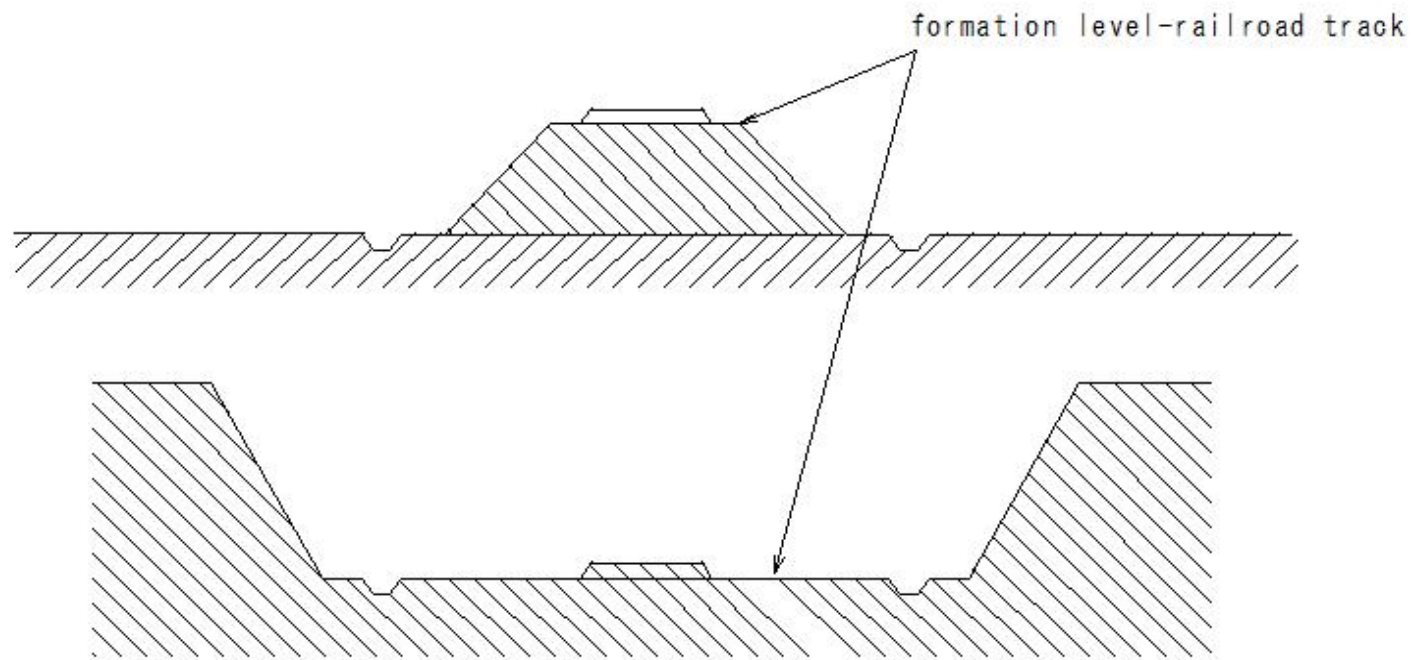
The slope of an embankment is made of broken stones, cobblestones, etc.



R400

(I568)Formation level-railroad track

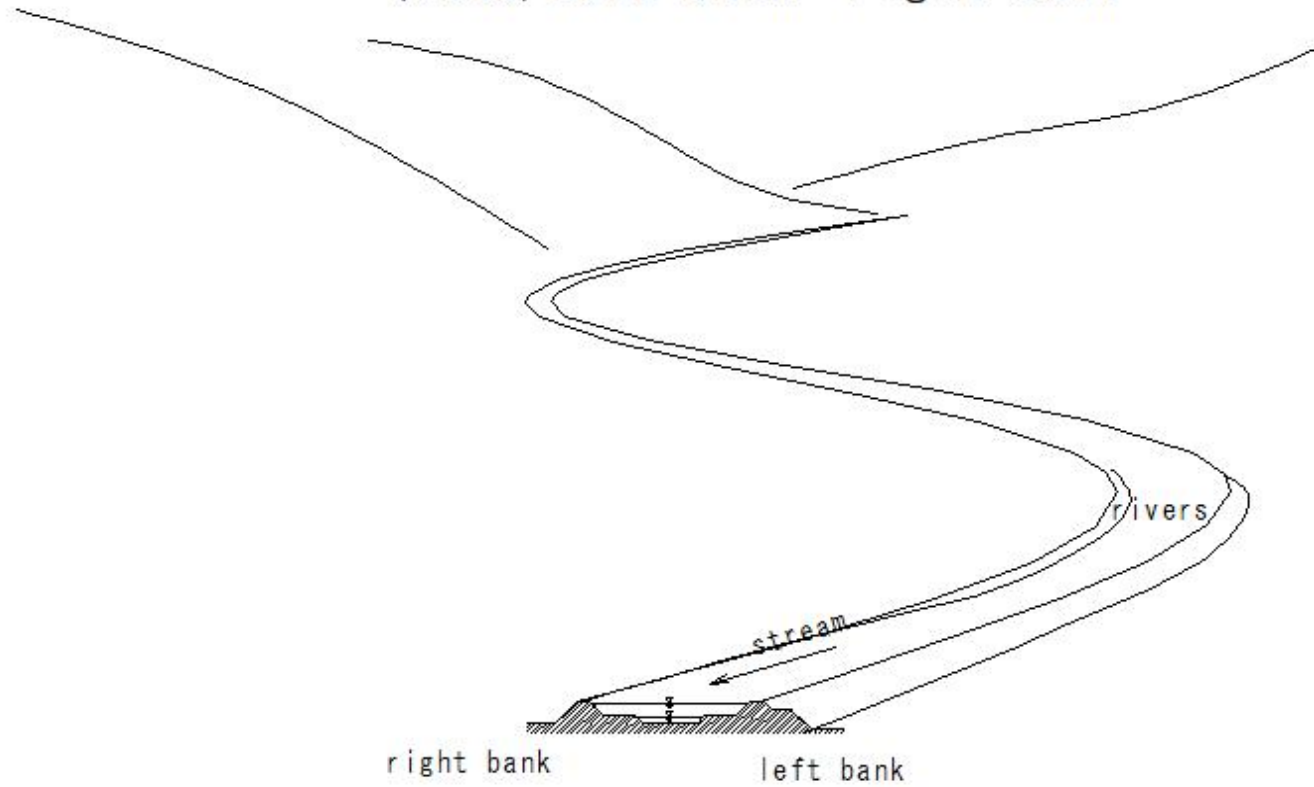
(I568)Formation level-railroad track



E558

(I569)Left bankright bank

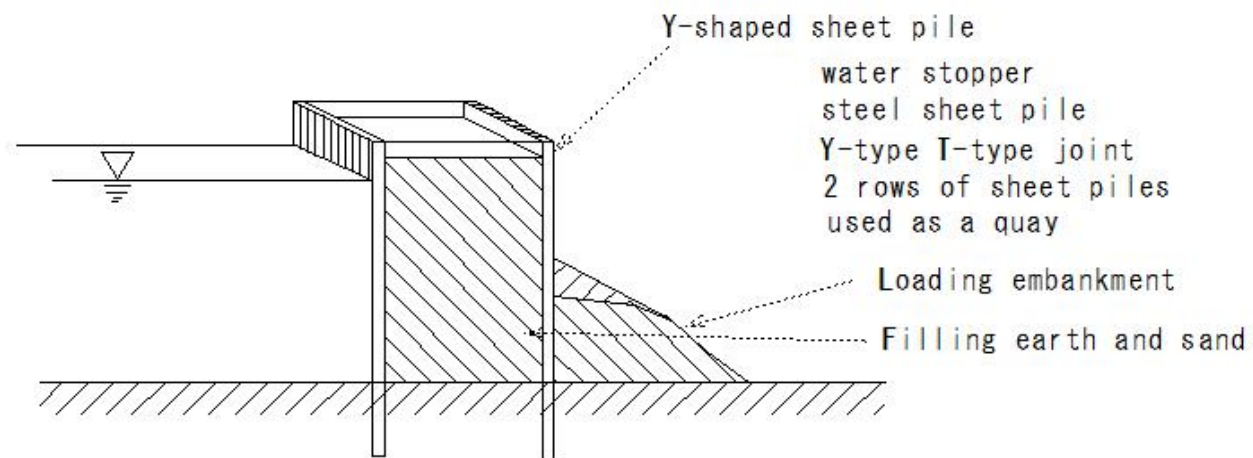
(I569)Left bank · right bank



(I570)Cellular sheet pile

(I570)Cellular sheet pile

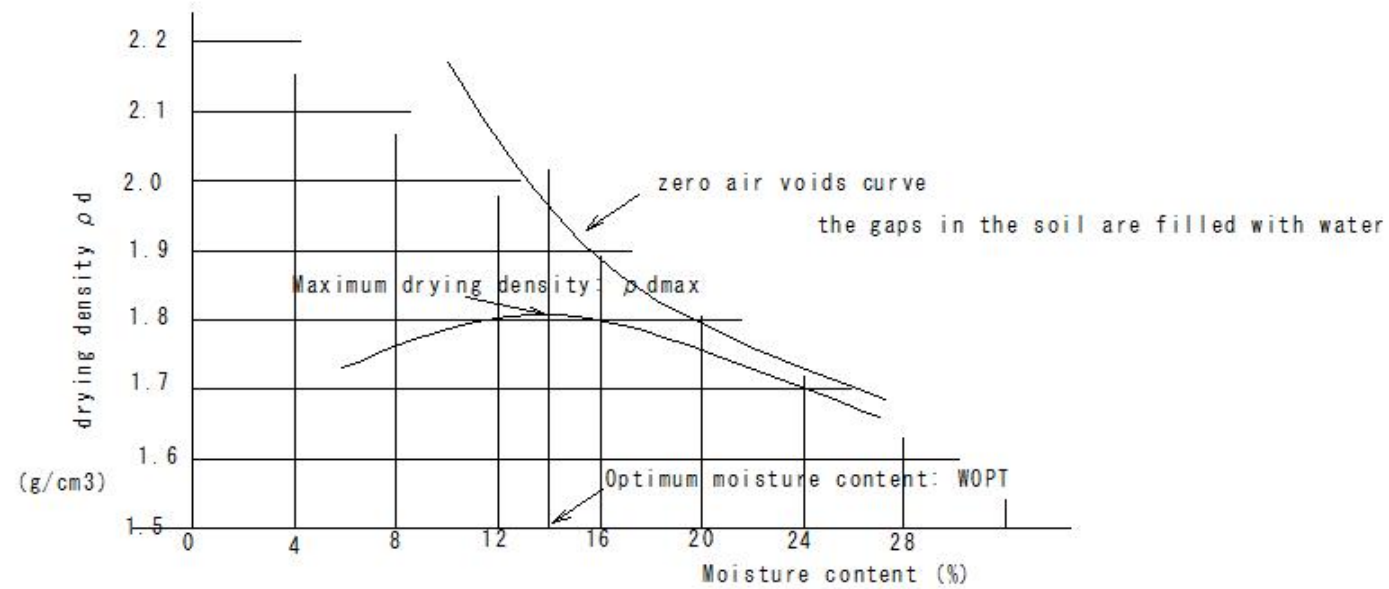
Cellular sheet pile



R401

(I571)Zero air voids curve

(I571)Zero air voids curve



(I572) Separation levee

(I572) Separation levee

Separation levee

To move the confluence downstream
Embankment between both rivers

Conditions requiring installation

both rivers

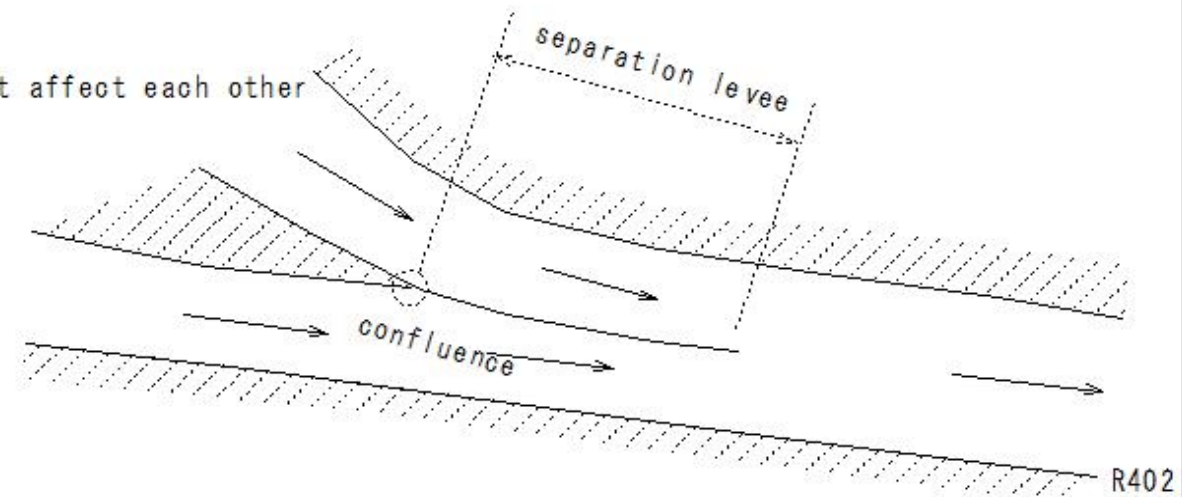
① River bed slope

② discharge

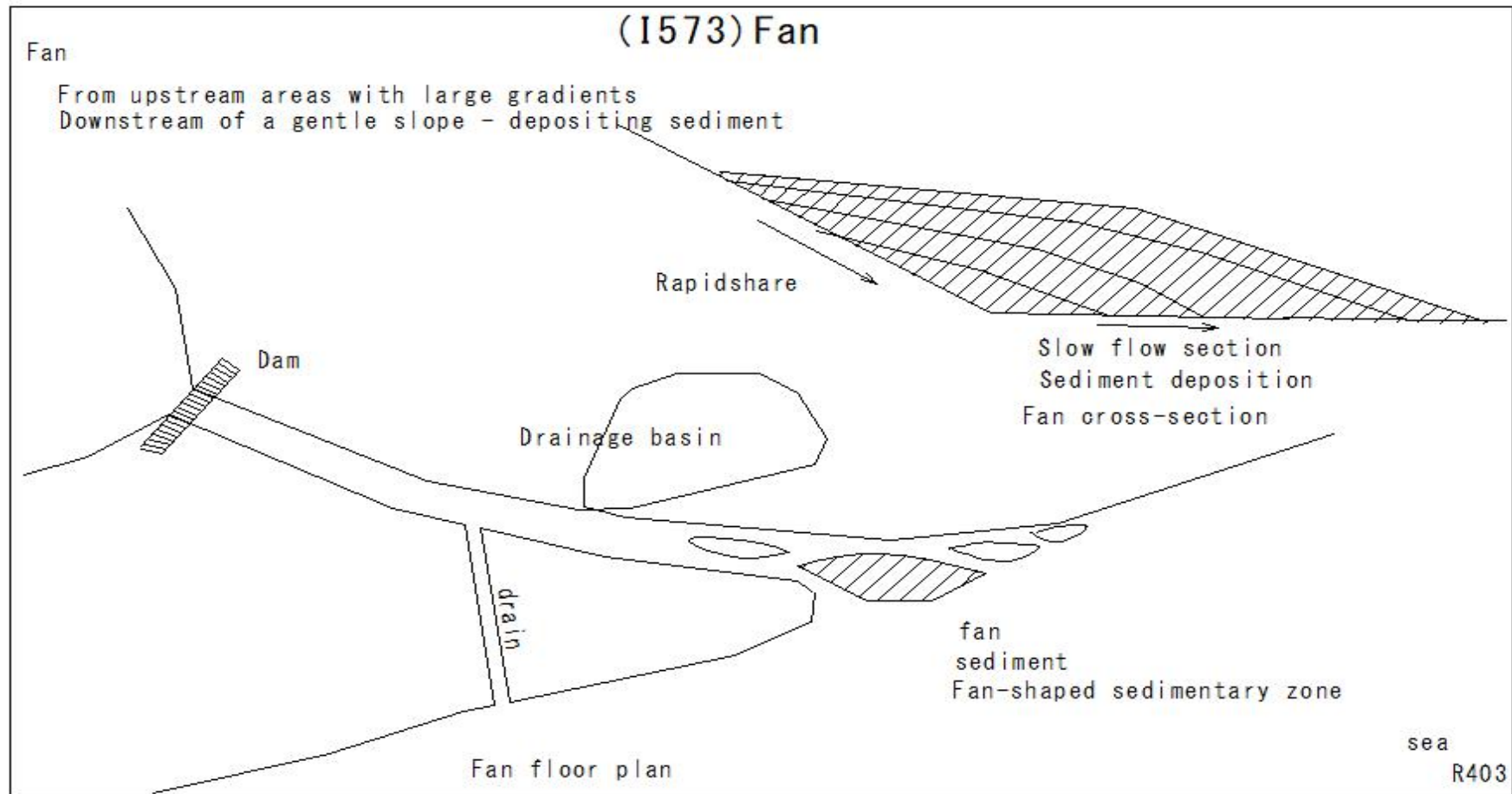
huge difference

separation levee

Extend to a position : do not affect each other



(I573) Fan



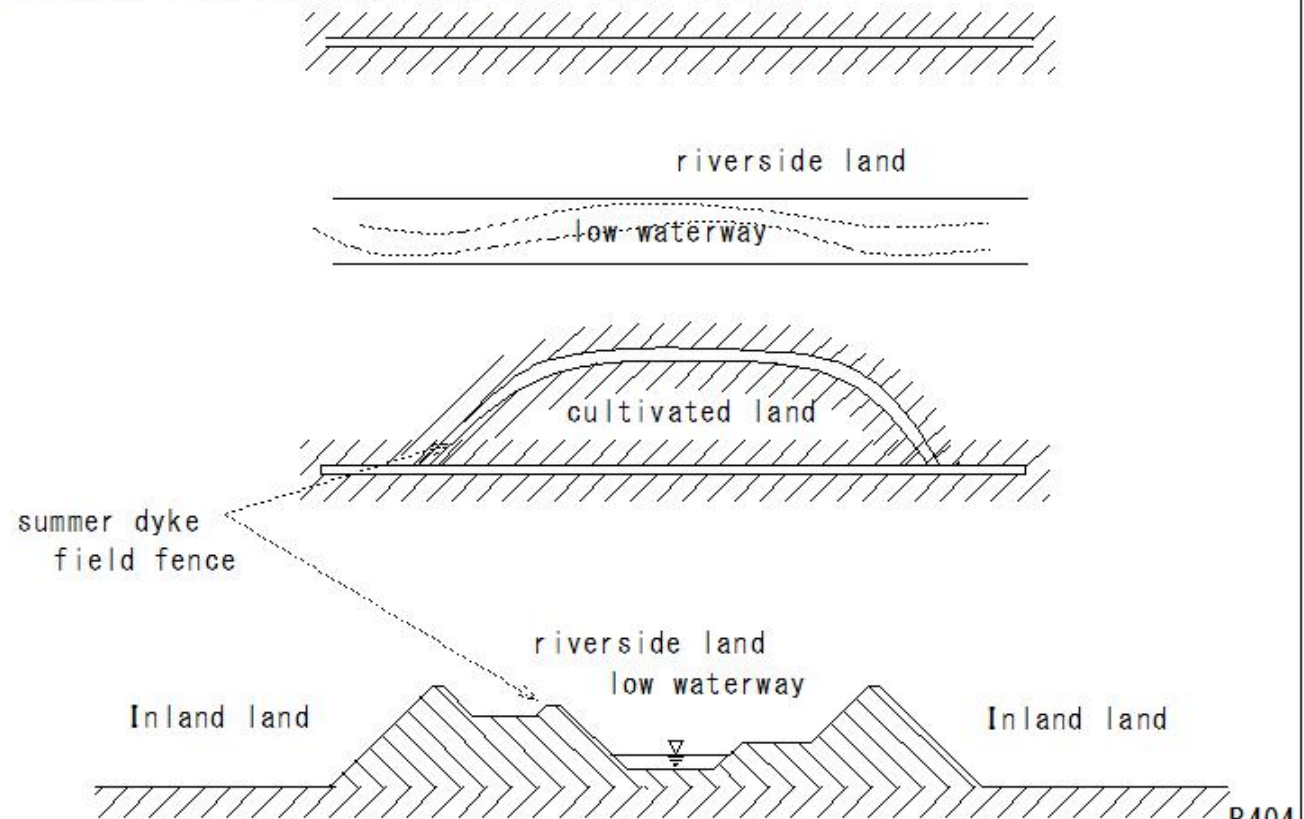
(I574)Summer dyke

(I574) Summer dyke

Summer dyke

Protecting cultivated riverside land the embankment from minor flooding

Inland land

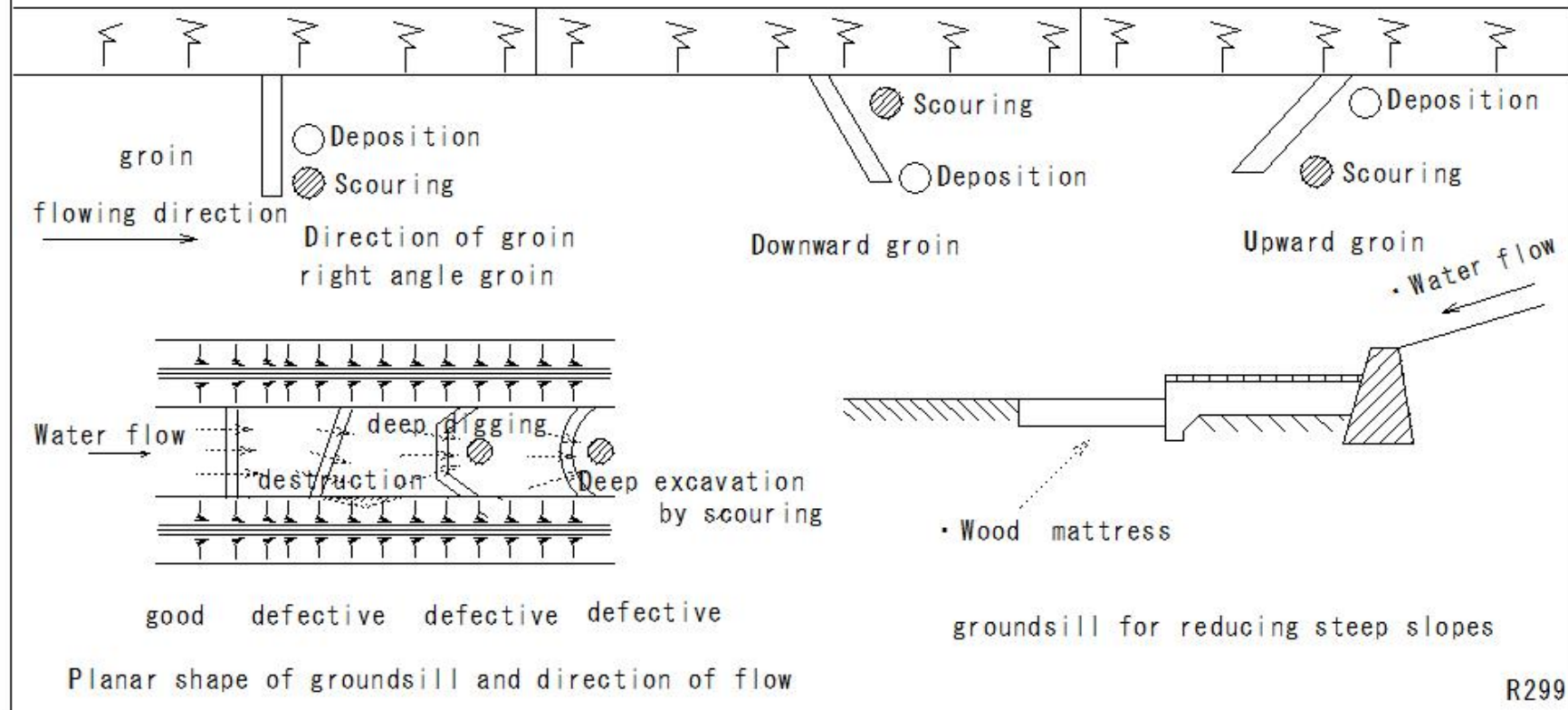


(I575)Scour

(I575) Scour

Scouring

Riverbank, riverbed, washed by running water



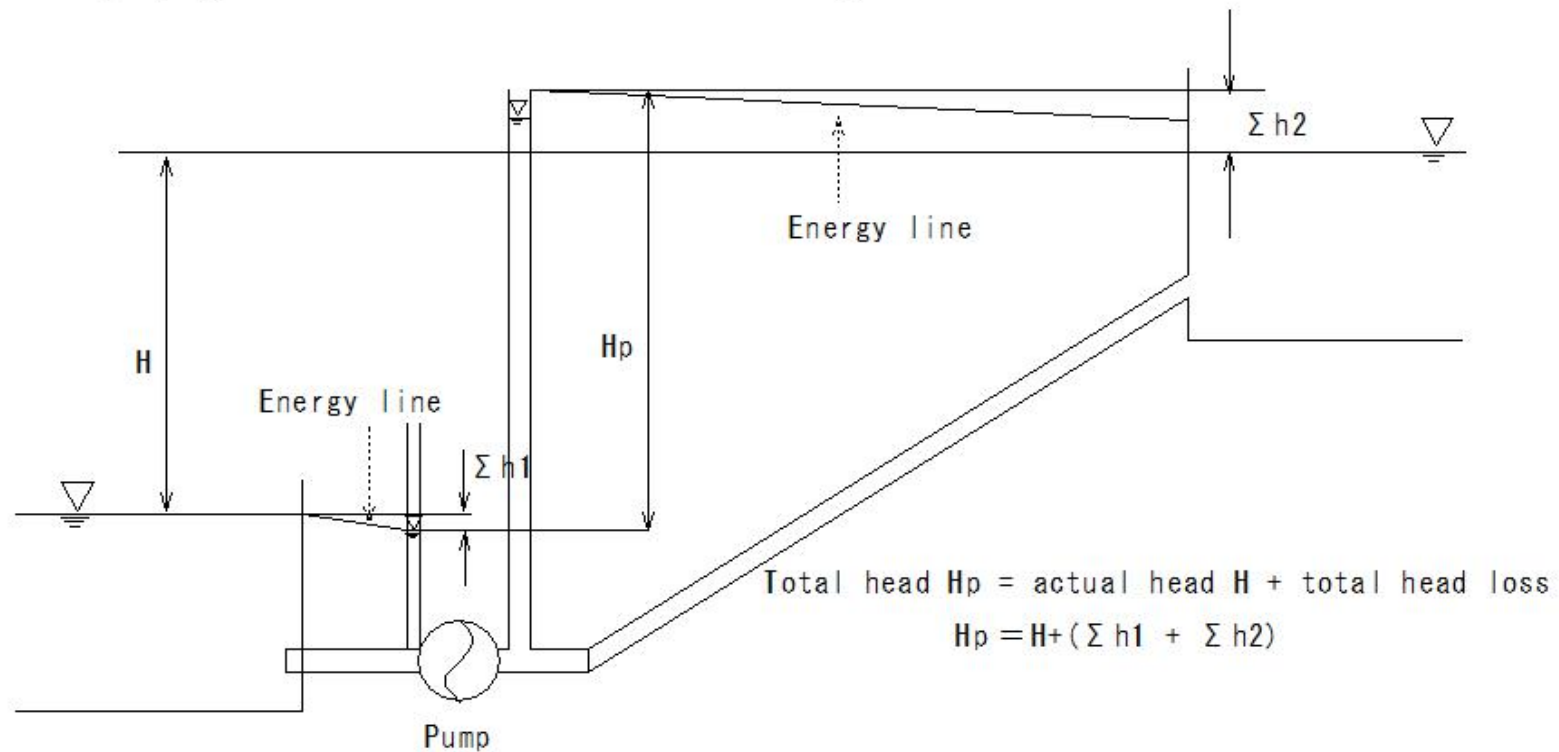
(I576)Water supply (Total head)

(I576)Water supply (Total head)

Water supply

Total head

in case of pumping water from a low water level to a high water level

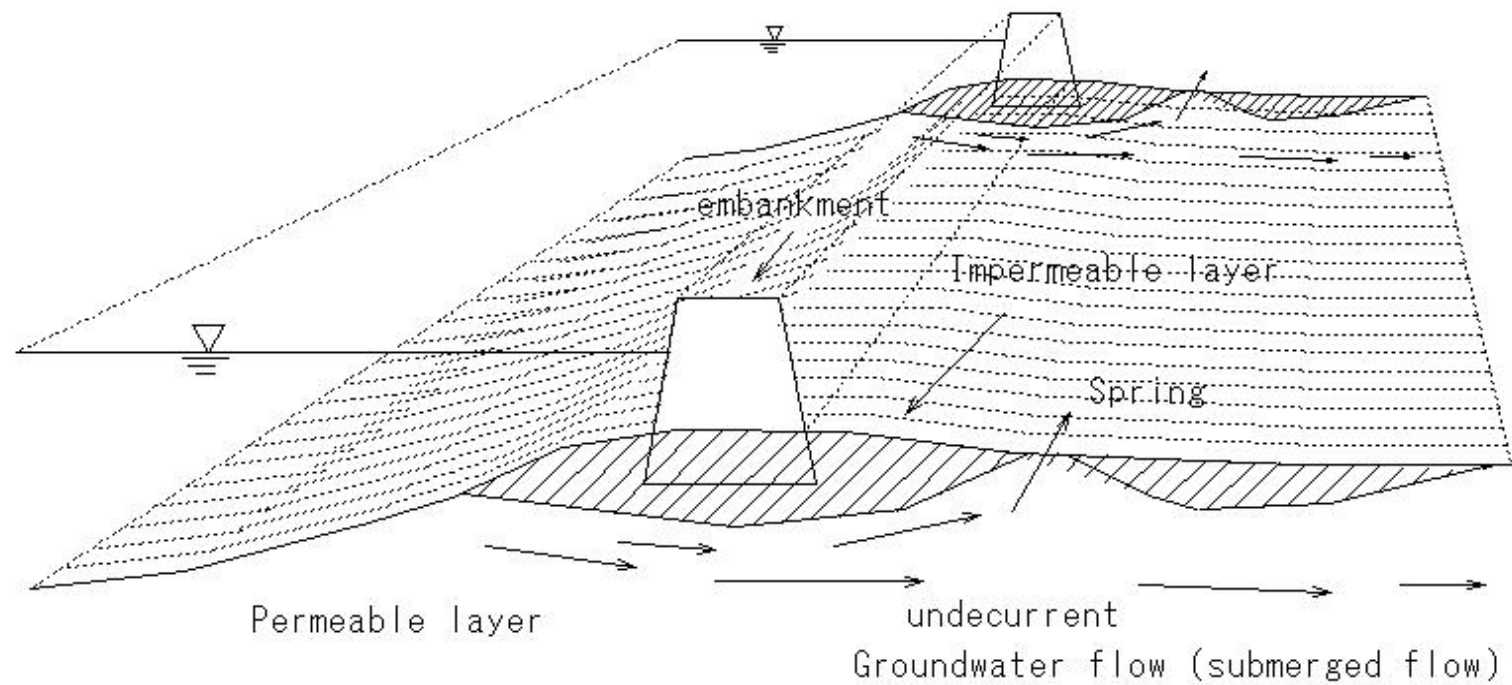


(I577)Undercurrent

(I577)Undercurrent

Undercurrent

Water flowing under the gravel layer of the river bed



R405

(I578)Soil stabilizer

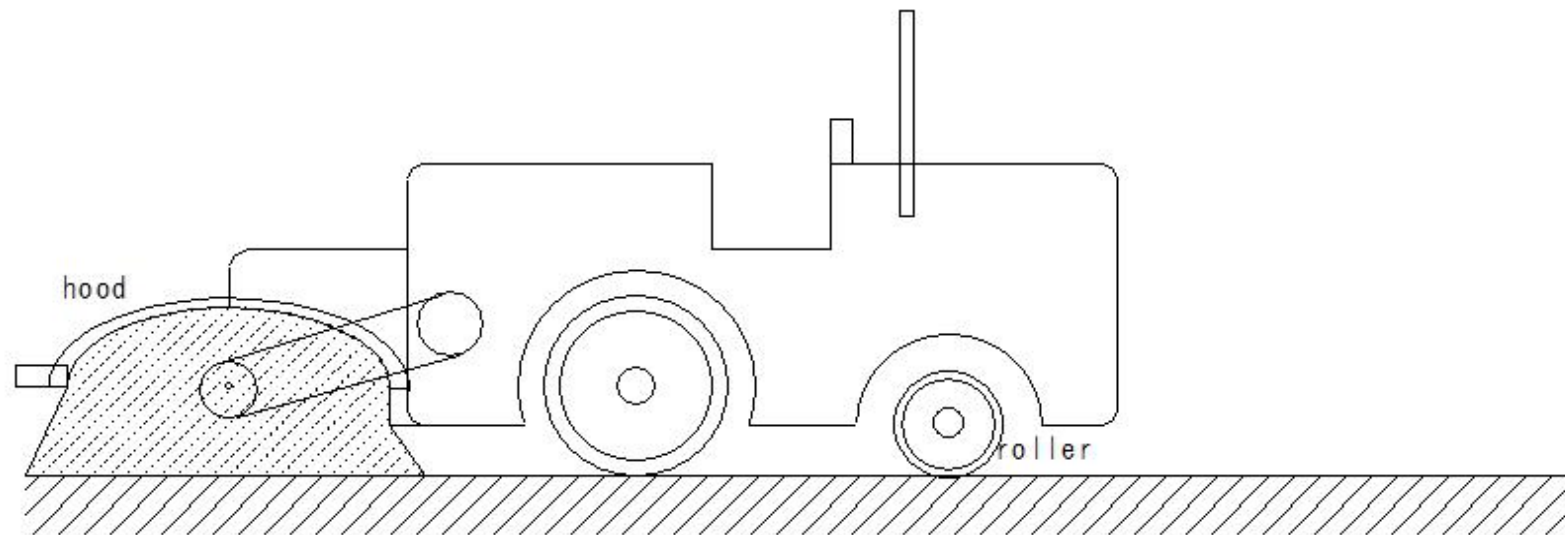
(I578)Soil stabilizer

Soil stabilizer

crush the soil

Additives: aggregate, sand, cement, asphalt, resin, lime

Uniform mixing and compaction



M382

(I579)Water supply (water-conveyance equipment(Water supply facility))

(I579)Water supply (water-conveyance equipment(Water supply facility))

Water supply

water-conveyance equipment(Water supply facility)

Water supply pipe from water purification area

Pumping to water supply reservoir

①Filtration pond

②Water supply pump

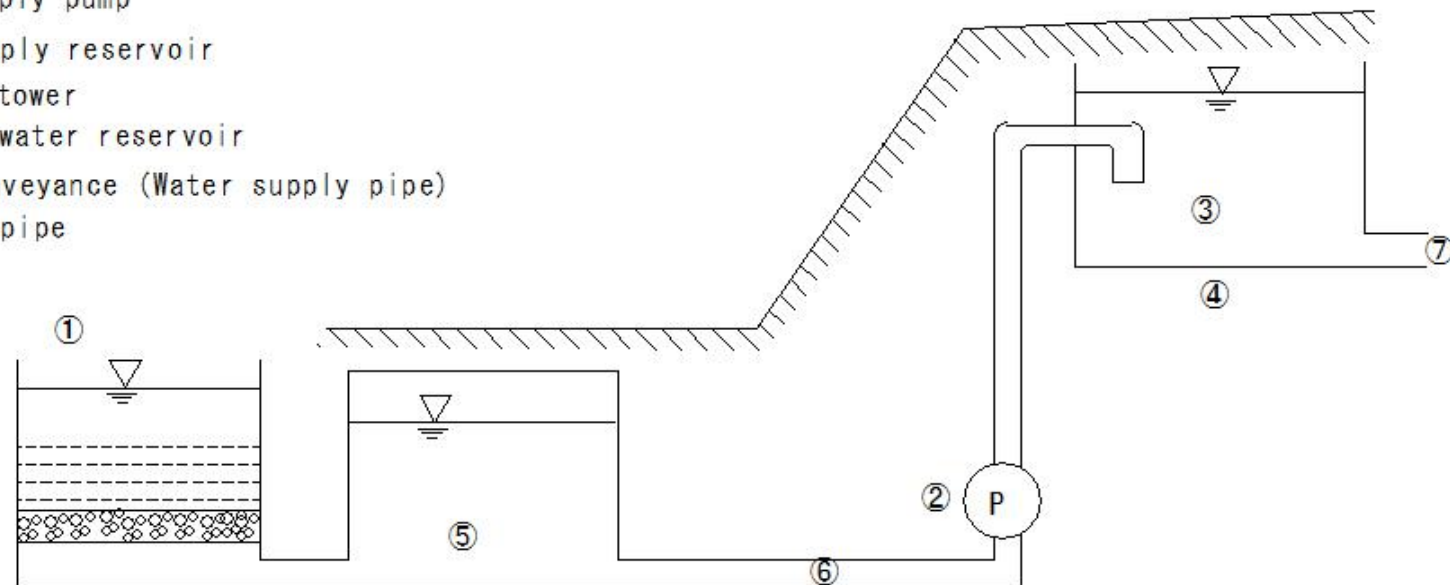
③Water supply reservoir

④Drainage tower

⑤Purified water reservoir

⑥water-conveyance (Water supply pipe)

⑦Drainage pipe



water-conveyance equipment(Water supply facility)

W247

(I580) Sodding

(I580) Sodding

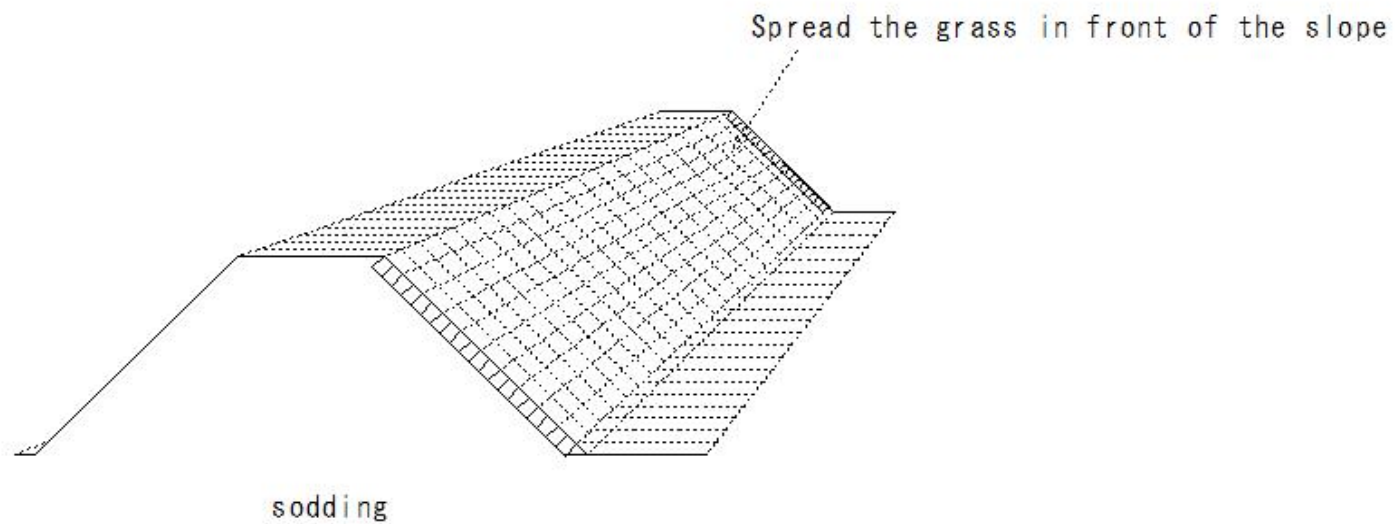
Sodding

slope protection

plant grass in front

slope covering(lining) works

Used on river surface of river embankment



(I581)Traction

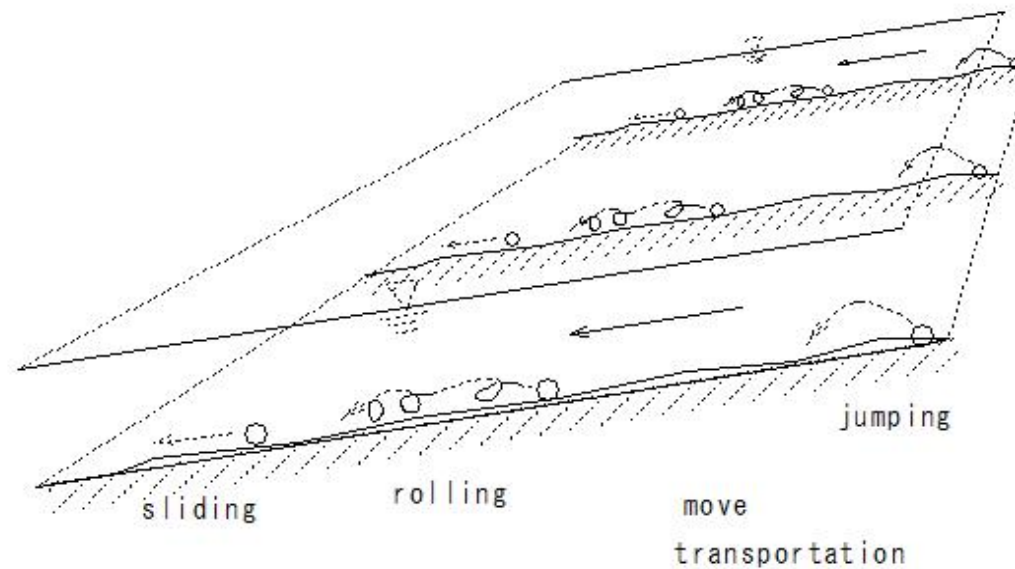
(I581)Traction

Traction: Flowing by rolling on the river bed

Sediment on the riverbed is Scouring

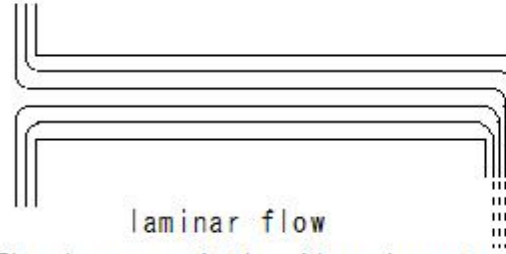
flow out

Sediment on the river bed

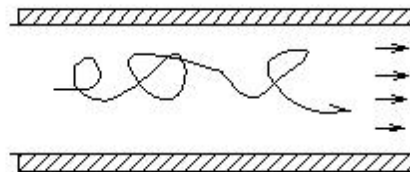


(I582)Laminar flow

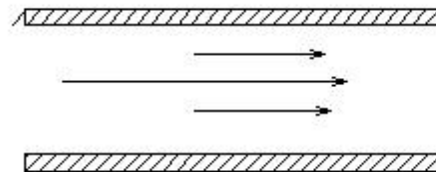
(I582)Laminar flow



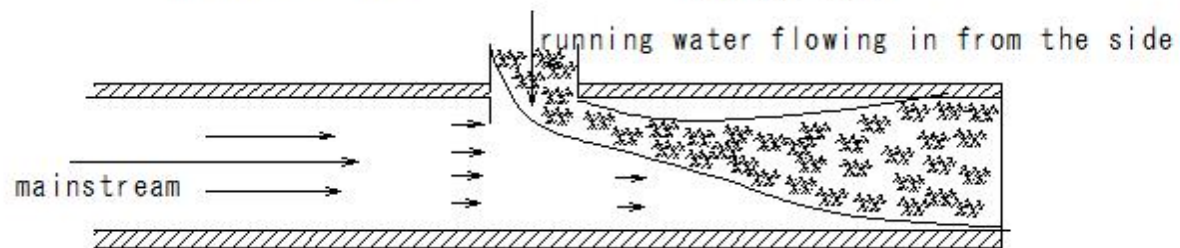
The layers of the flow do not get mixed up.
flows in not mix



turbulent flow



laminar flow



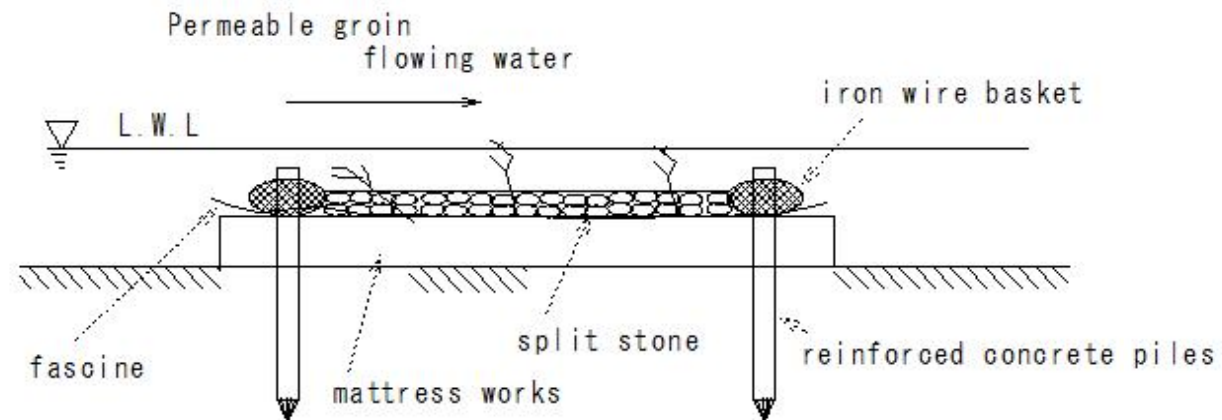
water diffusion phenomenon

(I583)Fascine

(I583) Fascine

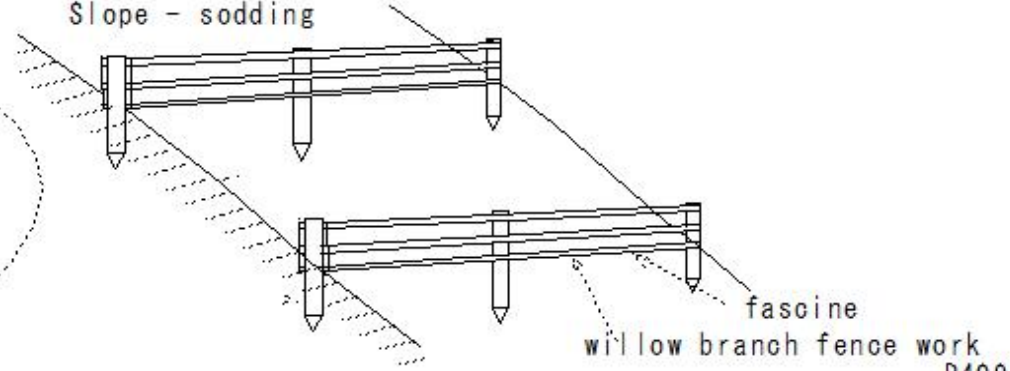
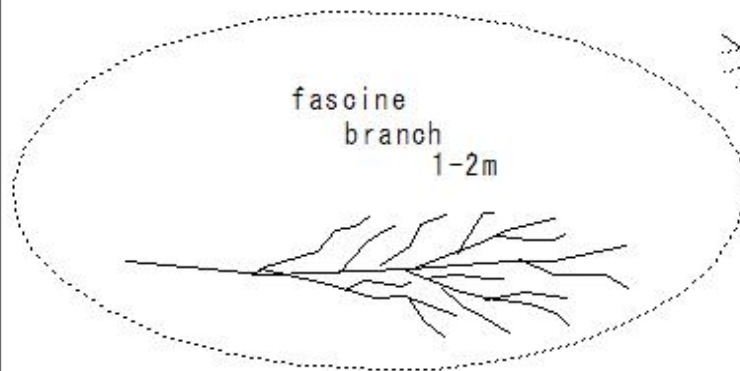
Fascine

mountainside
bank protection
groin
Flood protection



Used as material for landslide prevention facilities

Slope - sodding



R409

(I584)Flowing through capability

(I584)Flowing through capability

Flowing through capability

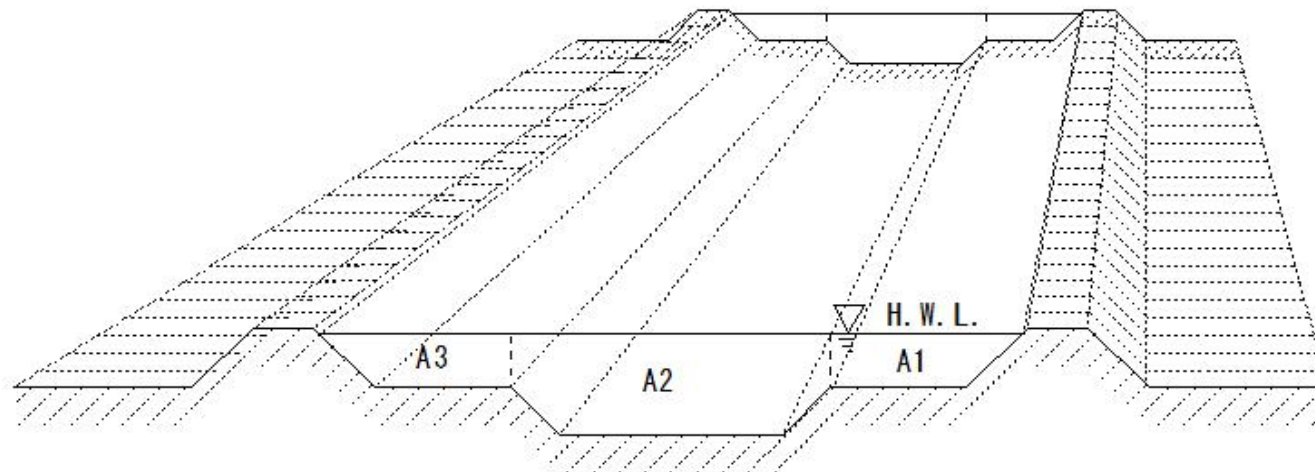
The limit to which rivers can safely carry flood waters

Divide the river cross section into 2-3 sections

Average flow velocity v_1 v_2 v_3

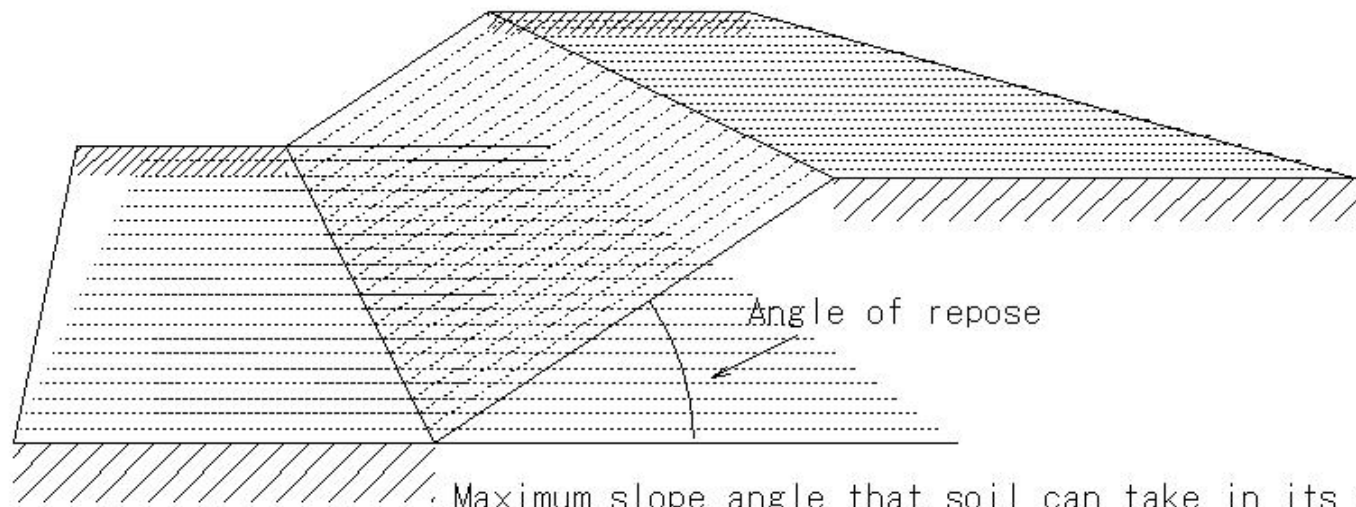
River area A_1 A_2 A_3

$$Q = A_1v_1 + A_2v_2 + A_3v_3$$



(1585)Angle of repose

(1585)Angle of repose



Maximum slope angle that soil can take in its natural state

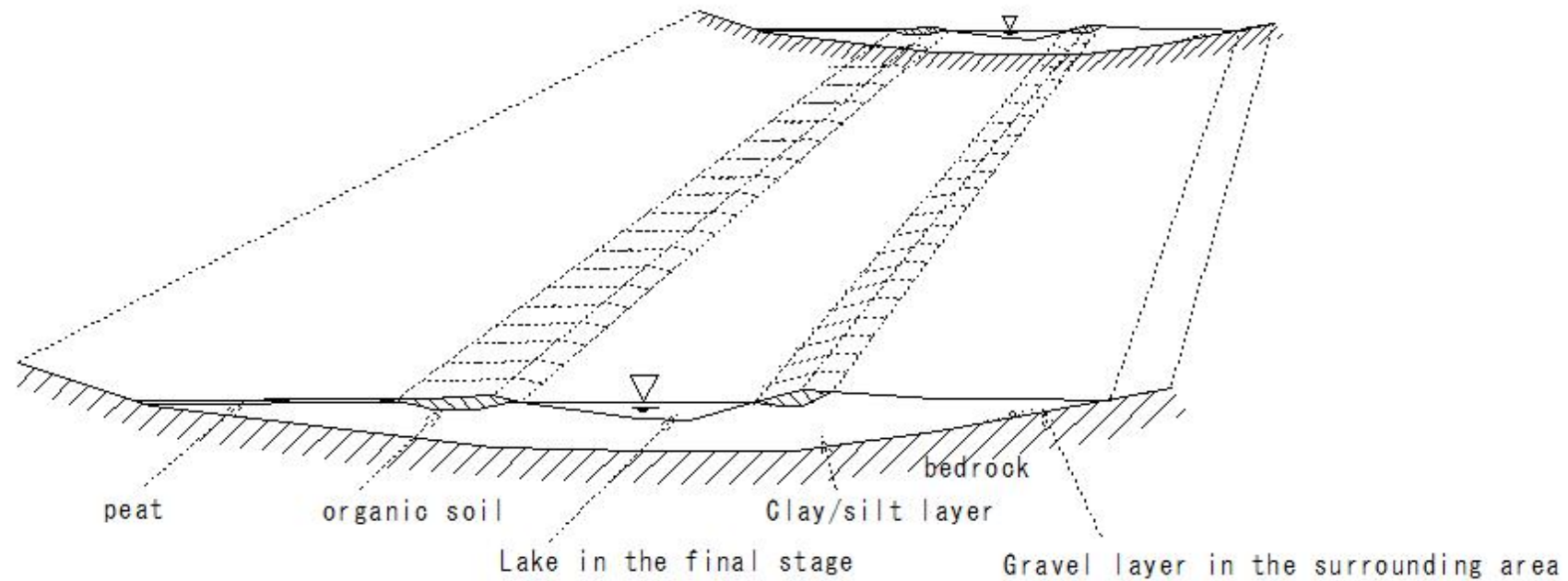
(I586)Deposition

(I586)Deposition

Deposition

Rocks eroded by running water
transported and deposited

Formation of lacustrine sedimentary soil



R411

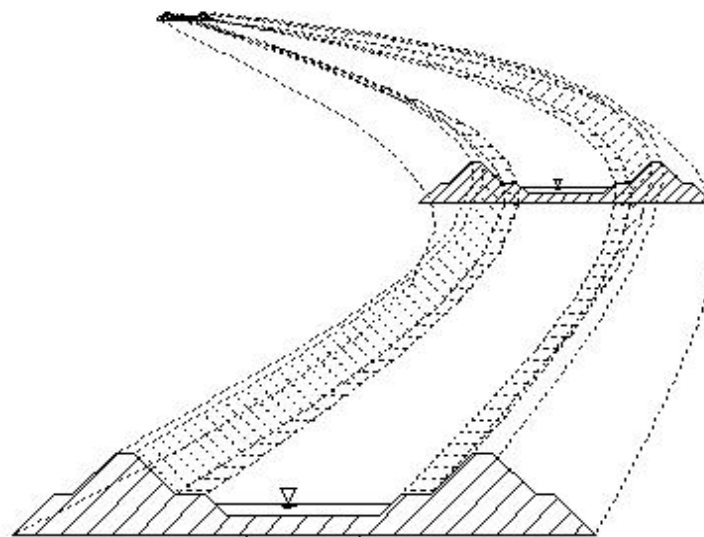
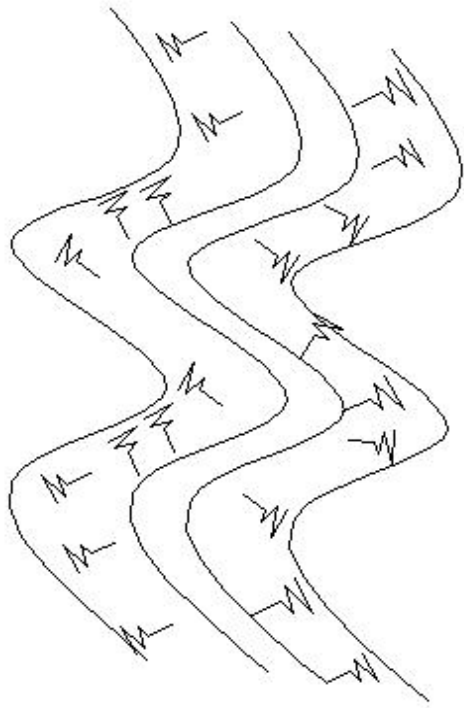
(I587)Meandering

(I587) Meandering

Meandering

River - meandering like a snake

The river flow -natural slope.



(I588)Vertical wire cylinder masonry work(gabion)

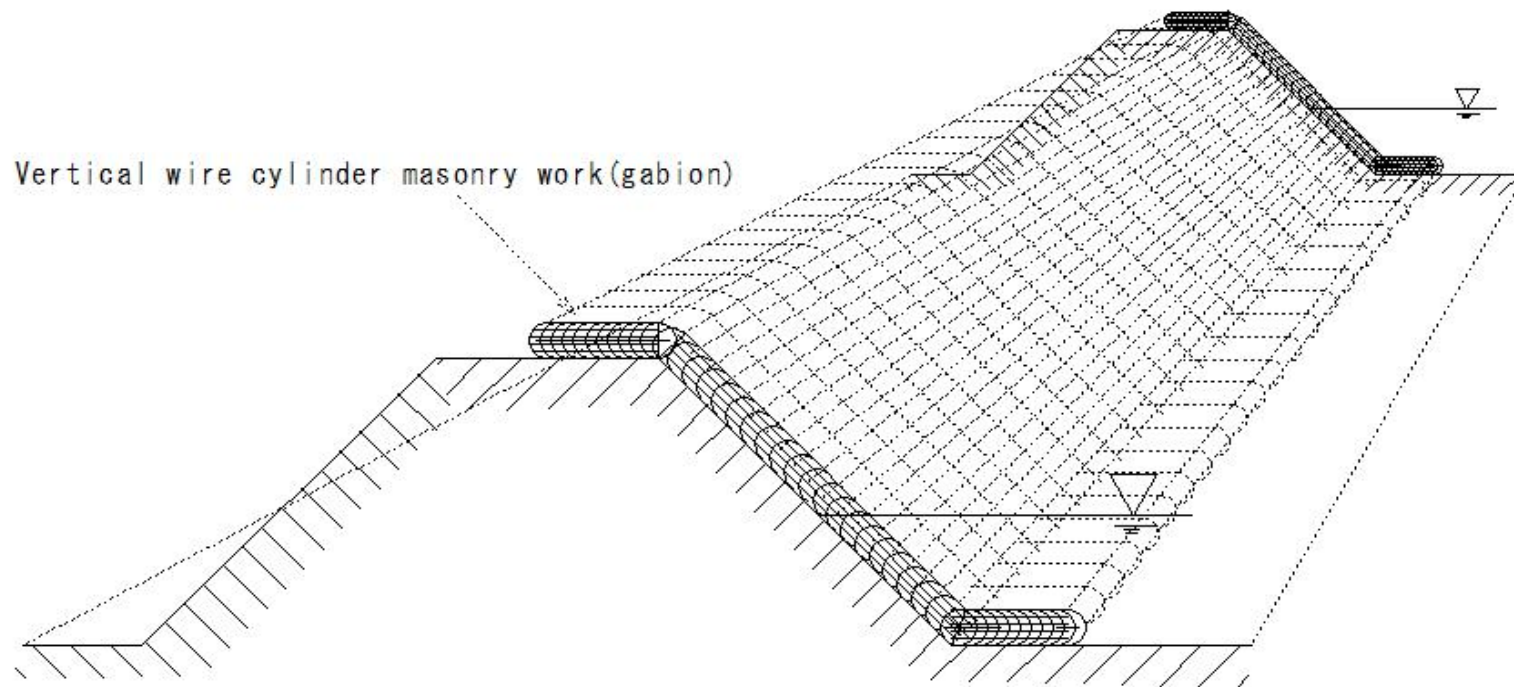
(I588)Vertical wire cylinder masonry work(gabion)

Vertical wire cylinder masonry work(gabion)

slope lining work of bank protection

wire cylinder masonry work(gabion) laid at right angles to the flow.

Embankment slope

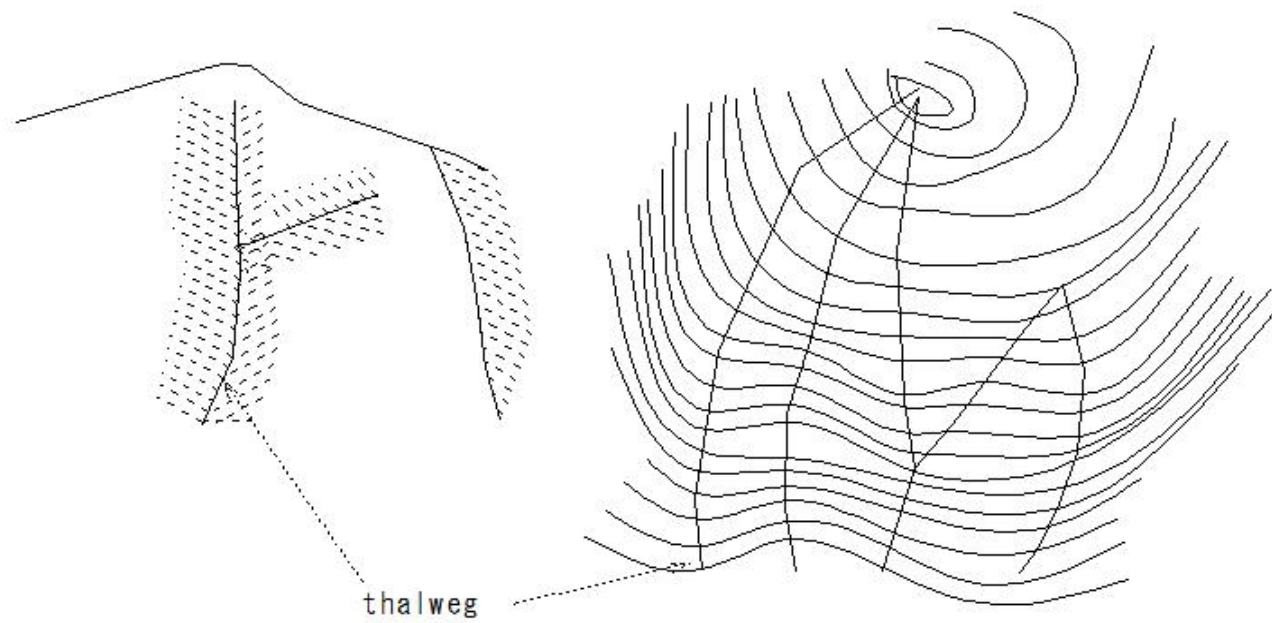


R413

(I589)Thalweg

(I589)Thalweg

Thalweg

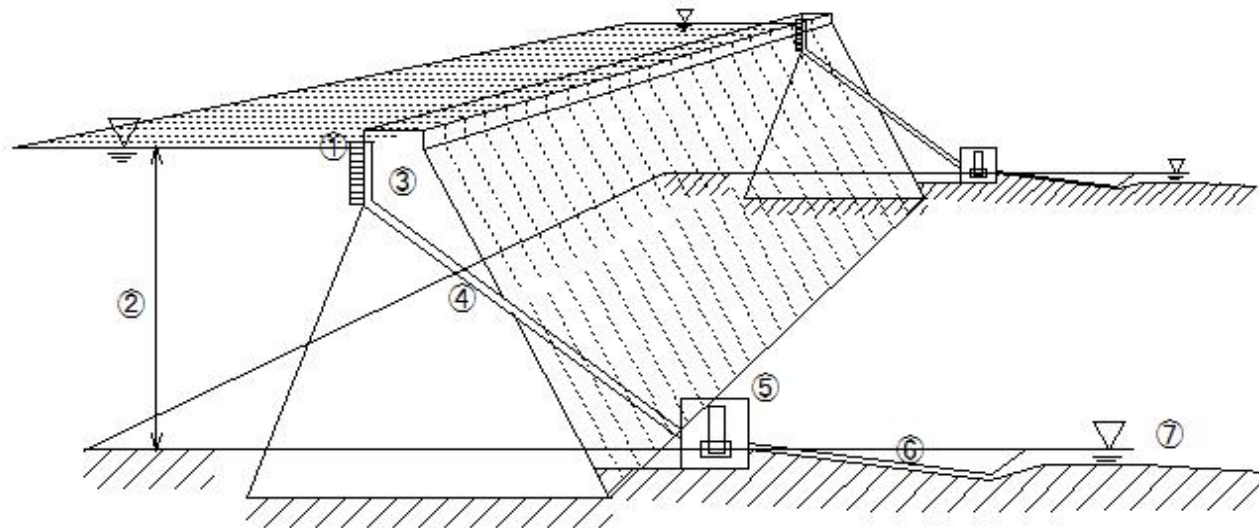


(I590)Dam type power

(I590)Dam type power

Dam type power

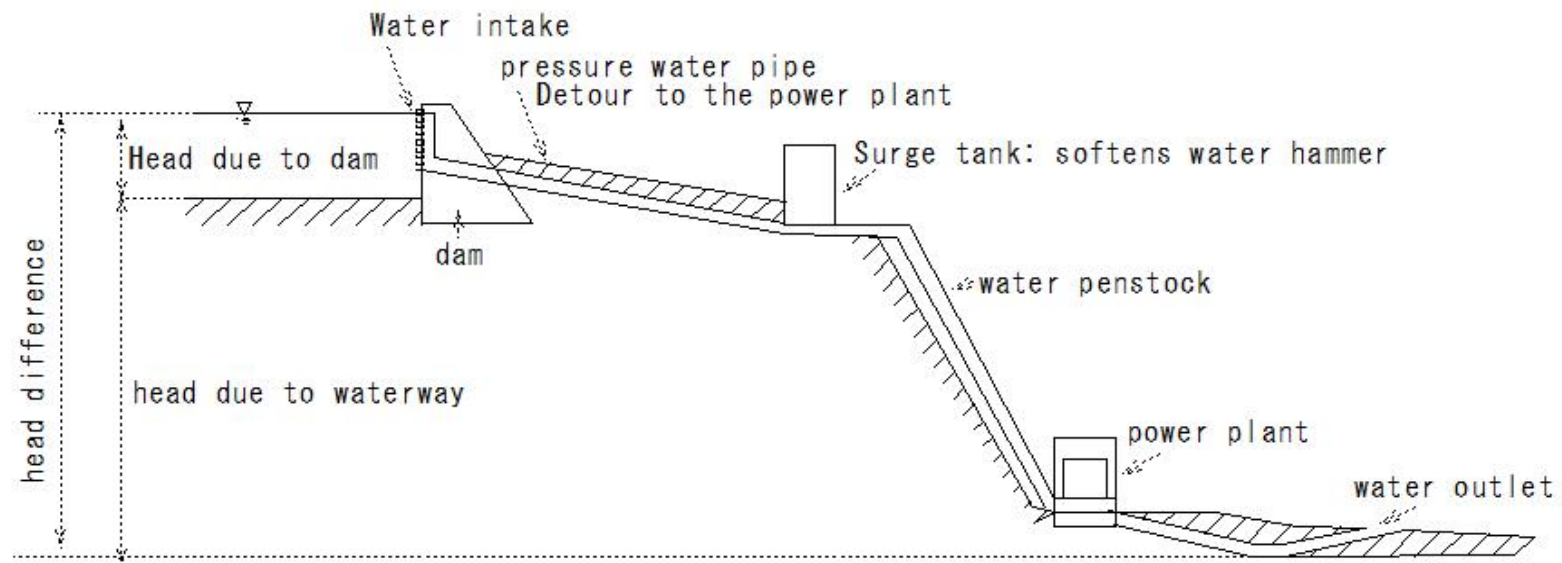
- ① Water intake
- ② Head
- ③ Dam
- ④ Penstock
- ⑤ Power plant
- ⑥ Spillway (Water outlet)
- ⑦ Spillway (Water outlet)



(I591)Dam and conduit type power

(I591)Dam and conduit type power

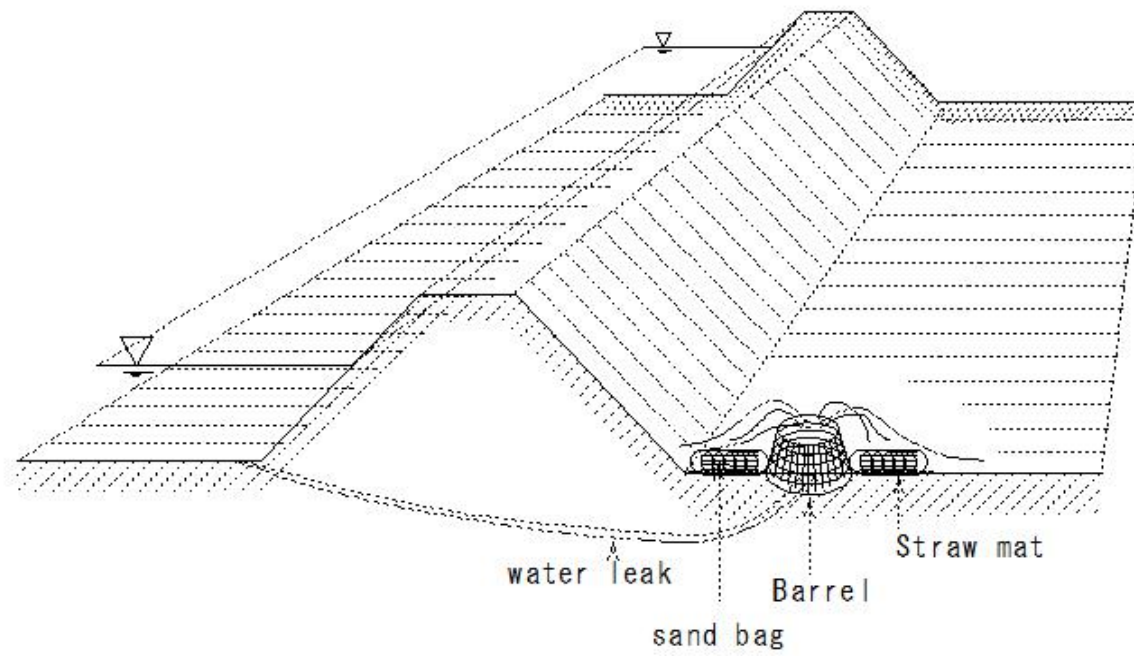
Dam and conduit type power



(I592) Prevent water leakage

(I592) Prevent water leakage

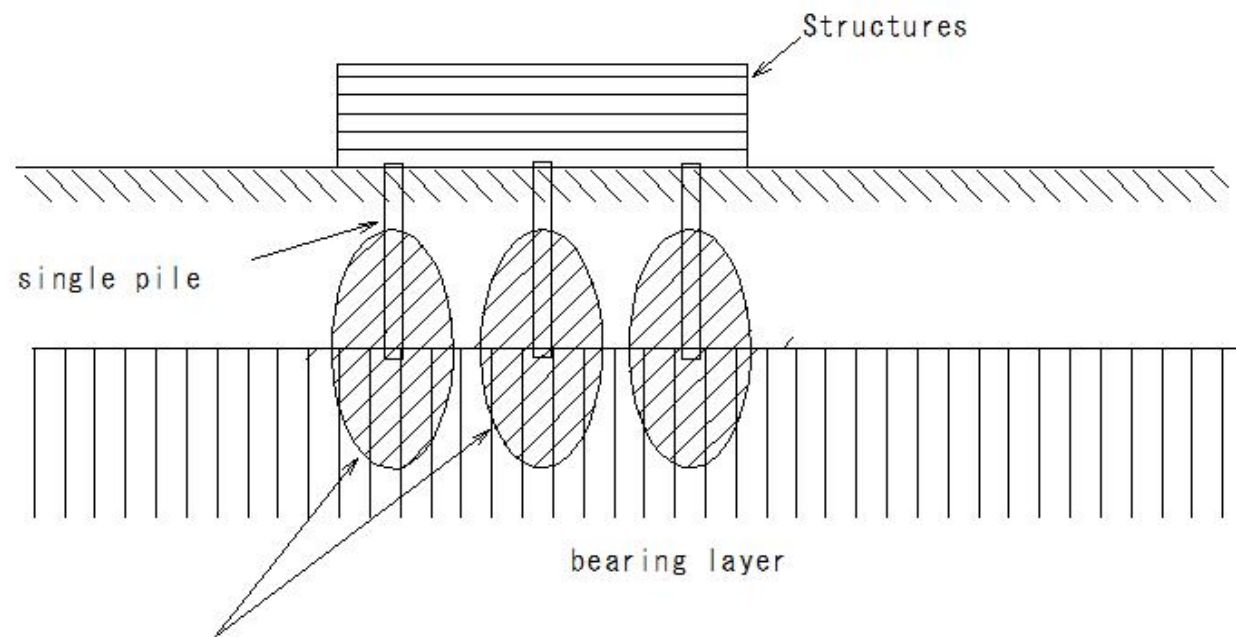
Prevent water leakage



R414

(I593)Single pile

(I593)Single pile

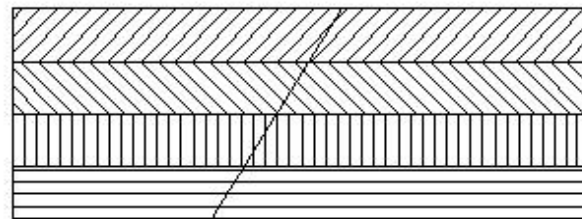


No interaction between piles

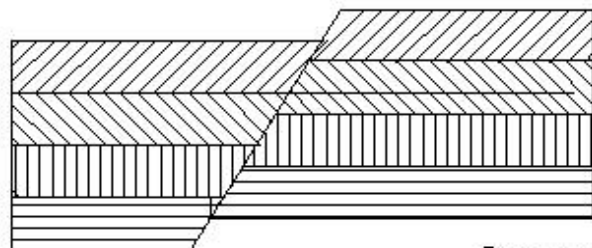
(I594)Fault

(I594)Fault

Fault plane

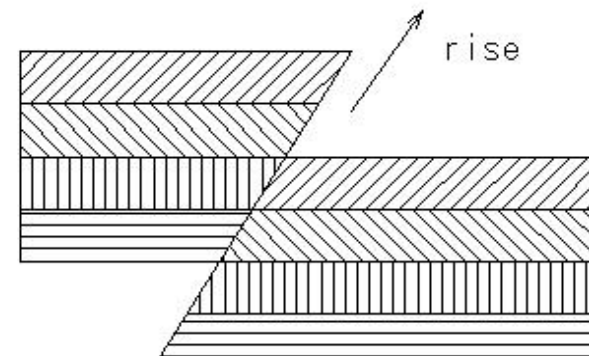


Normal faults



Reverse fault

Falling



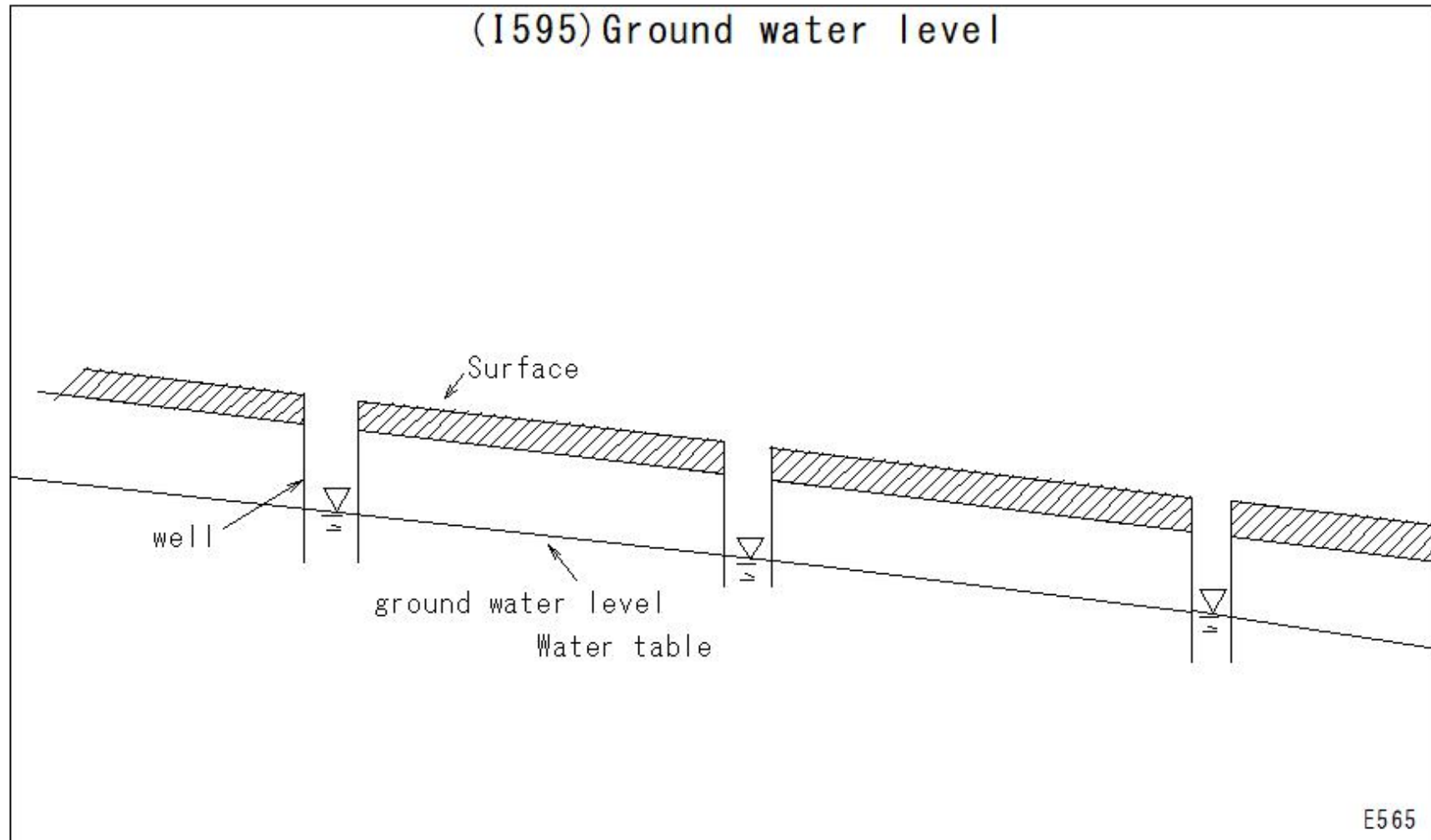
rise

Tectonic movements

E564

(I595)Ground water level

(I595)Ground water level

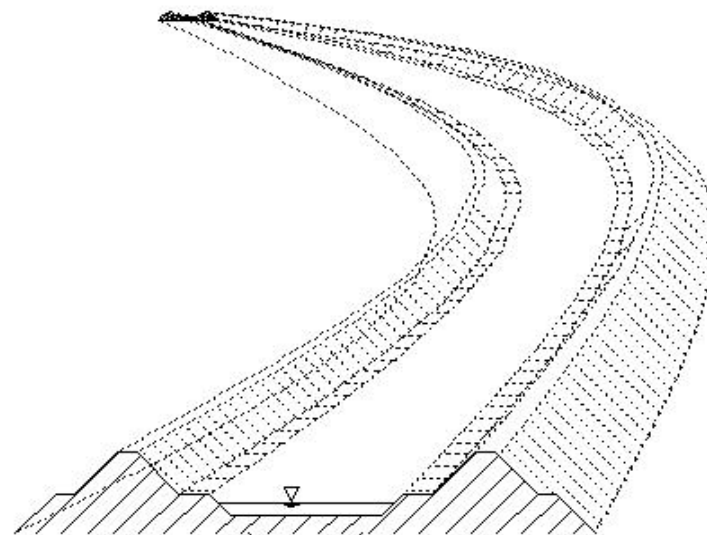


(I596) Embankment

(I596) Embankment

Embankment

long and narrow embankment



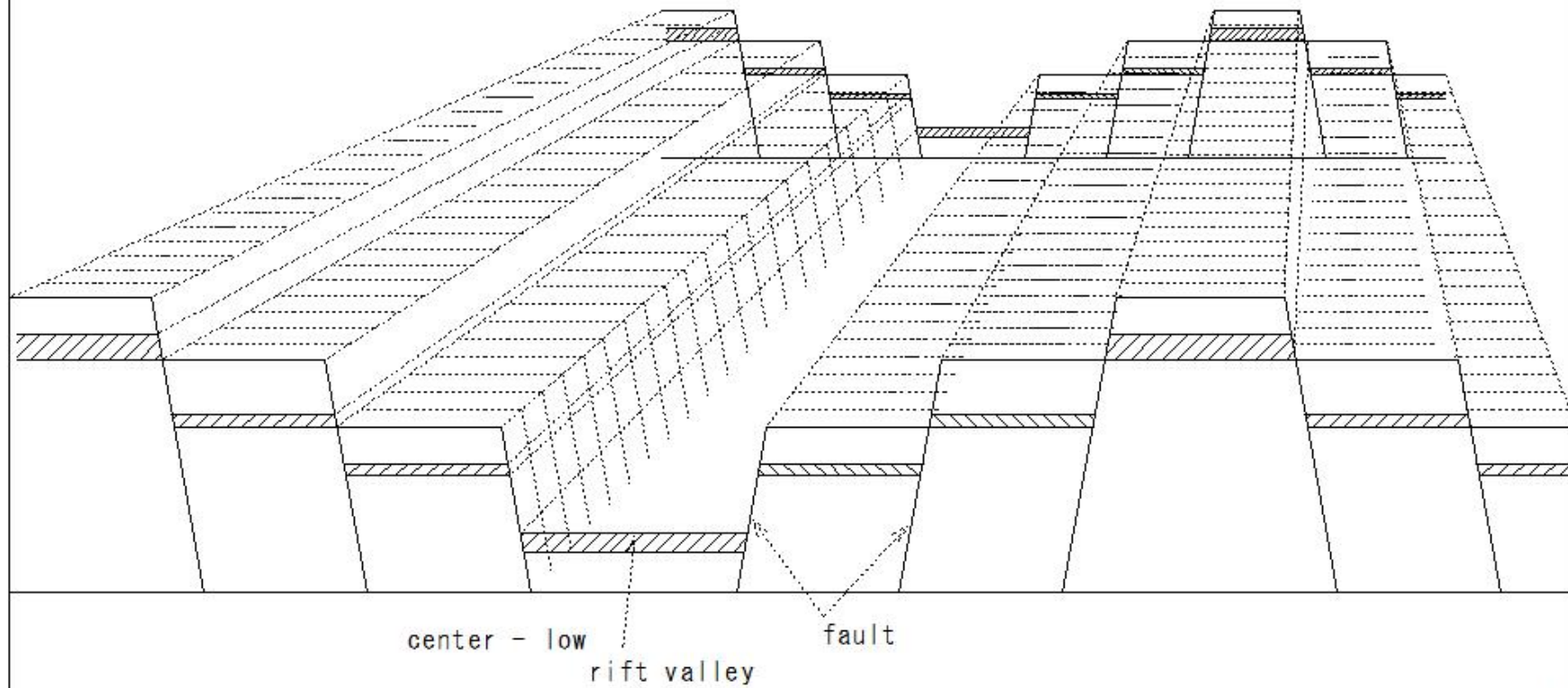
embankment

R416

(I597)Rift valley

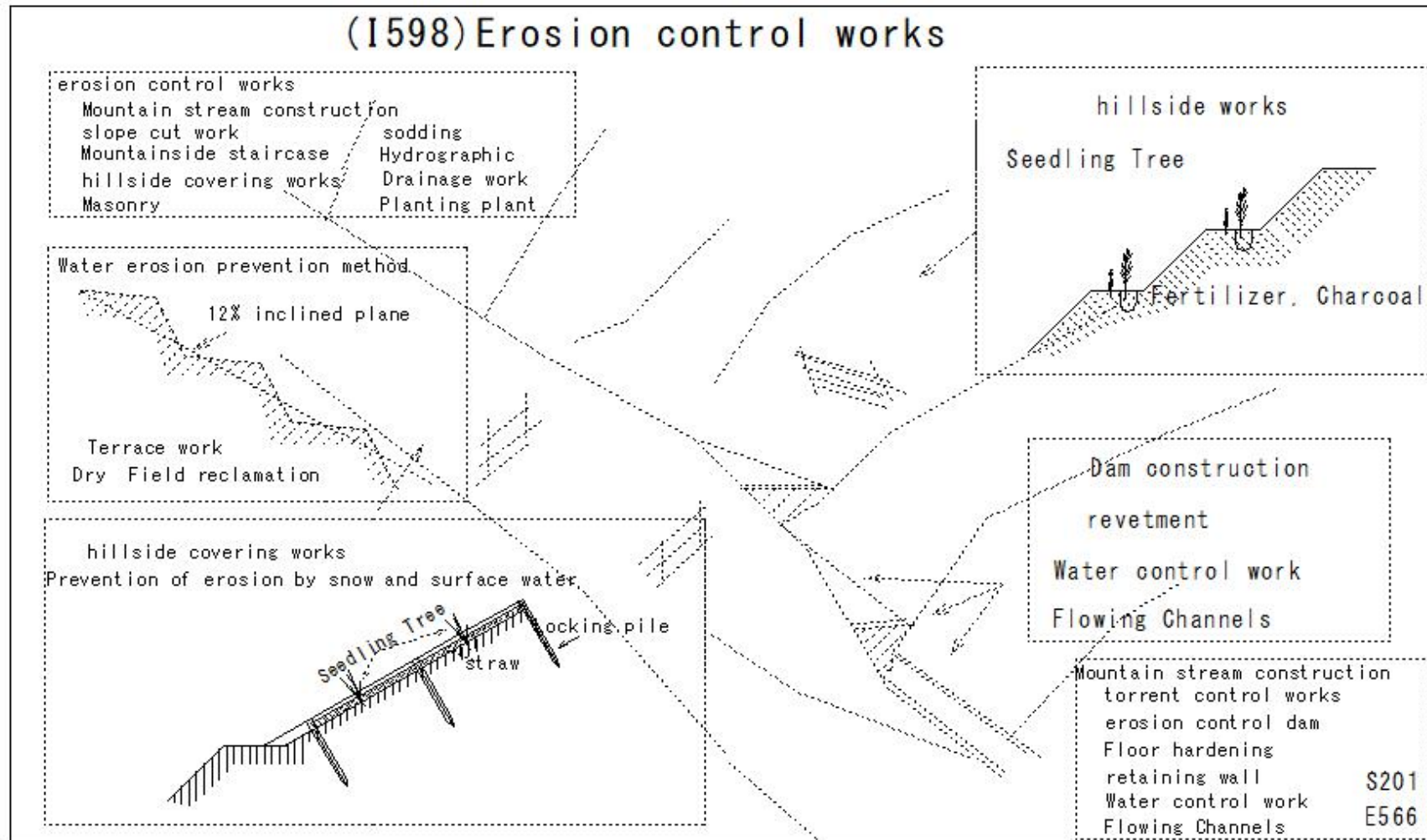
(I597)Rift valley

Rift valley

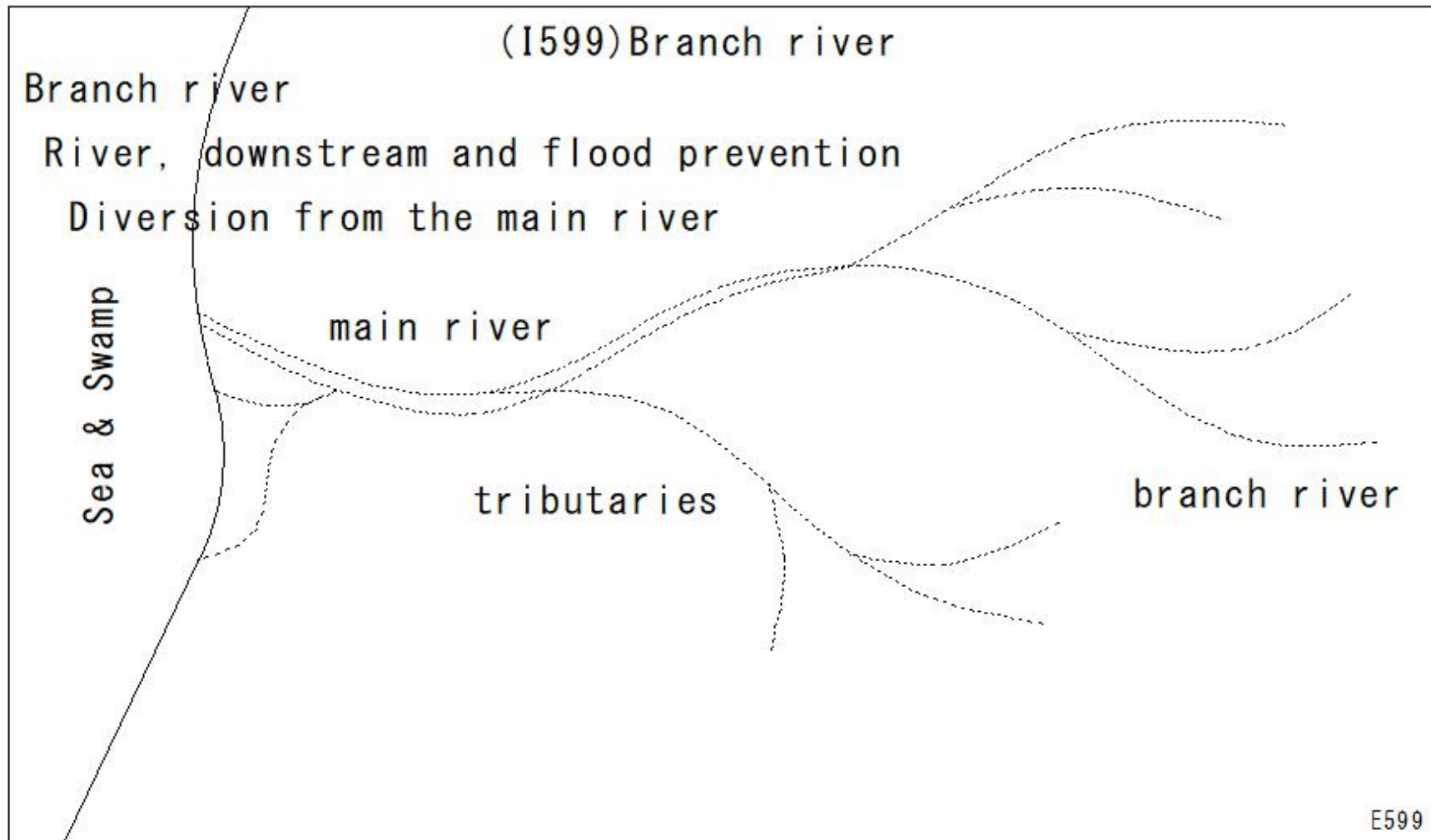


R417

(I598)Erosion control works



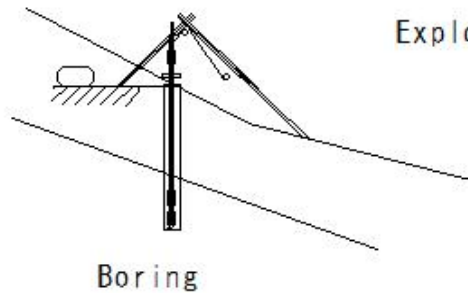
(I599)Test pit



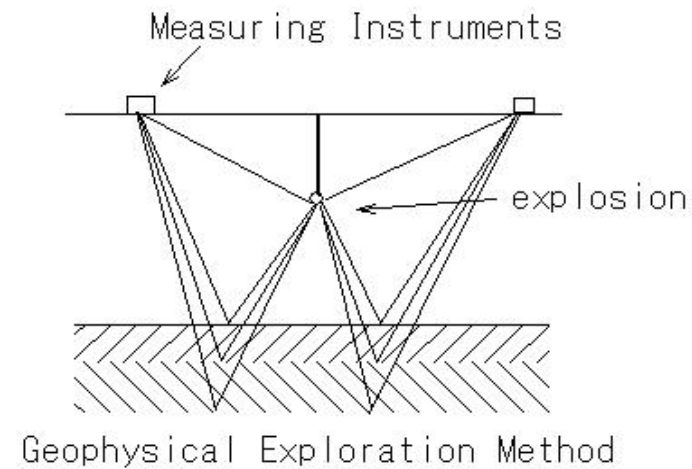
(I600)Geological Survey

(I600)Geologic survey

- Geological survey
 - Types of rocks
 - Distribution state
 - Geological structure



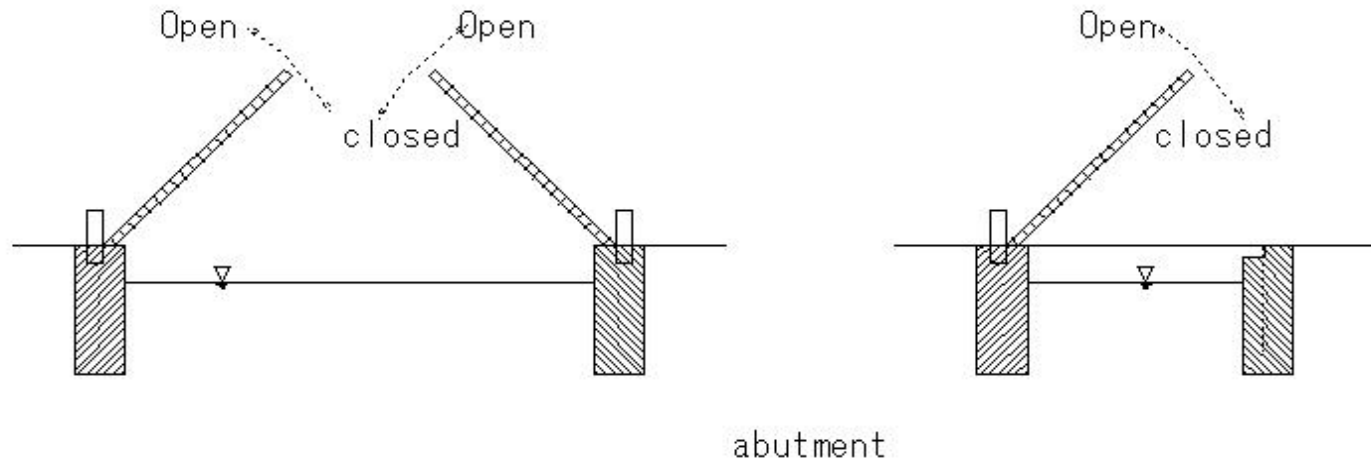
Exploration of the earth's surface



E567

(I601)Bascule bridge

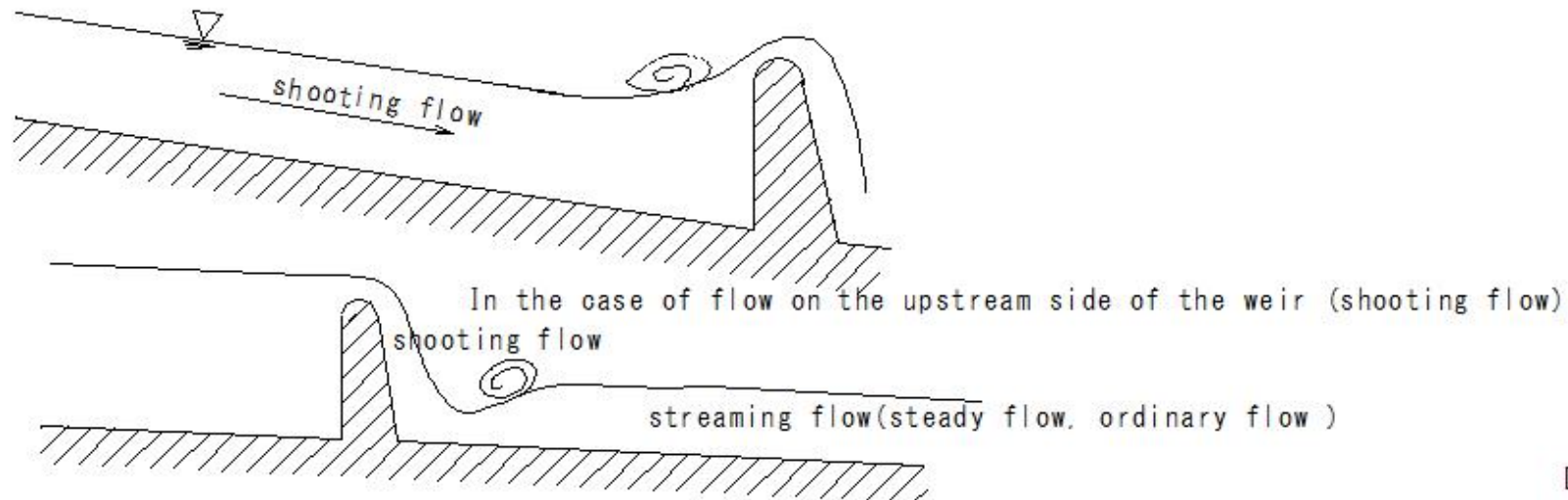
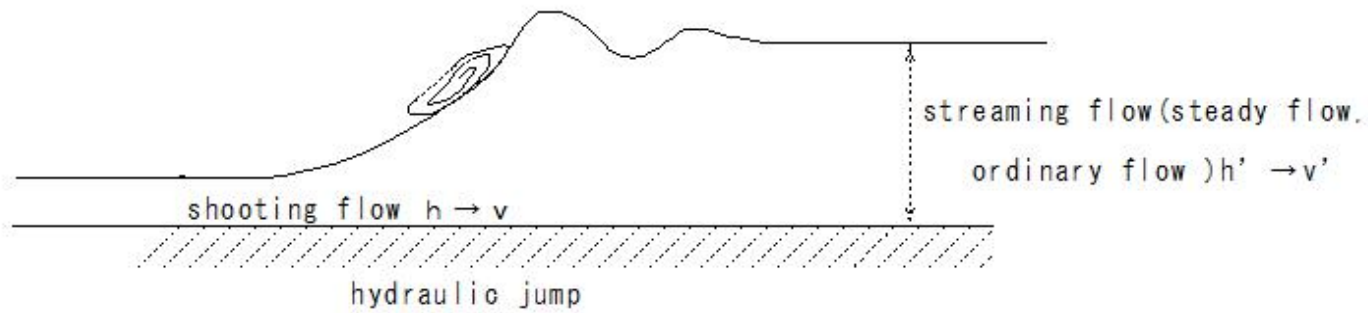
(I601)Bascule bridge



Water transportation - easy

(I602)Hydraulic jump

(I602)Hydraulic jump



In case of flow after overflowing a weir

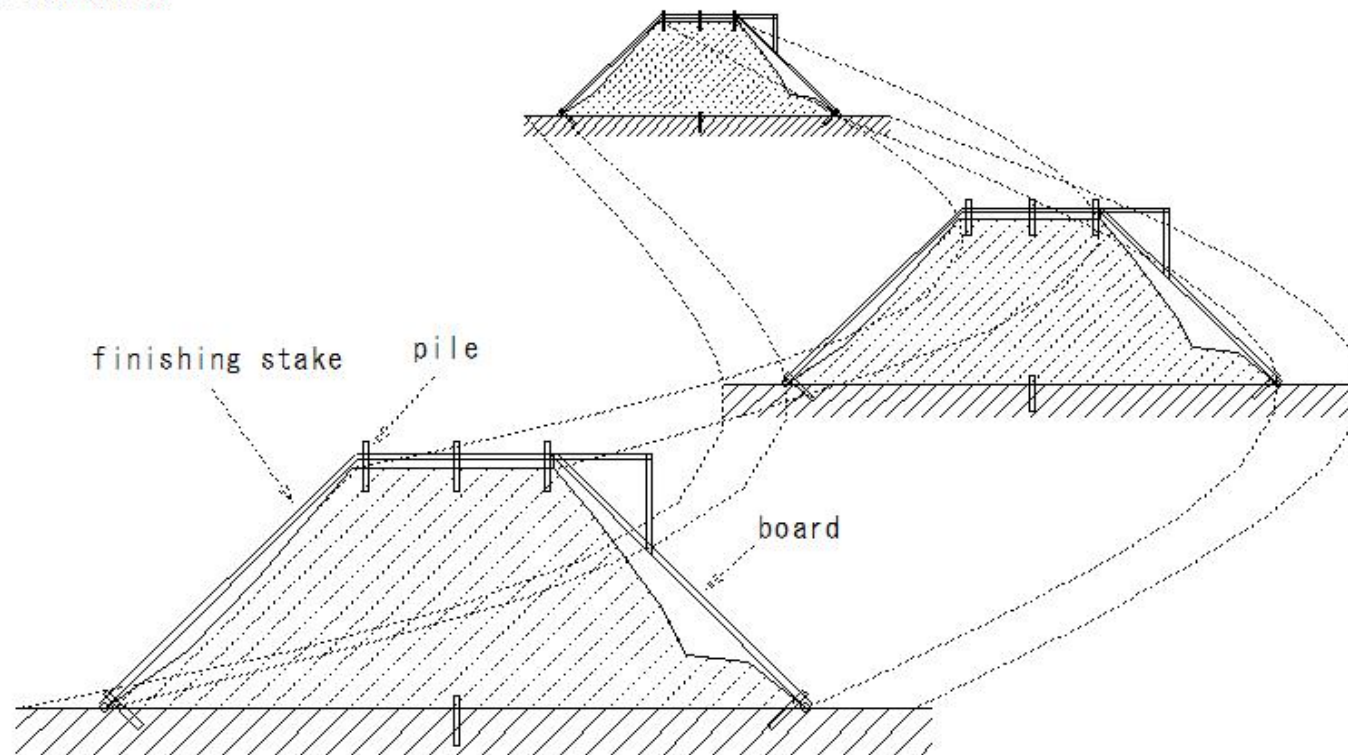
D224

R418

(I603)Finishing stake

(I603)Finishing stake

Finishing stake
Earthwork standards



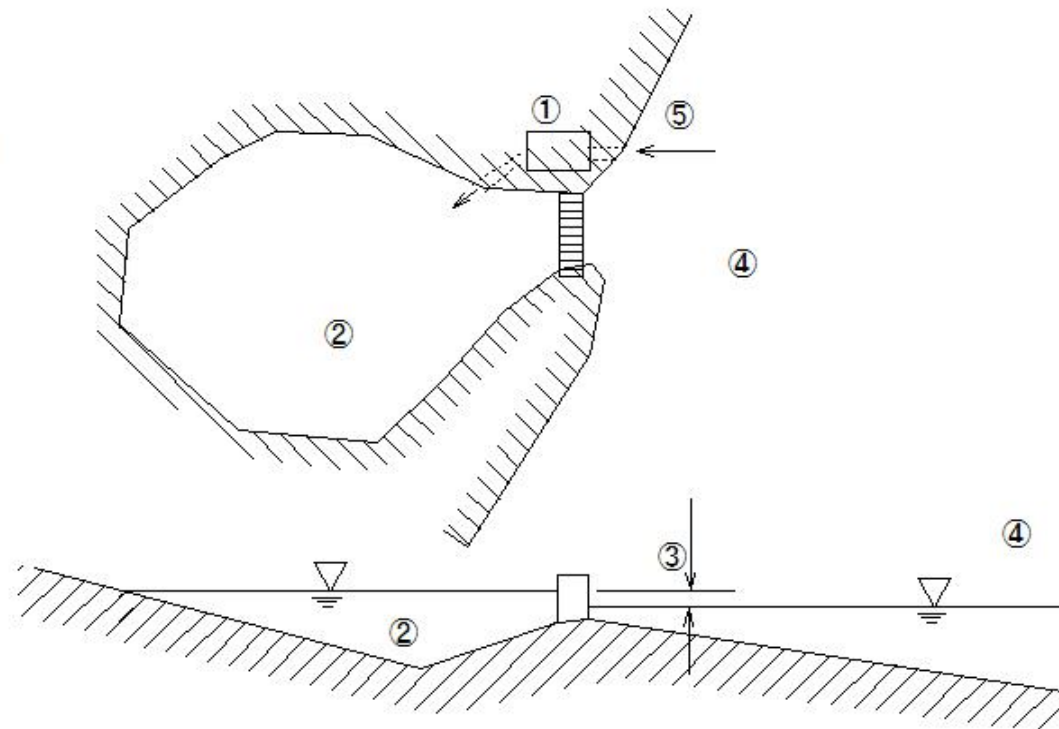
R419

(I604)Tidal power type

(I604)Tidal power type

Tidal power type

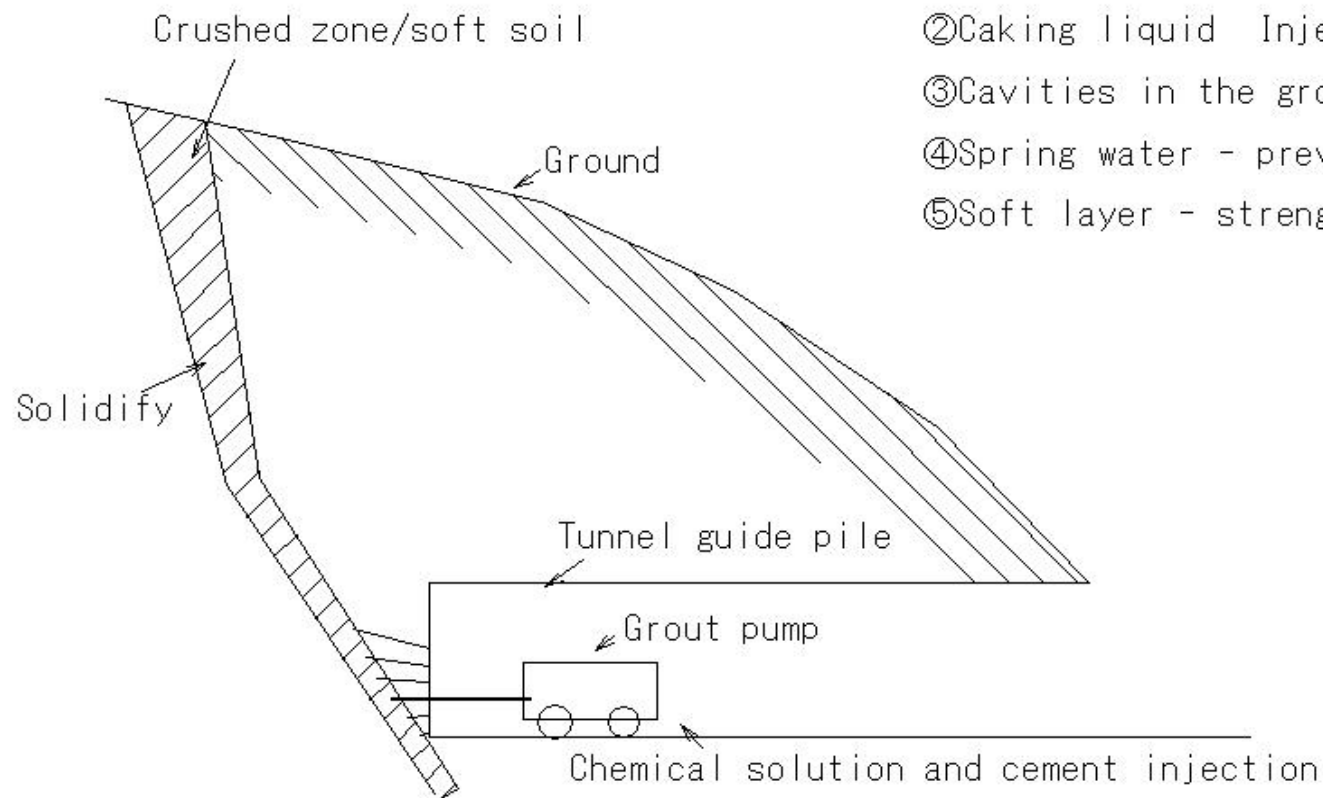
- ① Power station
- ② Bays and inlets
- ③ Tides
- ④ Open ocean
- ⑤ Tidal flow at high tide
(reverse flow at low tide)



(I605) Impregnation method

Impregnation method

(I605) Impregnation method



- ①Soft water-containing layer
- ②Caking liquid Injection
- ③Cavities in the ground- closed
- ④Spring water - prevent
- ⑤Soft layer - strength - increase

E569

(I606)Bank protection(mattress)

(I606)Bank protection(mattress)

Mattress

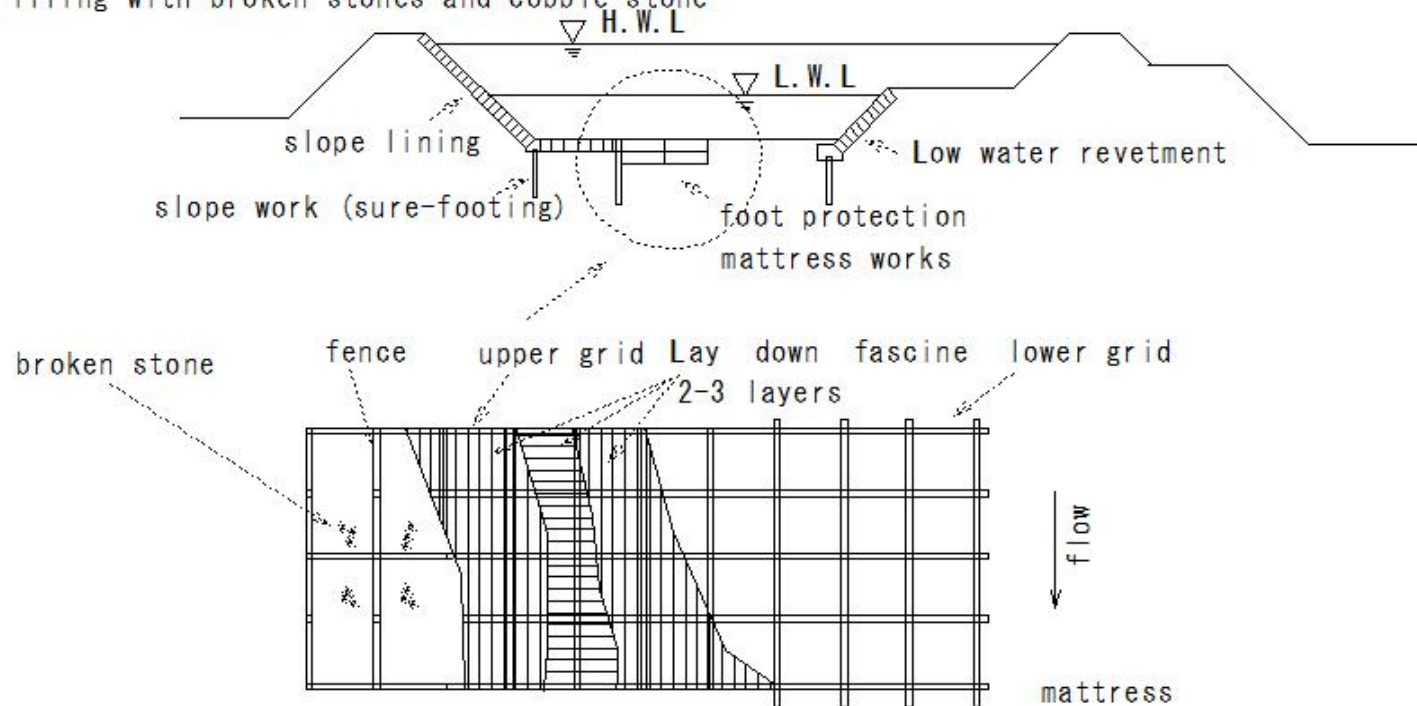
groin /bank protection

Prevention of riverbed scouring

lattice frame

sink into the river bed

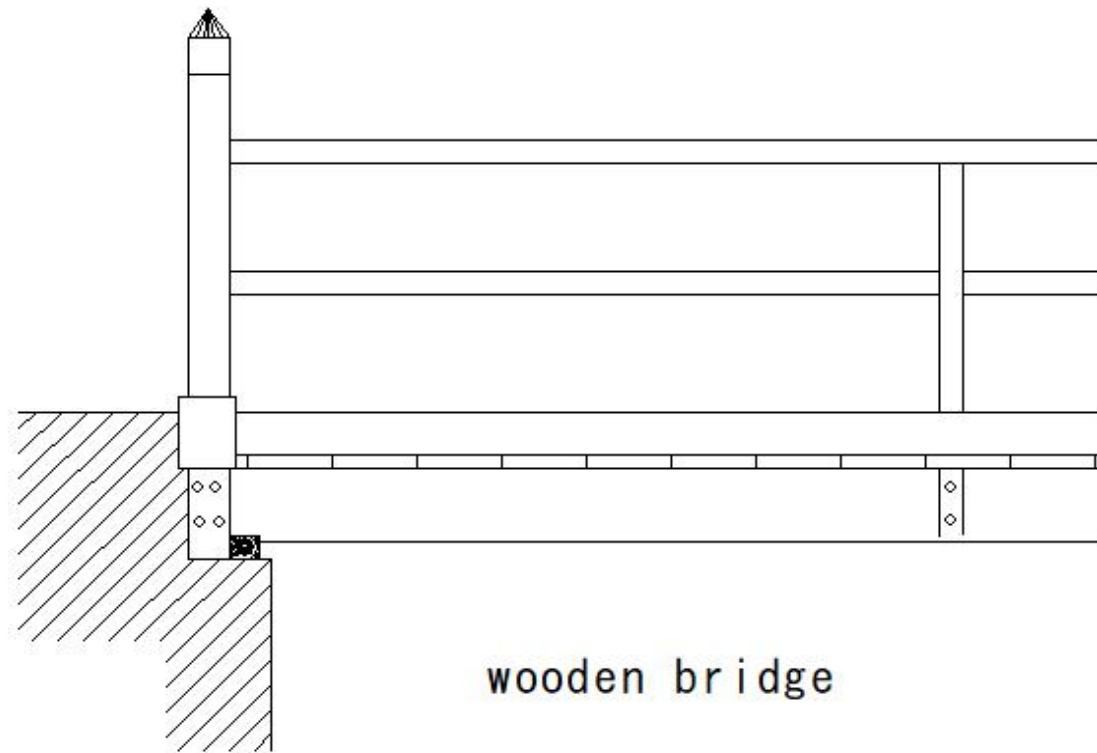
Filling with broken stones and cobble stone



R420

(I607)Wooden bridge

(I607)Wooden bridge



B349

(I608)Bank protection(patch up method)

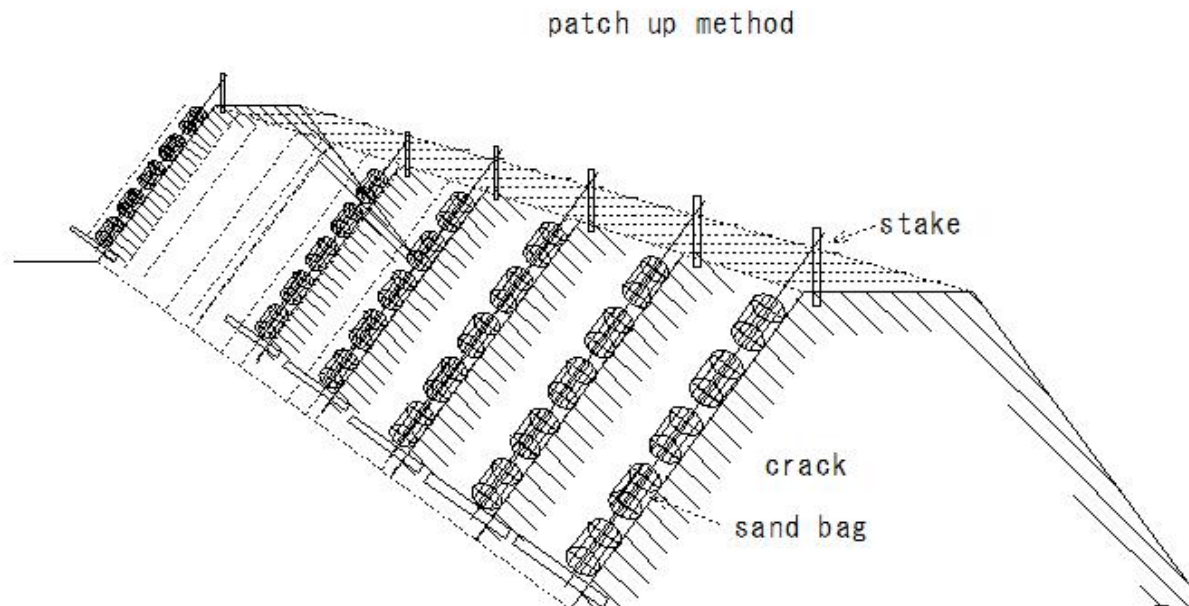
(I608)Bank protection(patch up method)

Bank protection(patch up method)

A type of flood prevention method

Preventing water leakage and collapse due to cracks in embankments

Repairing the slope with the sand bag



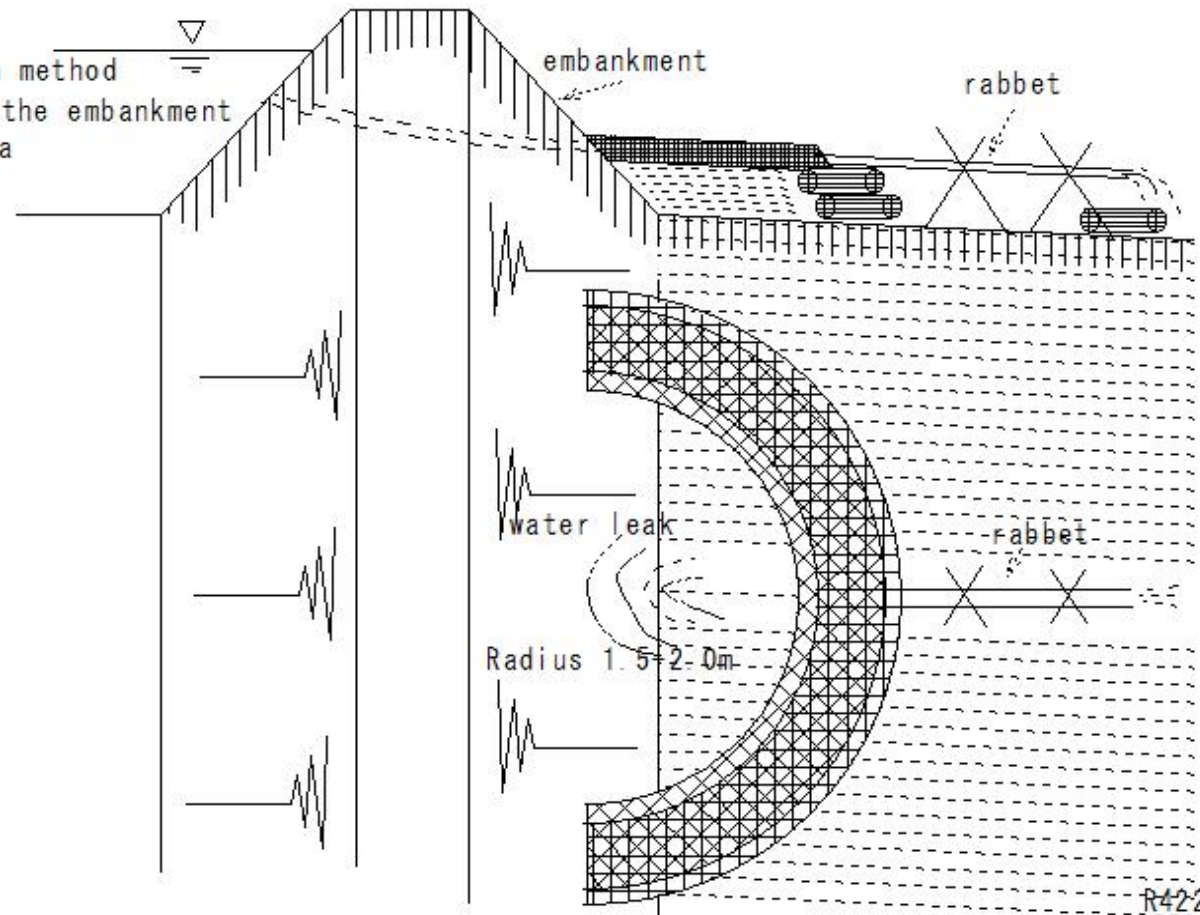
R421

(I609) Prevent water leakage (hooping)

(I609) Prevent water leakage (hooping)

Hooping

A type of flood prevention method
Water leakage from behind the embankment
soil bag on the inland area
stacked in a semicircle
prevent water leakage



(I610)Bank protection(back slope protection)

(I610)Bank protection(back slope protection)

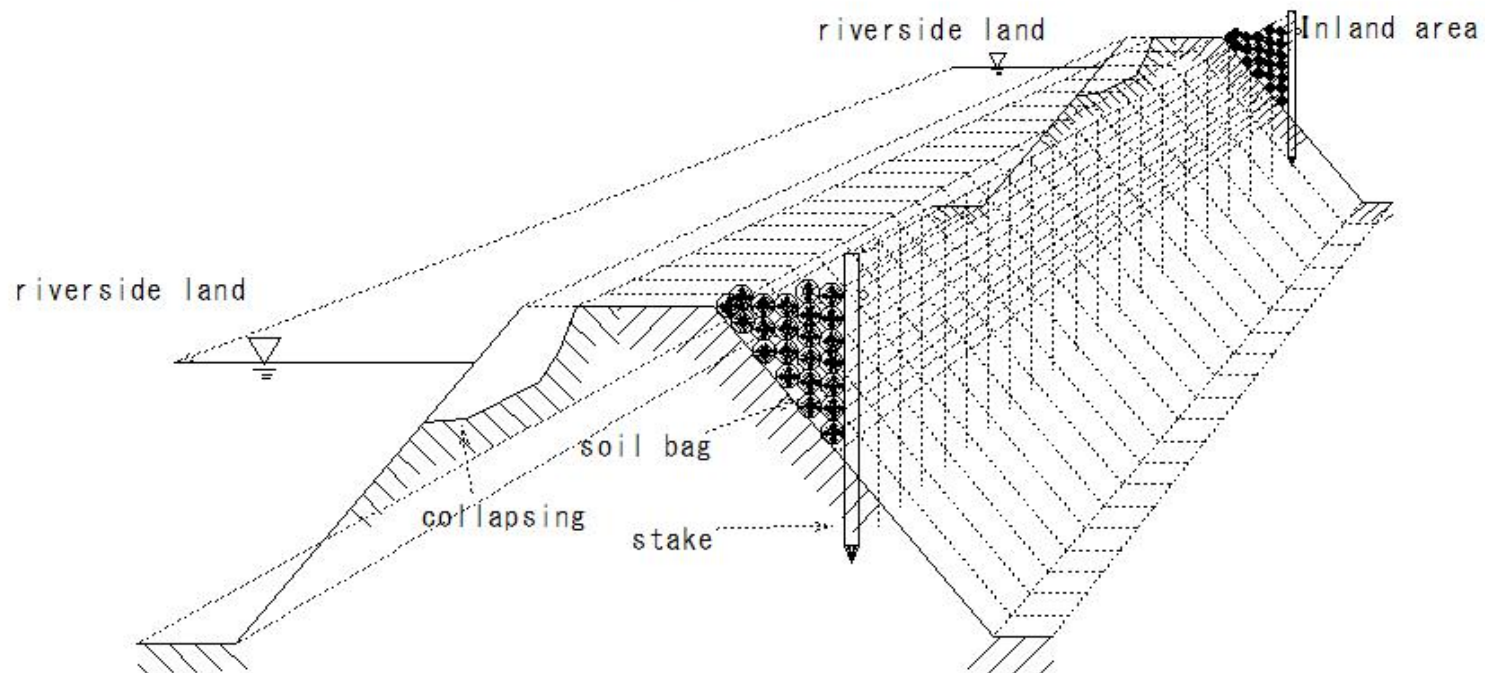
Back slope protection

the front slope is washed away by flood water

A type of flood prevention method

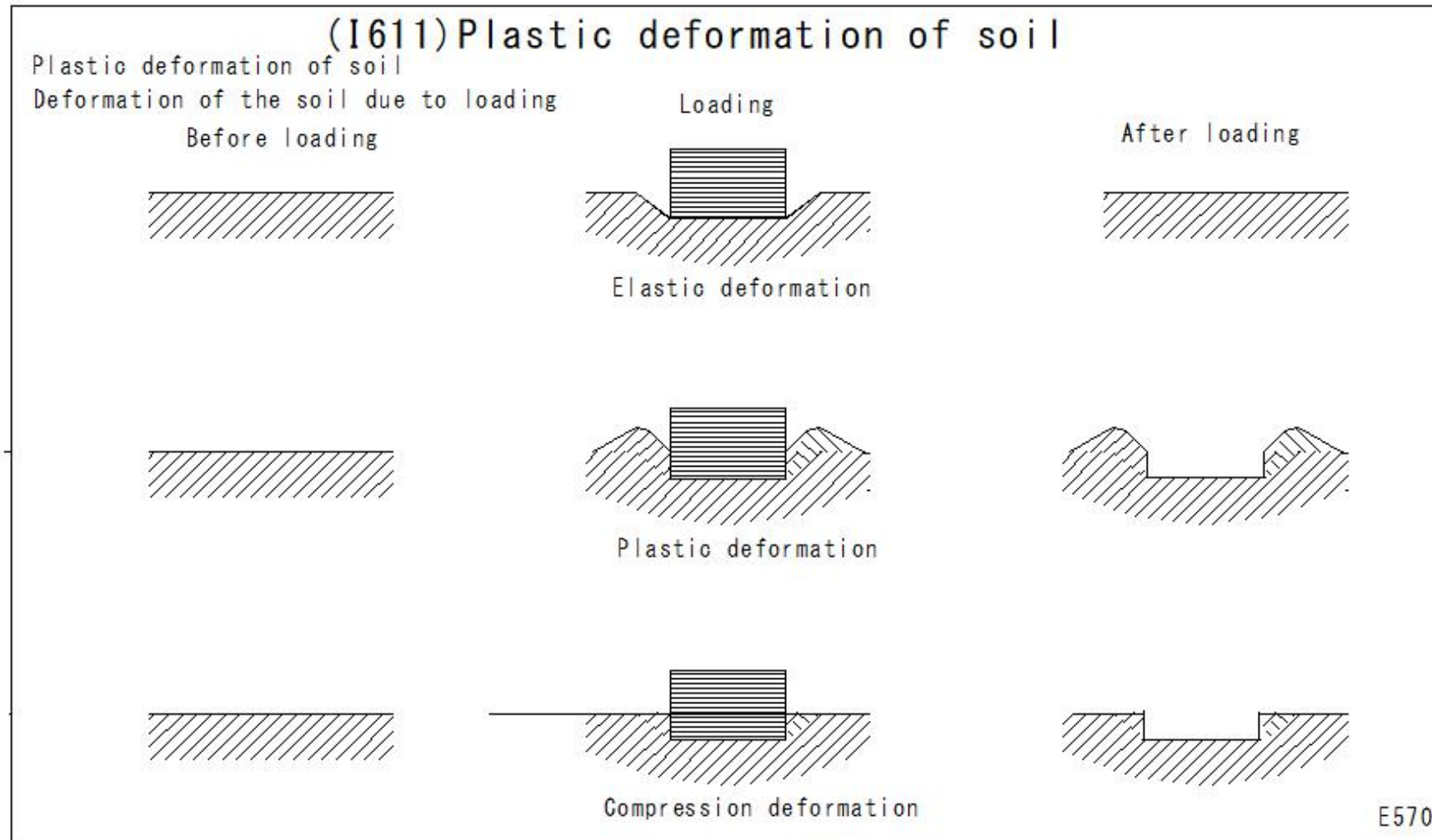
To prevent levees from collapsing

Reinforce the back slope with a soil bag and stakes



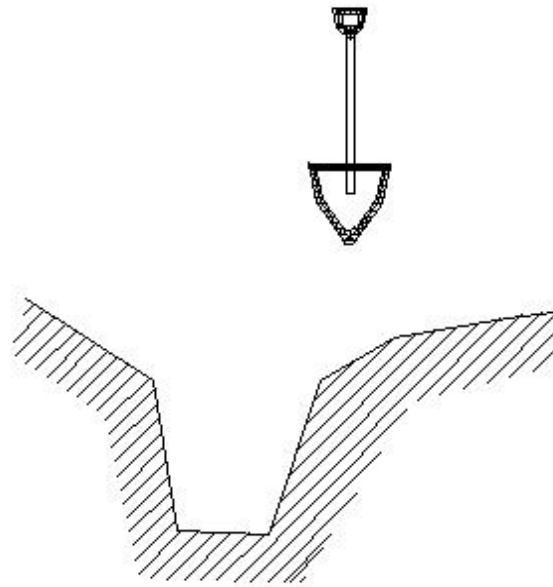
R423

(I611)Plastic deformation of the soil



(I612)Shaft sinking

(I612) Shaft sinking



Digging buried object survey holes

E571

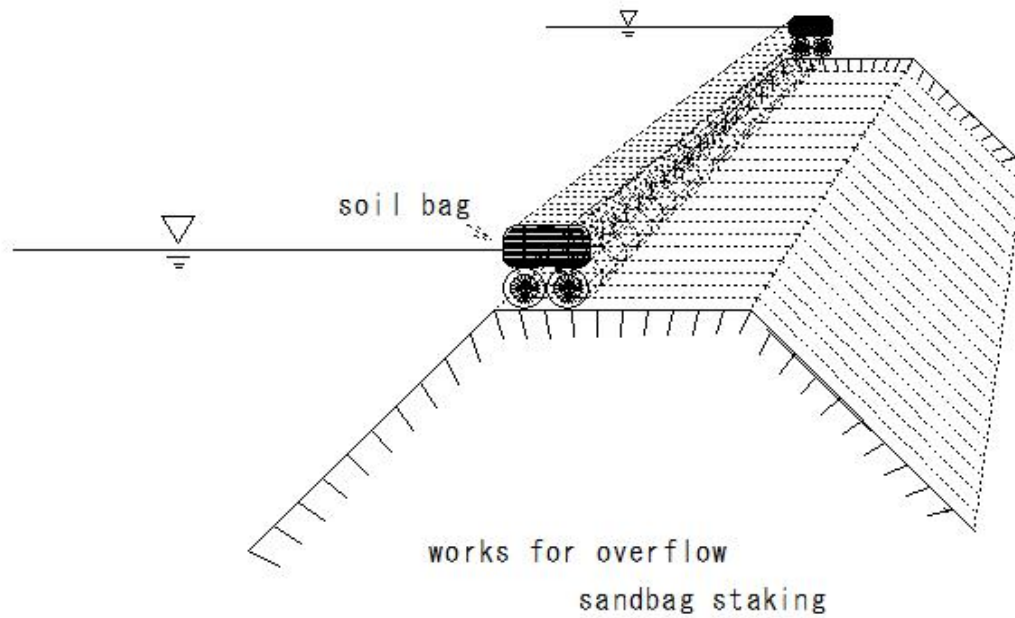
(I613)Works for overflow

(I613)Works for overflow

Works for overflow

sandbag staking

Flood overflow prevention



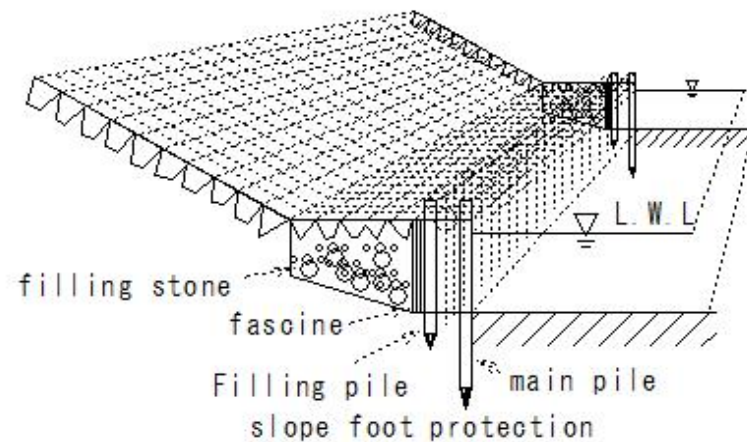
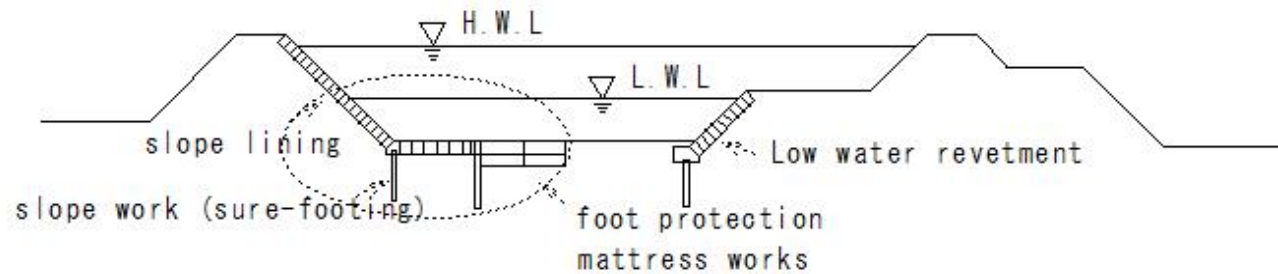
(I614)Slope foot protection(Filling pile work)

(I614)Slope foot protection(Filling pile work)

slope foot protection

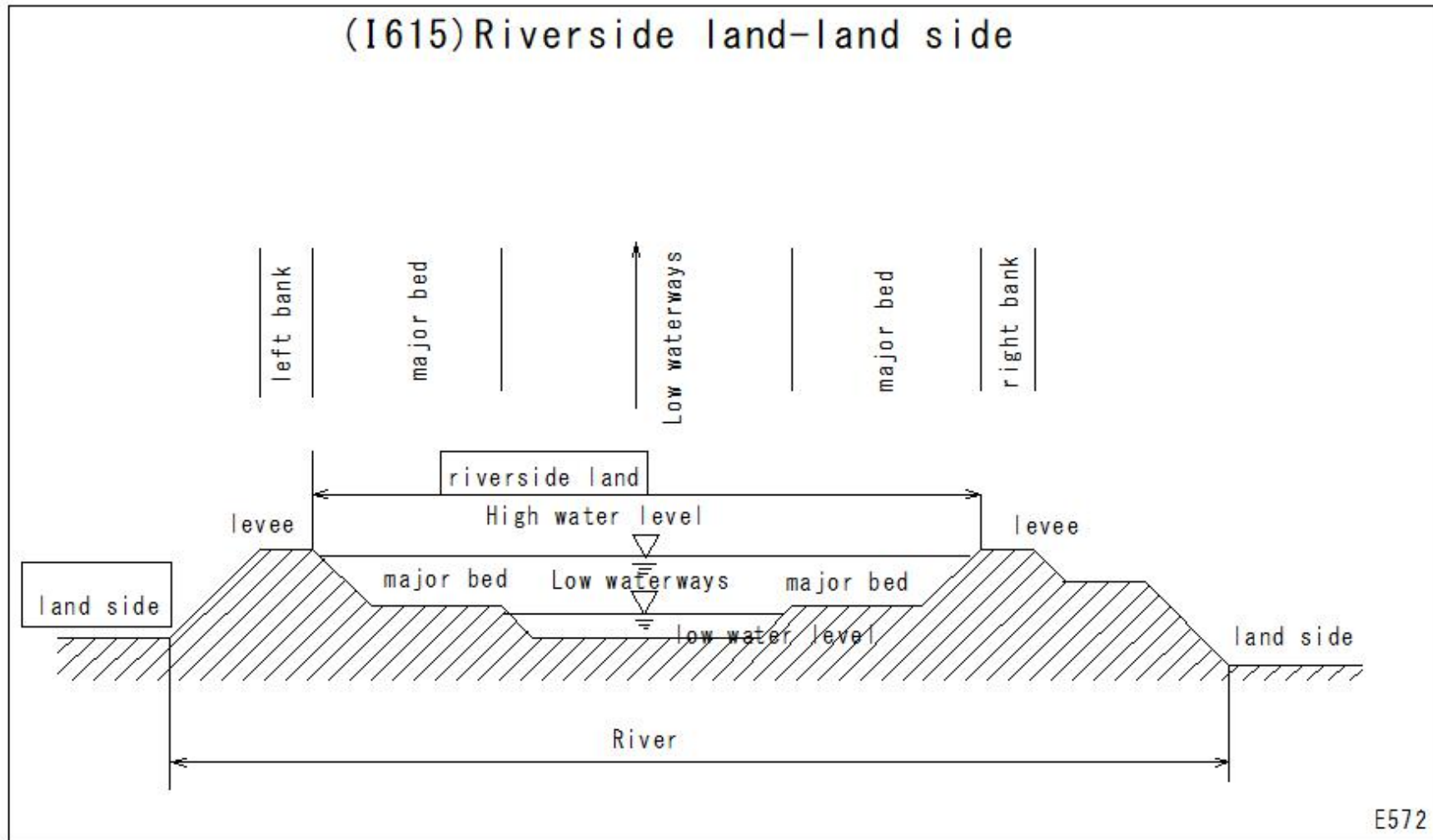
Filling pile work

Foundation work for river embankments

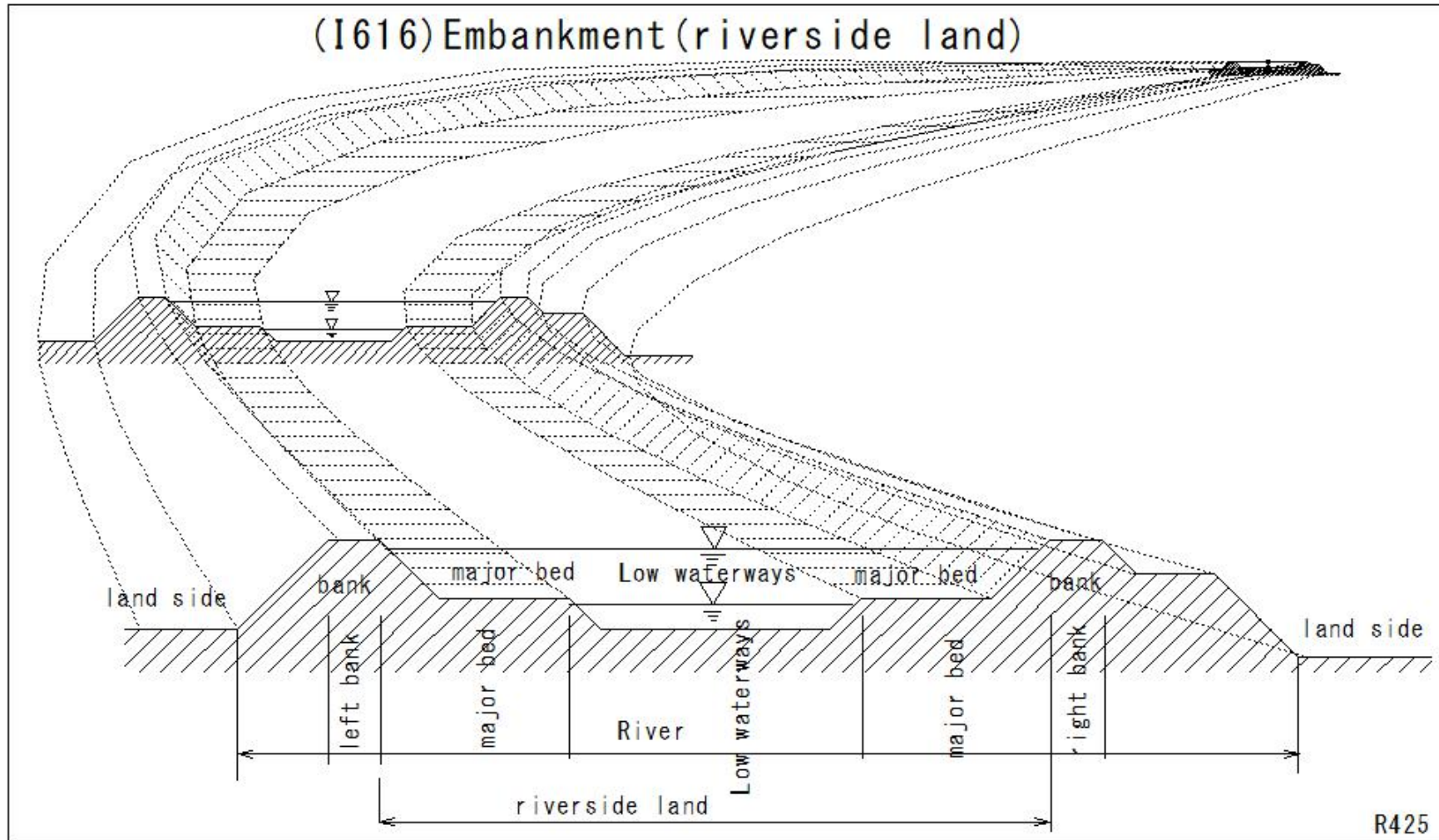


R424

(I615)Riverside land-land side

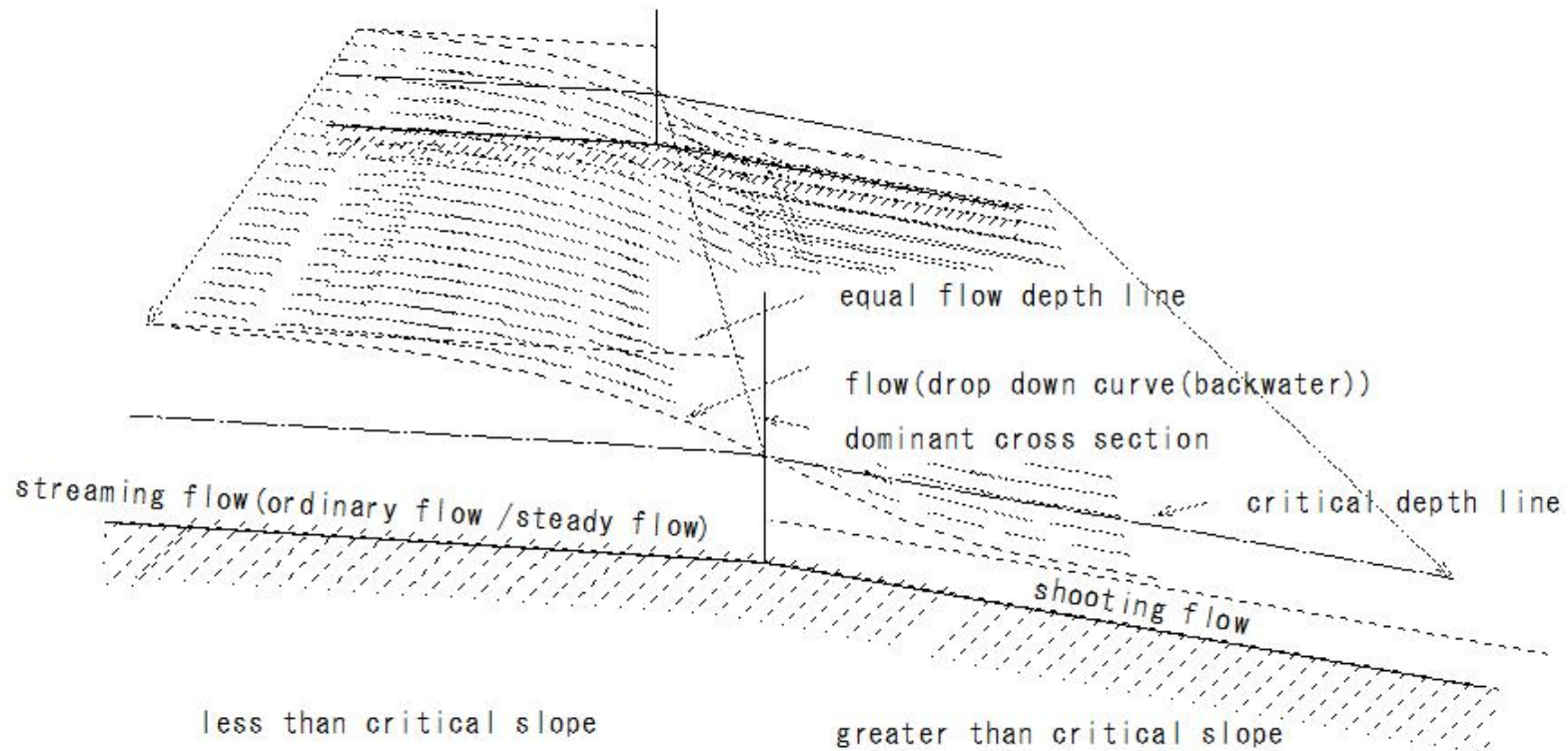


(I616) Embankment (riverside land)



(I617)Flow(drop down curve(backwater))

(I617)Flow(drop down curve(backwater))



R426

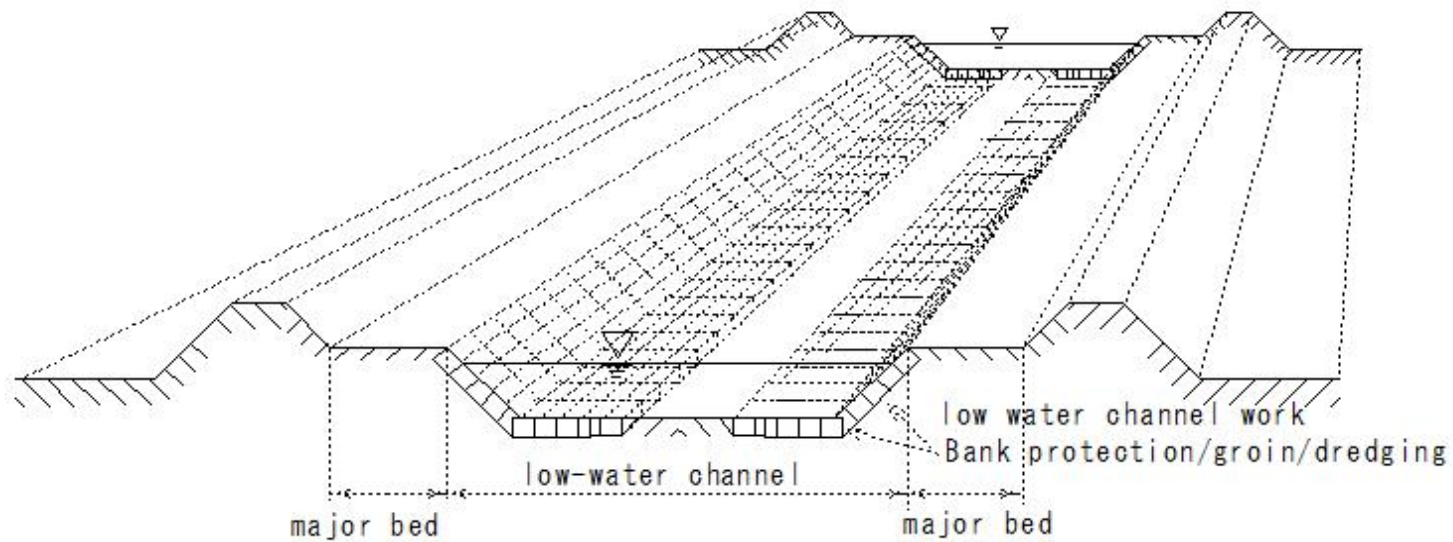
(I618)Low water channel work

(I618)Low water channel work

low water channel work

Work to organize and stabilize the flow path of low water channel work

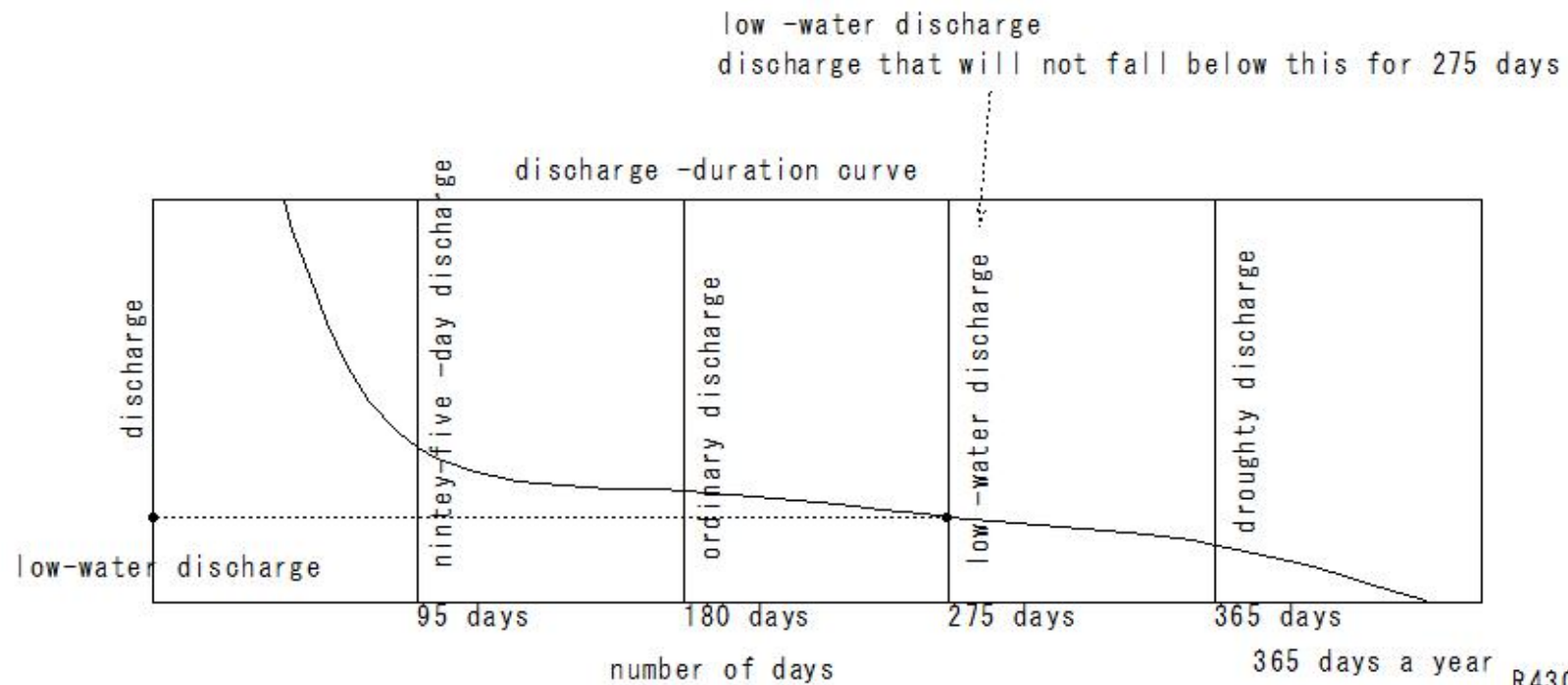
low-water channel



R428

(I619)Low -water discharge

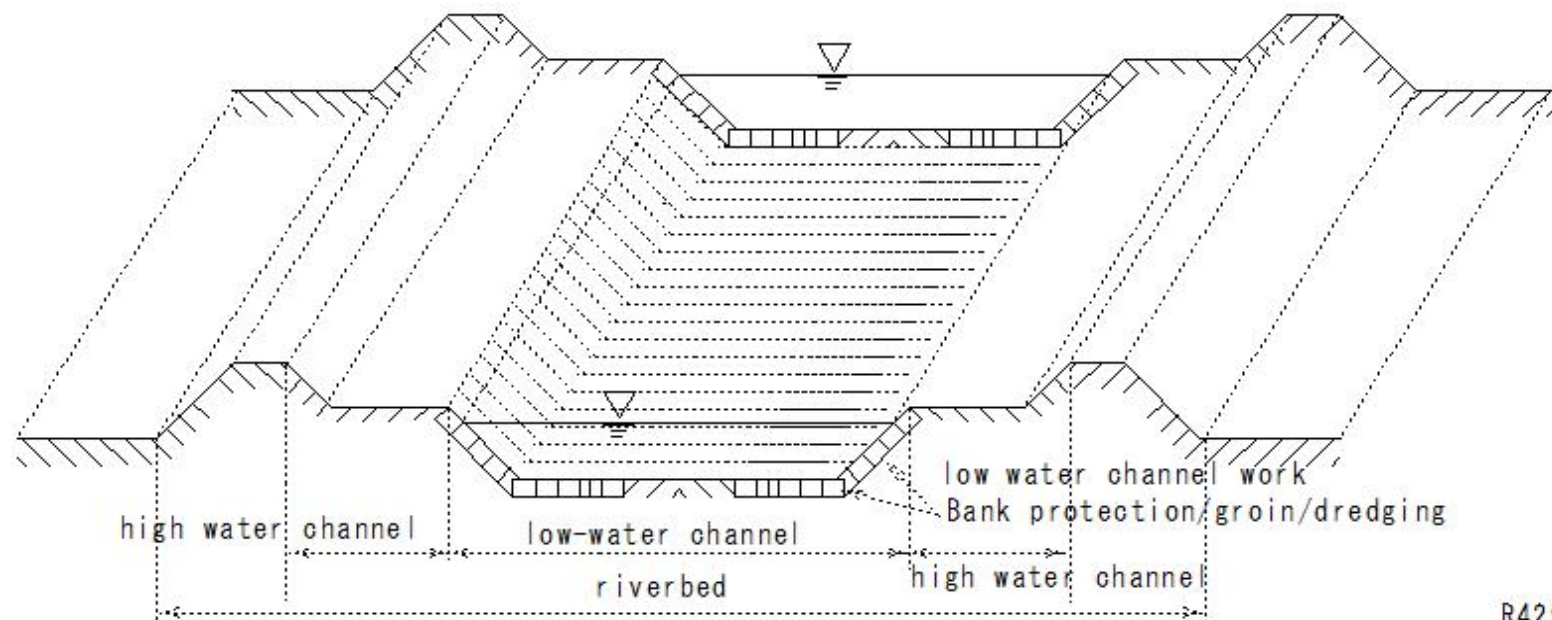
(I619)Low -water discharge



R430

(I620)Low-water channel

(I620)Low water channel



R429

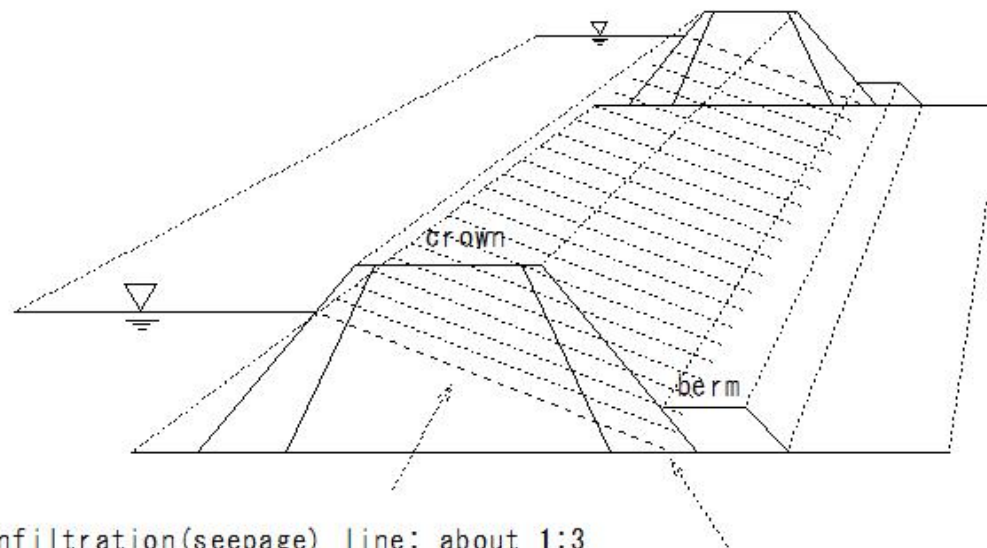
(I621)Infiltration(percolation) of levee

(I621) Infiltration(percolation) of levee

infiltration(percolation) of levee

case of the back slope intersect, it will be destroyed at that point.

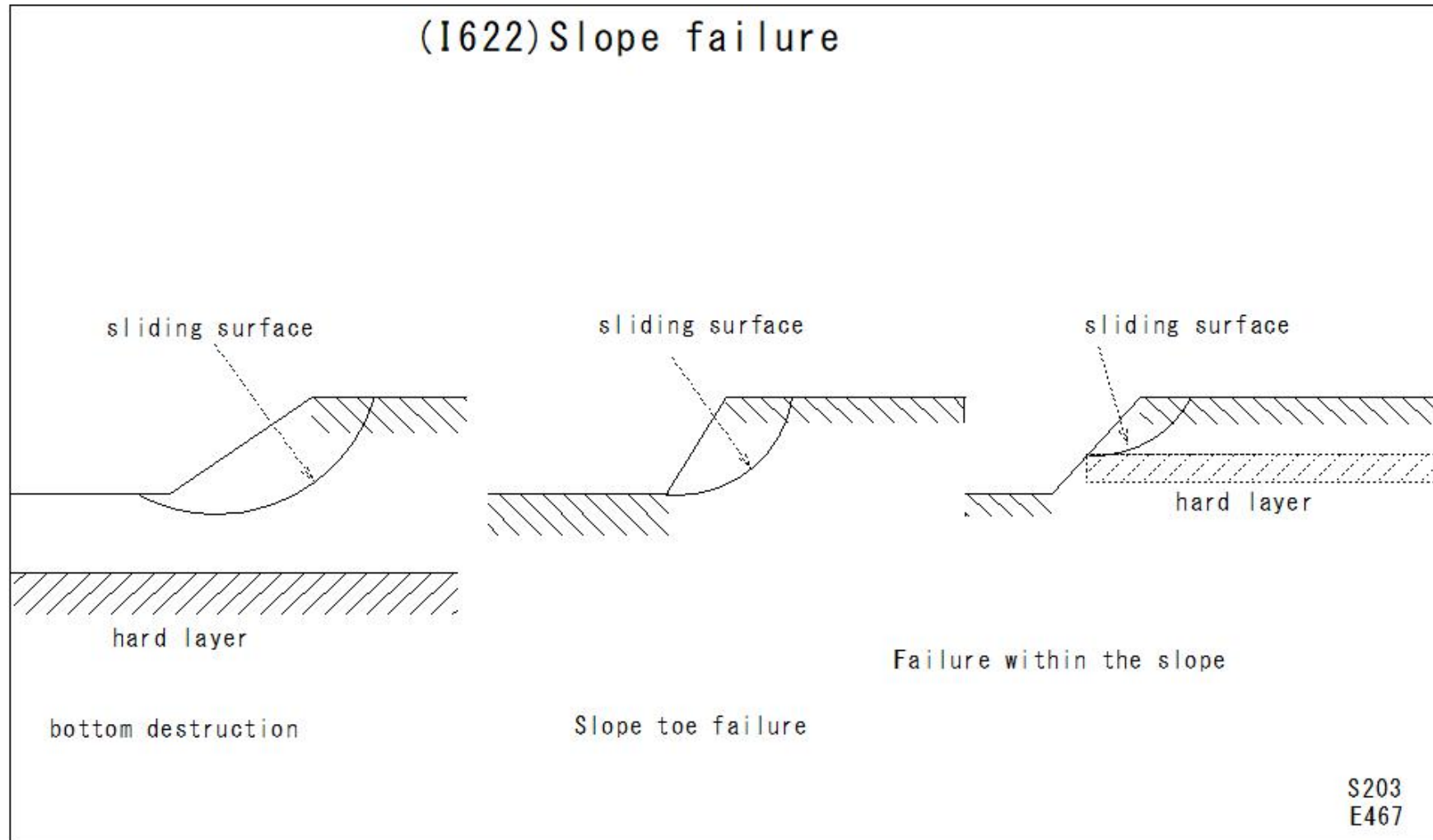
Make sure the back slope does not mix with the infiltration line.



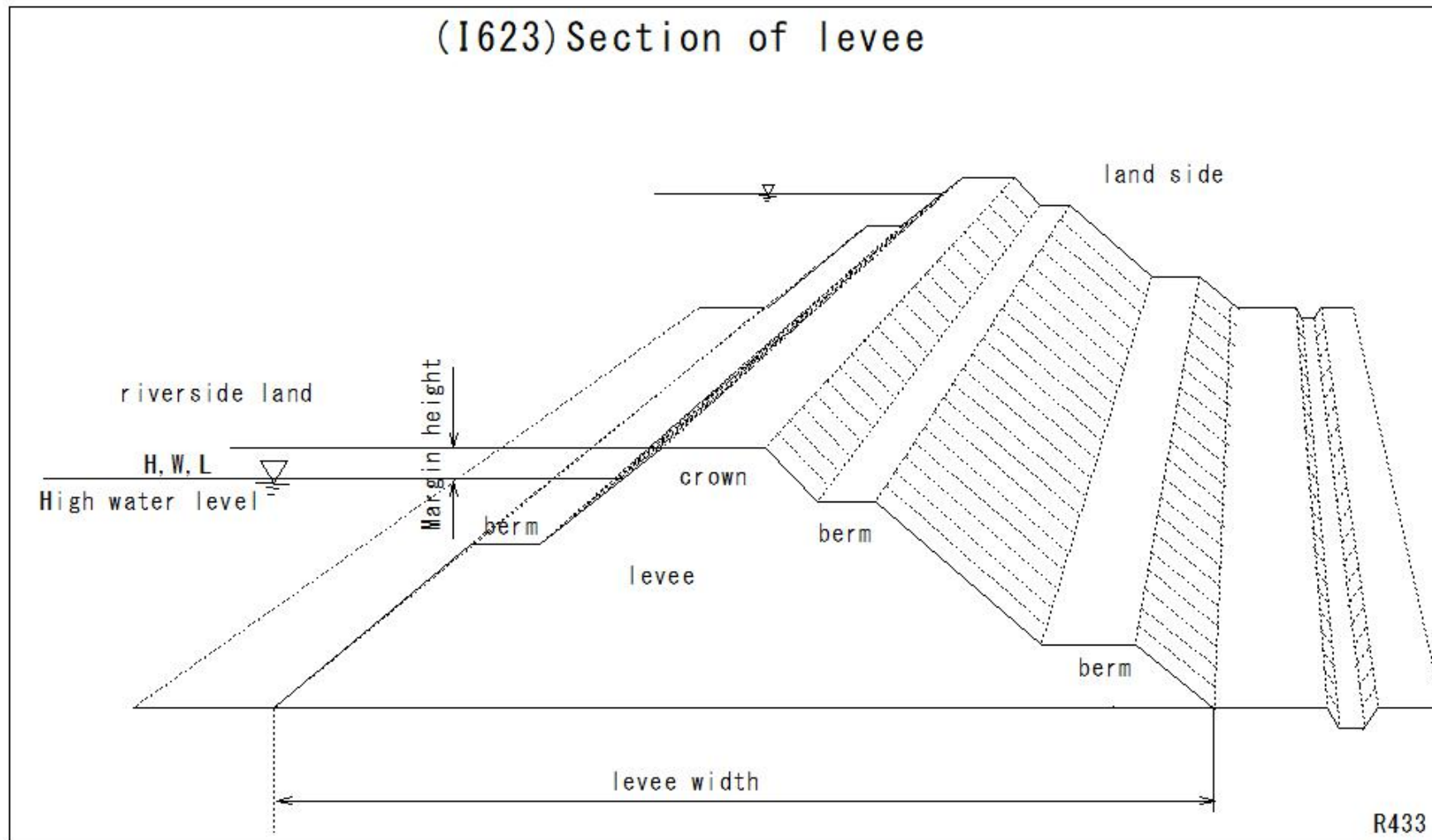
infiltration(seepage) line: about 1:3

Decide the crown width and back gradient

(I622)Slope failure

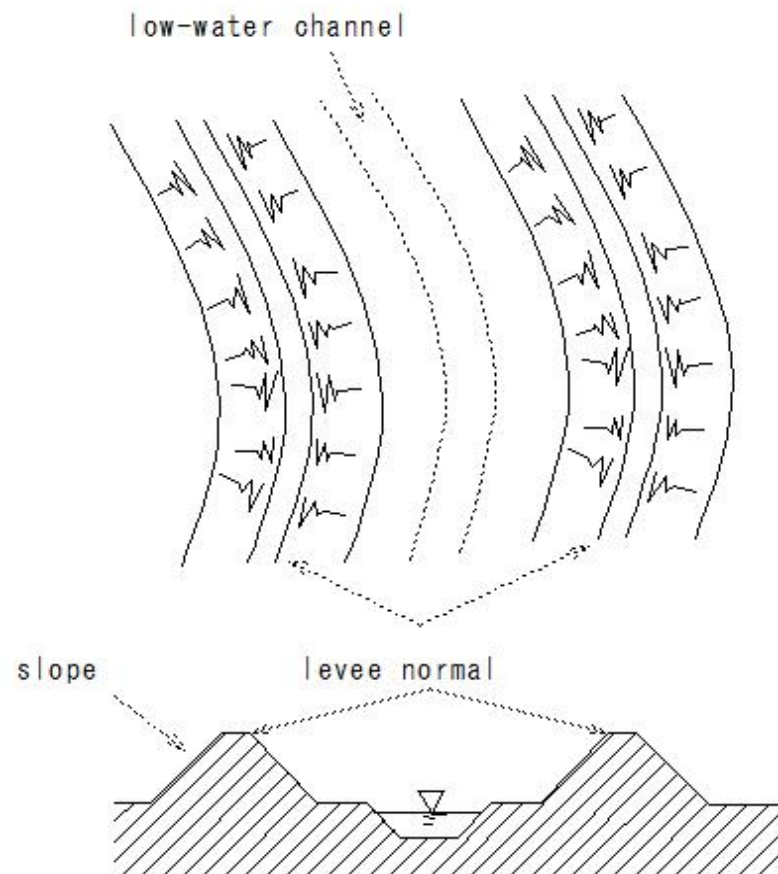


(I623)Section of levee



(I624) Embankment (levee normal)

(I624) Embankment (levee normal)



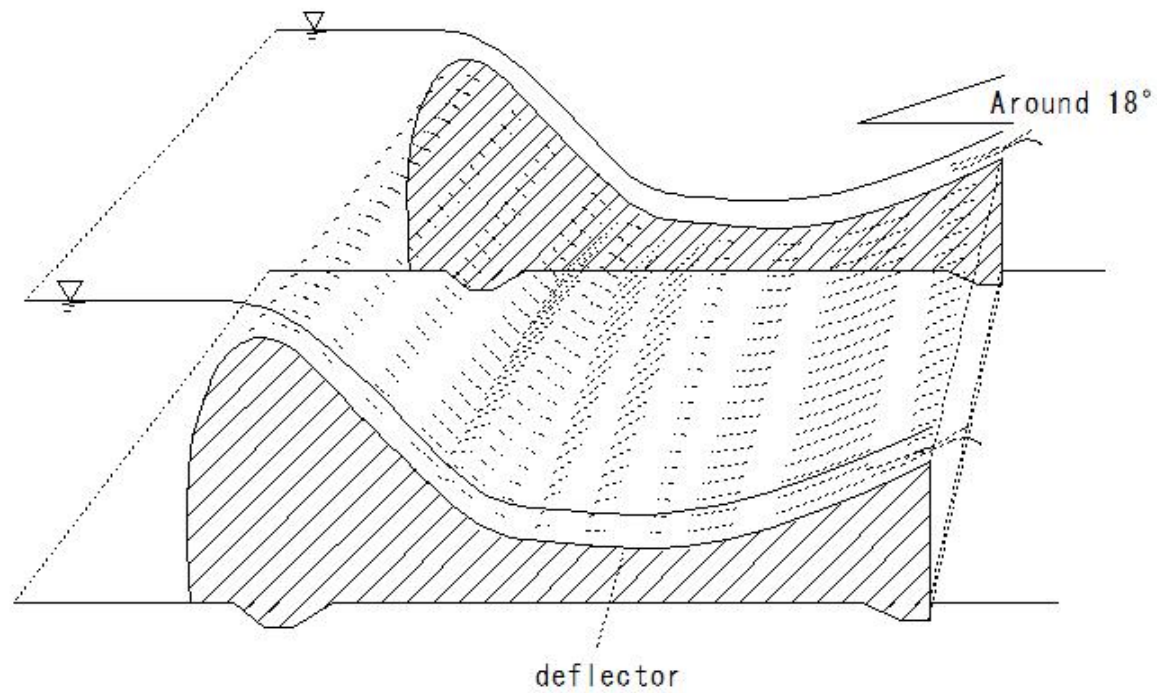
R434

(I625)Dam(deflector)

(I625) Dam(deflector)

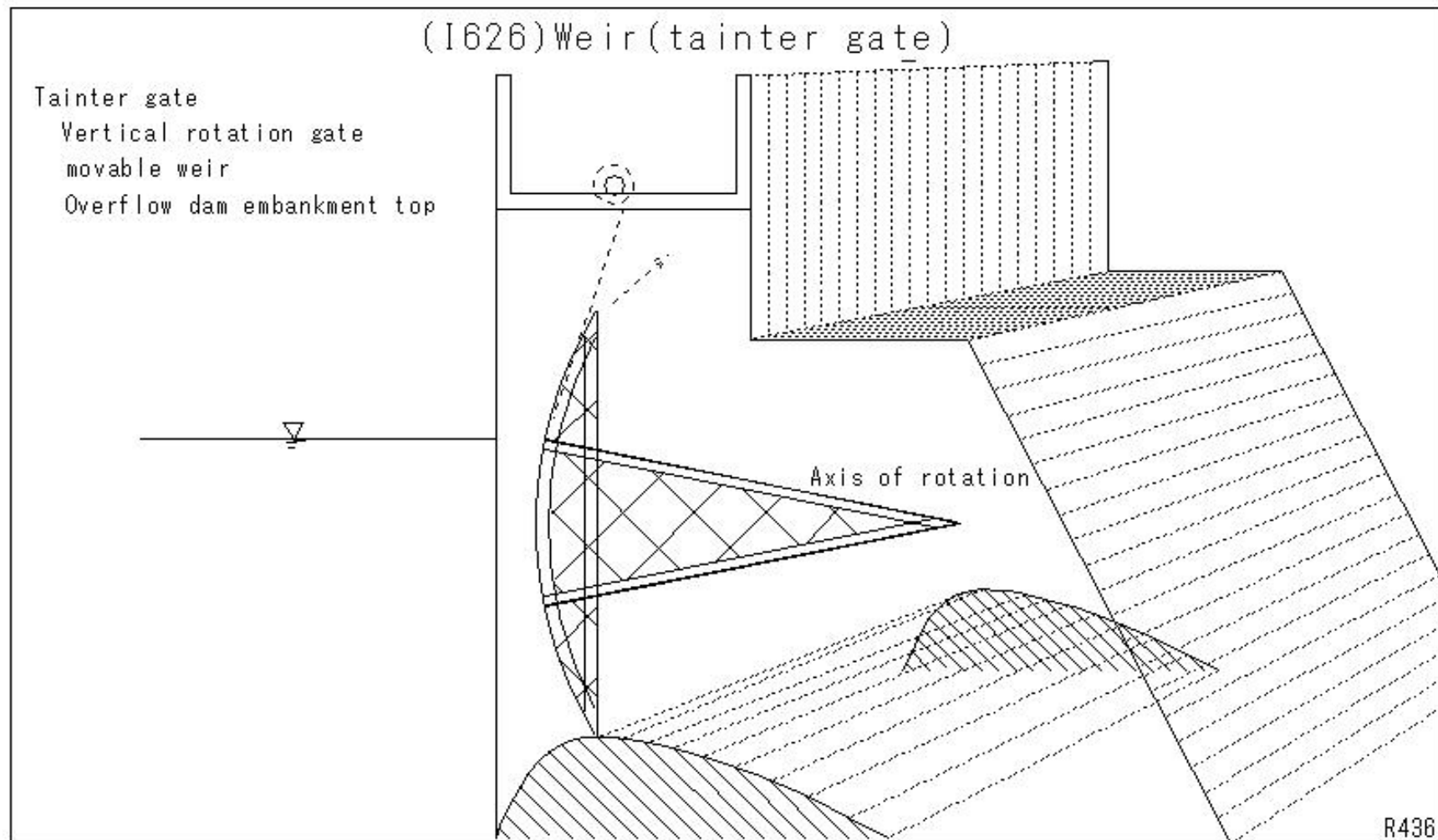
Deflector

A structure that consumes the energy of water that overflows a dam.



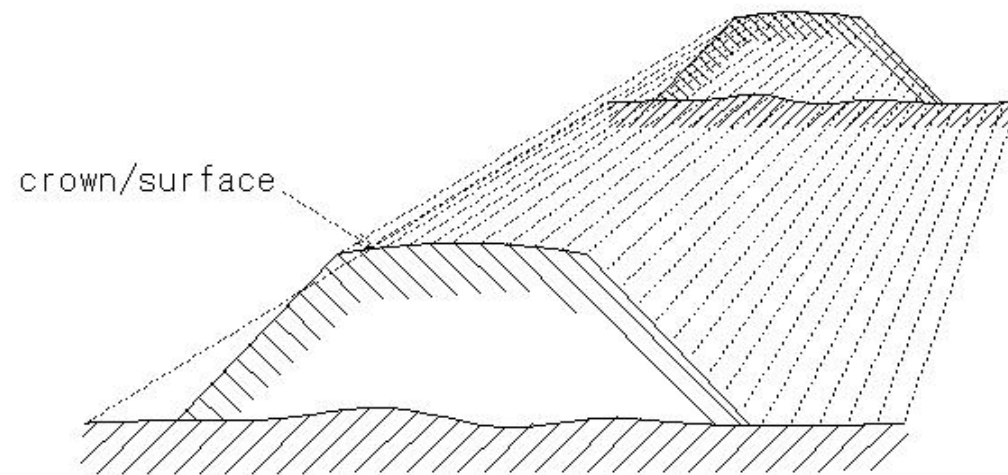
R435

(I626)Weir(tainter gate)



(I627) Embankment (crown/surface)

(I627) Embankment (crown/surface)



R437

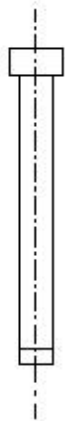
(I628)Water supply(earthenware pipe)

(I628)Water supply(earthenware pipe)

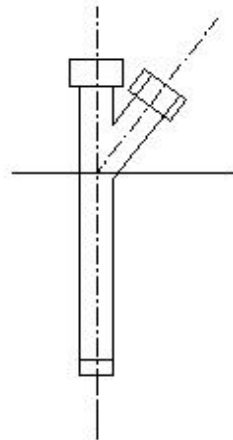
Water supply

earthenware pipe1(Ceramic pipe)

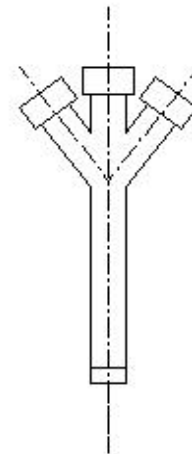
Clay - Extruder - After drying - Glaze - Firing



① Straight pipe



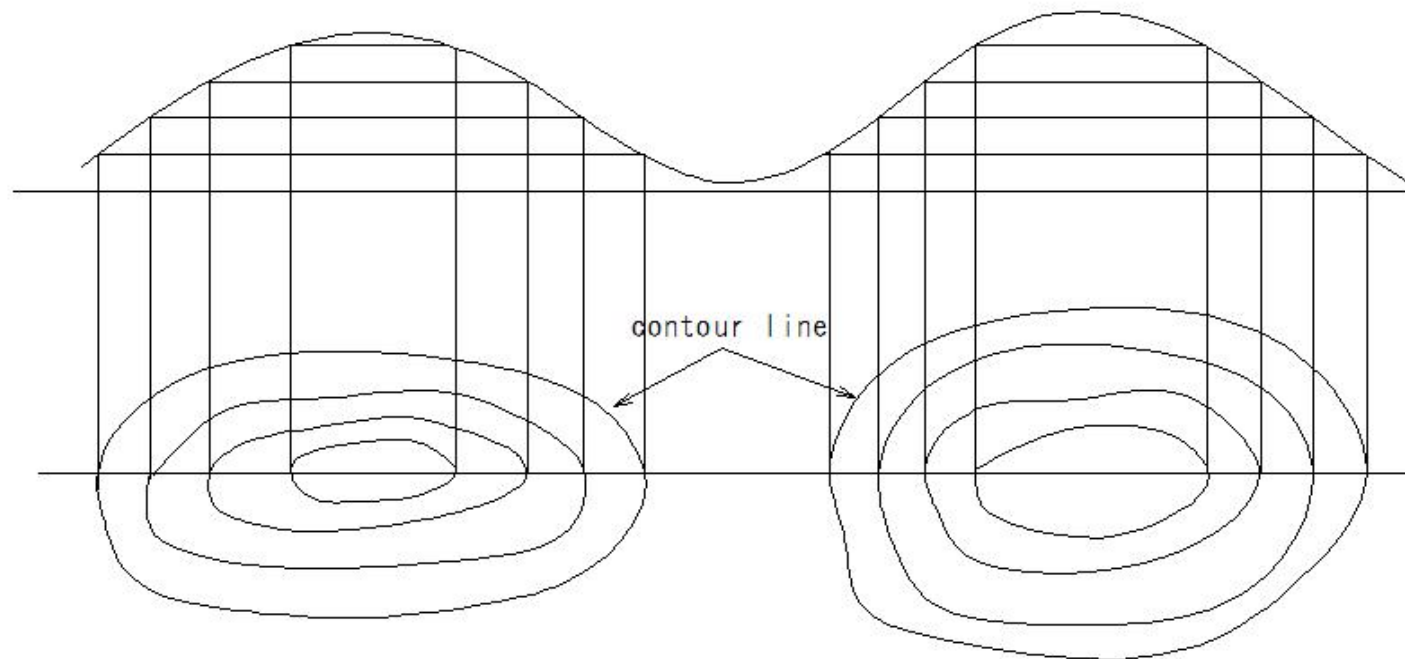
② Branched pipe



③ Double branch pipe

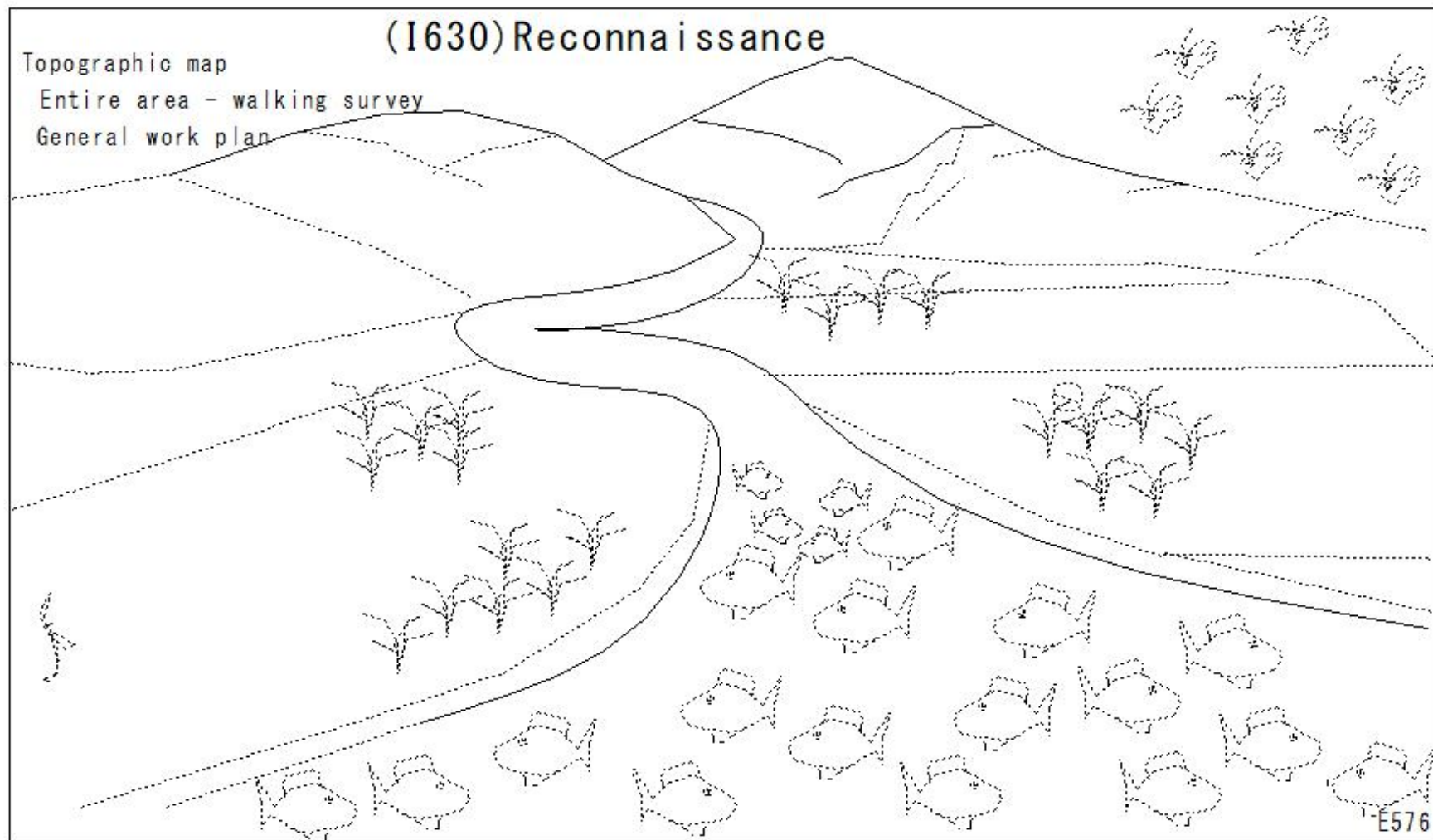
(I629)Contour line

(I629)Contour line



E575

(I630)Reconnaissance

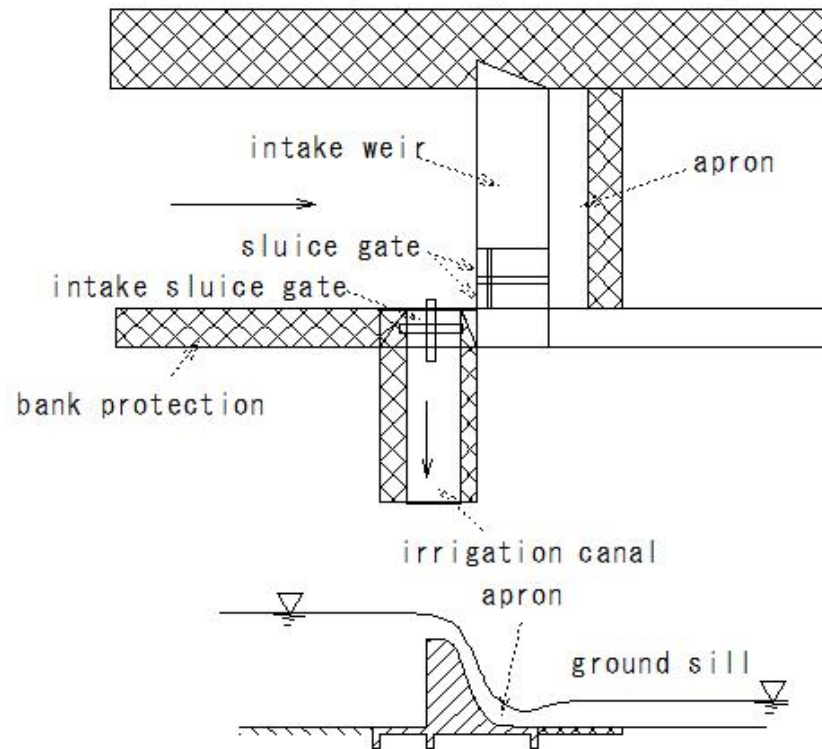


(I631)Weir(head works)

(I631)Weir (head works)

Weir (head works)

Facilities that draw water from lakes, rivers, etc. to irrigation canals



Weir cross section

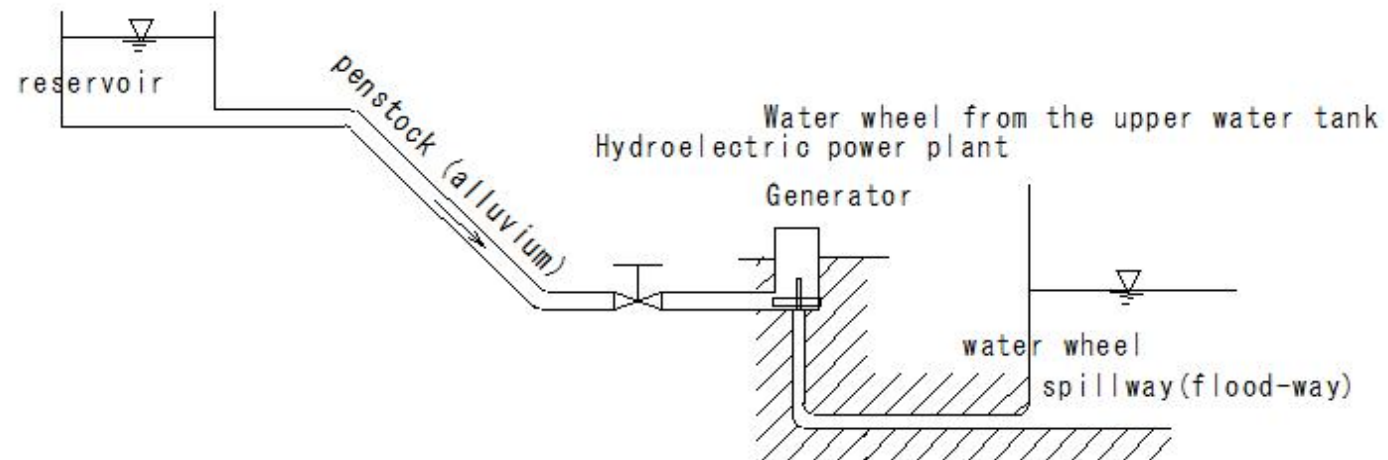
R438

(I632)Penstock (alluvium)

(I632)Penstock (alluvium)

Penstock (alluvium)

High pressure water pipe that leads water



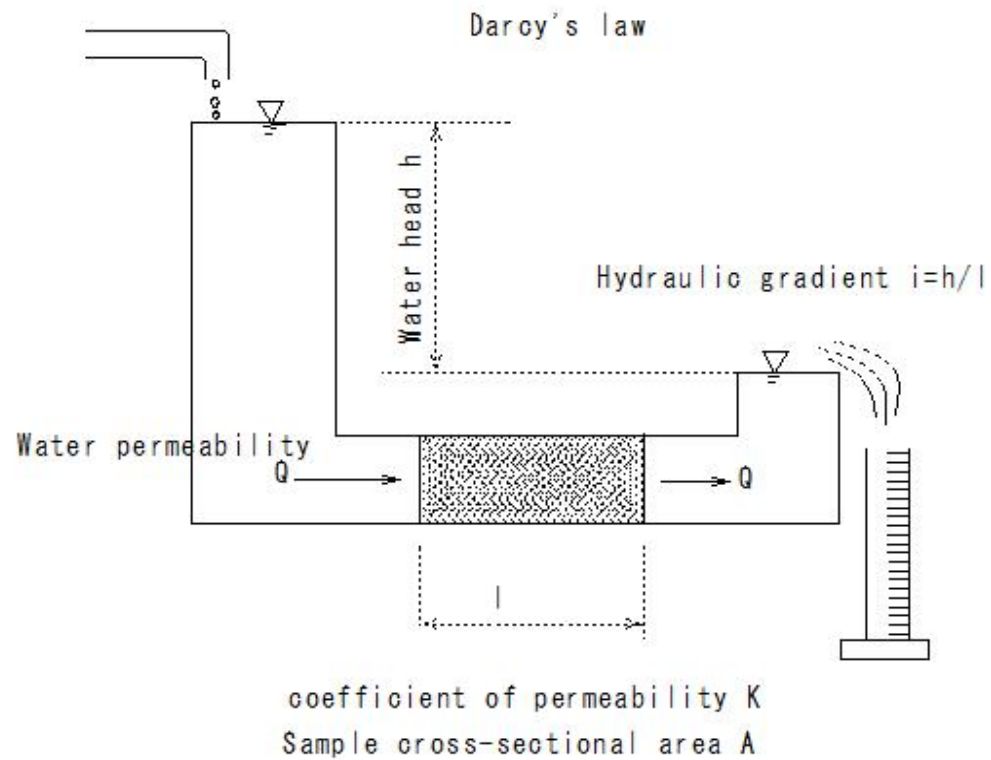
R439

(I633)Coefficient of permeability

(I633)Coefficient of permeability

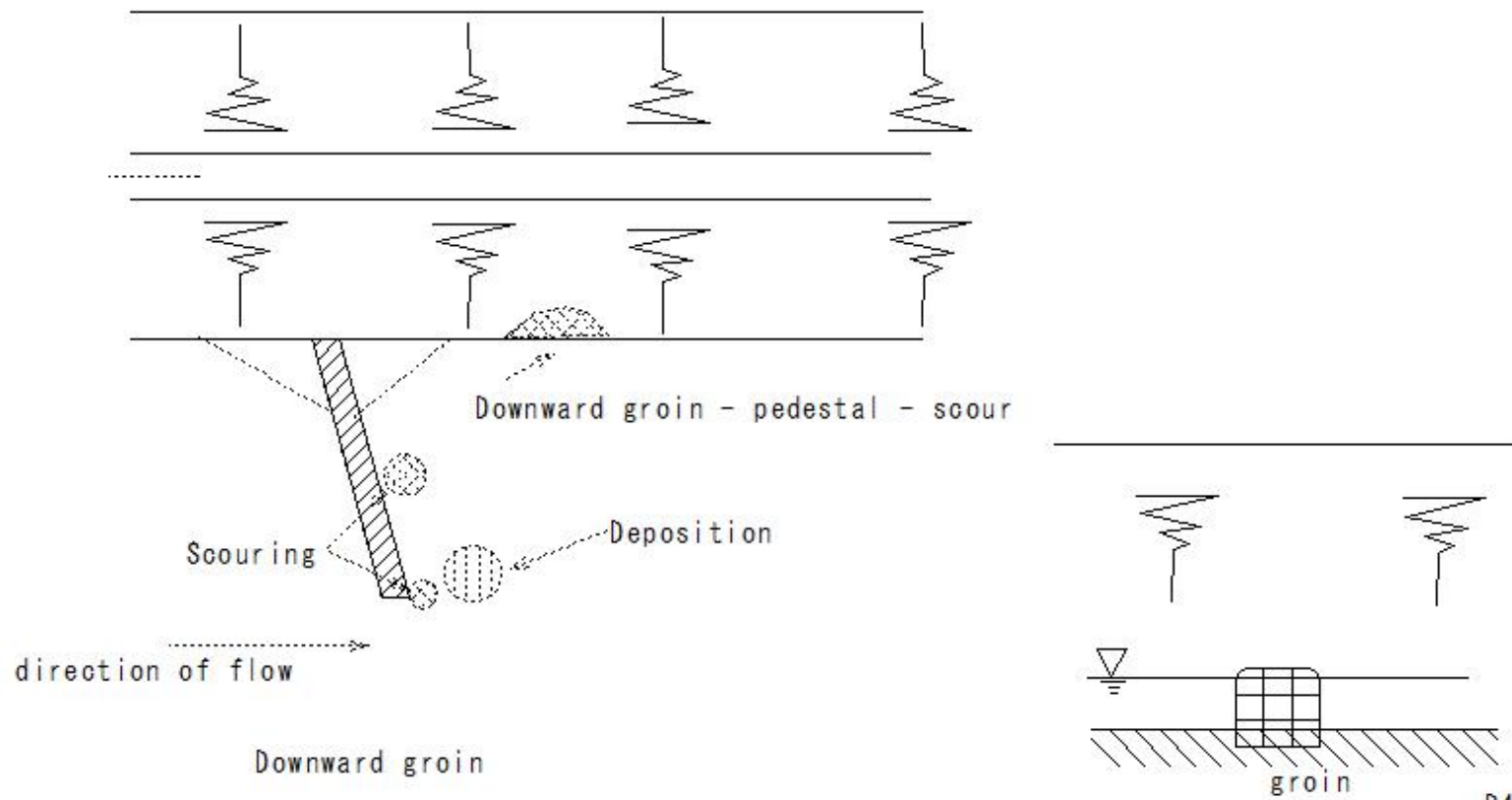
coefficient of permeability

Amount of water flowing through a unit cross-sectional area of soil per unit time, unit: cm/s



(I634)Equipotential line

(I634) Downward groin



R441

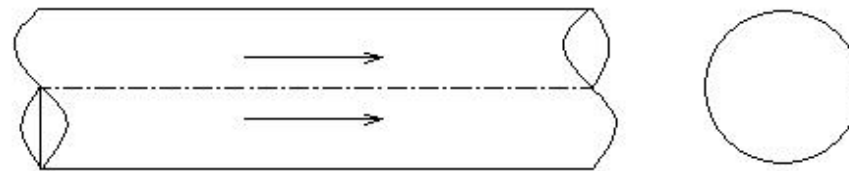
(I635)Uniform flow

(I635)Uniform flow

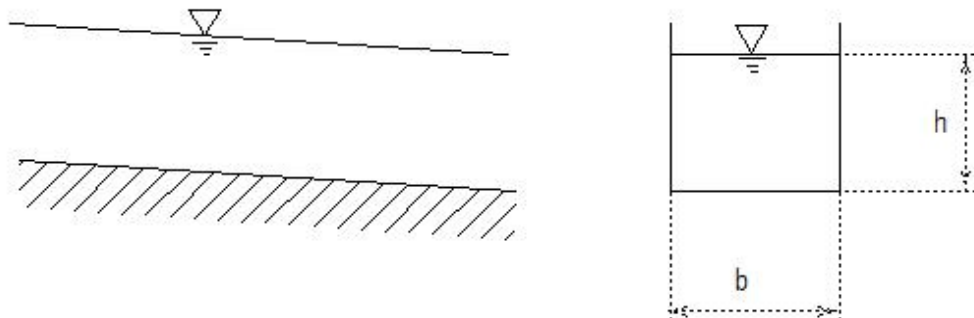
Uniform flow

steady flow (ordinary flow)

flow with equal velocity and volume



flow in a pipe channel with a uniform cross section



flow in an experimental open channel with uniform cross section

b, h : constant

(I636) Training dyke

(I636) Training dyke

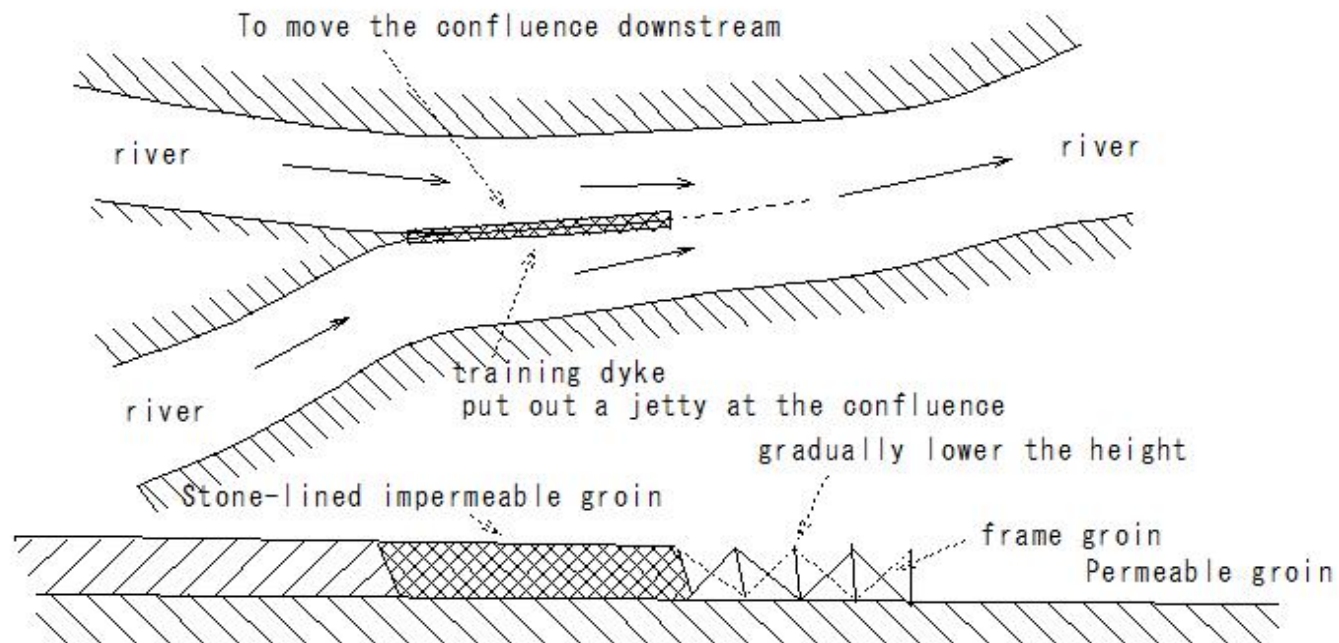
Training dyke

river confluence

Running water - leads smoothly

Embankment groin

Preventing water from two rivers from interfering with each other



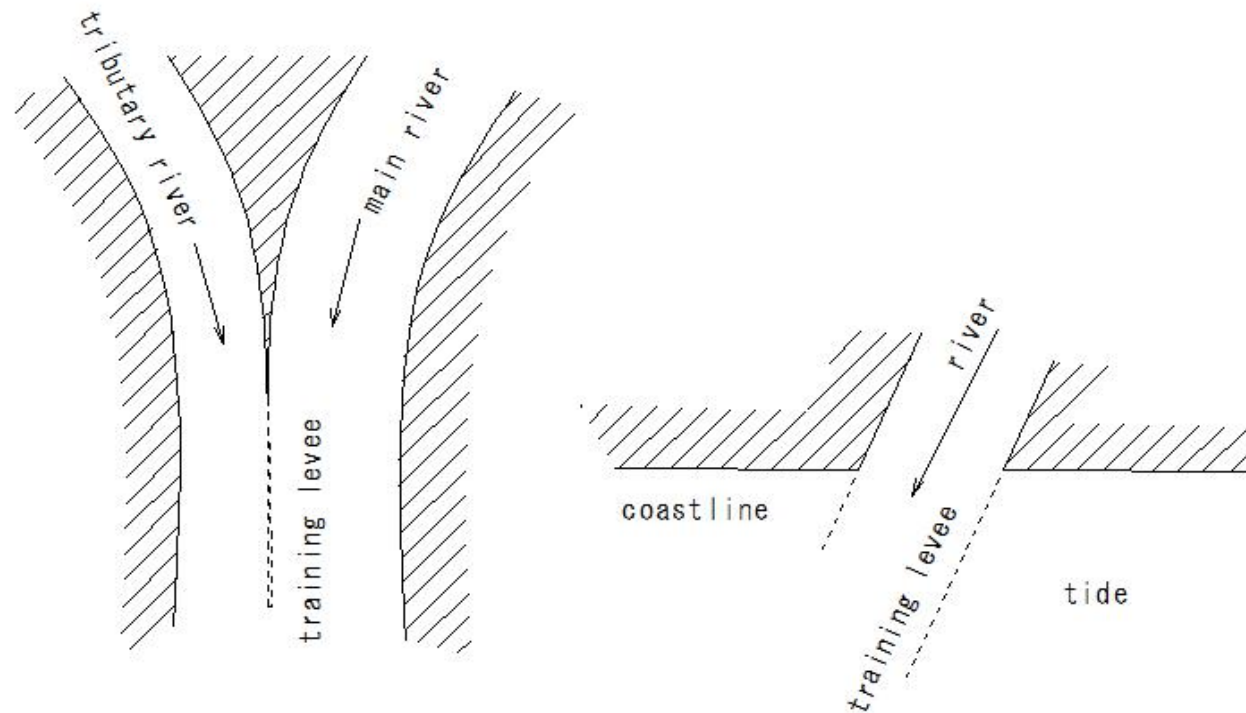
R443

(I637) Training levee

(I637) Training levee

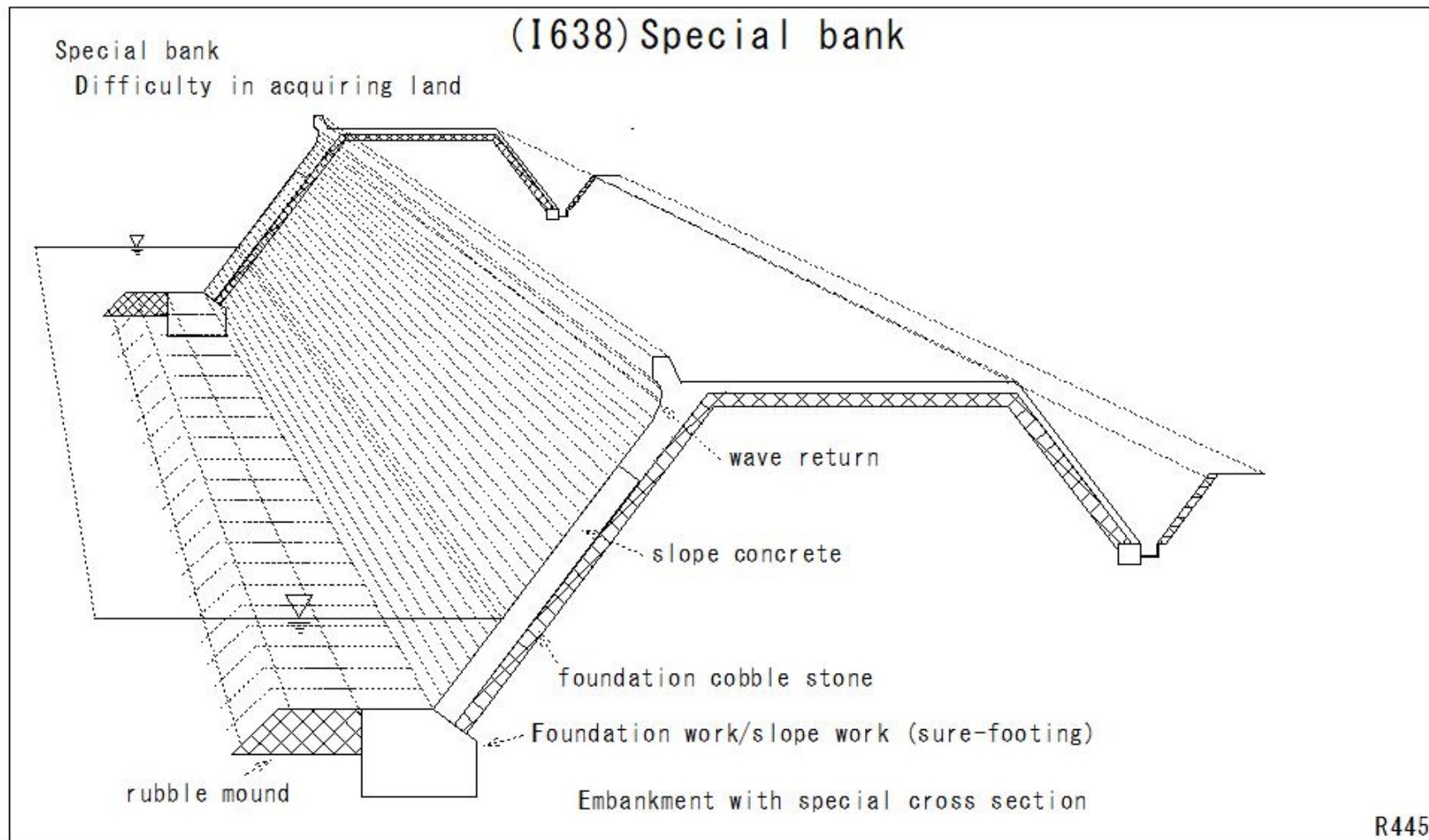
Training levee

Maintain water flow direction



R444

(I638)Special bank

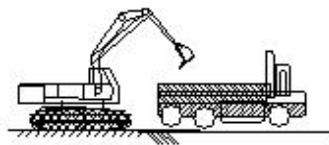
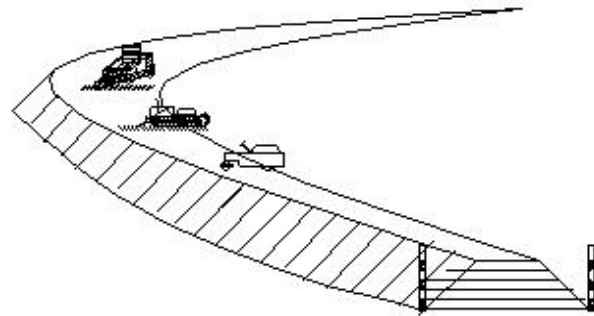


(I639)Earthwork

(I639) Earthwork

Cutting and embankment of soil

Cut soil
transport
embankment
Compaction
Finish
Mechanical earthwork



(I640)Roadway diagram

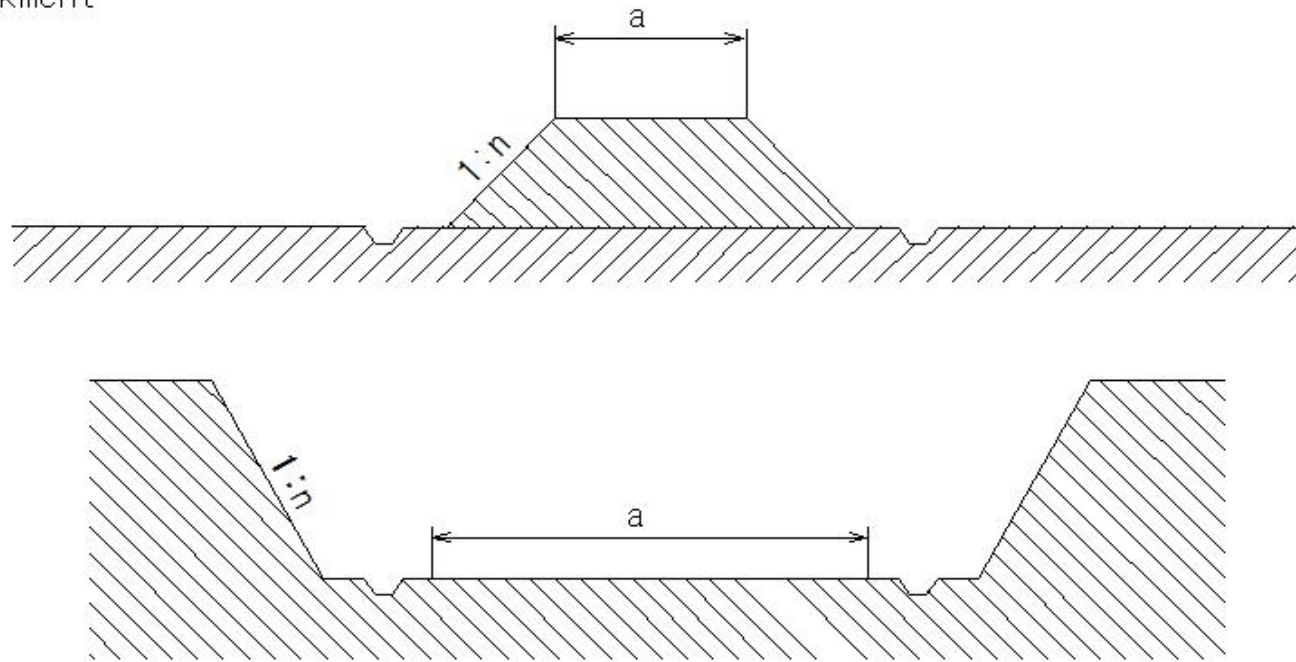
(I640)Roadway diagram

Roadway diagram

Levee and cutting

Cross-sectional shape standard

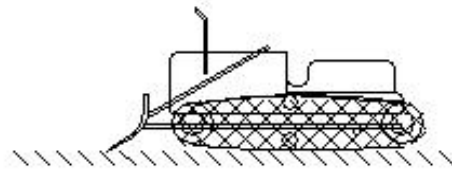
Cut soil
embankment



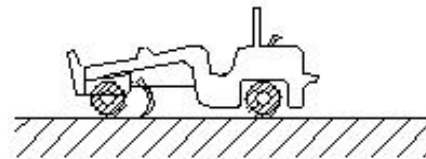
E578

(I641)Blade bowl

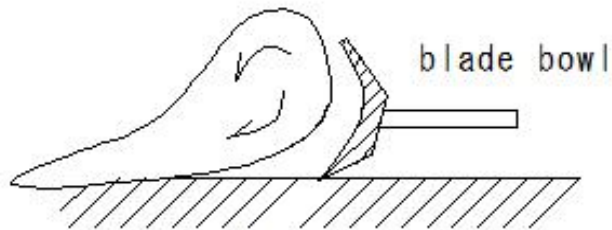
(I641)Blade bowl



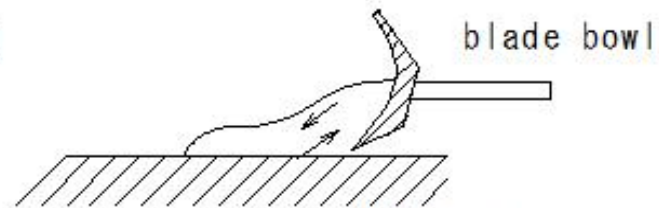
bulldozer



motor grader



cohesive soil



sandy soil

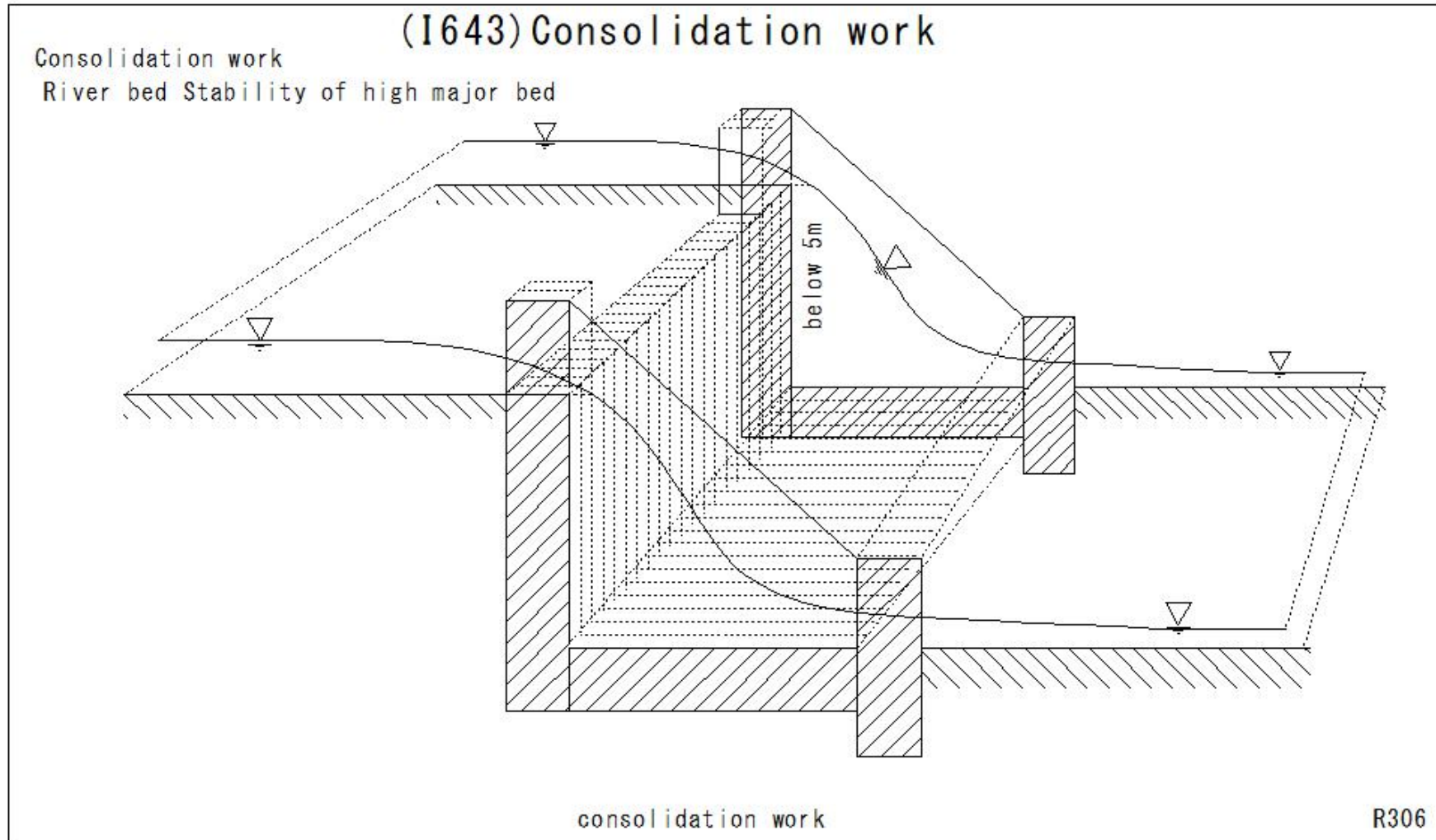
(I642) Consolidation works

A cross-sectional diagram of a fascine pile foundation. It shows a series of vertical piles driven into the ground. A horizontal layer of fascines (bundles of brush or logs) is placed around the piles, and a layer of soil is placed on top of the fascines. The word "fascine" is labeled with a line pointing to the brush layer.

consolidation work

R305

(I643)Consolidation work



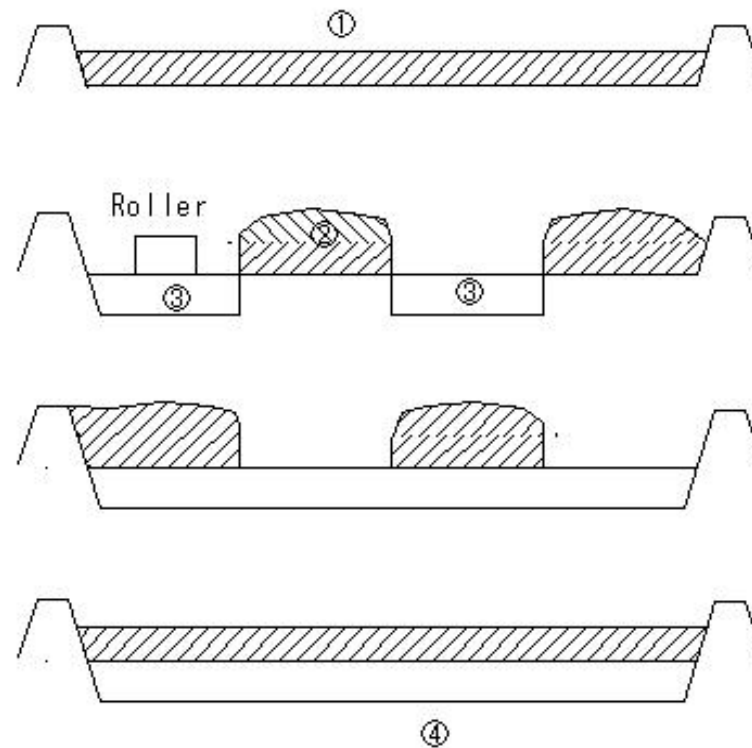
(I644)Subsoil compacting

(I644)Subsoil compacting

Subsoil compacting

Compacting the soil layer to improve the permeability of paddy fields

- ① Plow soil
- ② Subsoil
- ③ Subsoil compacting
- ④ Subsoil



(I645)Sediment settling

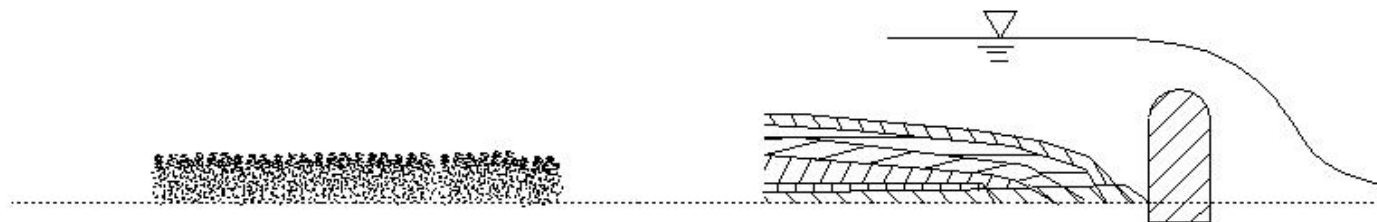
(I645)Sediment settling

Sediment settling

Water flow

Stationary soil pressure

Sediment in water - precipitation



Precipitation in still water

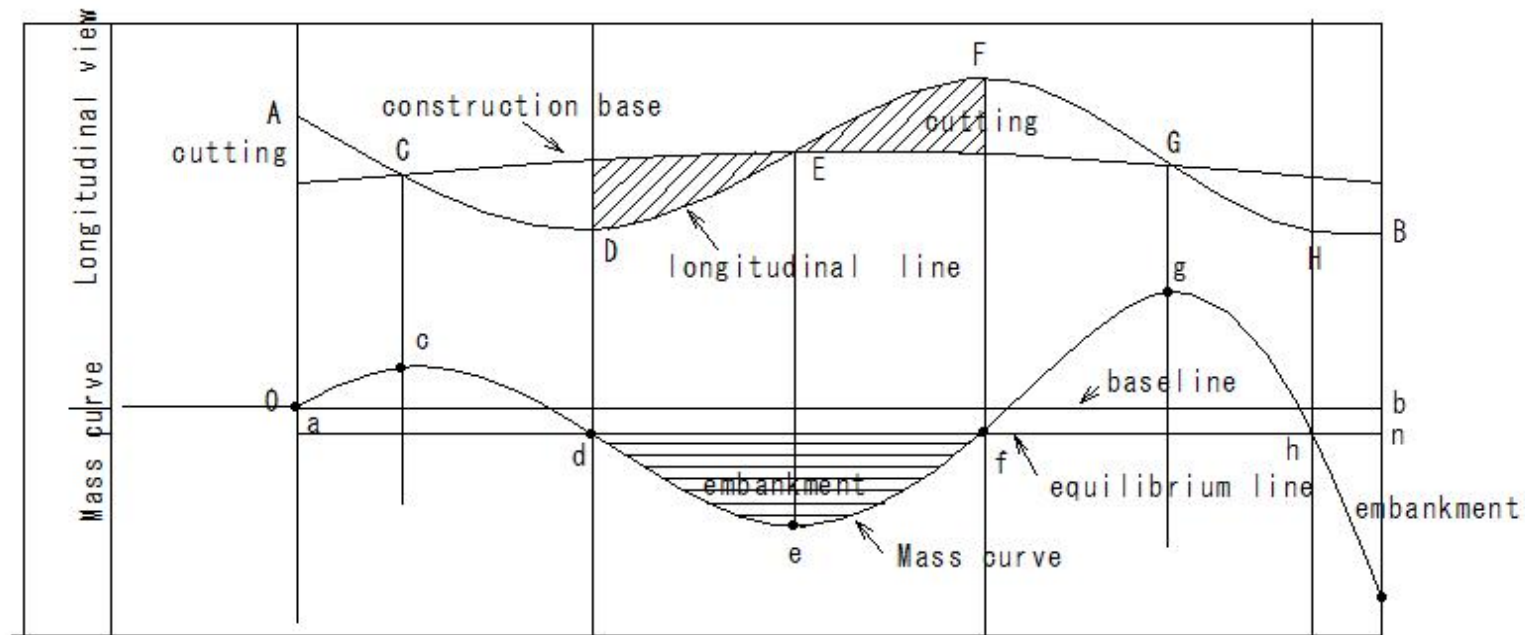
The lower layer has a larger particle size

The tip is attached to the dam
Deposition

D228
E580

(I646)Mass curve

(I646)Mass curve

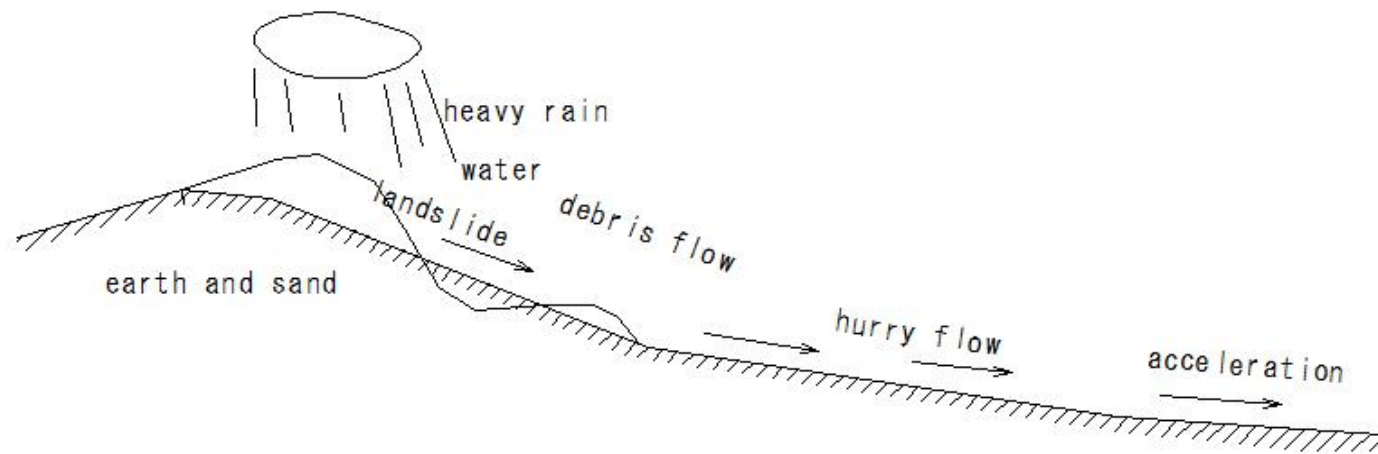


Volume distribution for cutting and embankment
soil volume equilibrium
Consider transportation distance

(I647)Debris flow

(I647)Debris flow

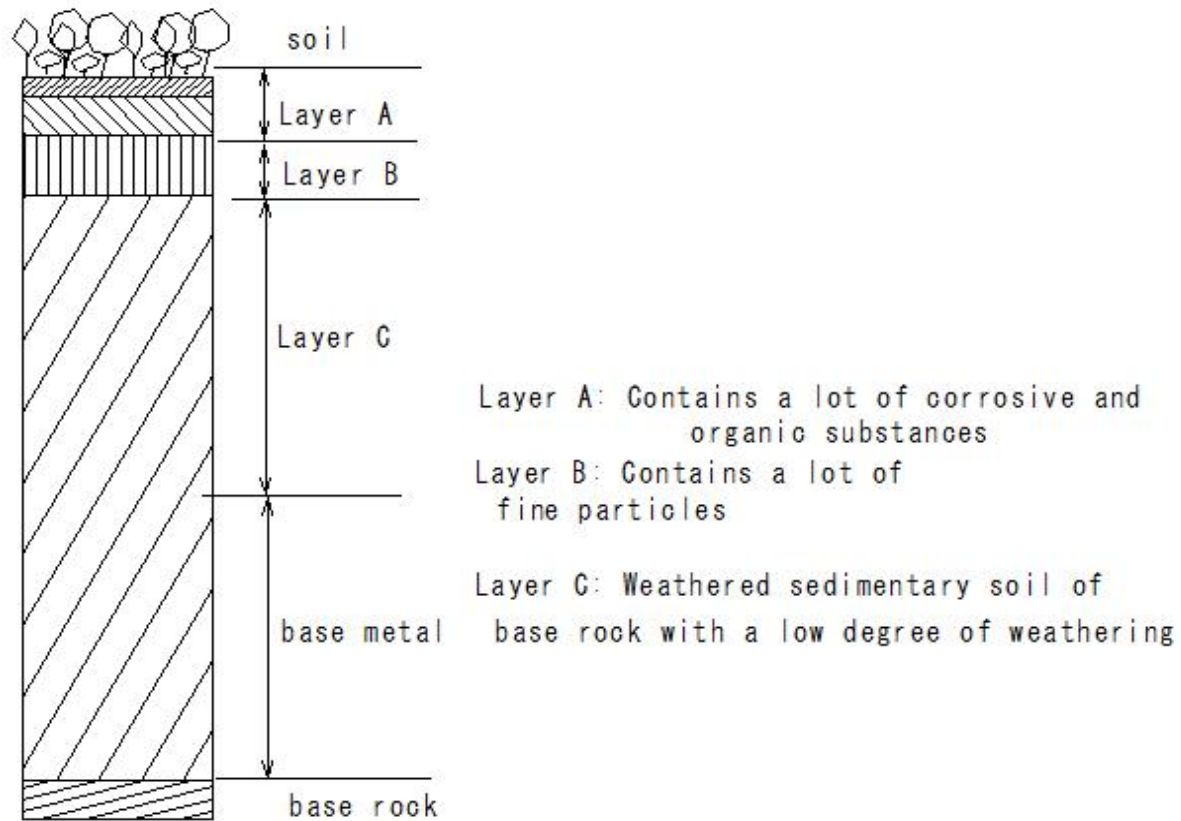
Debris flow



E582

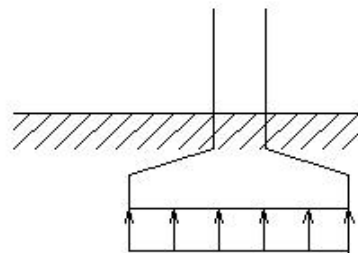
(I648) Soil profile

(I648) Soil profile

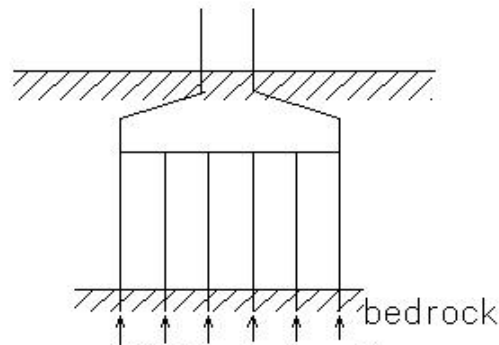


(I649)Foundation work

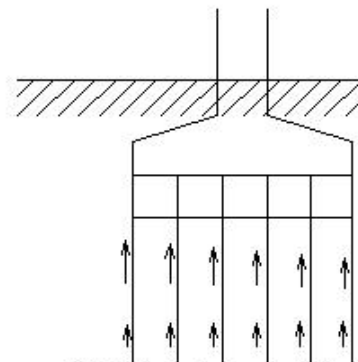
(I649)Foundation work



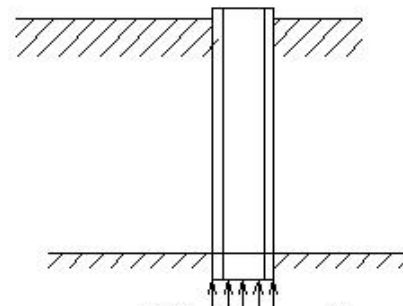
① Spread foundation



② Support pile



③ Friction pile

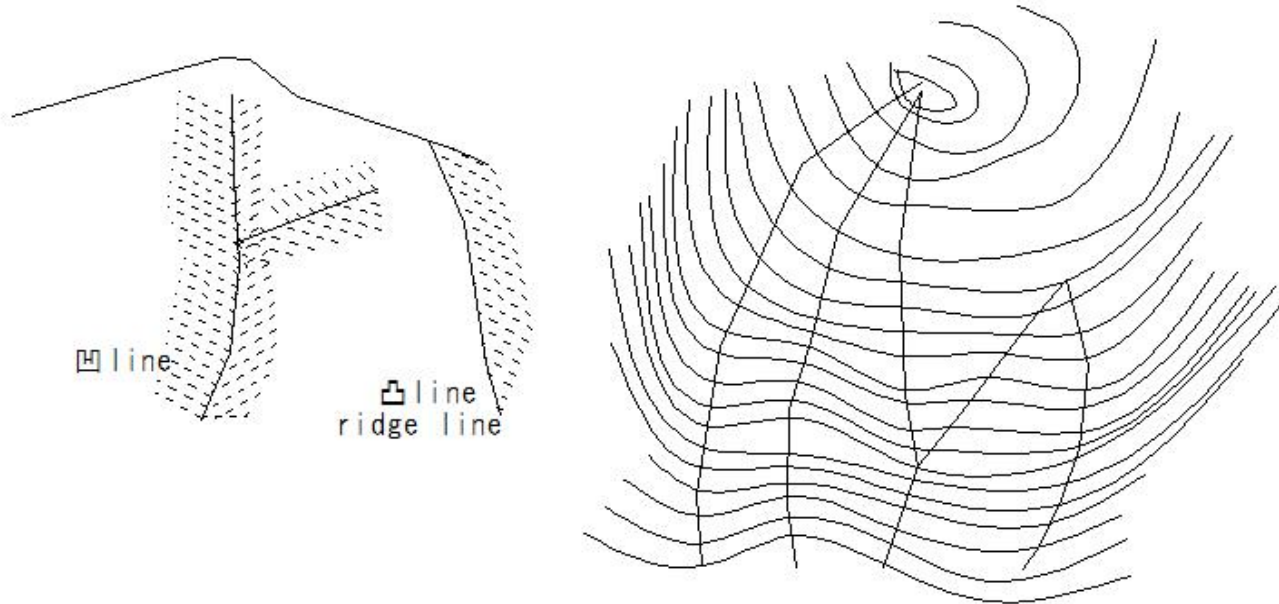


④ Caisson foundation

(I650)Ridge line

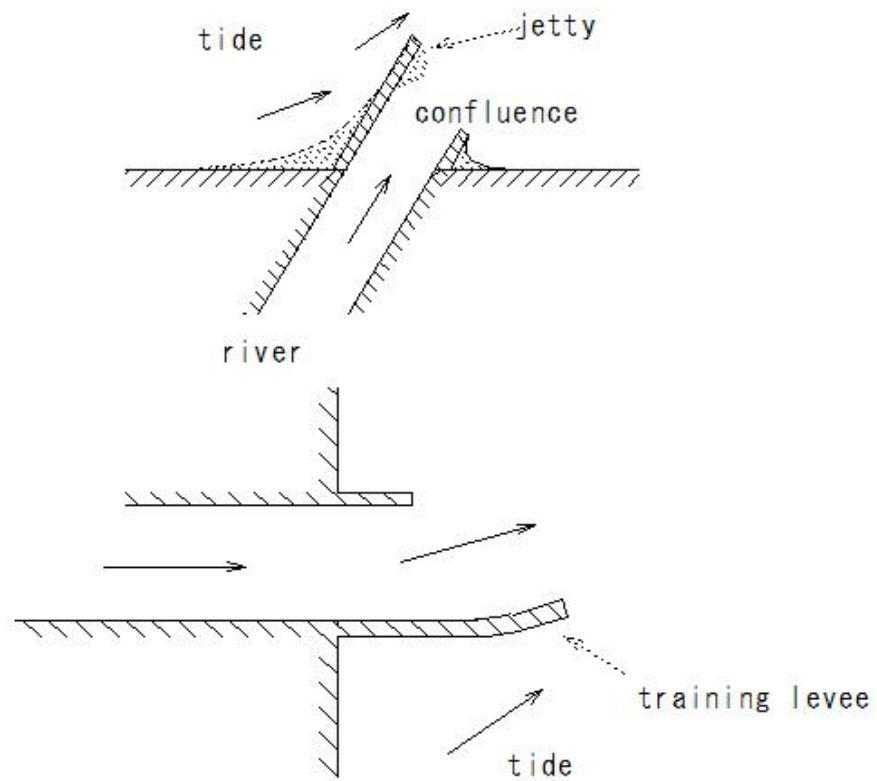
(I650)Ridge line

Ridge line



(I651) Jetty

(I651) Jetty

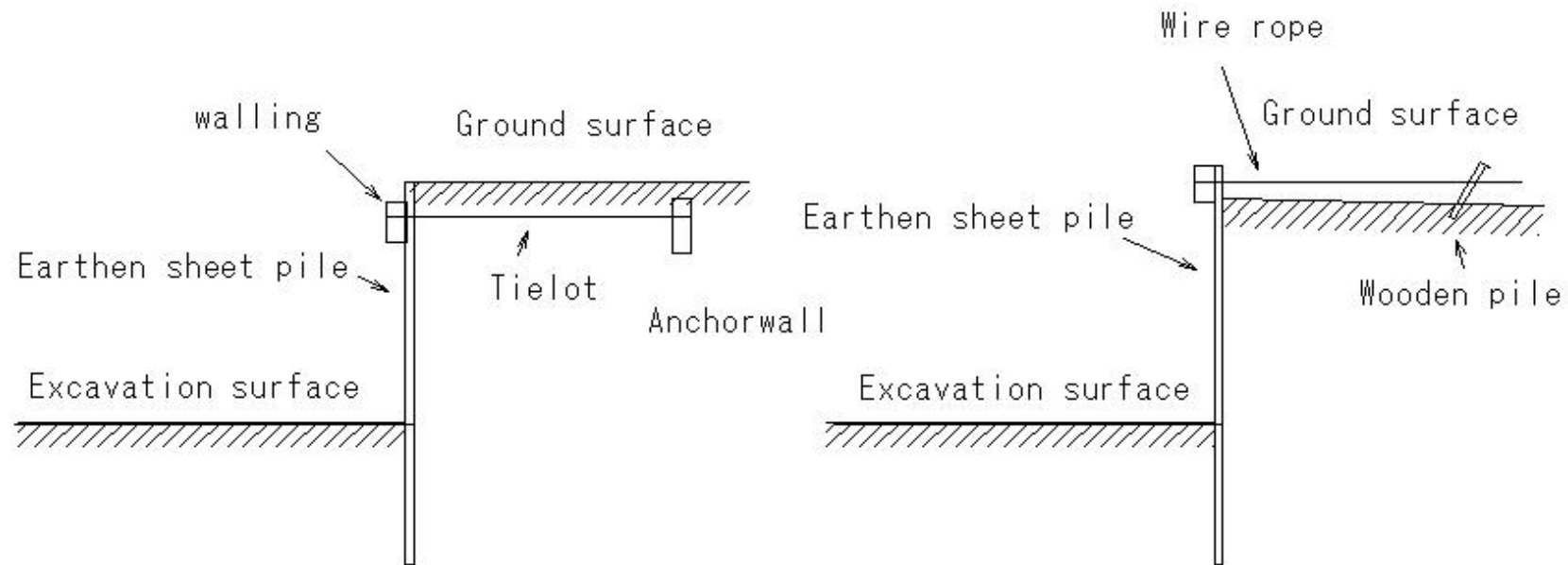


R446

(I652)Sheathing work

(I652)Sheathing work

Sheathing work



F252

(I653)Slope tamping

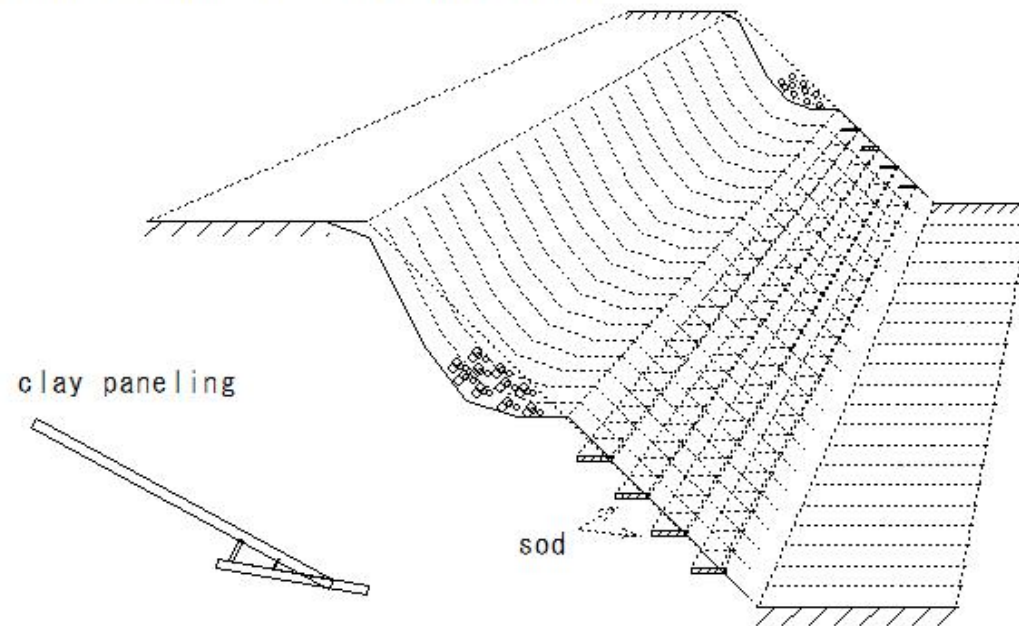
(I653)Slope tamping

Slope tamping

Plant sod on the slope of the embankment

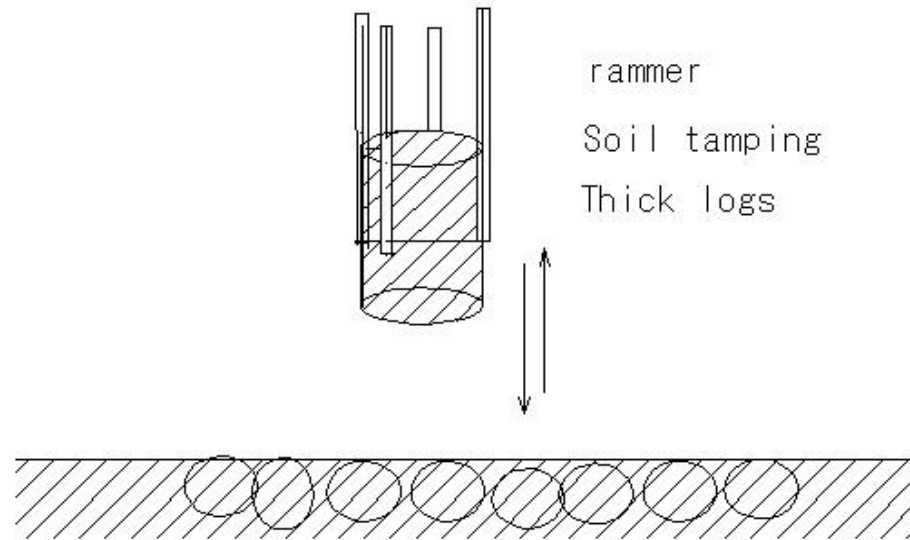
Compact and finish the slope surface

Compact the slope by pounding it with clay panels.



(I654)Rammer

(I654) Rammer



(I655)Trafficability

(I655) Trafficability

Trafficability

Degree of runnability of the machine

1 Wetland bulldozer

2 Scrape Dozer

3 Bulldozer

4 towed scraper

5 Motor Scraper

6 Dump Truck

Cone Index (kN/m²)

over 300

600 or more

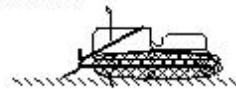
500-700 or more

700-1000 or more

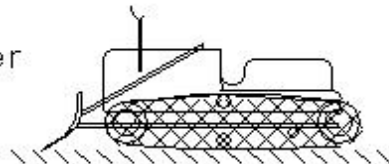
1000-1300 or more

1200-1500 or more

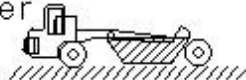
1 Wetland bulldozer



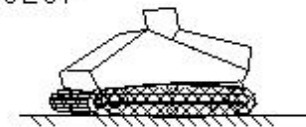
3 Bulldozer



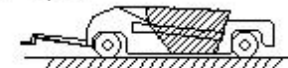
5 Motor Scraper



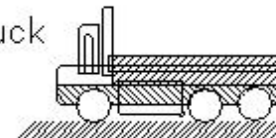
2 Scrape Dozer



4 towed scraper



6 Dump Truck



E585

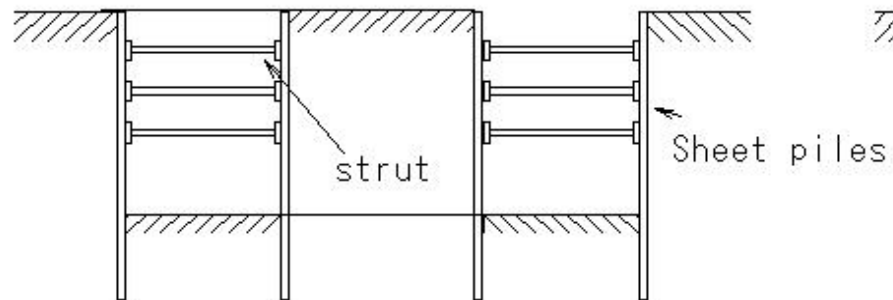
(I656)Trench cut method

(I656)Trench cut method

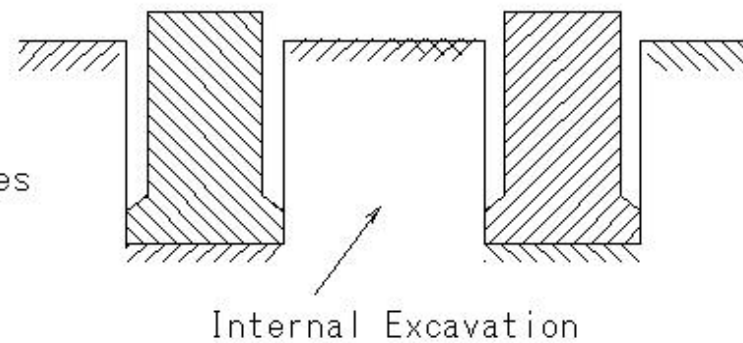
Trench cut method

Construction of underground structures

Excavation of the periphery



Construction of the periphery

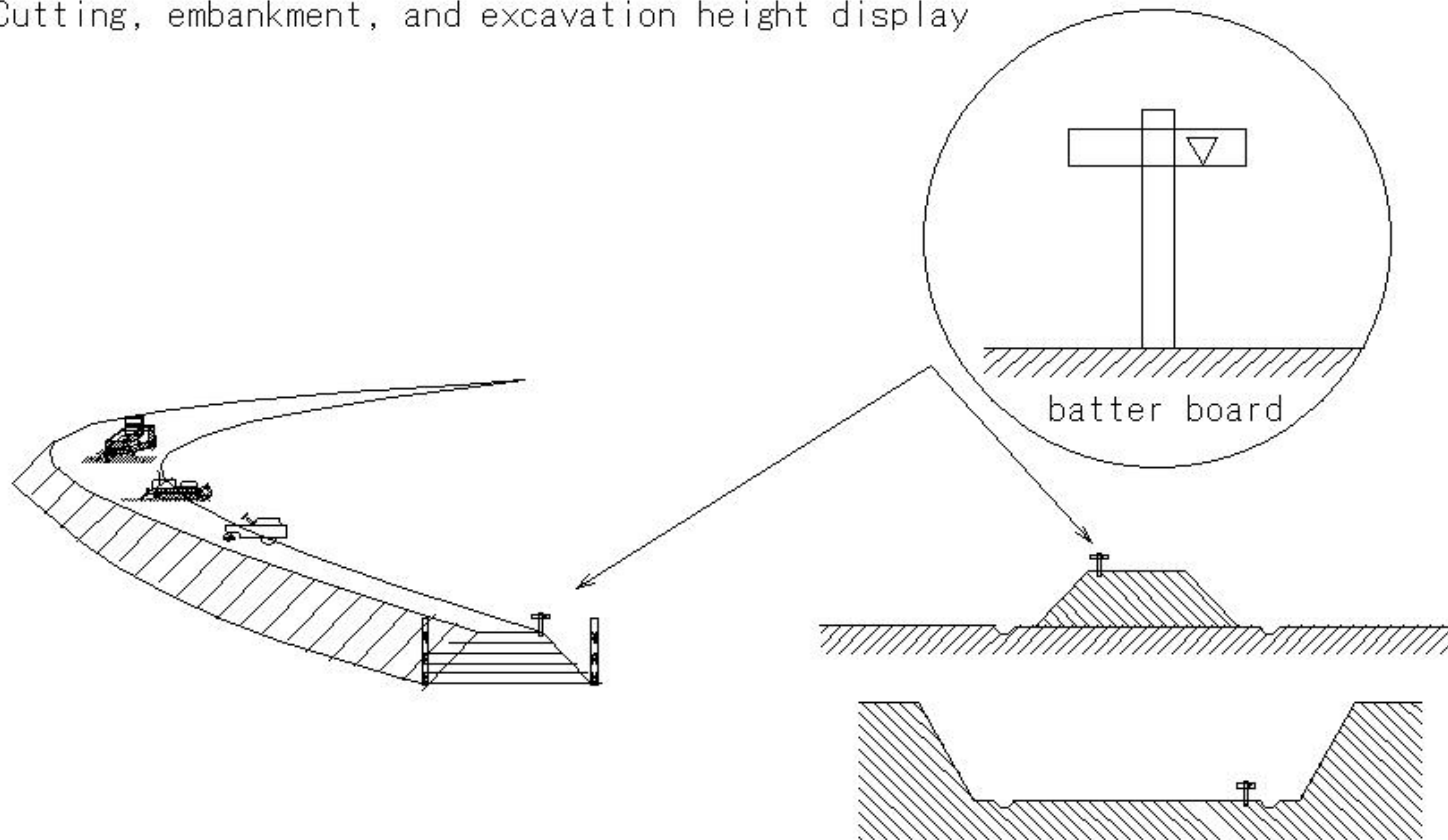


(I657) Batter board

(I657) Batter board

Batter board

Cutting, embankment, and excavation height display



E588

(I658)Impermeable wall

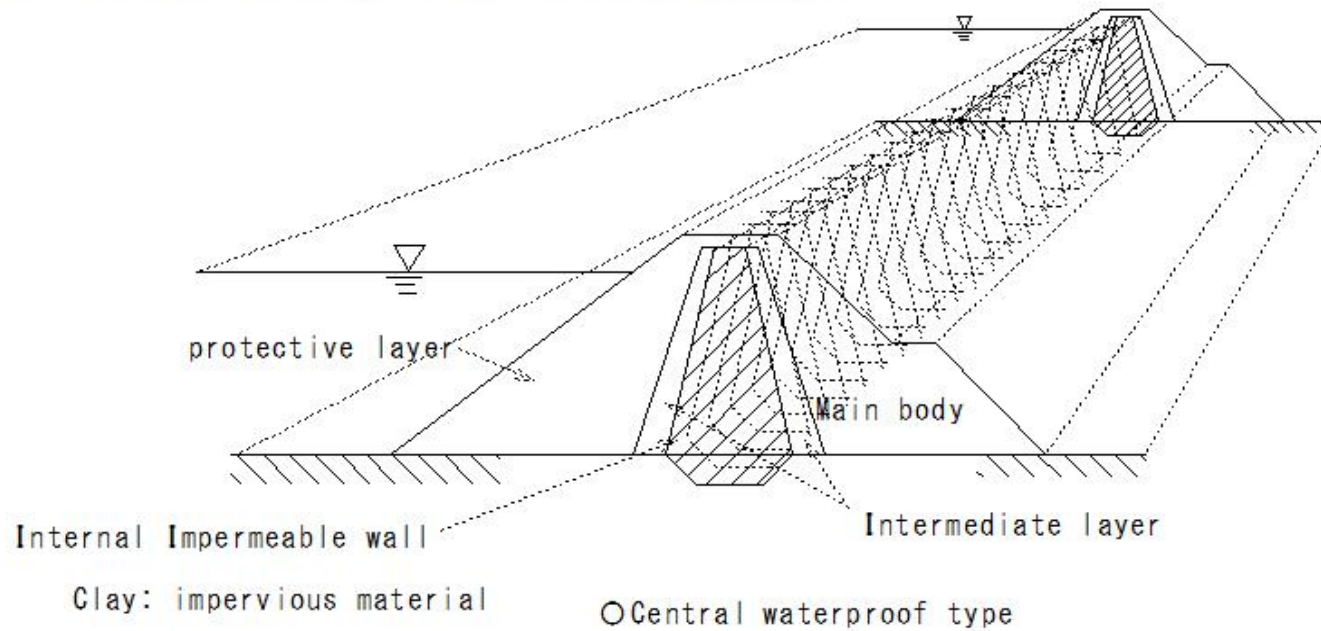
(I658) Impermeable wall

Internal impervious wall

earth dam

rock fill dam

- Impermeable wall installed inside the embankment body



(I659)Internal impervious wall

(I659)Internal impervious wall

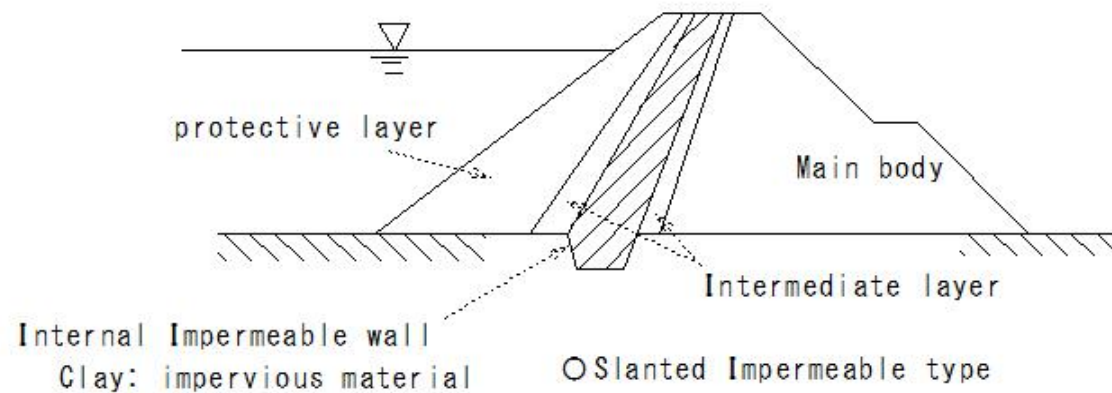
Internal impervious wall

earth dam

rock fill dam

- Impermeable wall installed inside the embankment body

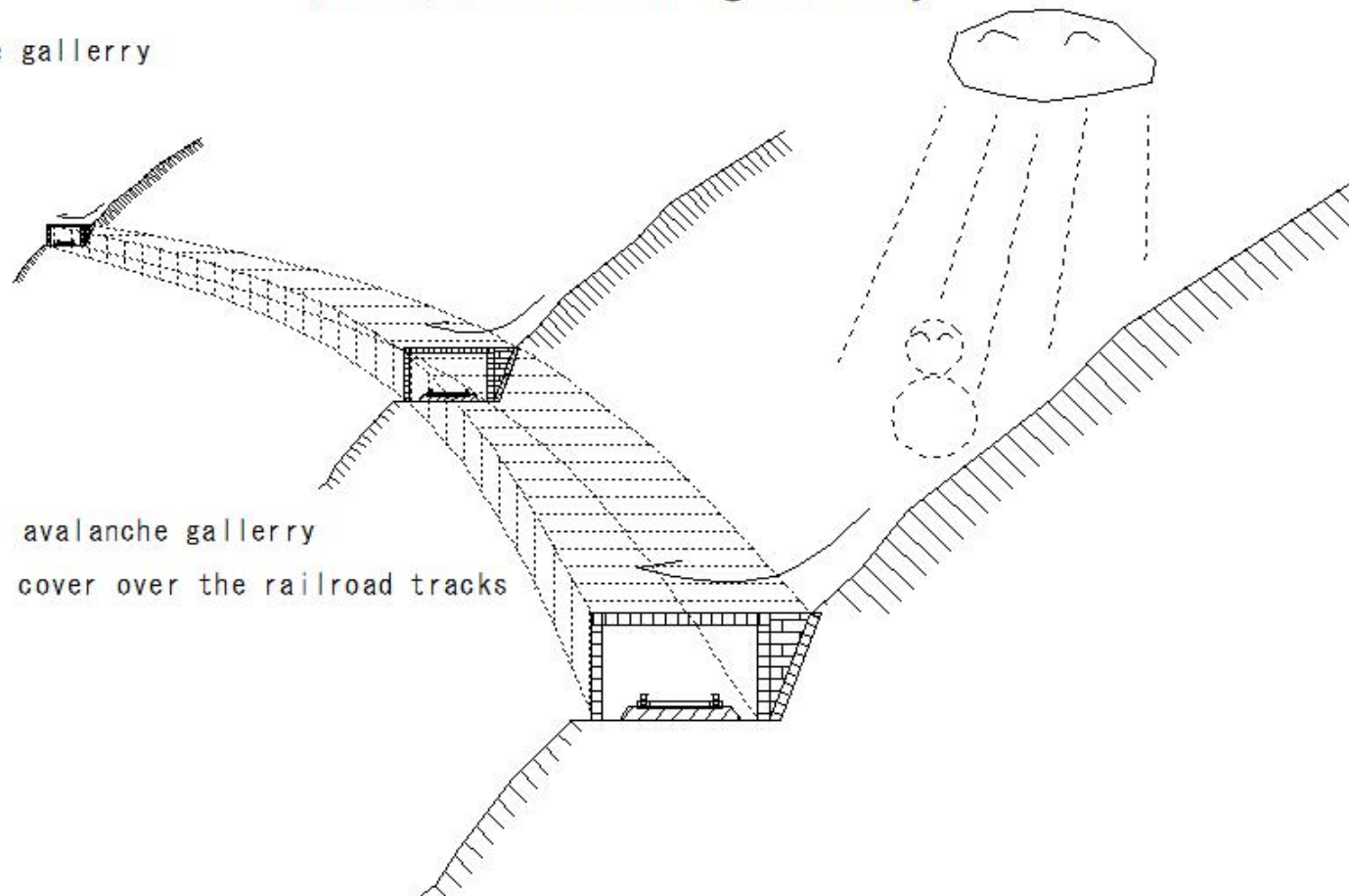
○ Slanted Impermeable type



(I660)Avalanche gallery

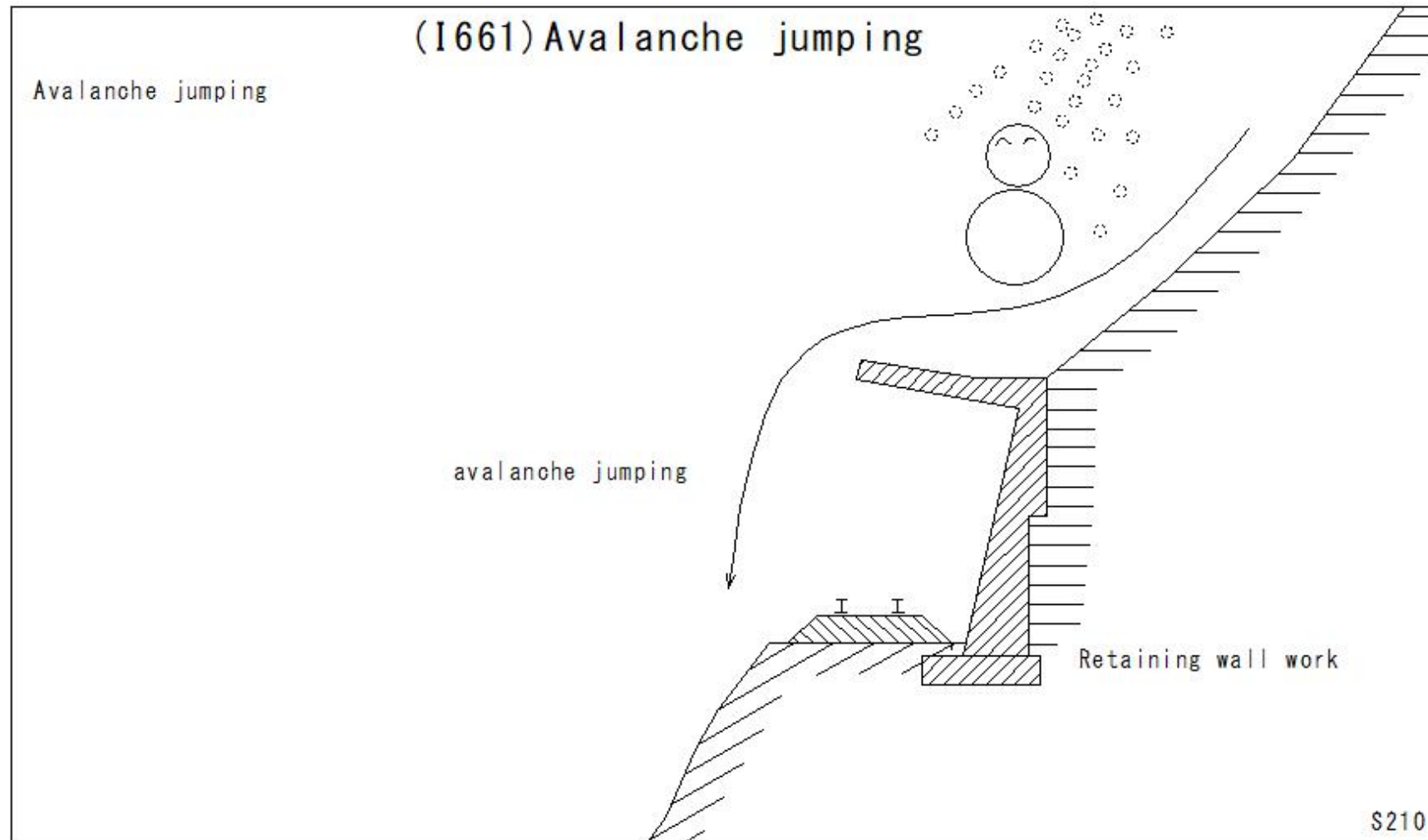
(I660)Avalanche gallery

Avalanche gallery



S209

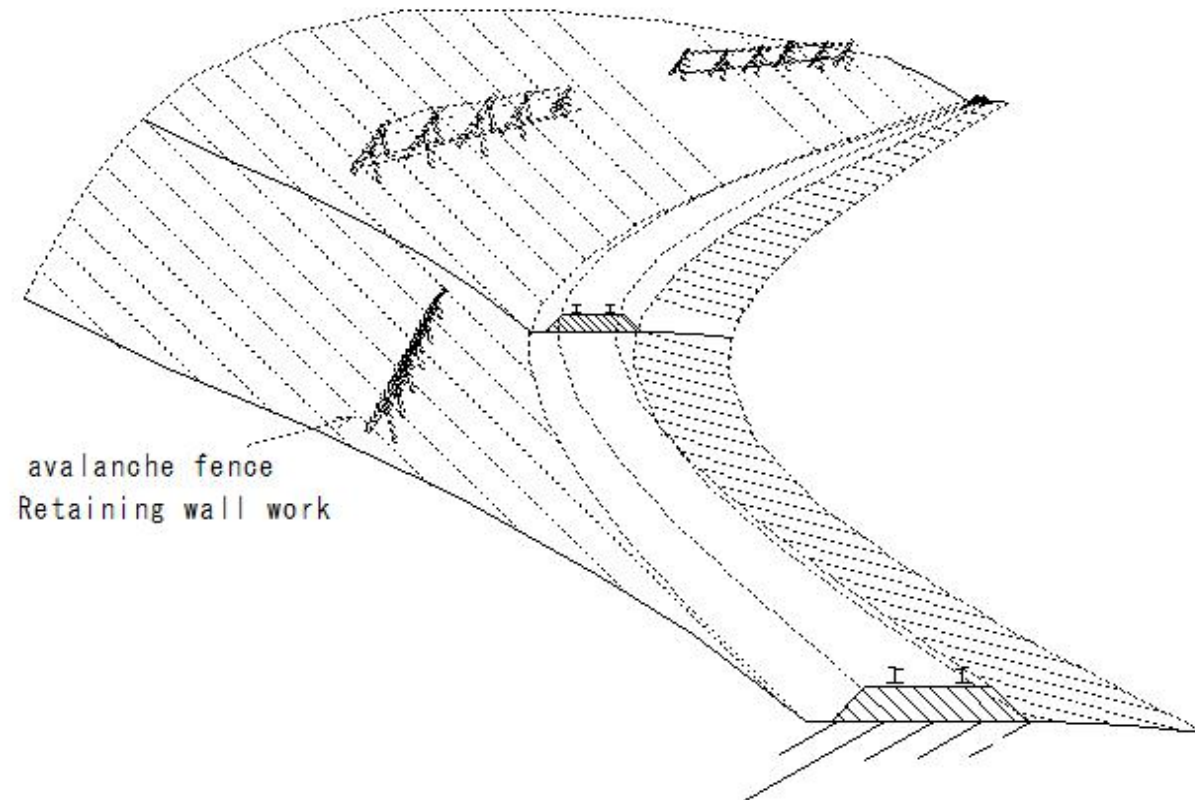
(I661)Avalanche jumping



(I662)Avalanche fence

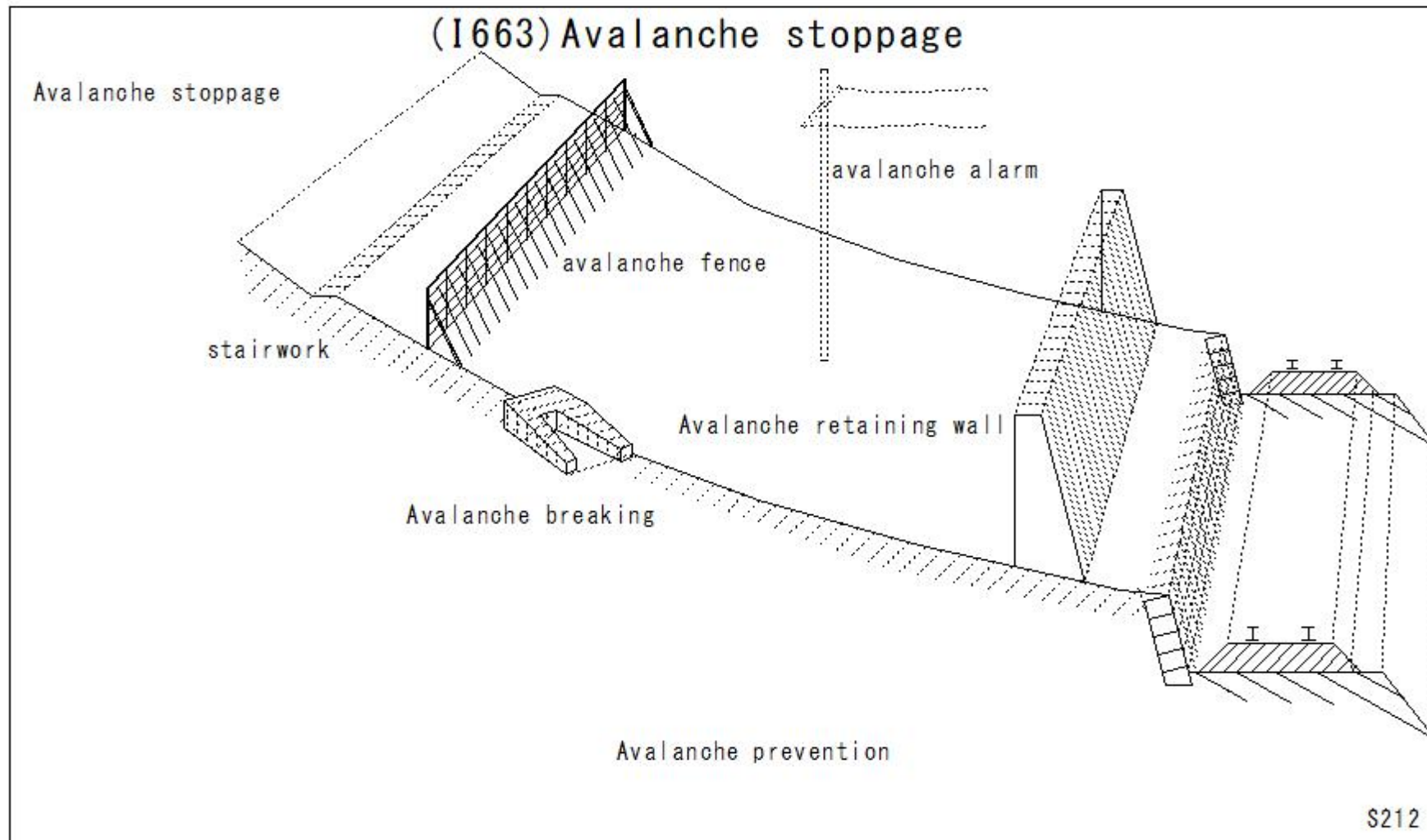
(I662)Avalanche fence

Avalanche fence



S211

(I663)Avalanche stoppage

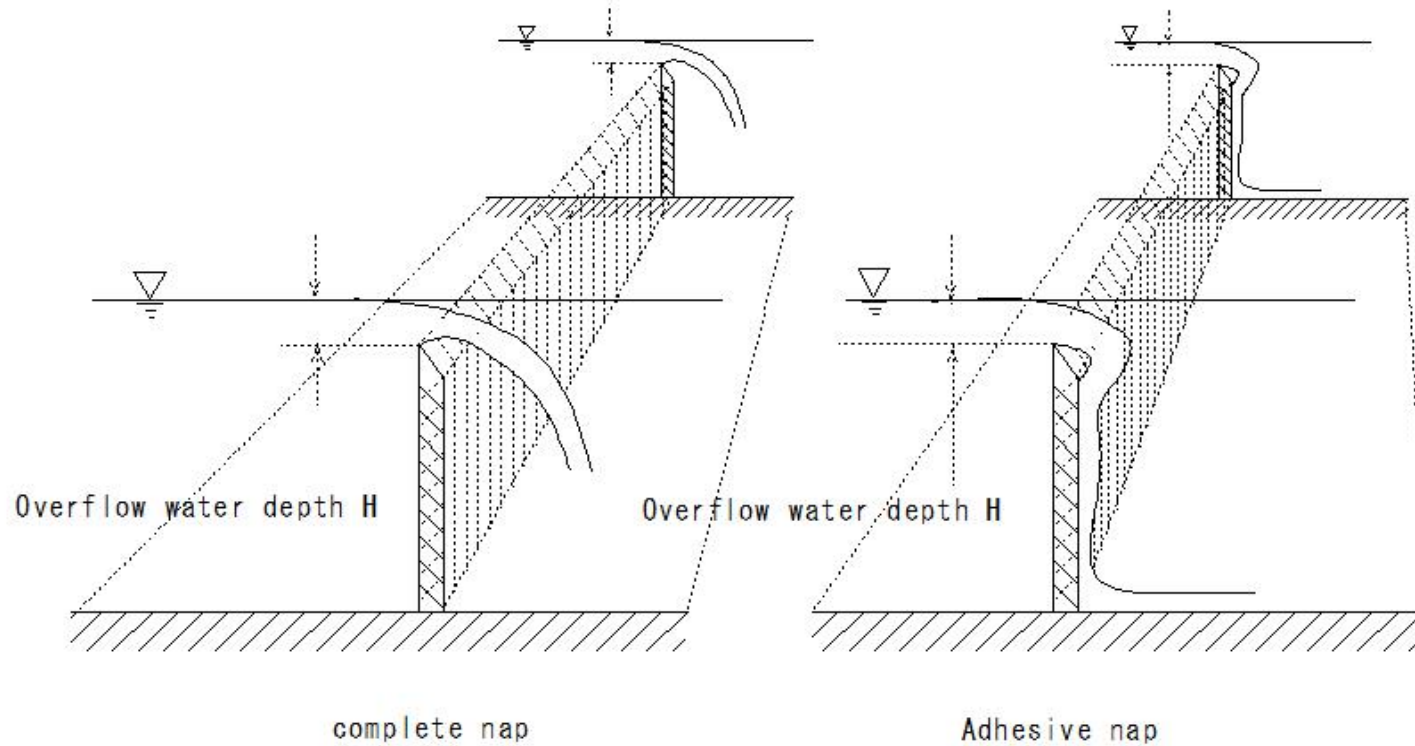


(I664)Nappe

(I664) Nappe

Nappe

Shape of water falling over a tooth-shaped weir



R448

(I665)Water supply(Water softening)

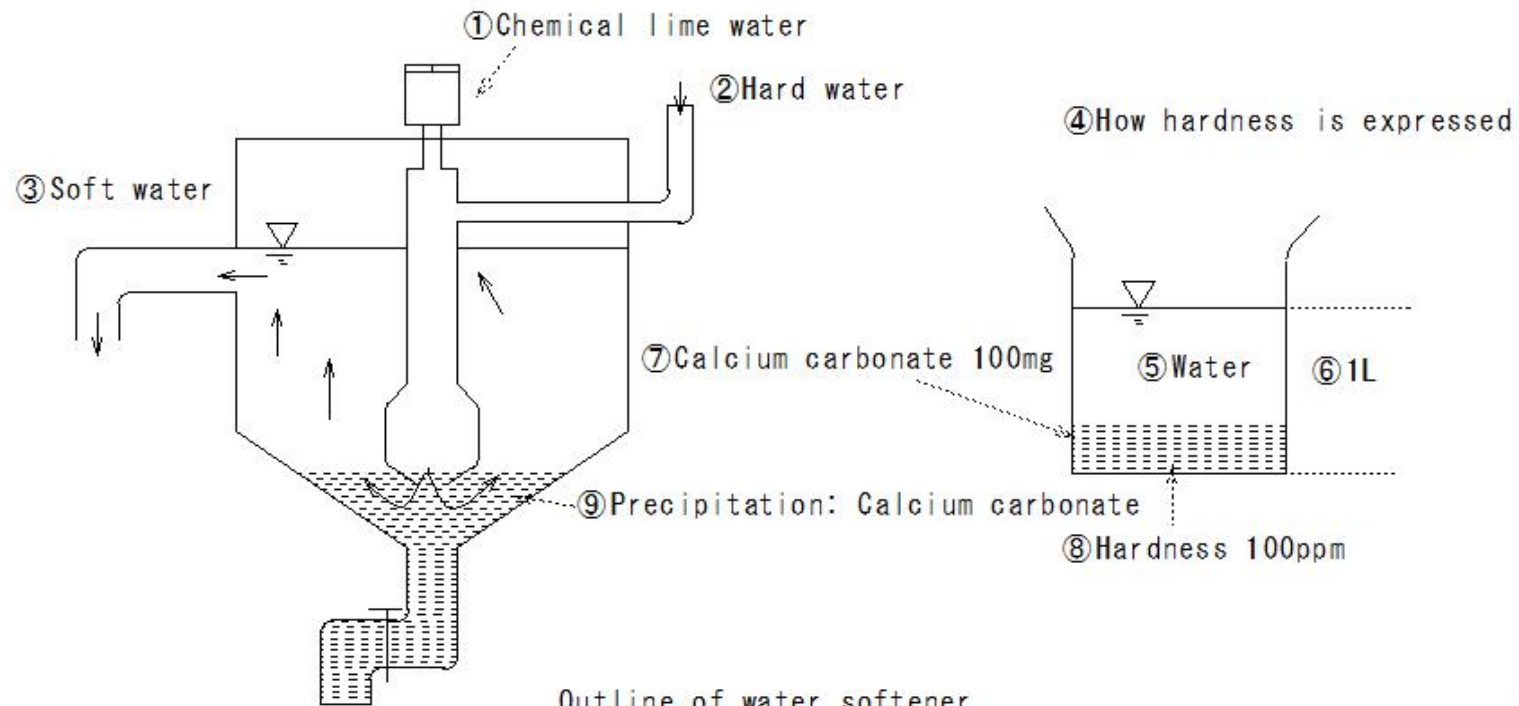
(I665)Water supply(Water softening)

Water softening method

How to treat hard water to make it soft

Lowering water hardness

Soft water: calcium carbonate in water 100ppm or less

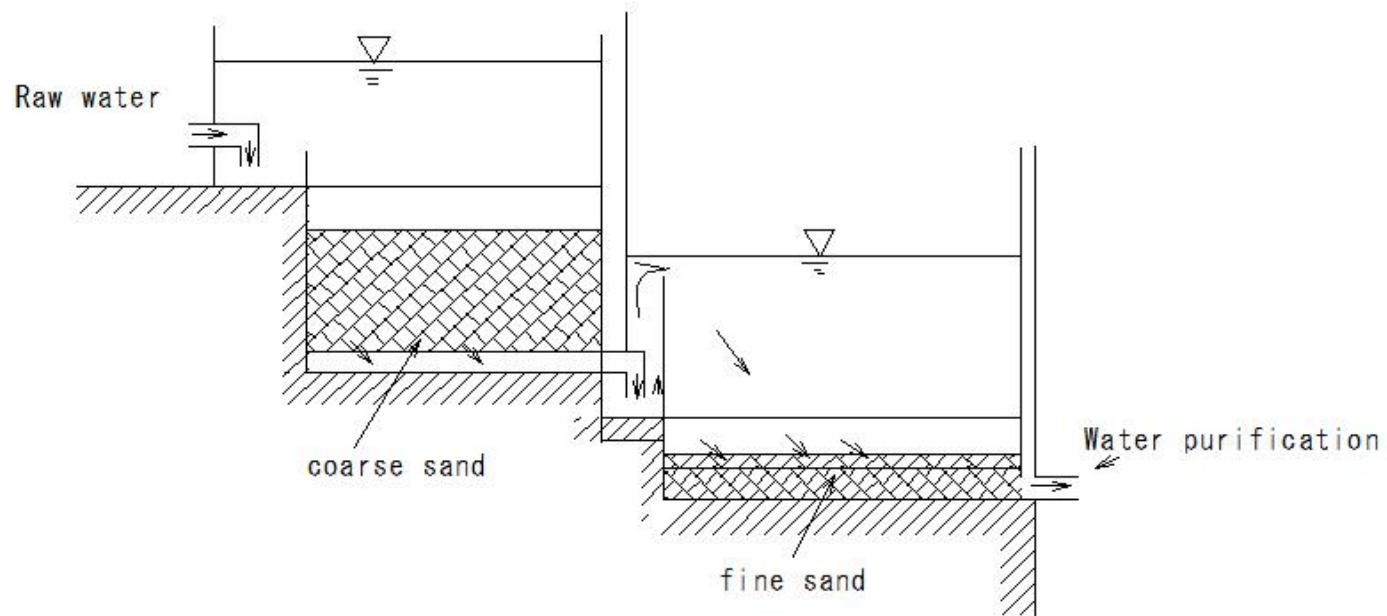


Outline of water softener

(I666)Double filtration

(I666)Double filtration

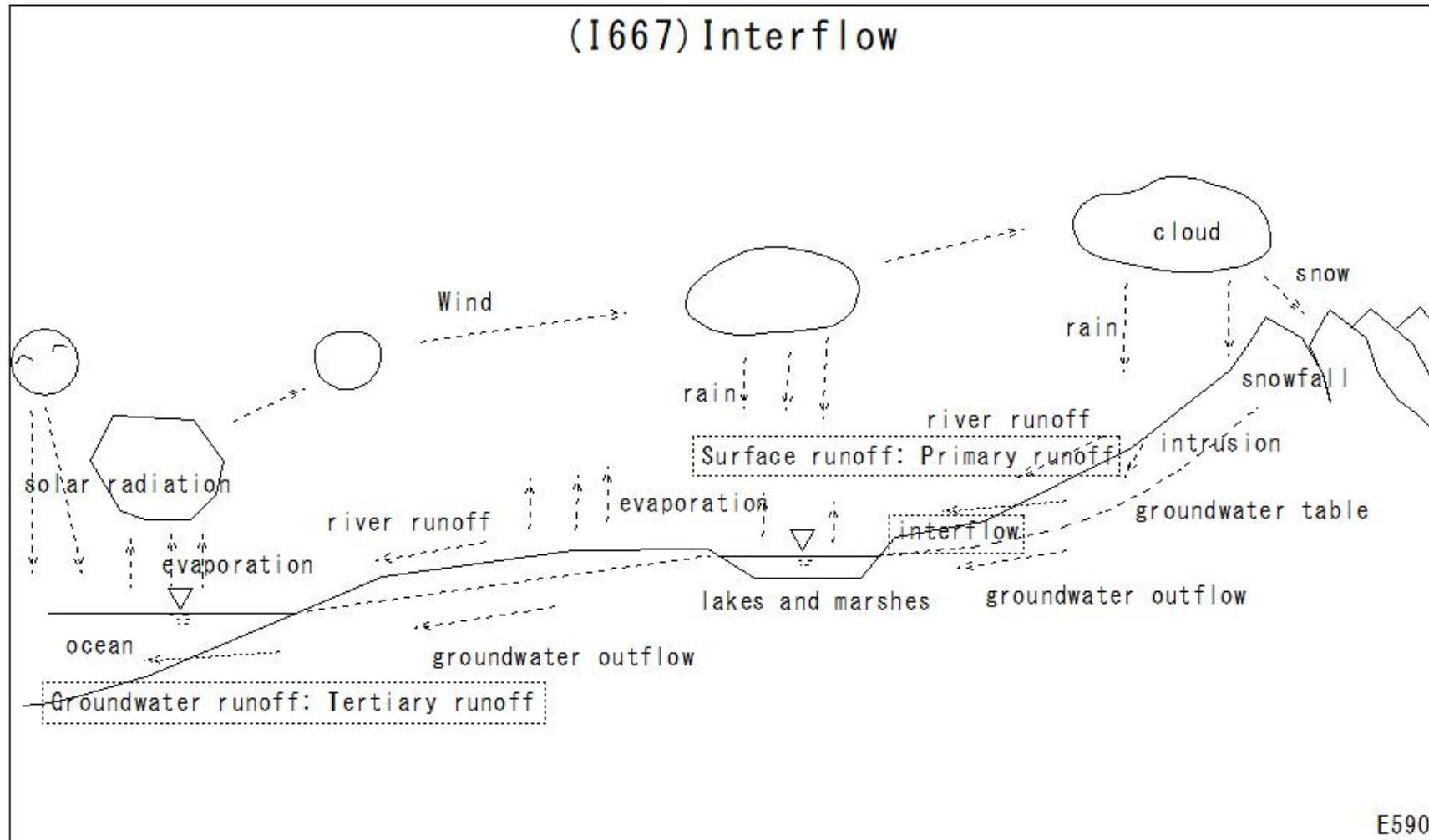
Double filtration



Filtration performed twice before and after

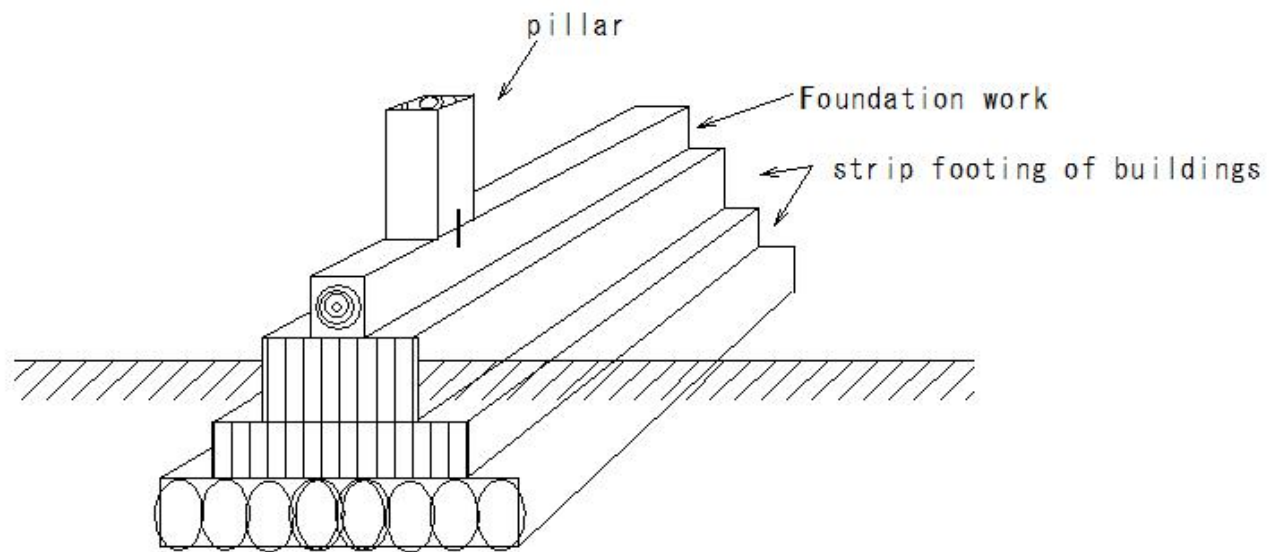
E589

(I667)Interflow



(I668)Strip footing

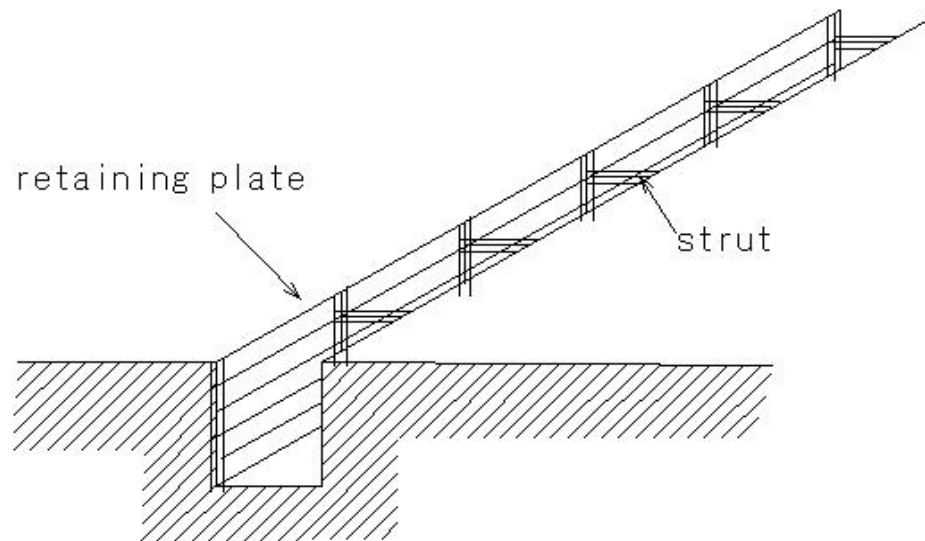
(I668)Strip footing



(I669)Trench excavation

(I669)Trench excavation

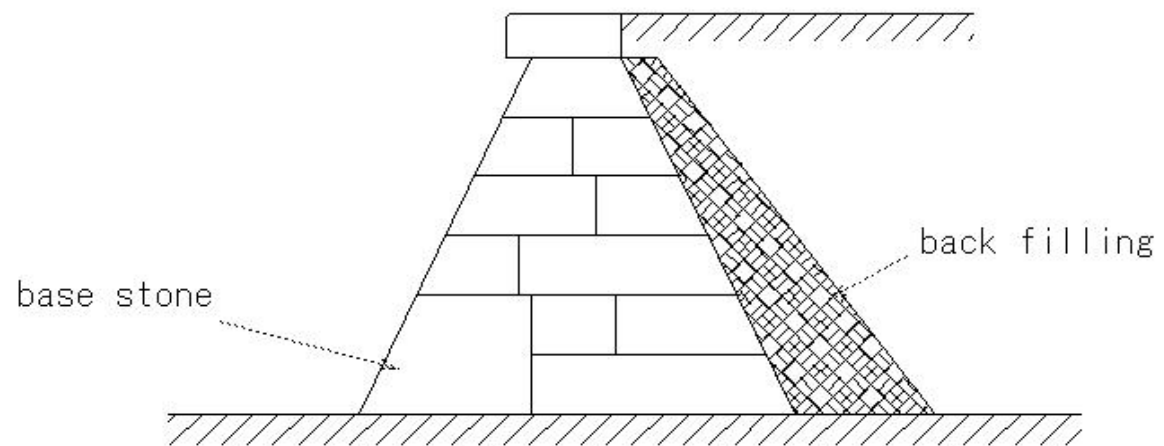
Trench excavation



Excavation in the shape of an elongated groove

(I670)Base stone

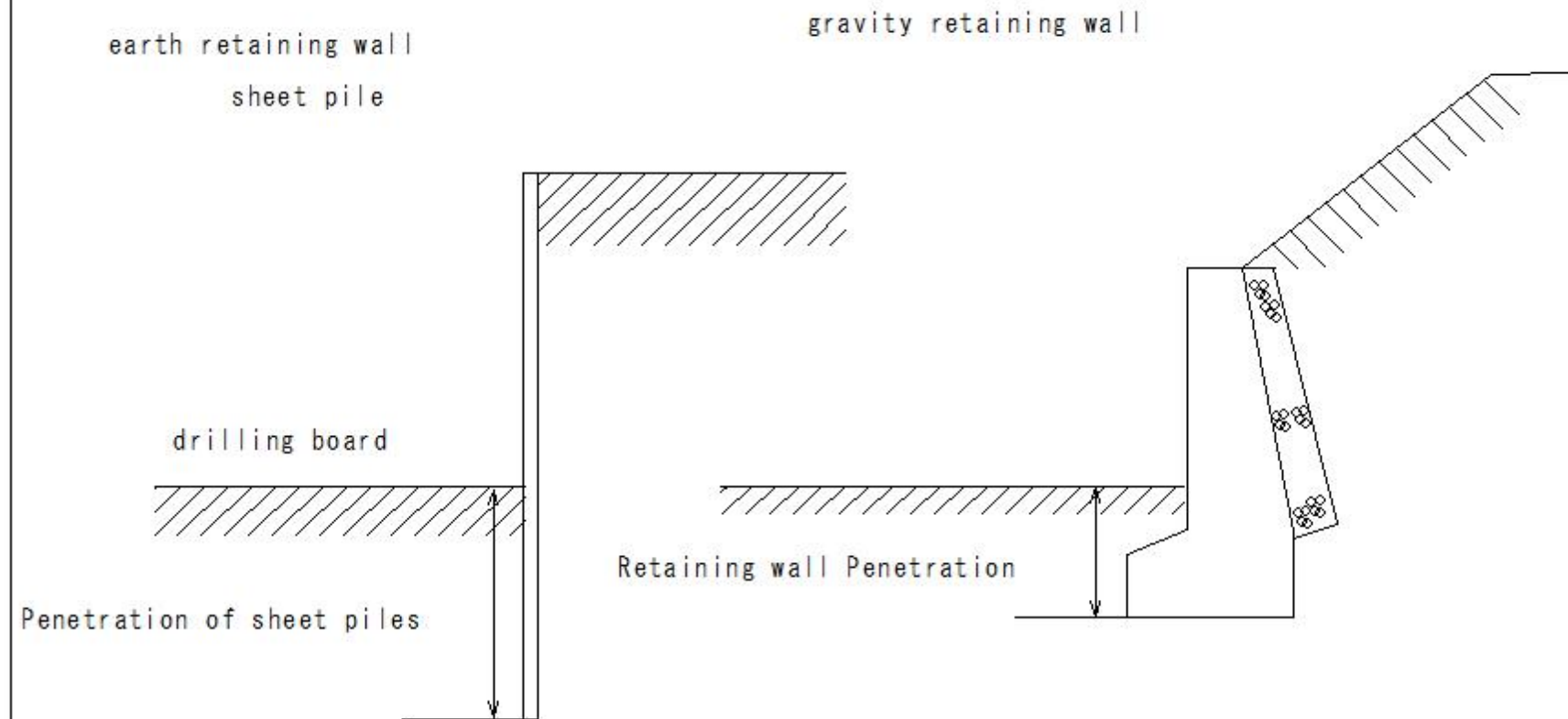
(I670)Base stone



F257

(I671)Penetration

(I671)Penetration



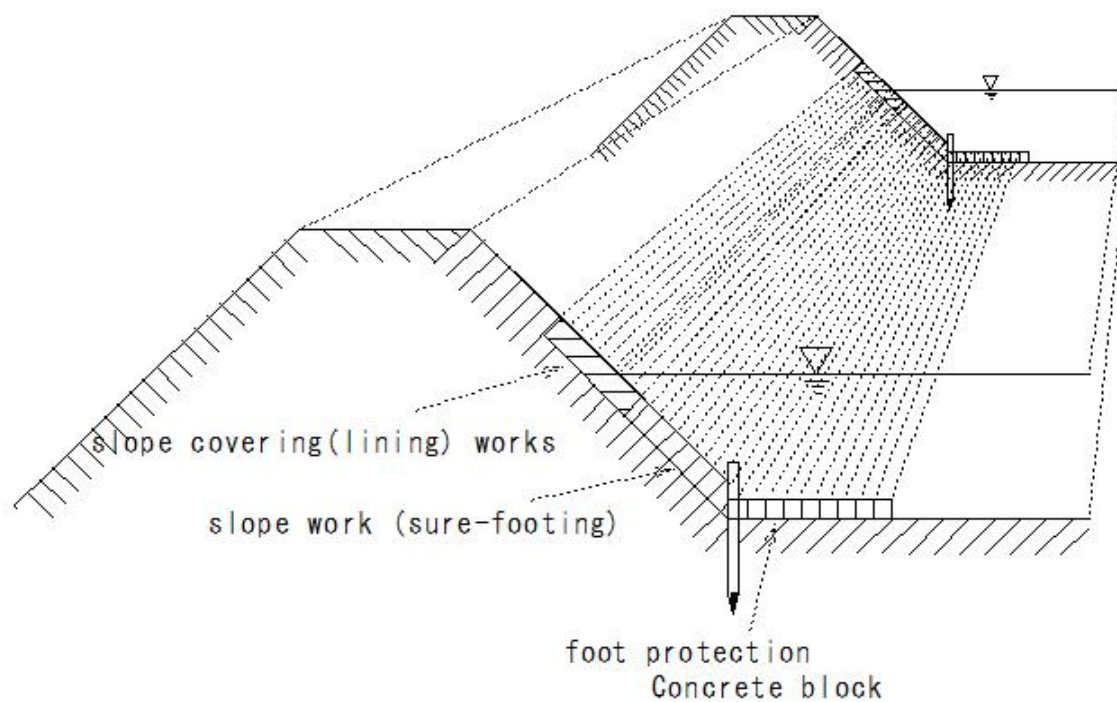
F258

(I672)Foot protection

(I672)Foot protection

foot protection

The toe of slope in front of the bank protection
Prevent from being destroyed by scouring



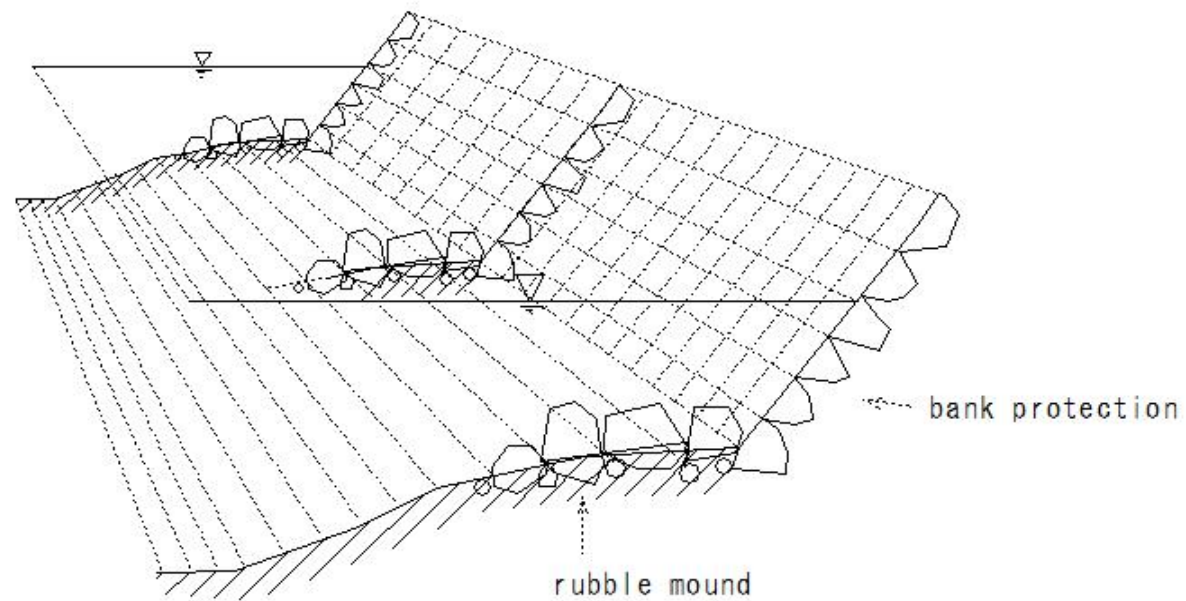
R450

(I673)Foot protection

(I673)Foot protection

Foot protection

Prevent bank protection- toe of slope from being destroyed by scouring



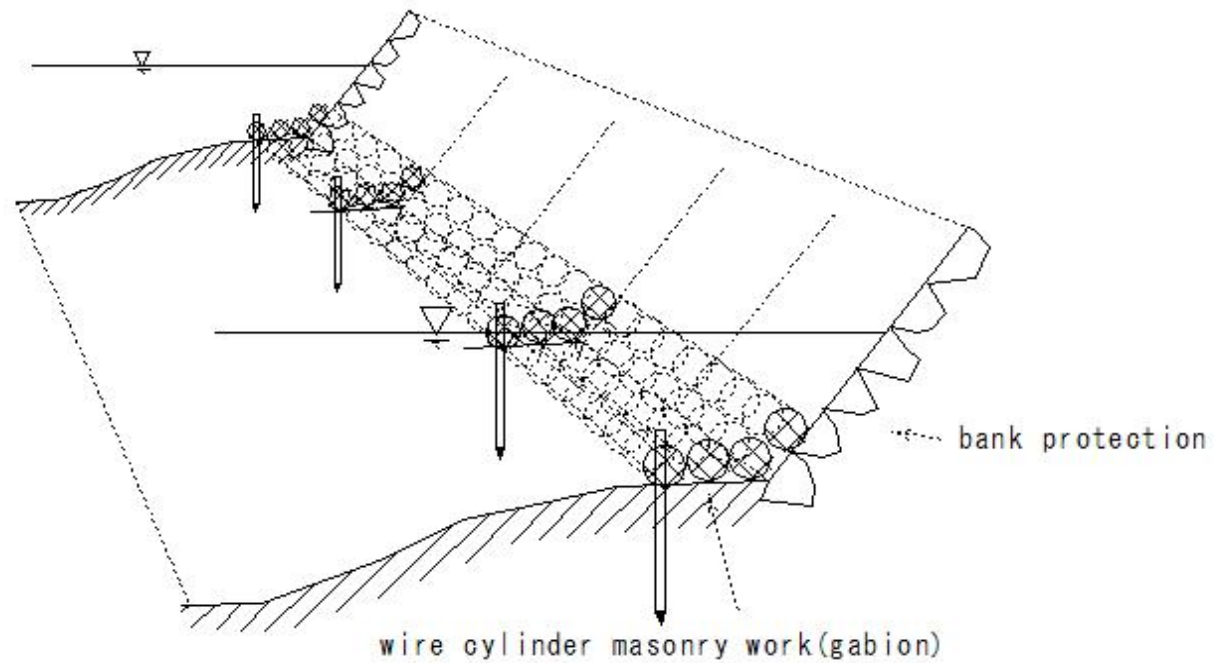
R451

(I674)Foot protection

(I674)Foot protection

Foot protection

Prevent bank protection- toe of slope from being destroyed by scouring



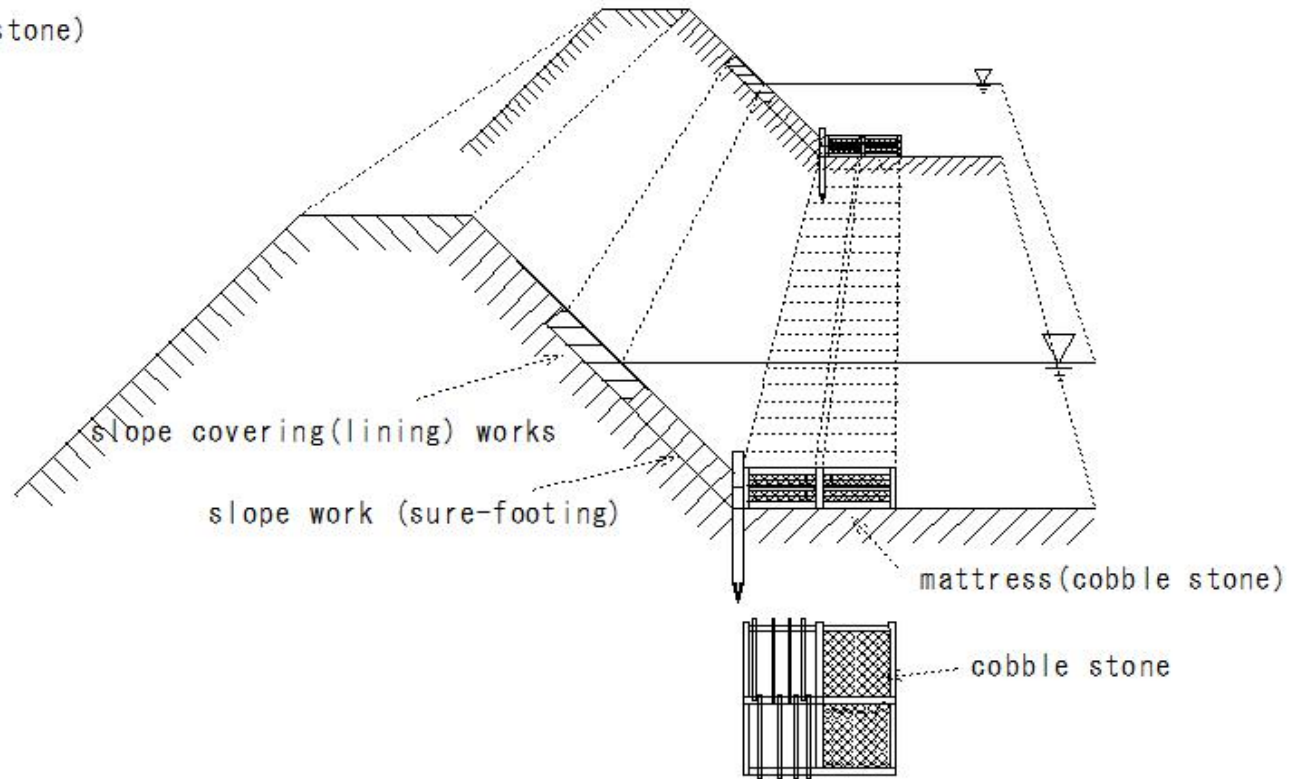
R452

(I675)Foot protection

(I675)Foot protection

Foot protection

Prevent bank protection- toe of slope from being destroyed by scouring
mattress(cobble stone)



R453

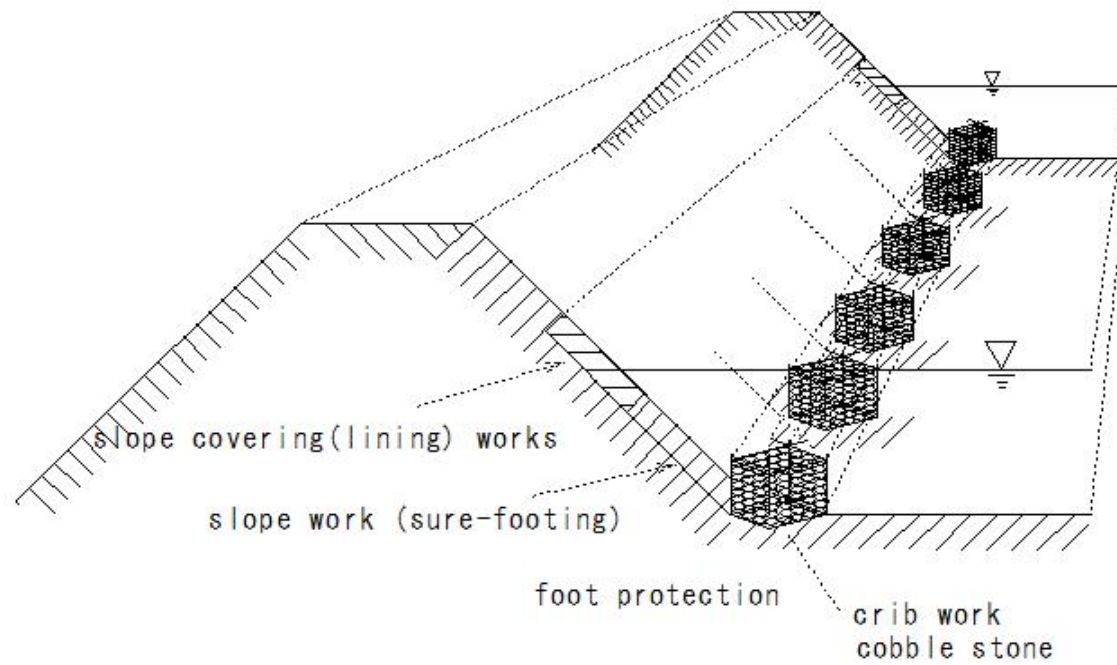
(I676)Foot protection

(I676)Foot protection

Foot protection

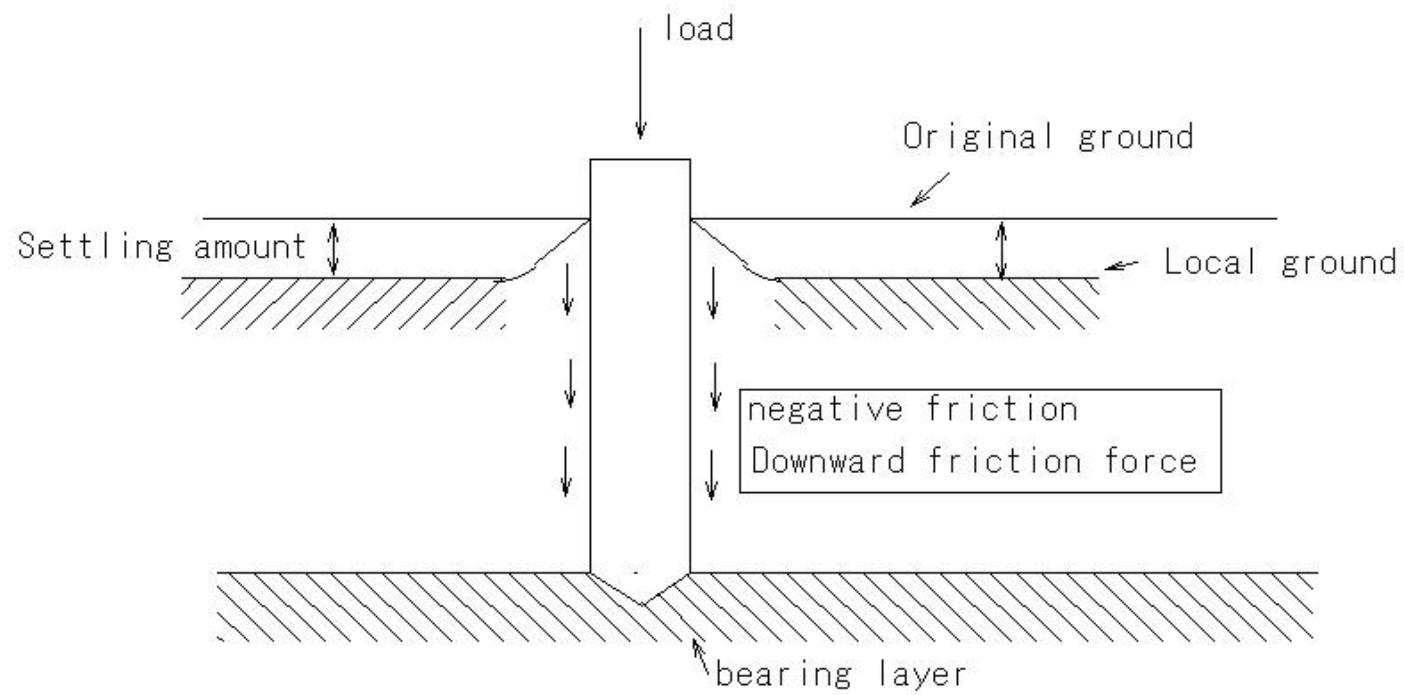
The toe of slope in front of the bank protection
Prevent from being destroyed by scouring

crib work



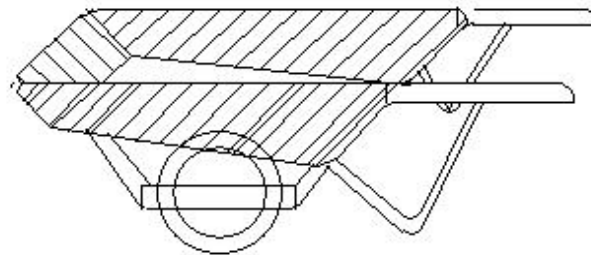
(I677)Negative friction

(I677)Negative friction



(I678)Wheel barrow

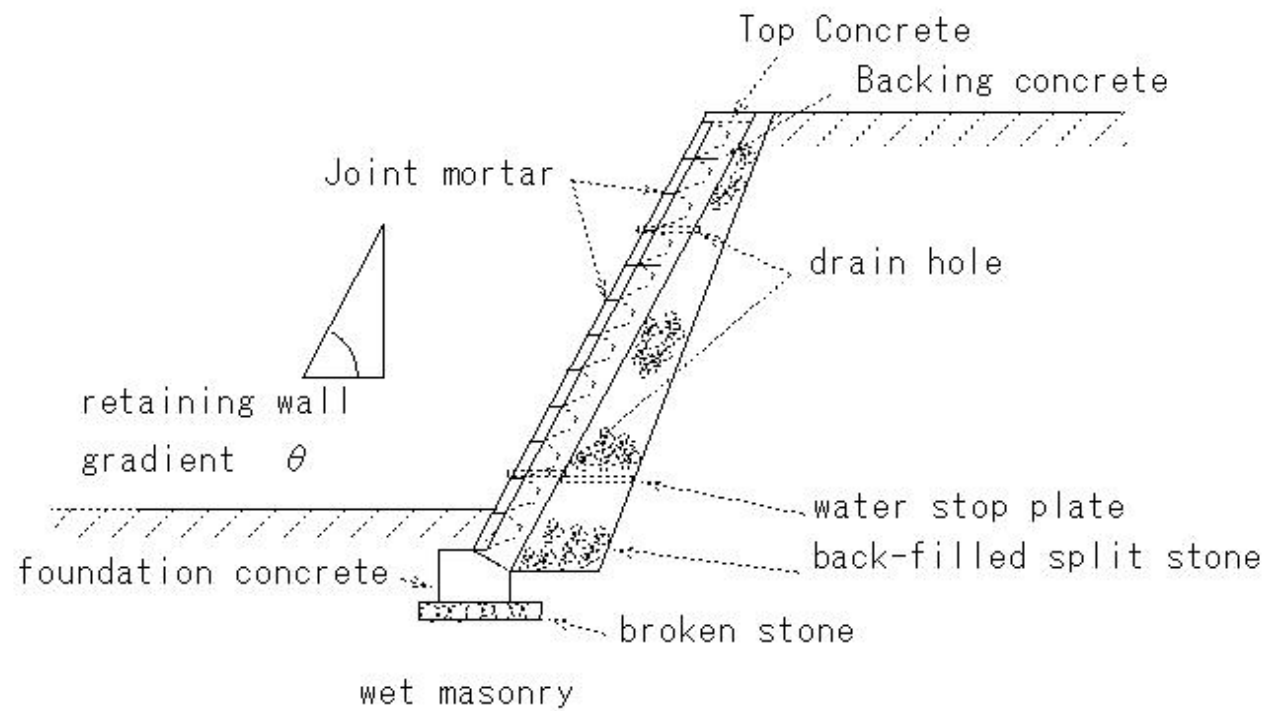
(I678)Wheel barrow



E594

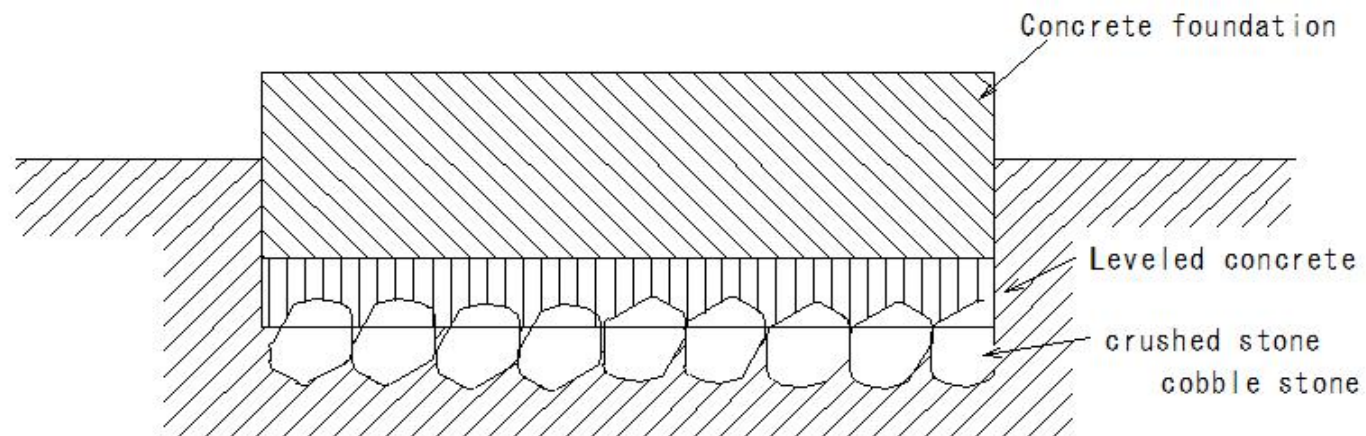
(I679)Wet masonry

(I679)Wet masonry



(I680) Spread foundation

(I680) Spread foundation



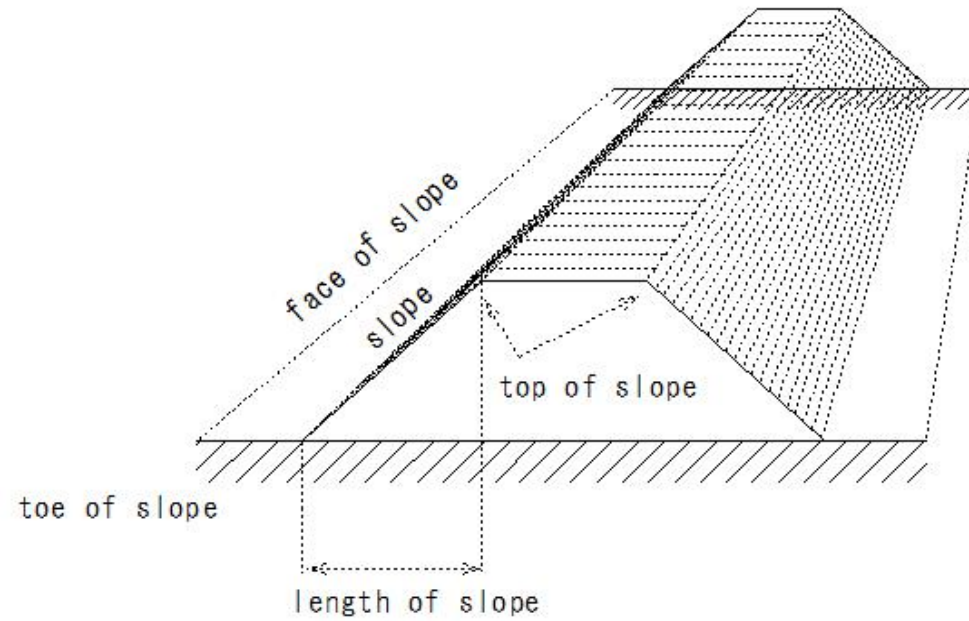
spread foundation

Sand layer N value ≥ 30

Clay layer N -value ≥ 20

(I681)Embankment(slope)

(I681) Embankment (slope)



R455

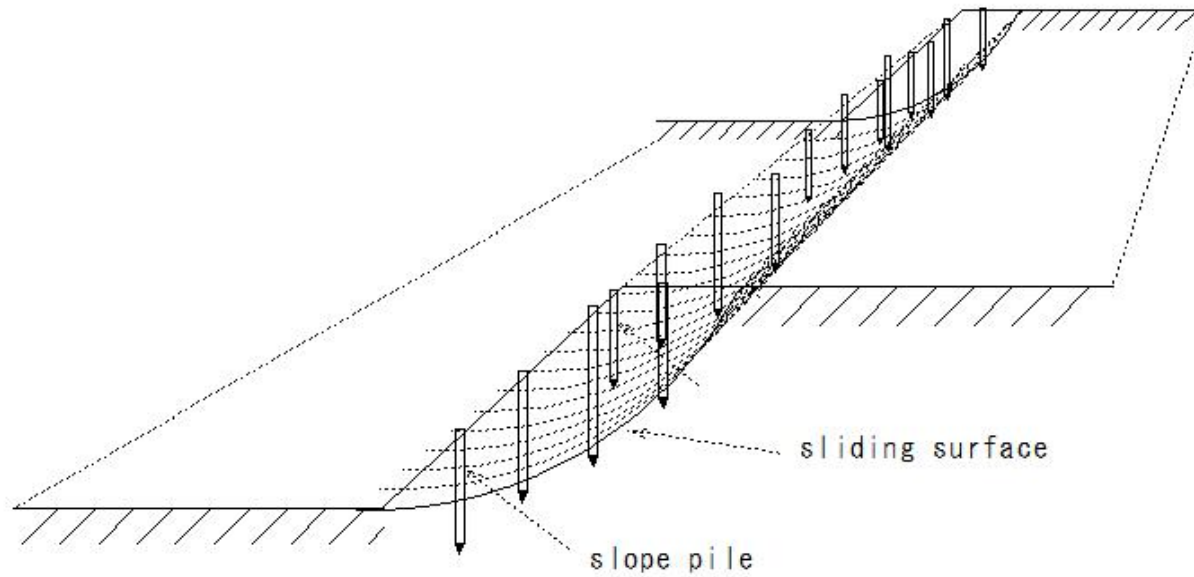
(I682)Stability of the slope(slope pile)

(I682) Stability of the slope(slope pile)

slope pile

Driving piles to strengthen the stability of the slope

Penetrate the sliding surface

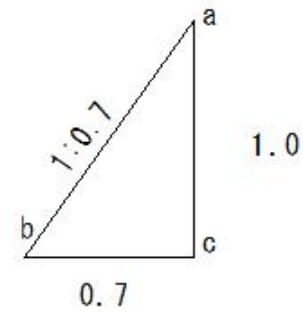
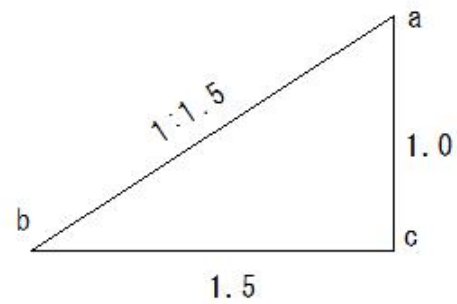
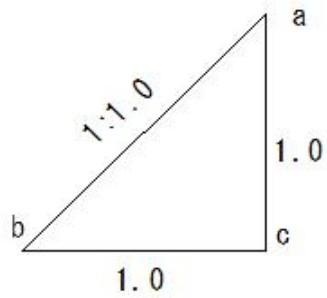


(I683) Embankment (slope gradient)

(I683) Embankment (slope gradient)

slope gradient (split)

Degree of inclination of the slope

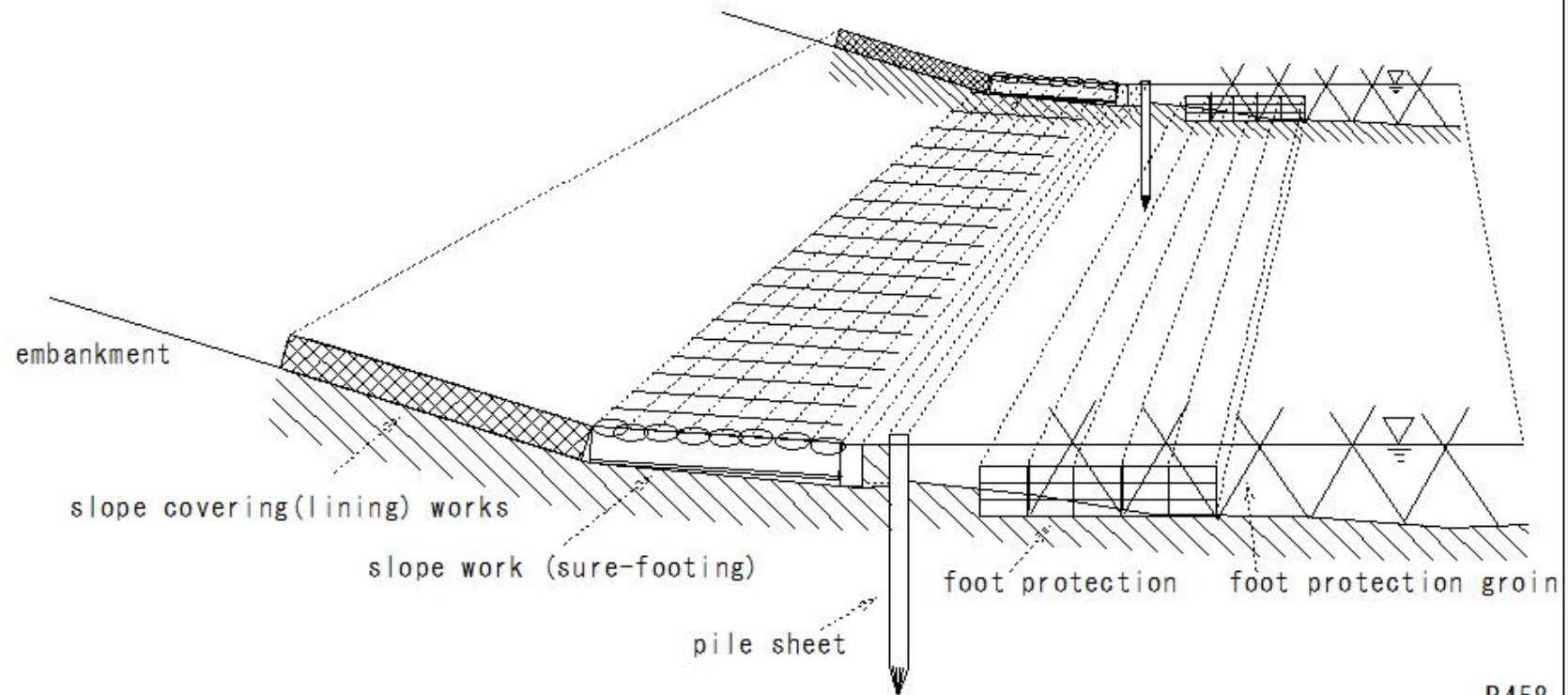


(I684)Bank protection(sure-footing)

(I684)Bank protection(sure-footing)

slope work (sure-footing)

Prevents scouring at the tip of the embankment or riverbank



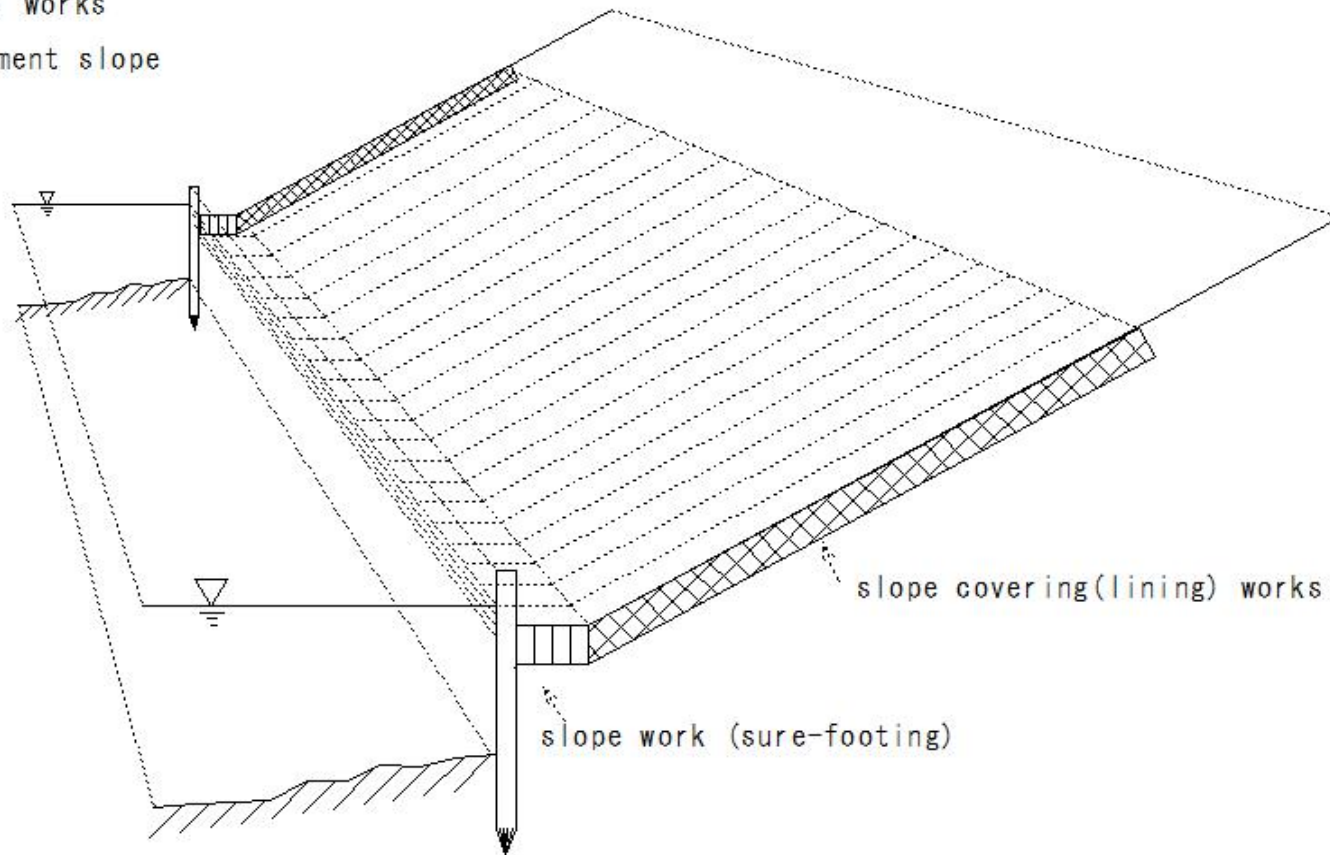
R458

(I685)Bank protection(slope covering(lining) works)

(I685)Bank protection(slope covering(lining) works)

slope covering(lining) works

Covering the embankment slope

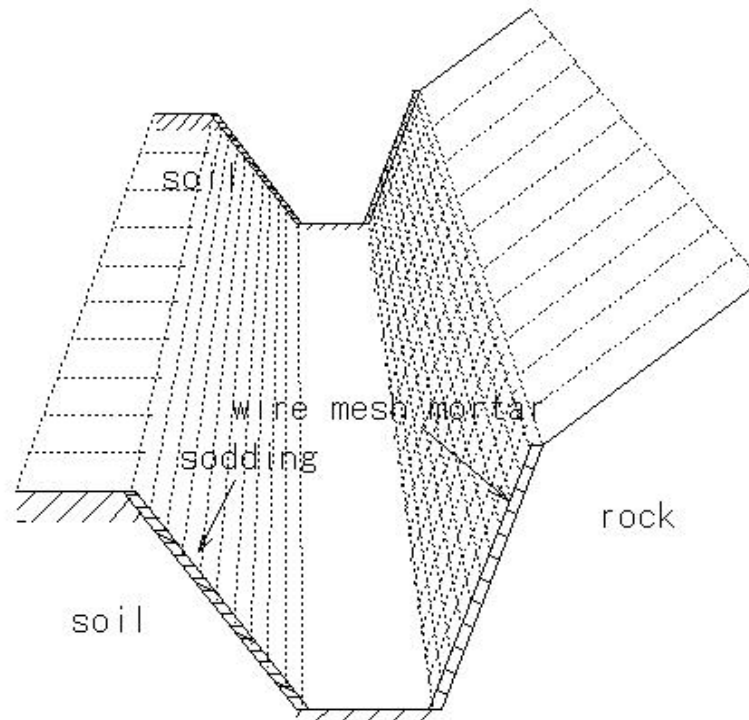


R459

(I686)Bank protection(slope protection)

(I686)Bank protection(slope protection)

Slope protection

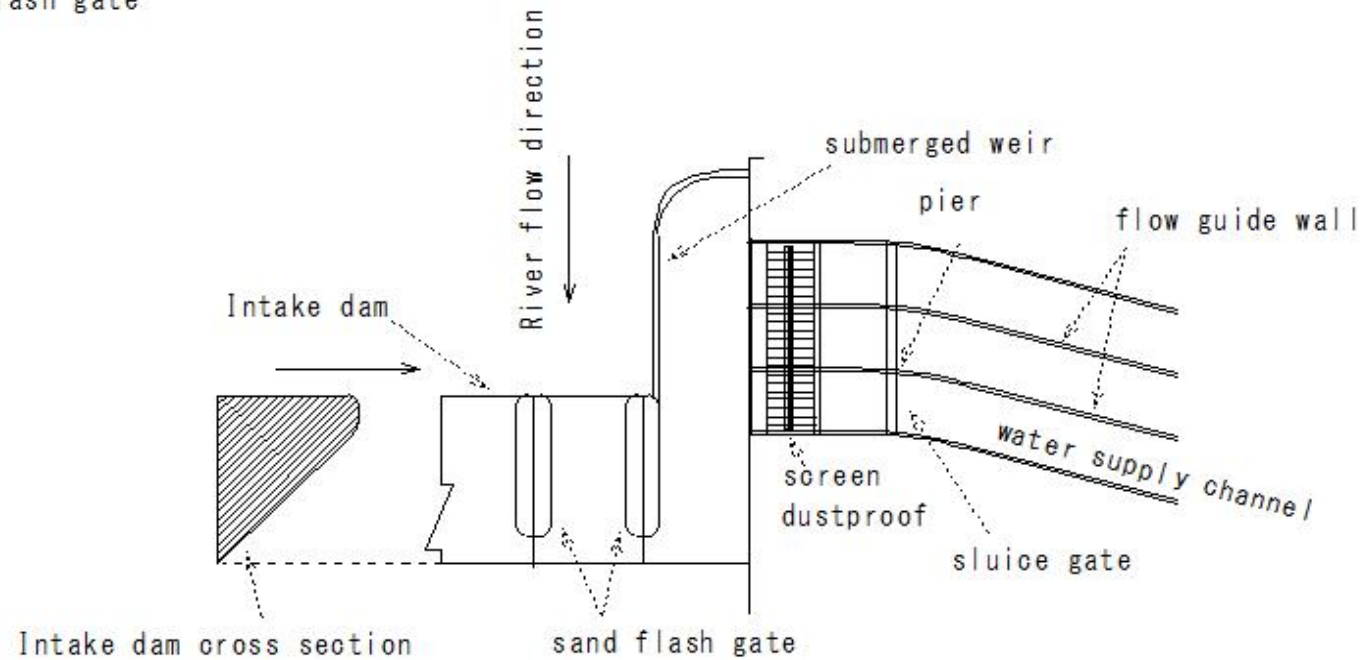


R462

(I687)Sand flash gate

(I687)Sand flash gate

Sand flash gate



R510

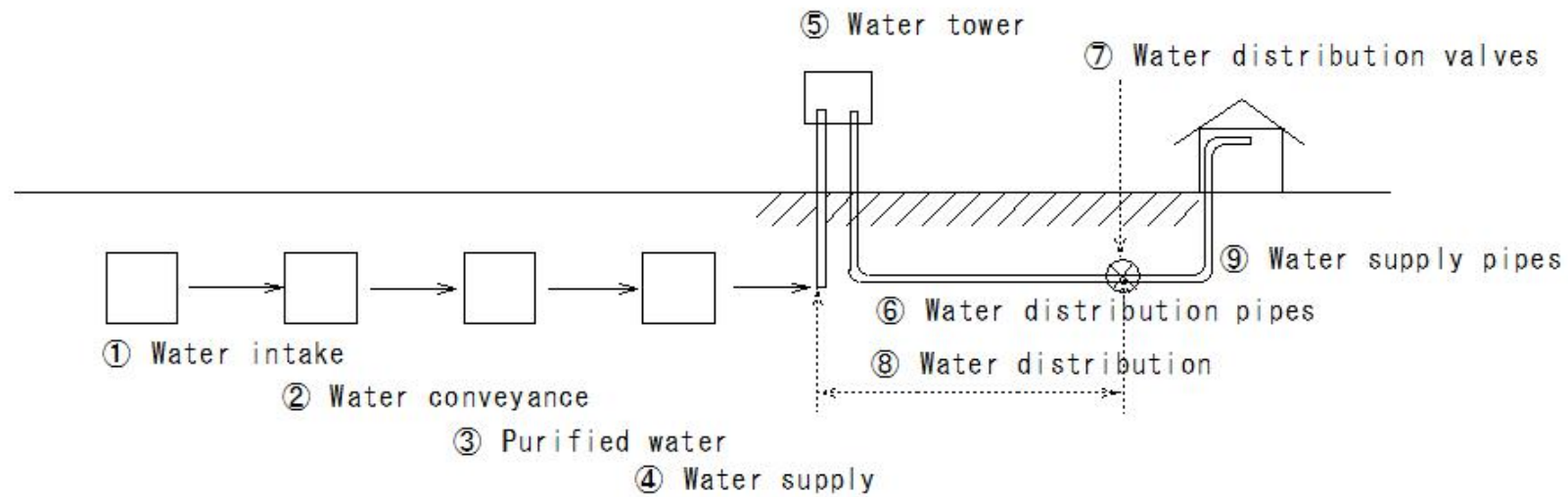
(I688)Water supply(Water Distribution)

(I688)Water supply(Water Distribution)

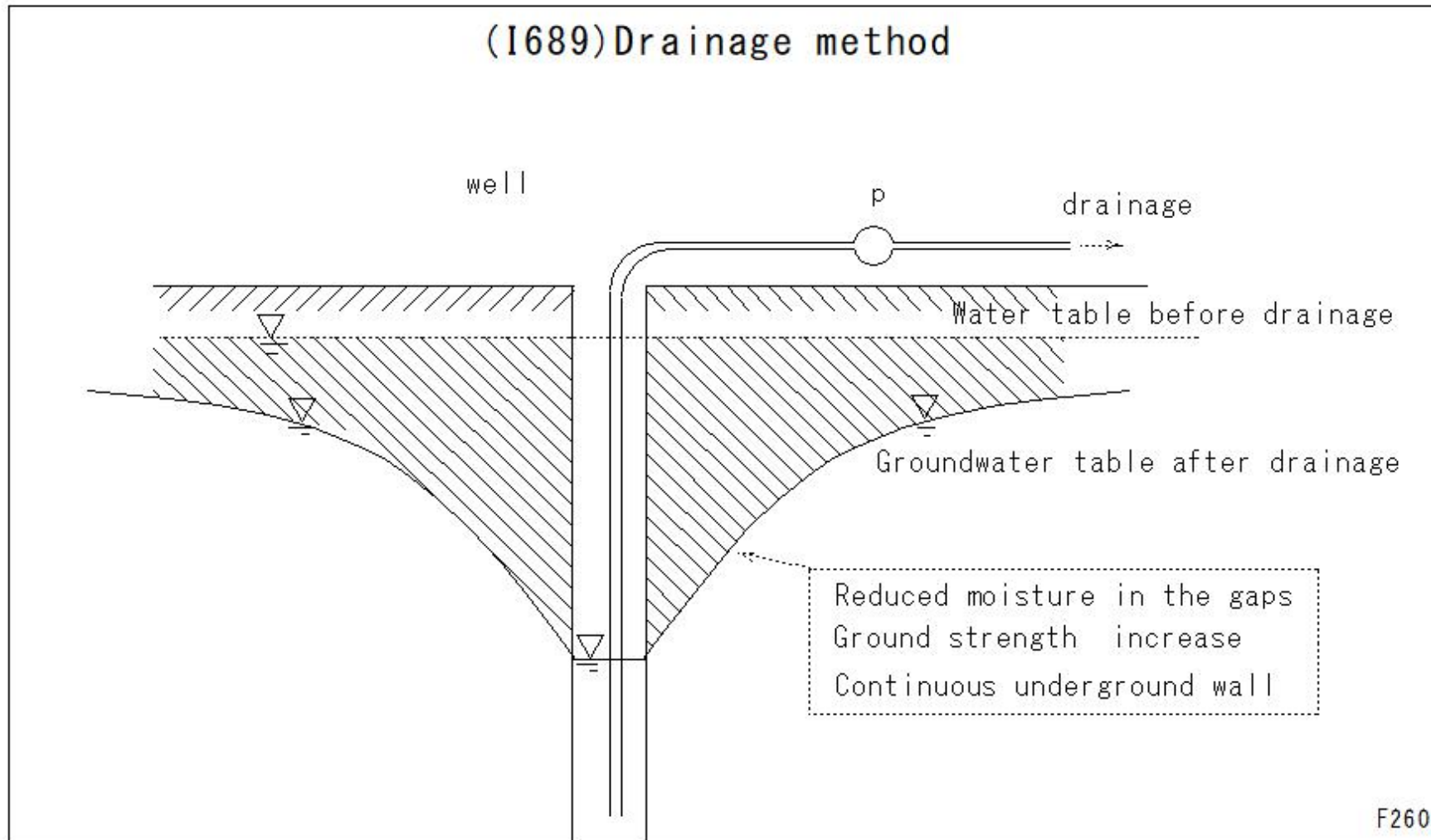
Water supply

Water Distribution

Reservoirs and towers: Sending water from pump stations to distribution areas



(I689) Drainage method

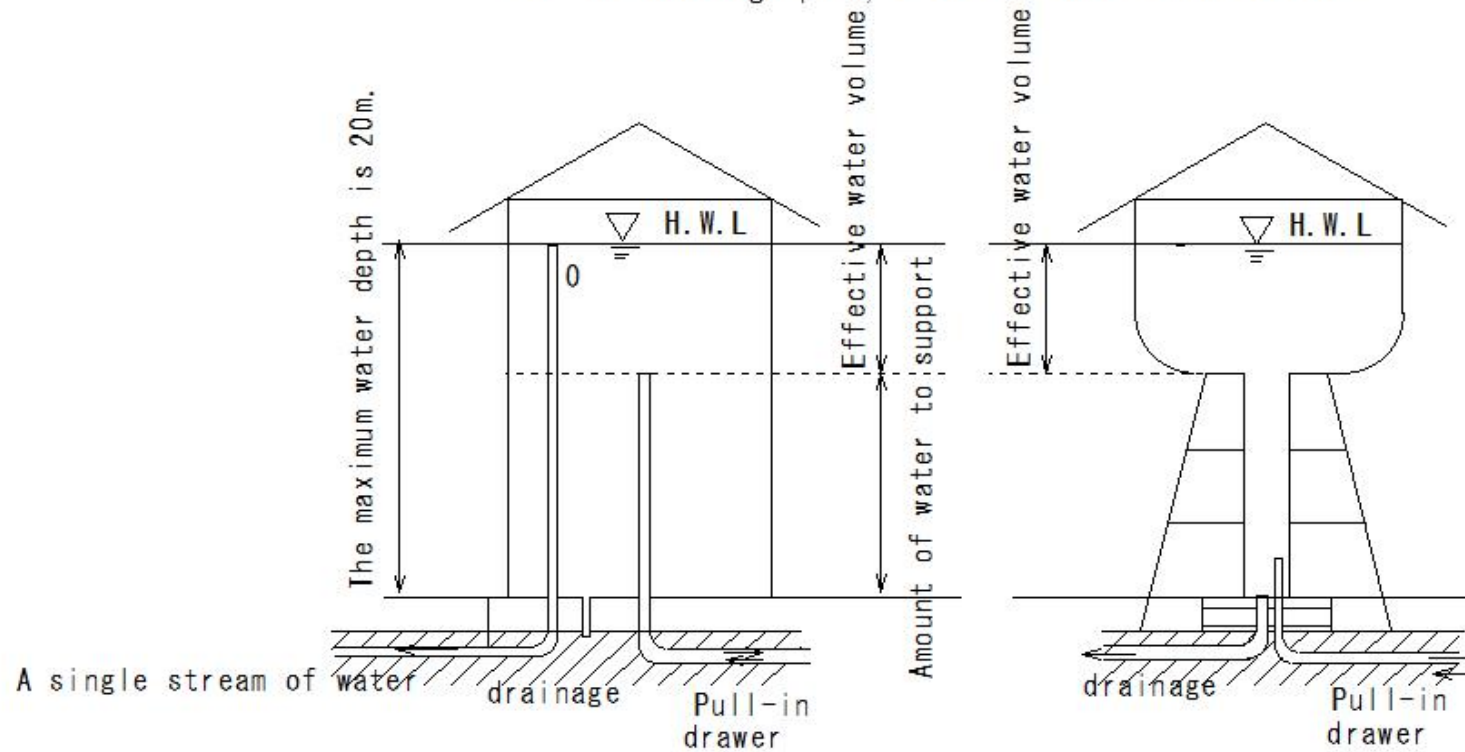


(I690)Water supply(water-tower)

(I690)Water supply(water-tower)

Water-tower

Near the water supply area - in case of a suitable elevation cannot be obtained for the drainage pond, a water tower is installed.



Elevated water tank

W198

(I691)Weir(dentated sill)

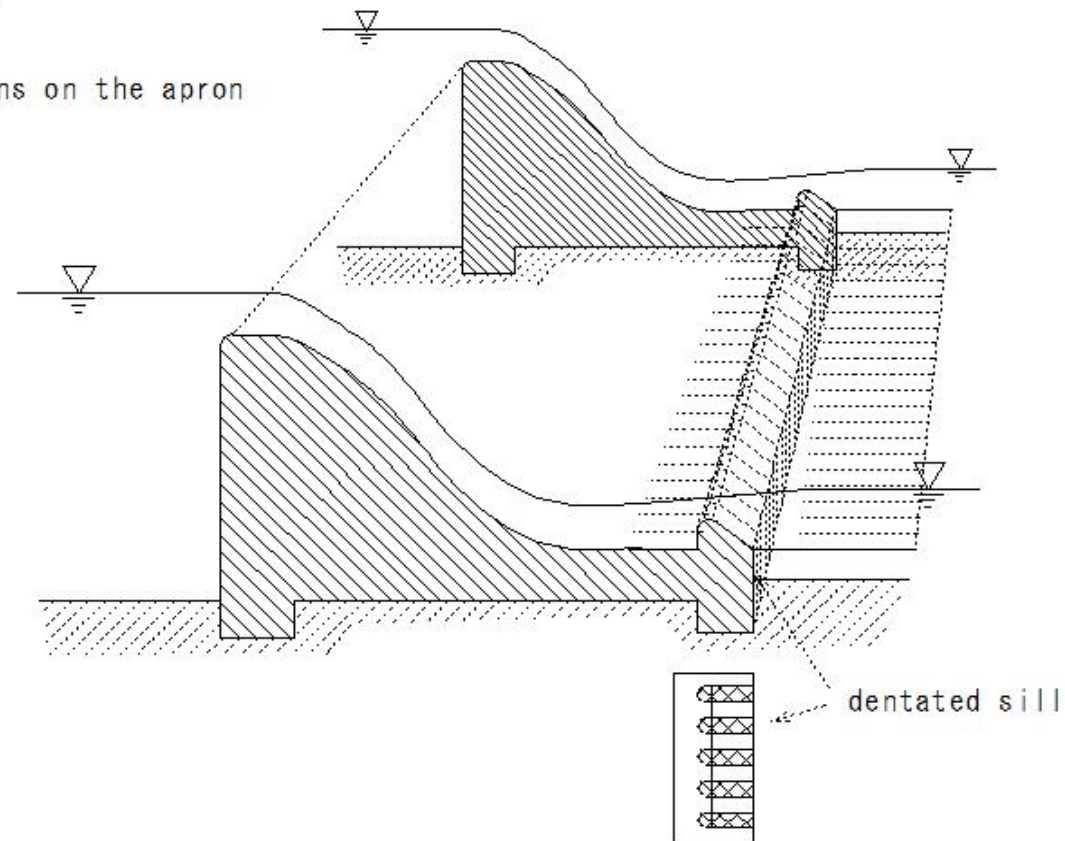
(I691)Weir(dentated sill)

Dentated sill

Overflowing a weir/dam

reduce water energy

Tooth-shaped protrusions on the apron



R463

(I692)Weir(sharp crested weir)

sharp crested weir

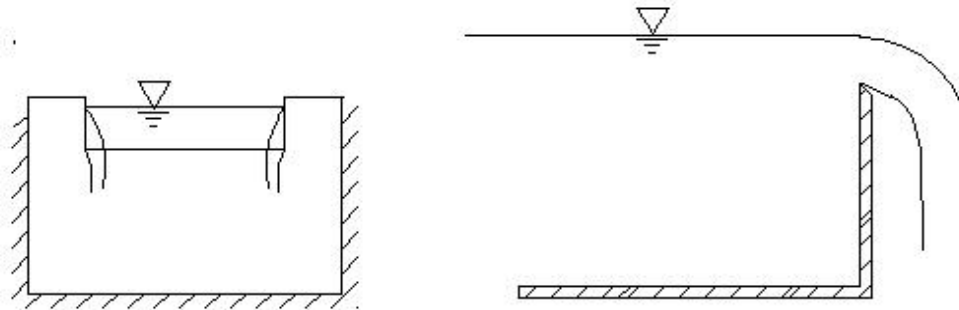
The overflow part is sharp.

blade shaped weir: Stable nap

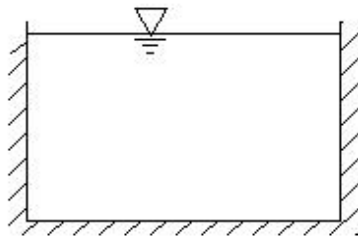
Easily measure overflow depth

Open channel flow measurement

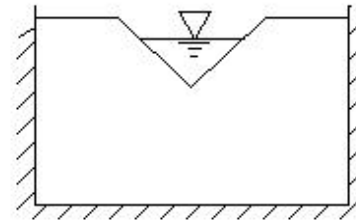
(I692)Weir(sharp crested weir)



square cough

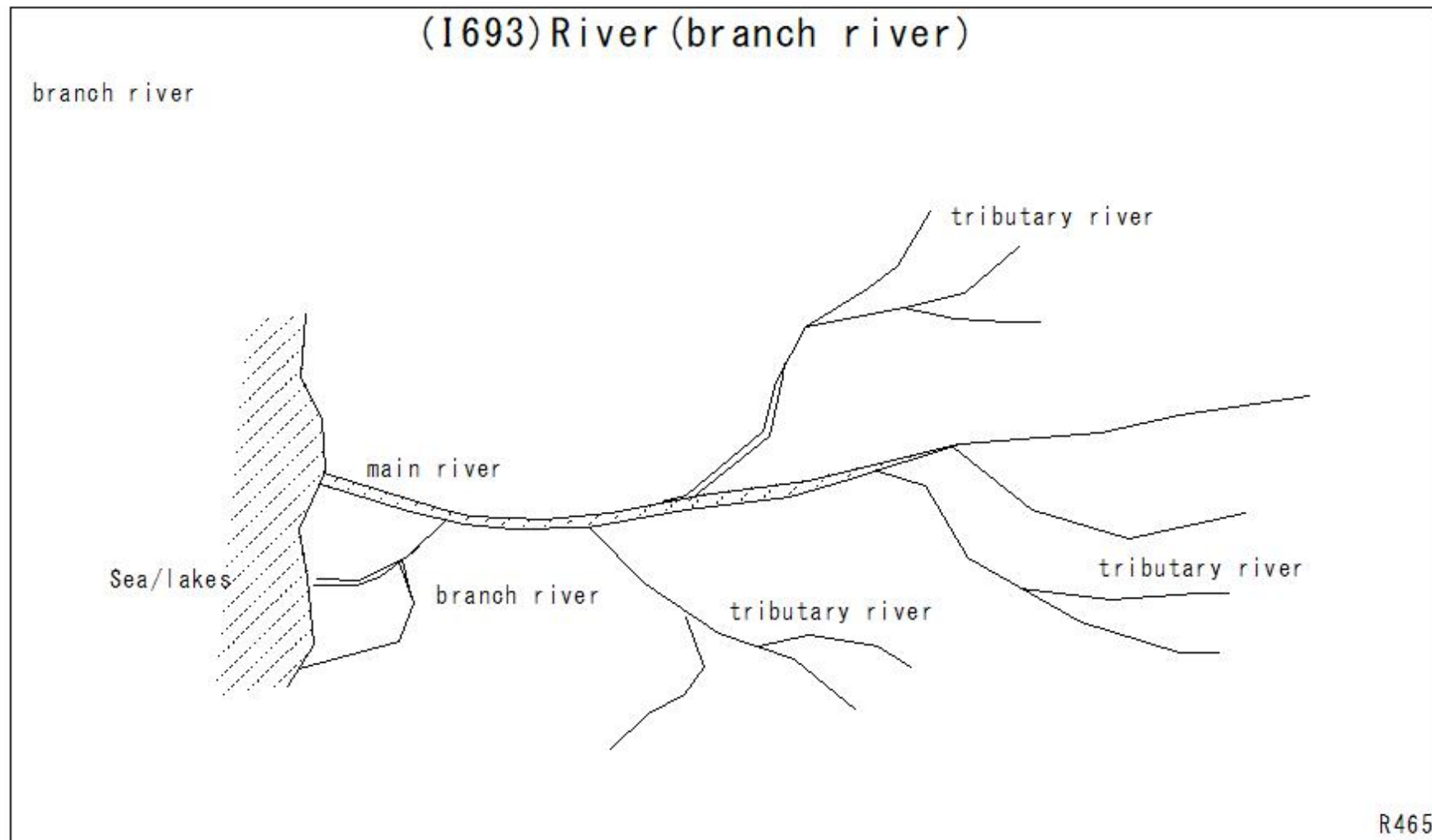


full width weir



triangular weir

(I693)River(branch river)



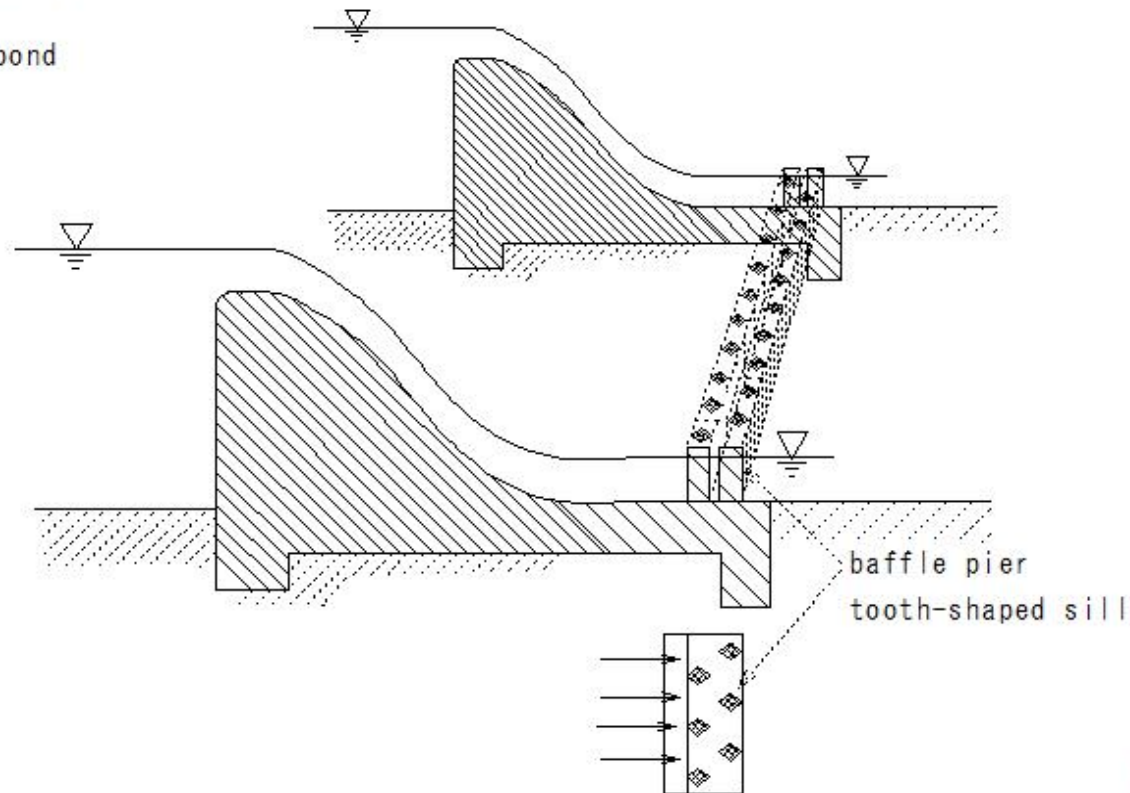
(I694)Baffle pier

(I694) Baffle pier

baffle pier

Stabilizes the hydraulic jump (overflows the dam)
reduce energy
Arranged in front of the pond
protruding obstacles

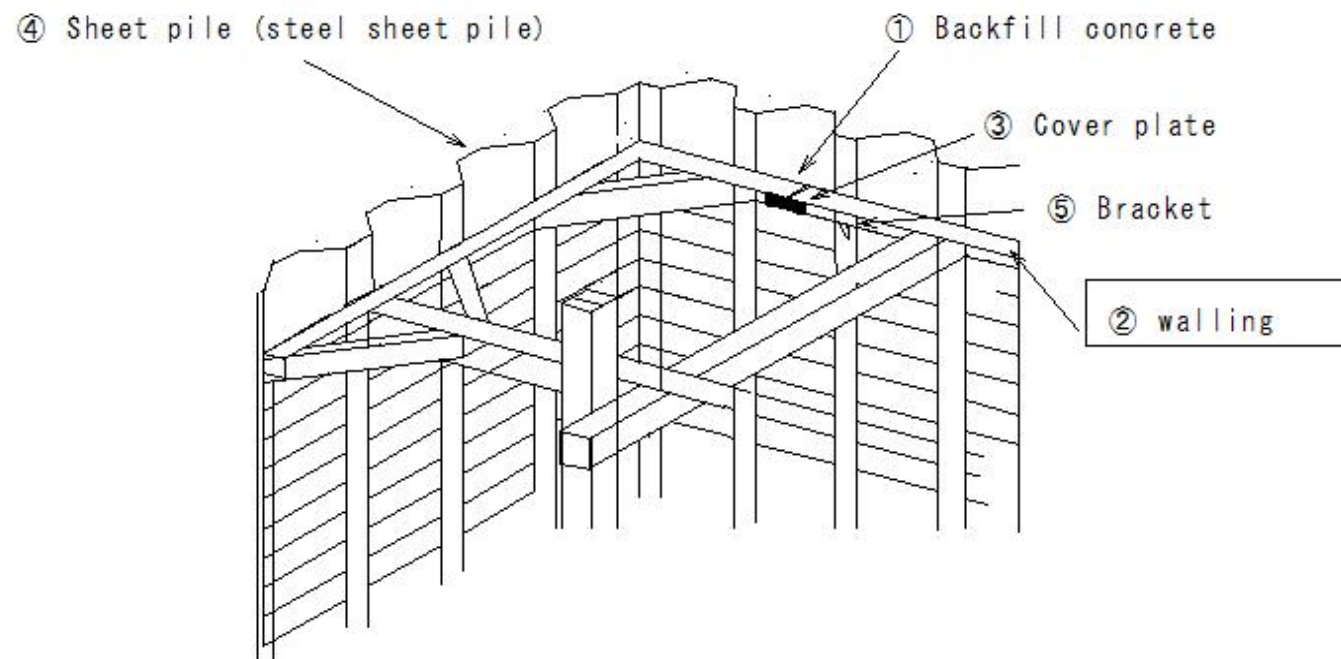
Energy reduction method
deflector
auxiliary dam



D235
R466

(I695)Walling

(I695)Walling



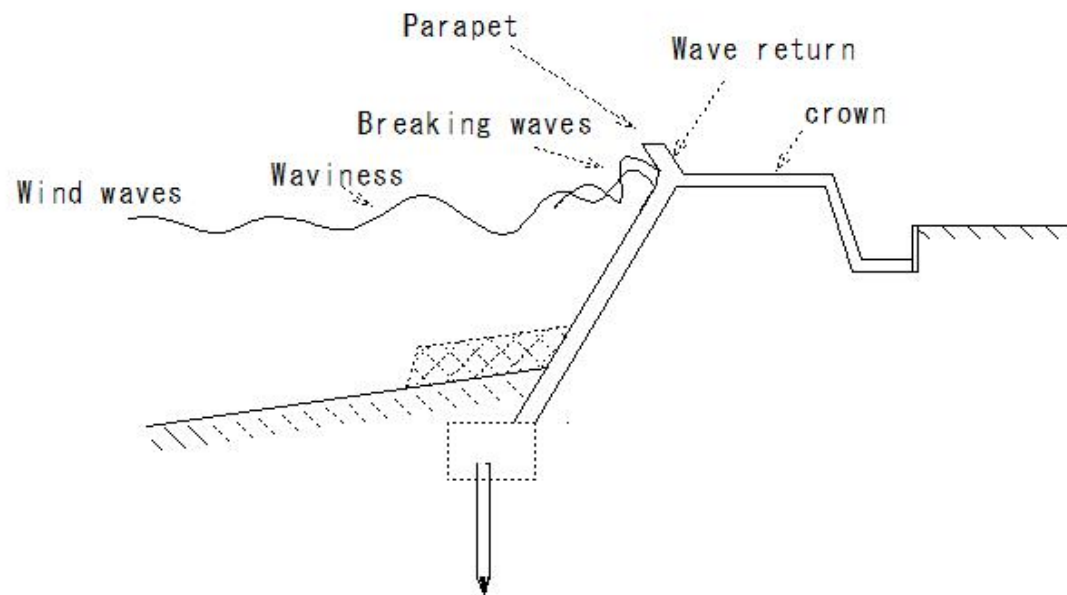
(I696)Parapet

(I696) Parapet

Parapet

Surf-breaking structure

Breakwater crown

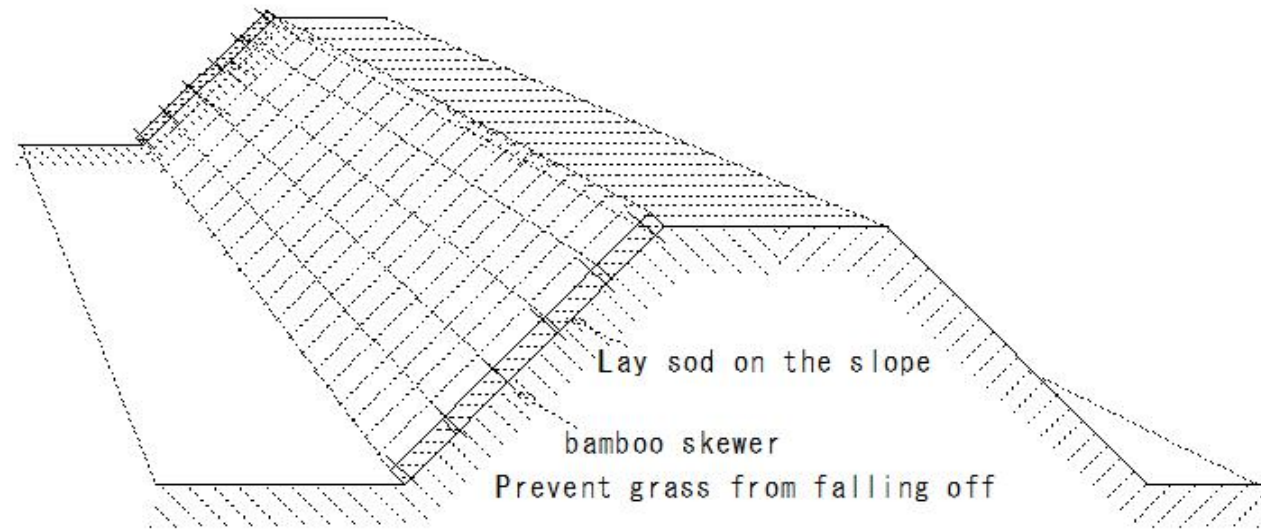


P193
P91

(I697)Embankment(sodding)

(I 697) Embankment (sodding)

Sodding



sodding

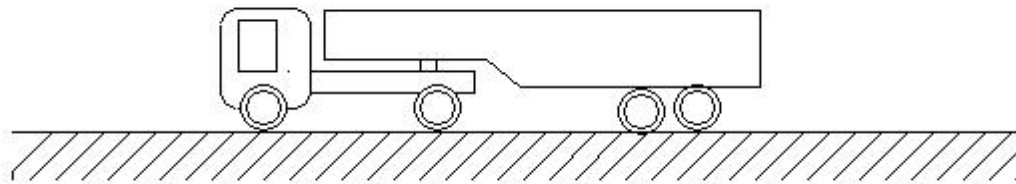
R467

(I698)Trailer

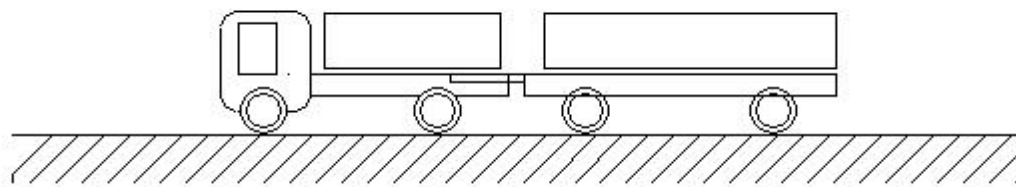
(I698)Trailer

Trailer

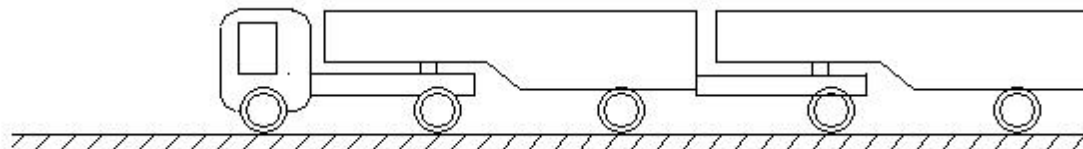
① Semi-trailer



② full trailer



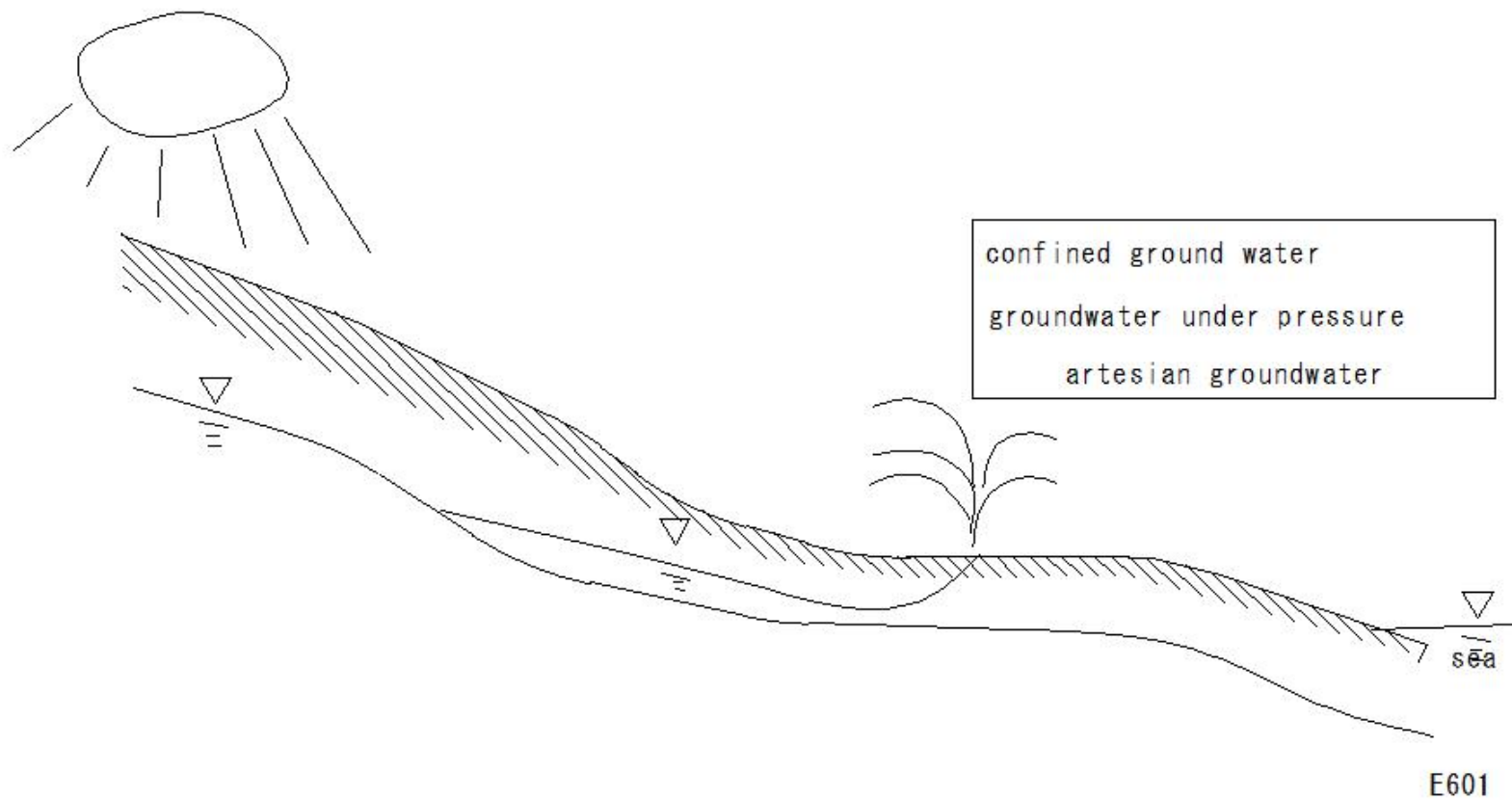
③ Doubles trainer



M398

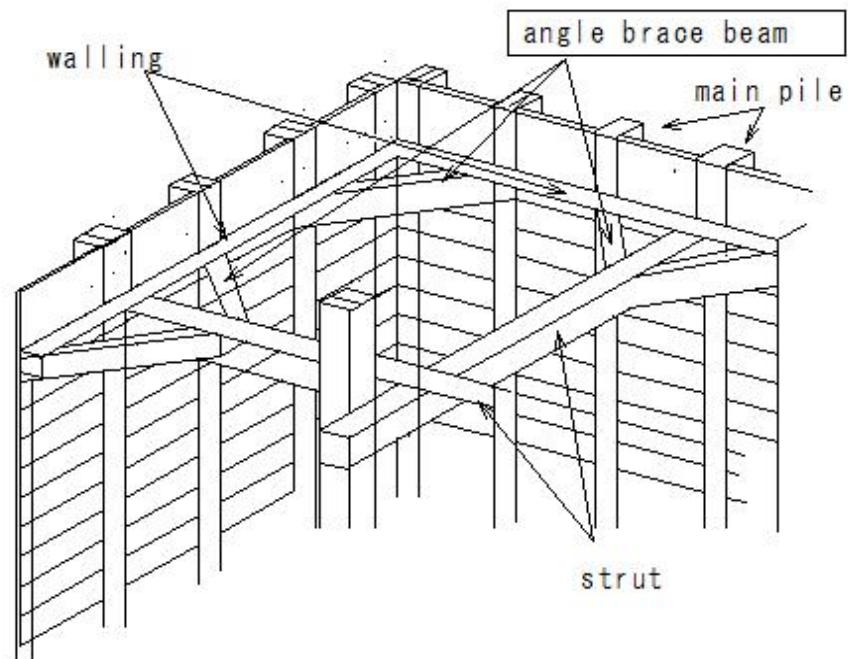
(1699) Confined ground water

(1699) Confined ground water



(I700)Angle brace

(I700) Angle brace



Earth retaining wall method

(I701)Embankment(secondary levee)

(I701)Embankment(secondary levee)

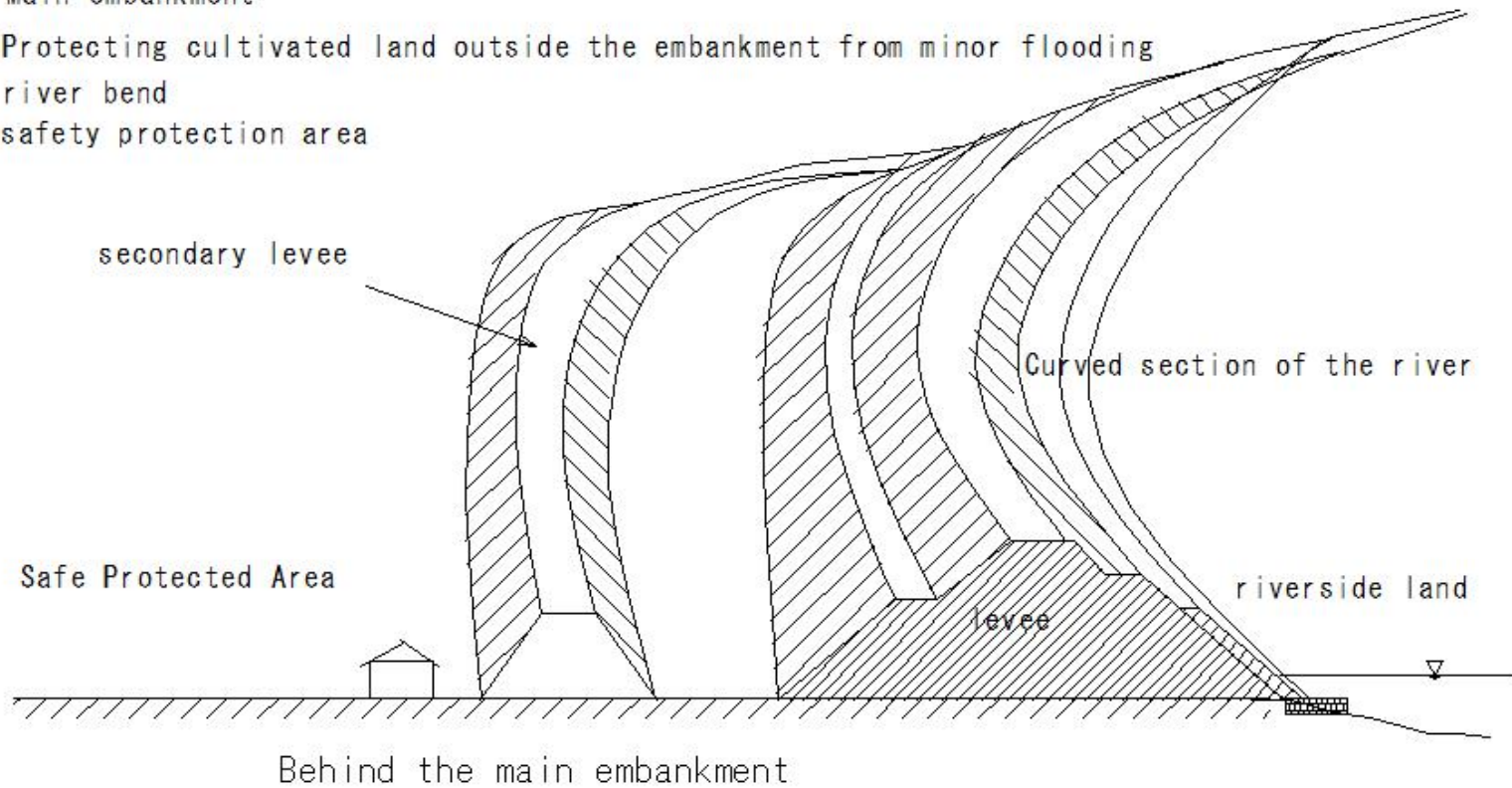
Secondary levee

Main embankment

Protecting cultivated land outside the embankment from minor flooding

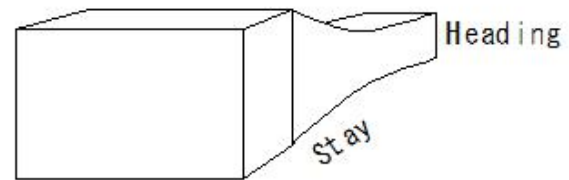
river bend

safety protection area



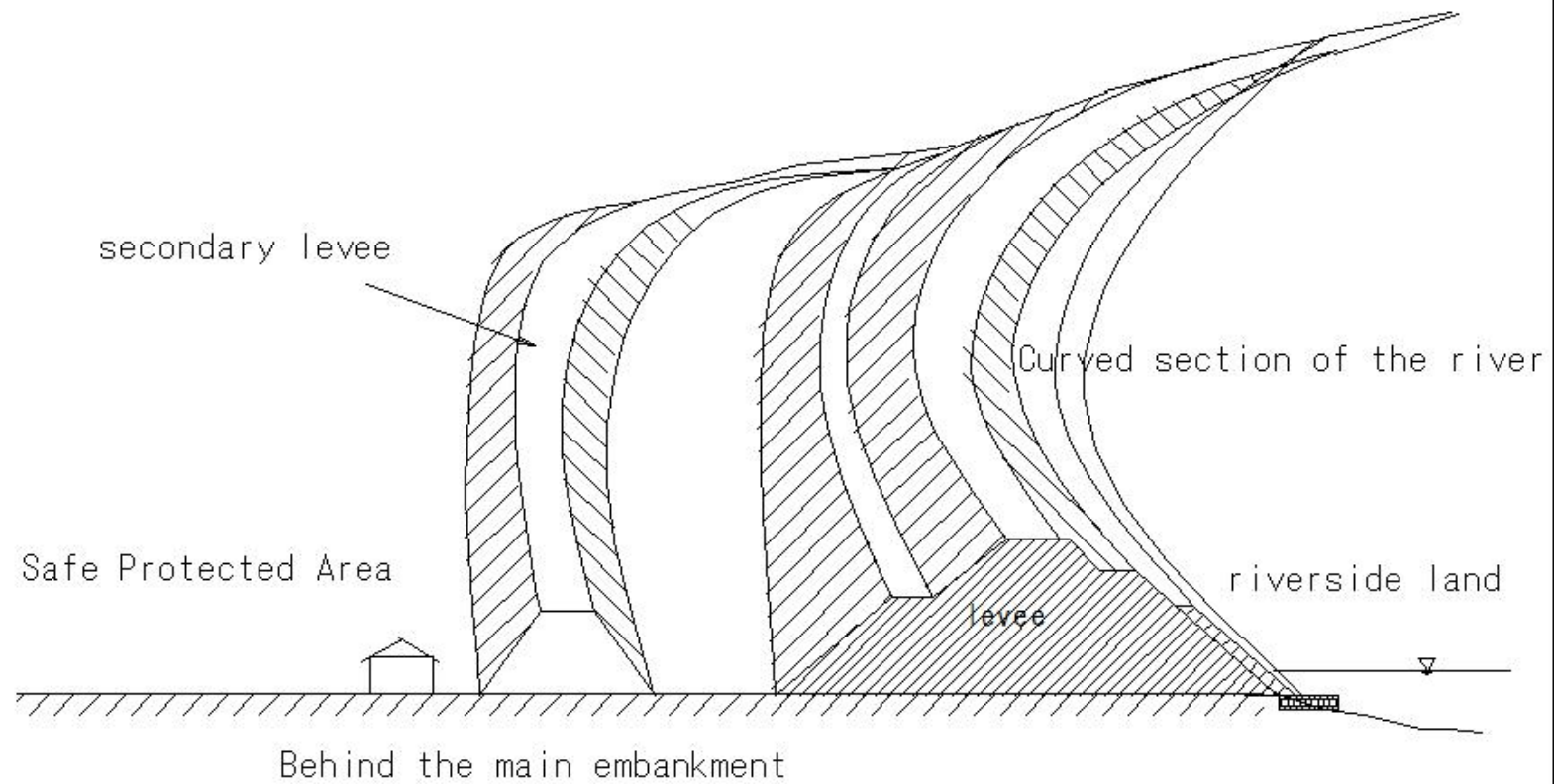
(I702)Stay

(I702) Stay



(I703)Secondary levee

(I703) Secondary levee

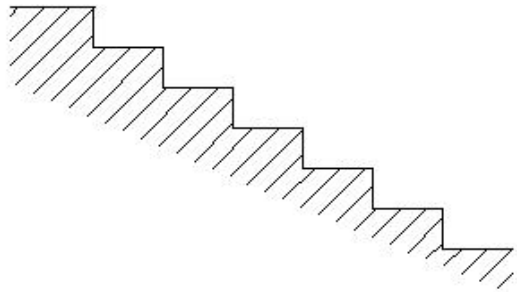


E603

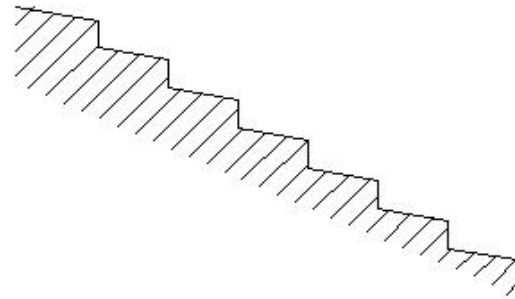
(I704)Bench terraced fields

(I704)Bench terraced fields

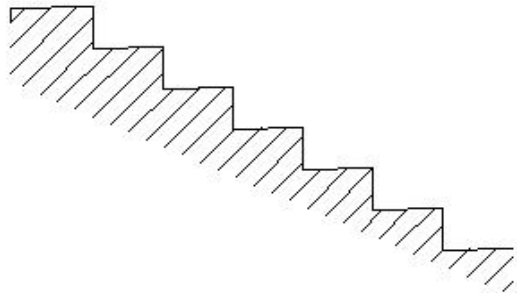
horizontal bench terrace field



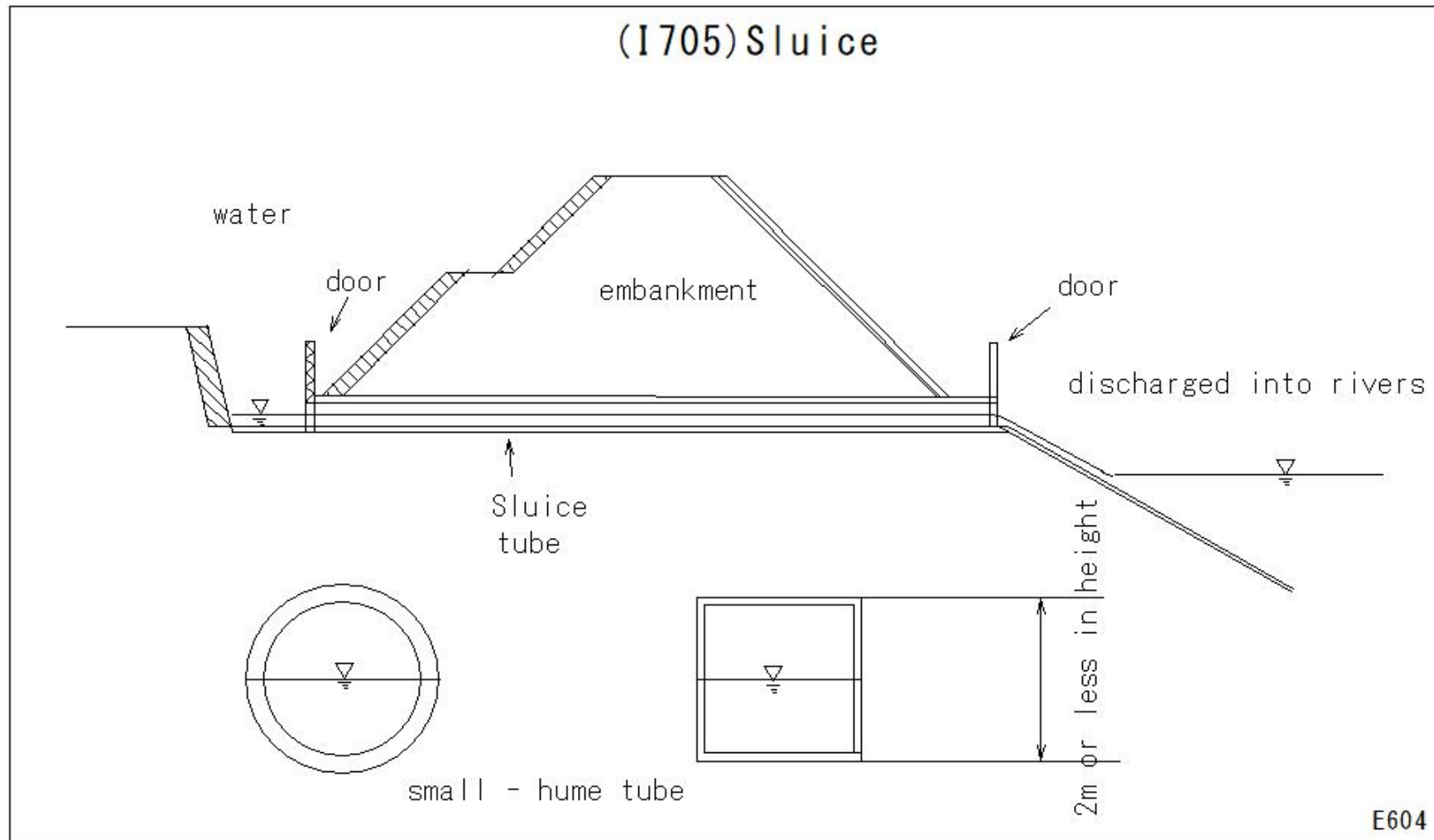
sloping bench terraced field



reverse bench slope terrace field



(I705)Sluice



(I706)Embankment(setting back of levee)

(I706) Embankment(setting back of levee)

Flood control

Adjustment of river channel part

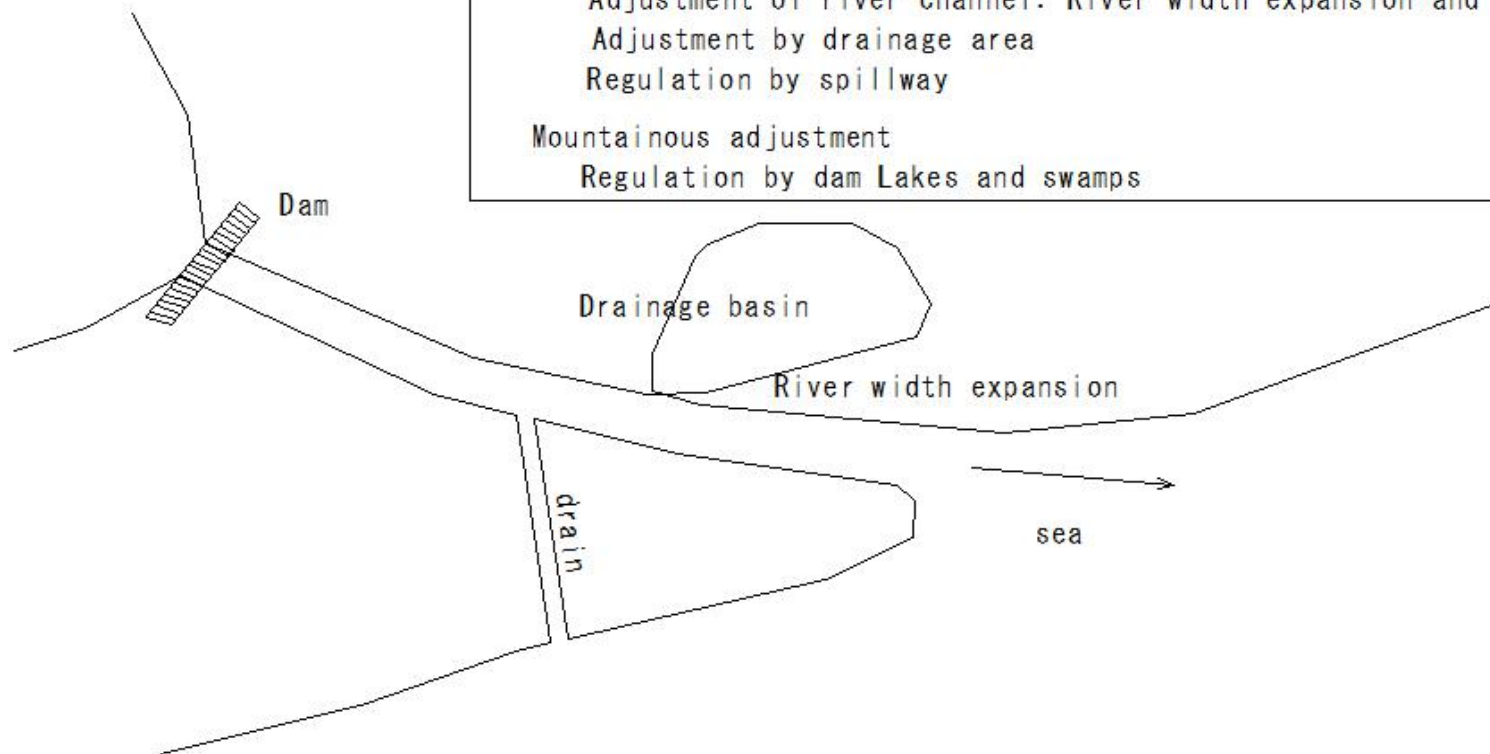
Adjustment of river channel: River width expansion and transverse

Adjustment by drainage area

Regulation by spillway

Mountainous adjustment

Regulation by dam Lakes and swamps

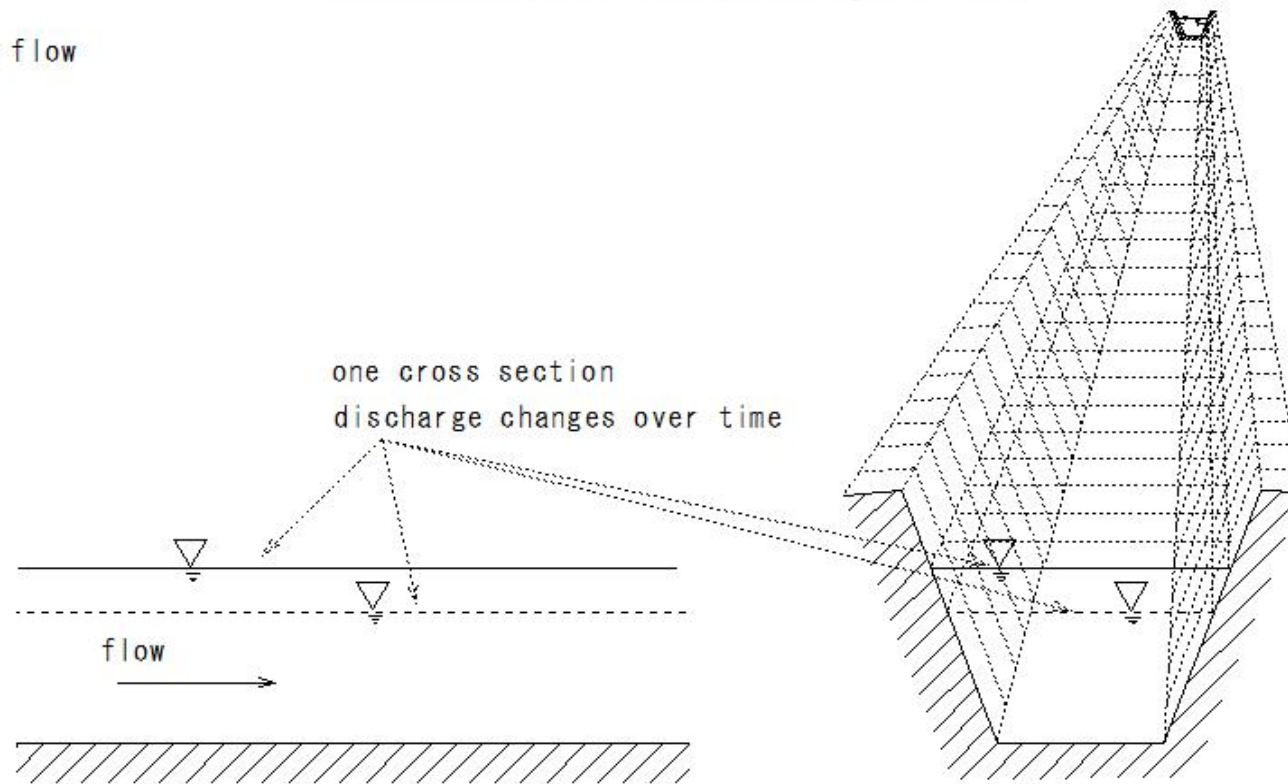


R471

(I707)Flow (unsteady flow)

(I707)Flow (unsteady flow)

Unsteady flow



R472

(I708)Sluice

(I708) Sluice

Sluice

Water intake from rivers

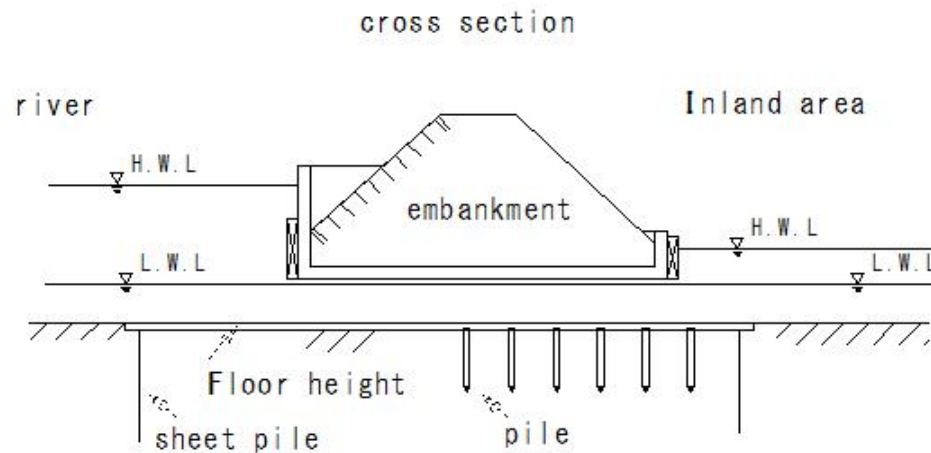
drainage to rivers

Embankment crossing - culvert

Small sluice pipe

2m or more-sluice

Higher than the embankment - sluice gate



R473

(I709)Standard penetration test

(I709)Standard penetration test

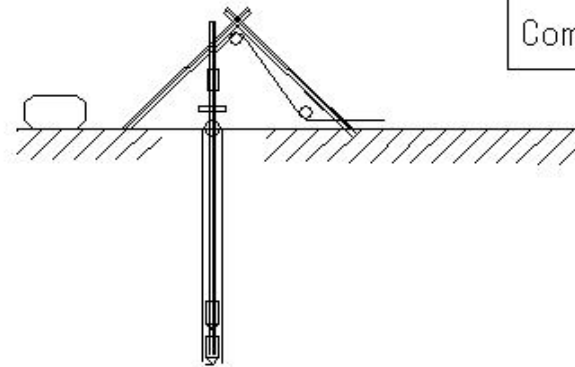
Drop height: 75cm

Hammer: 63.5kg

Penetration 30cm

Number of blows N value

Combined boring



(I710)Surface impermeable wall

(I710)Surface impermeable wall

surface impermeable wall

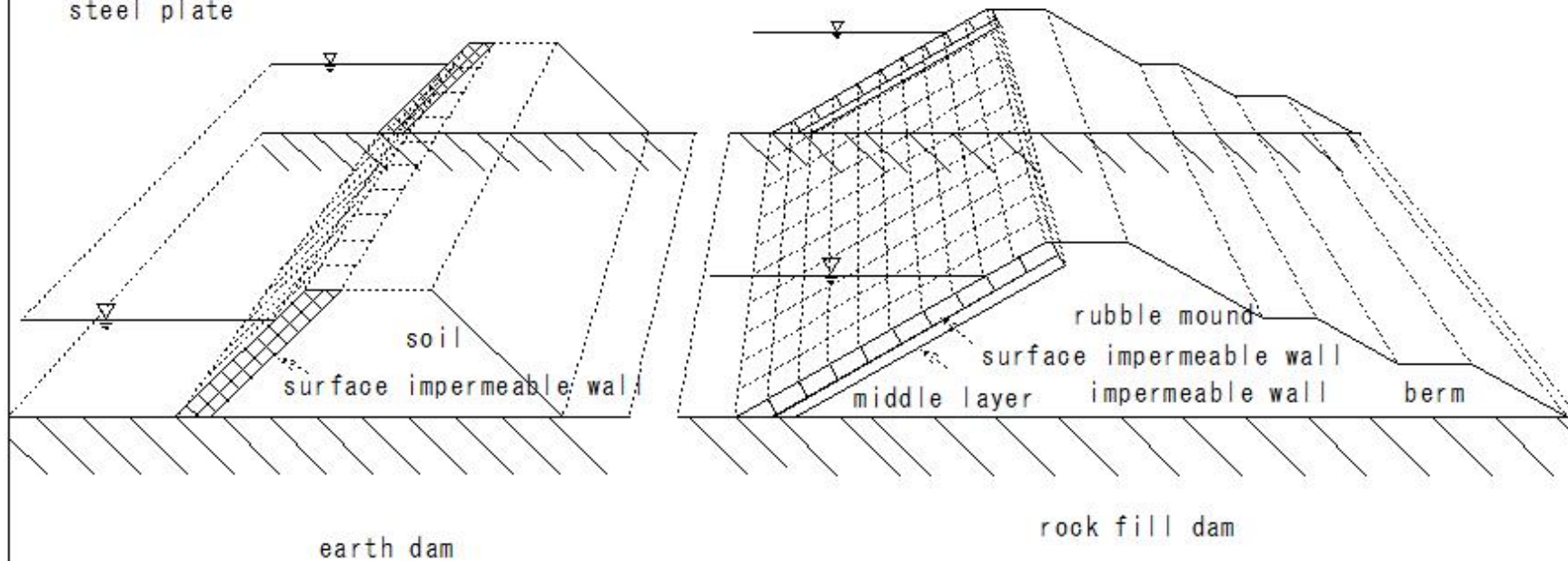
Impermeable wall on upstream surface

material

reinforced concrete

asphalt

steel plate



R474

(I711)Water supply(surface washing(Surface cleaning))

(I711)Water supply(surface washing (Surface cleaning))

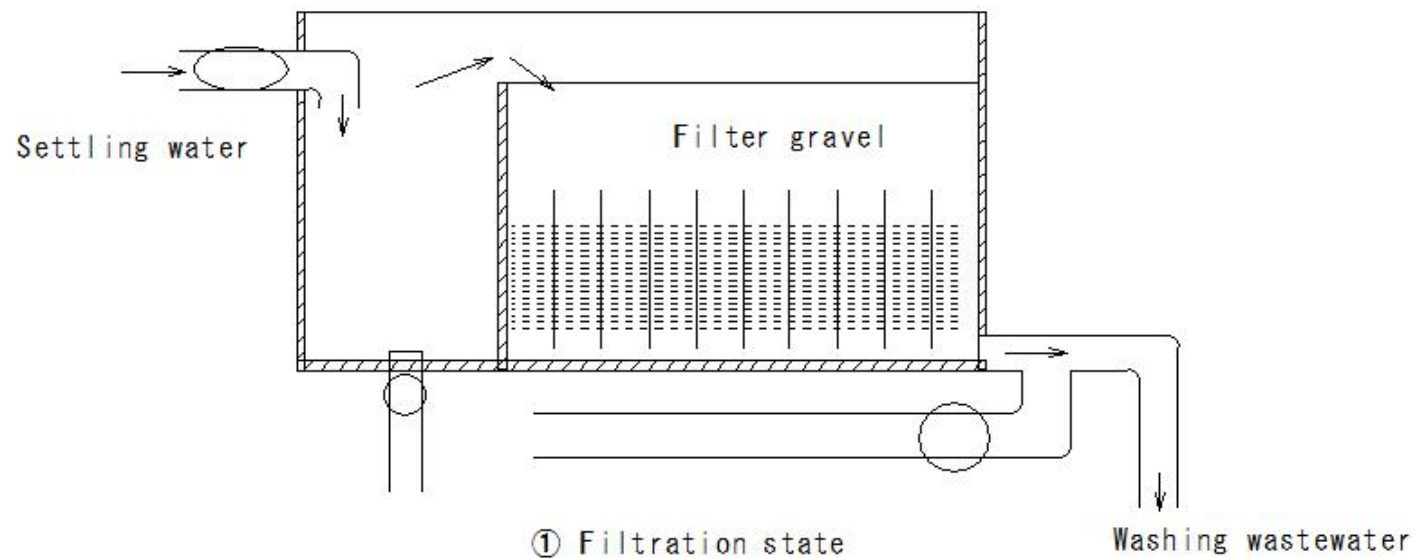
Surface washing (Surface cleaning)

Rapid filtration of water supply

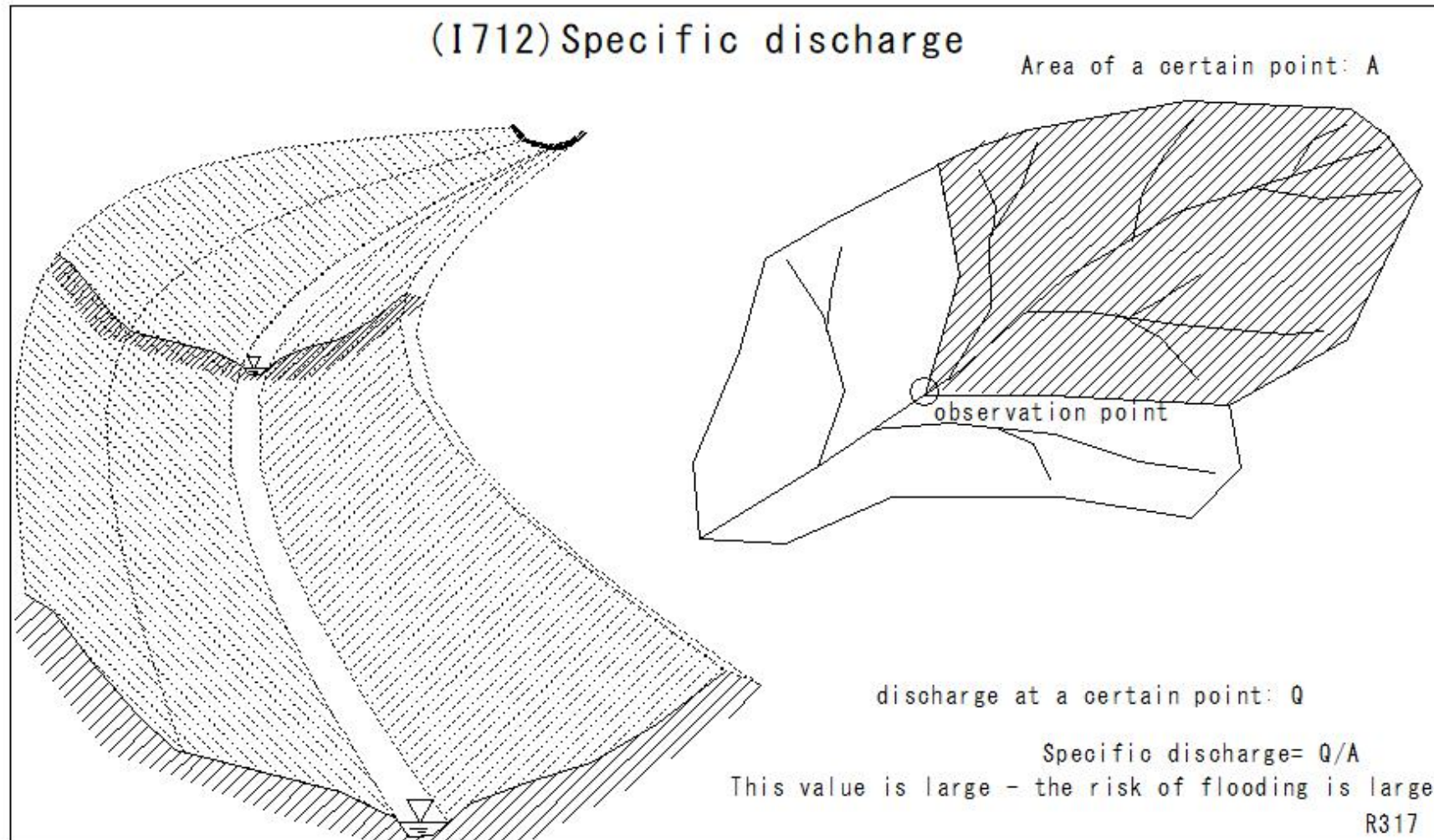
Backwash cleaning of filter pond

Sand layer surface - spraying cleaning water

Rotary



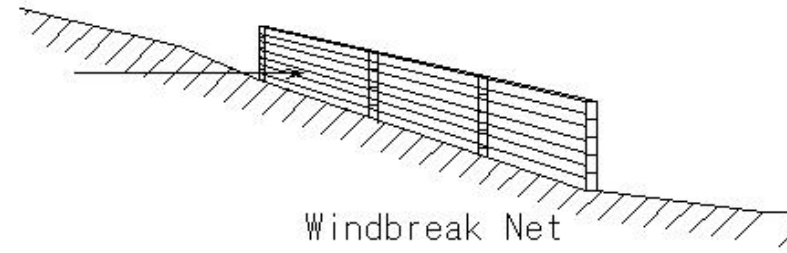
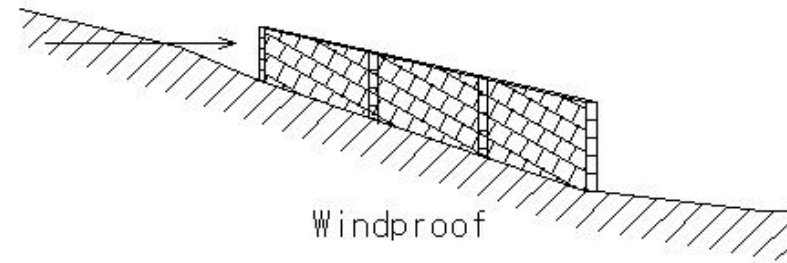
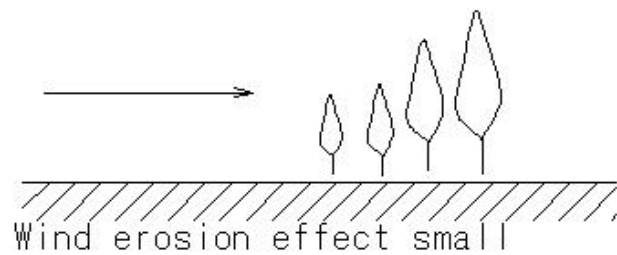
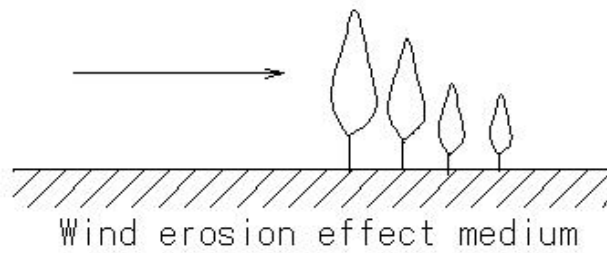
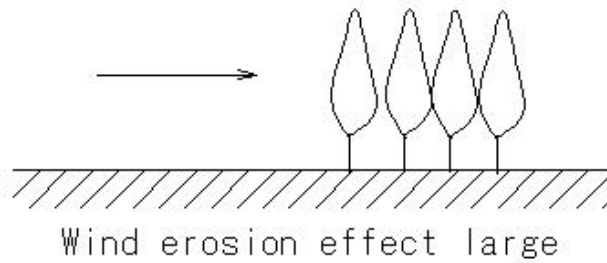
(I712)Specific discharge



(I713)Wind erosion control

(I713)Wind erosion control

Wind erosion prevention method



(I714)Wind erosion farm

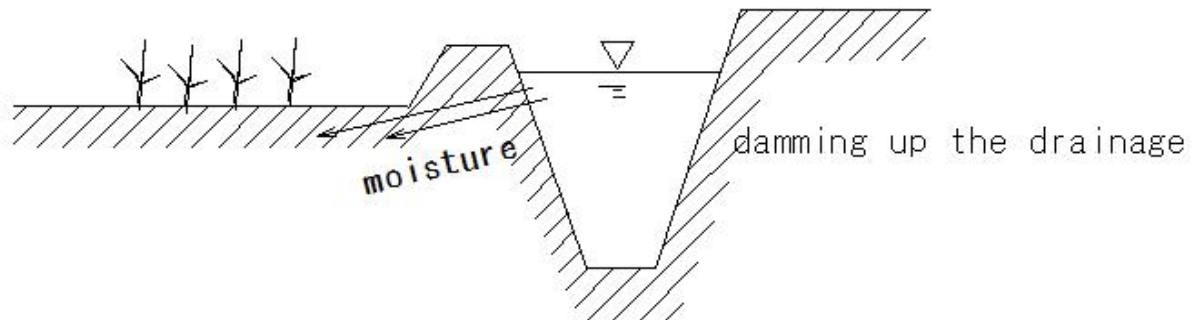
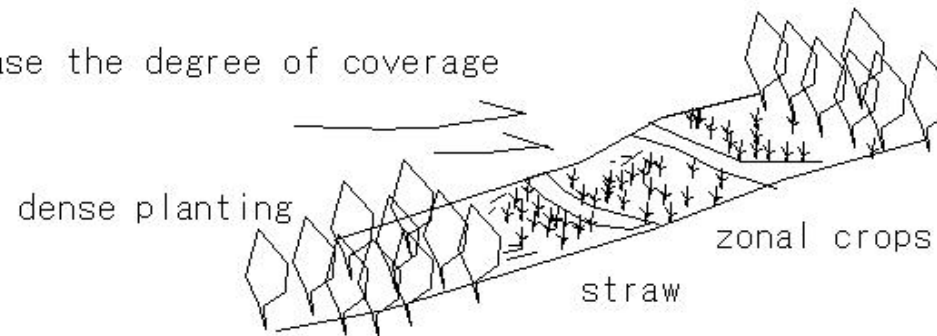
(I714)Wind erosion farm

Wind erosion farm

Wind erosion prevention farming method

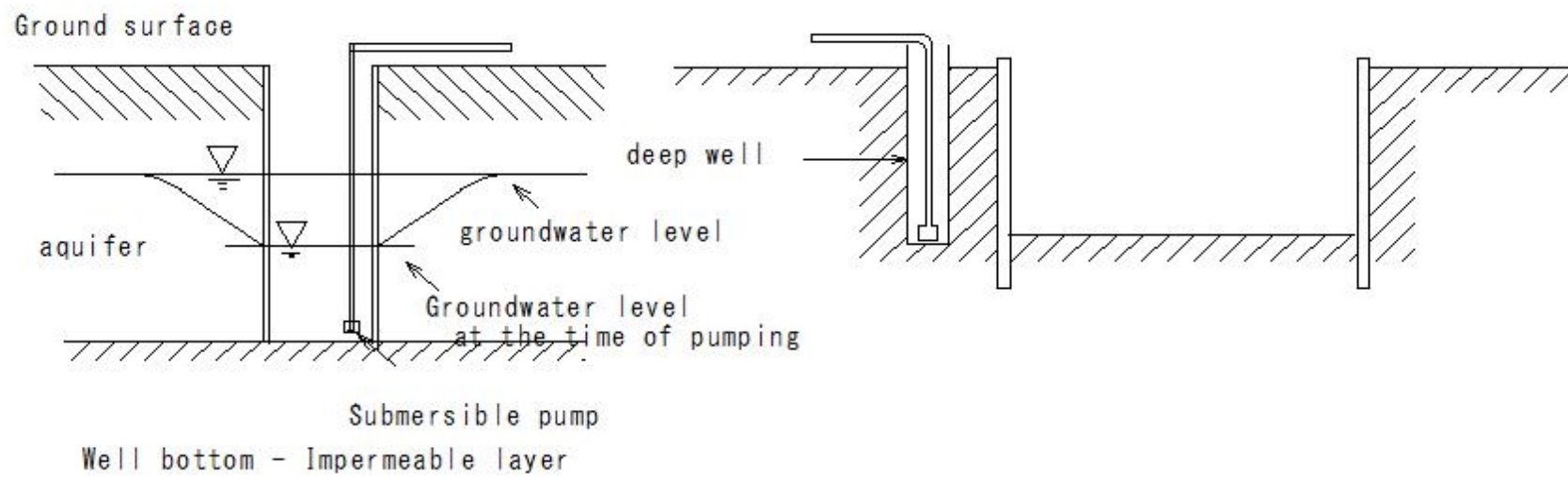
- Ground wind speed - decrease
- Enhance soil corrosion resistance

- (1) Zonal crops
- (2) Dense planting: Increase the degree of coverage
- (3) Straw
- (4) Moisten the soil



(I715)Deep well

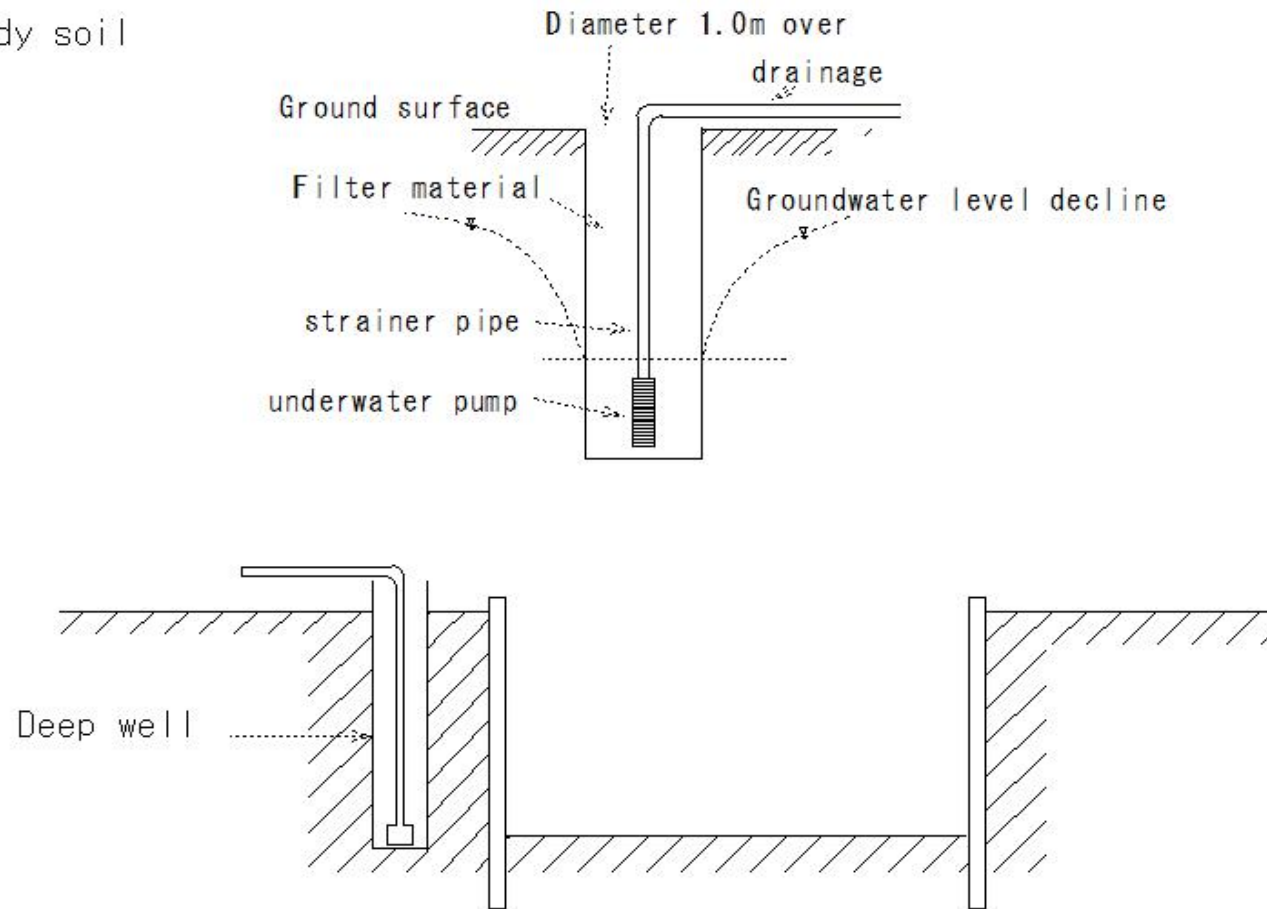
(I715)Deep well



(I716)Deep well method

Deep well: sandy soil

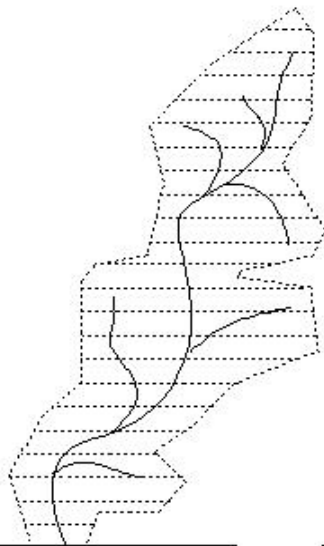
(I716)Deep well method



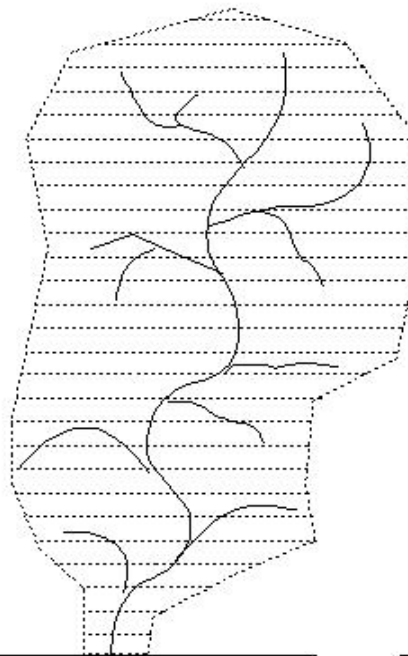
(I717)Composite drainage basin

(I717)Composite drainage basin

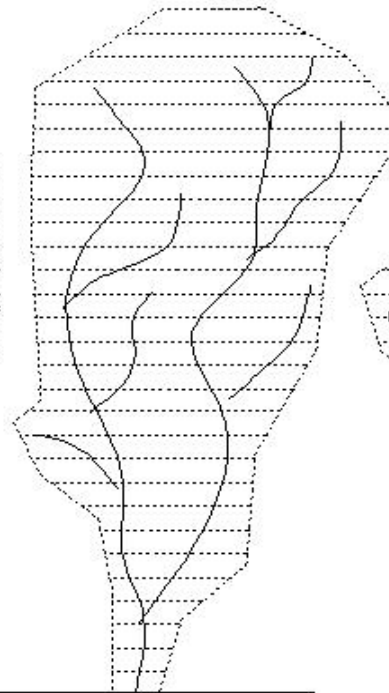
Composite drainage basin



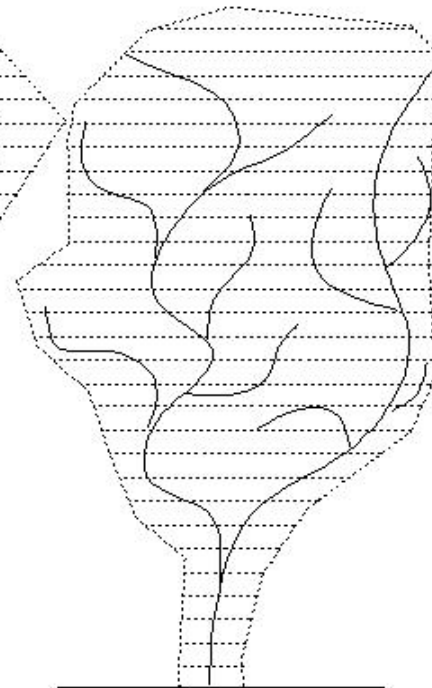
pinnate basin



radial basin



parallel basin



composite basin

(I718)Auxiliary dam

(I718)Auxiliary dam

Auxiliary dam

Preventing scouring downstream of overflow dams

Installed at the apron of this dam

small overflow dam

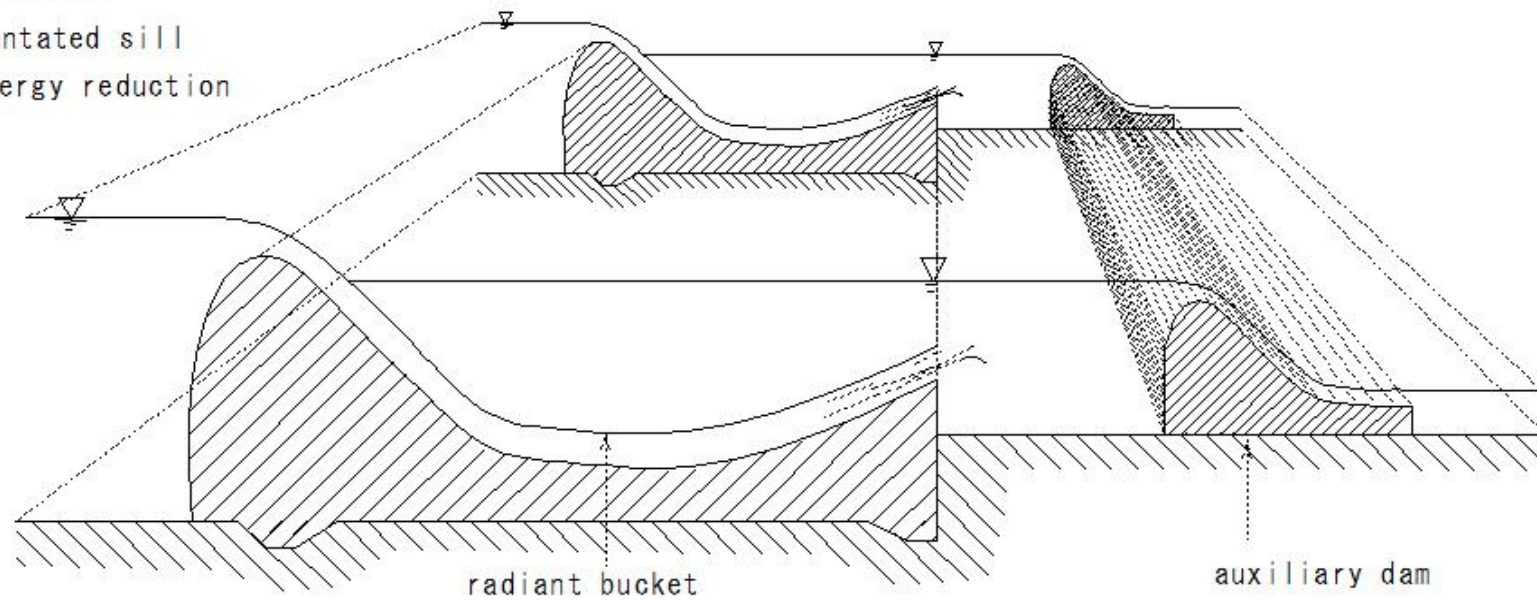
Rear end of apron

baffle pier

deflector

dentated sill

energy reduction



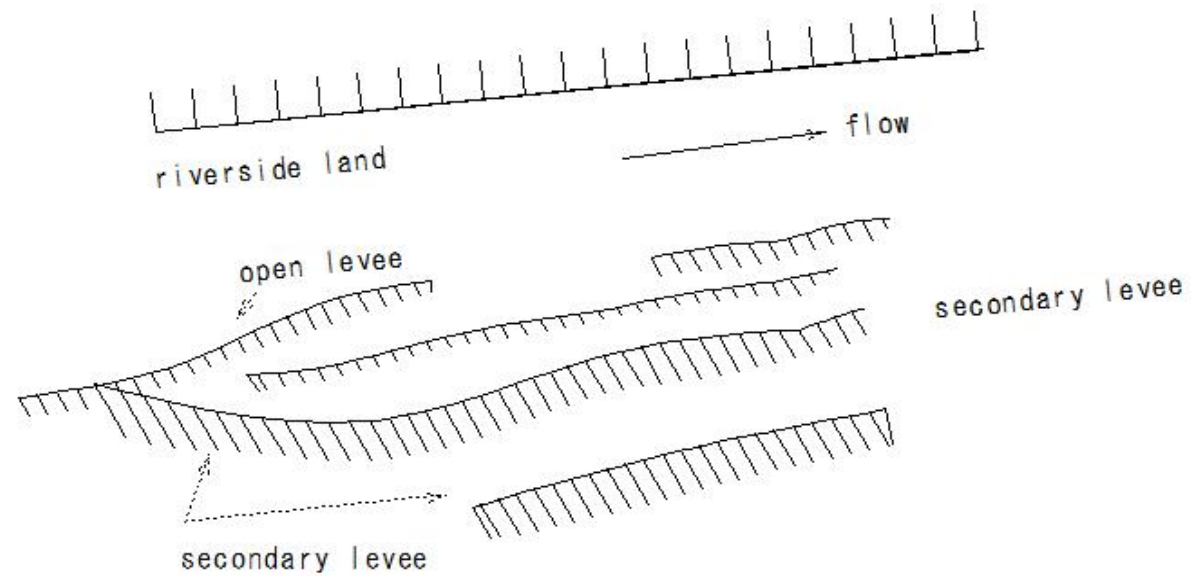
R476

(I719)Secondary levee

(I719)Secondary levee

Secondary levee

Embankment parallel to the main embankment

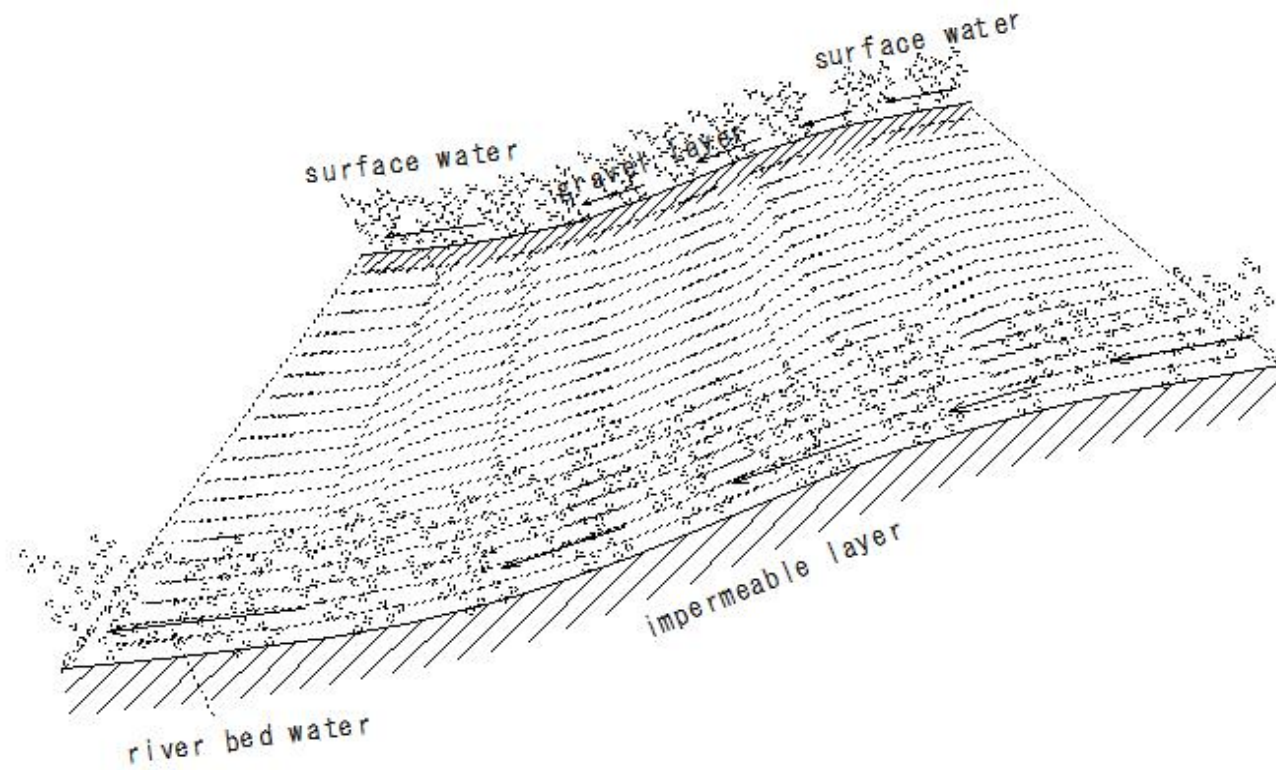


R477

(I720)River bed water

(I720)River bed water

River bed water



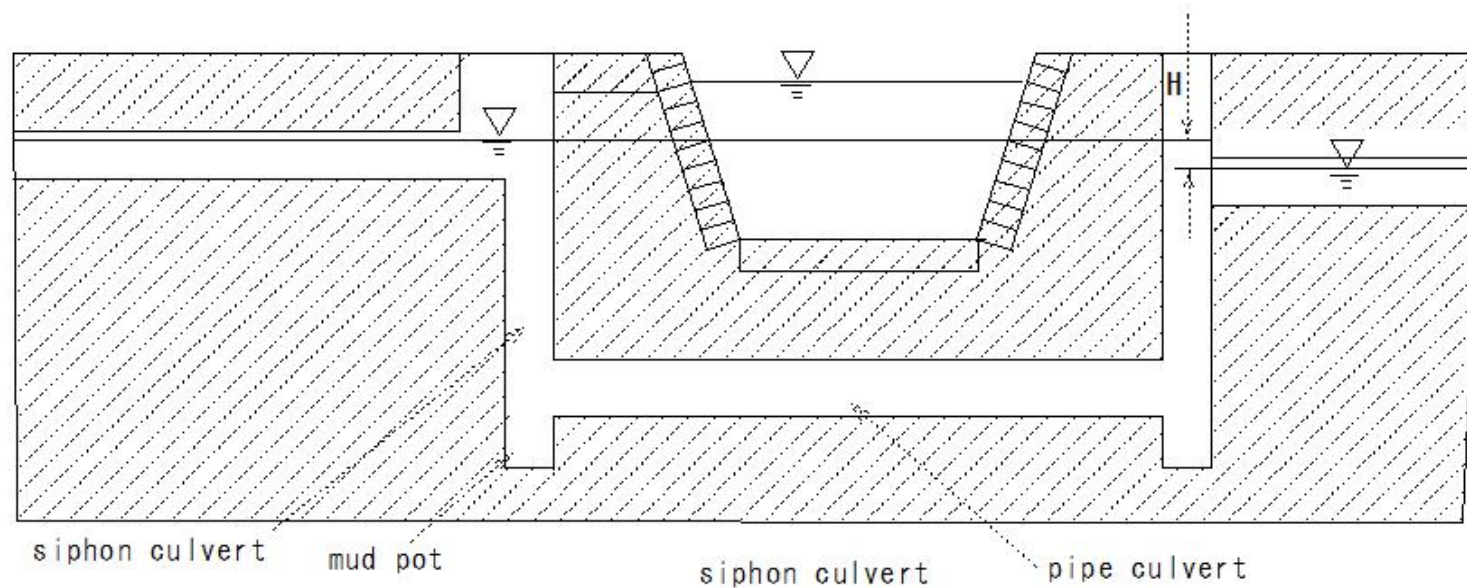
R478

(I721)Siphon culvert

(I721)Siphon culvert

siphon culvert

Waterways that cross under waterways, railways, and roads



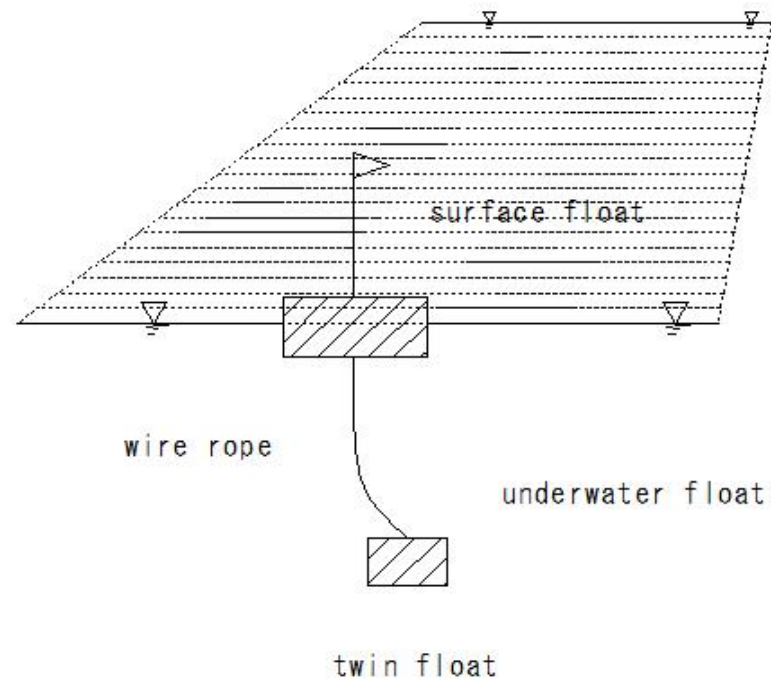
R612

(1722)Twin float

(1722)Twin float

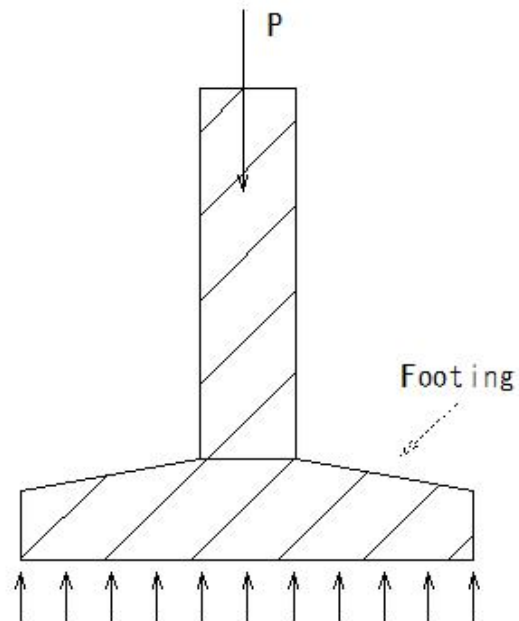
Twin float

A float that connects a surface float and an underwater float with a wire.
Measurement of flow velocity in rivers at peak times



(I723)Footing

(I723)Footing



Pillars, walls, piers

Bottom - Enlarge

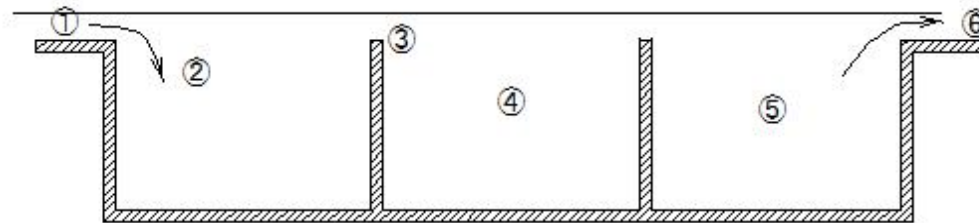
(I724) Plain precipitation (Normal sedimentation)

(I724) Plain precipitation (Normal sedimentation)

Plain precipitation (Normal sedimentation)

Normal sedimentation is a method of separating solid components in water by allowing them to settle by gravity without adding coagulants.

- ① Raw water
- ② Sedimentation time: 12 hours is standard
- ③ Flow straightening wall
- ④ Flow rate: within 30cm/min
- ⑤ Water depth: 3-4m
- ⑥ Outlet

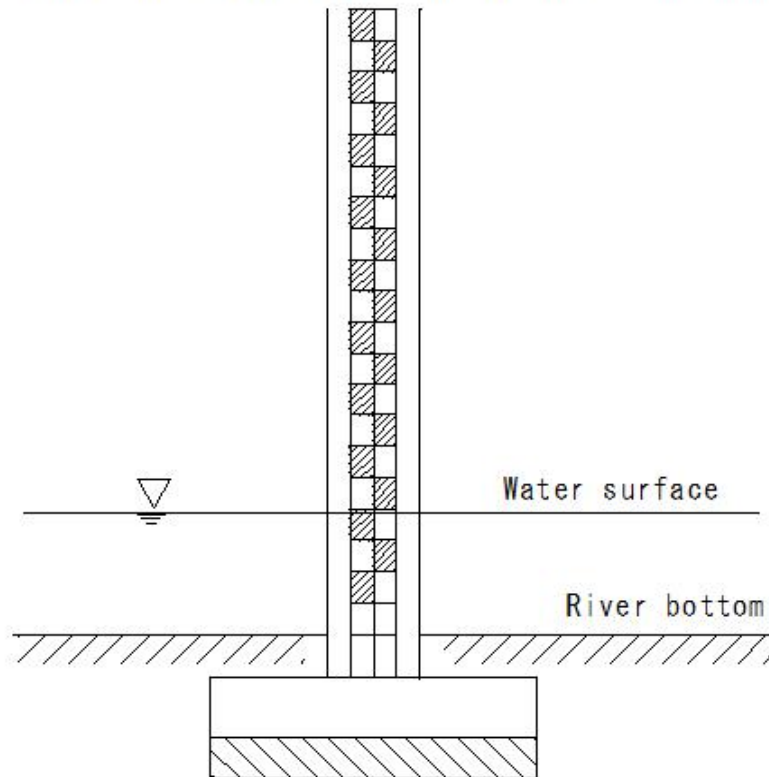


(I725)Normal water gauge(Ordinary water gauge)

(I725)Normal water gauge(Ordinary water gauge)

Normal water gauge(Ordinary water gauge)

Ordinary water gauge is a scale plate installed on the bank to measure the water level of a river.



(I726)Unsteady flow

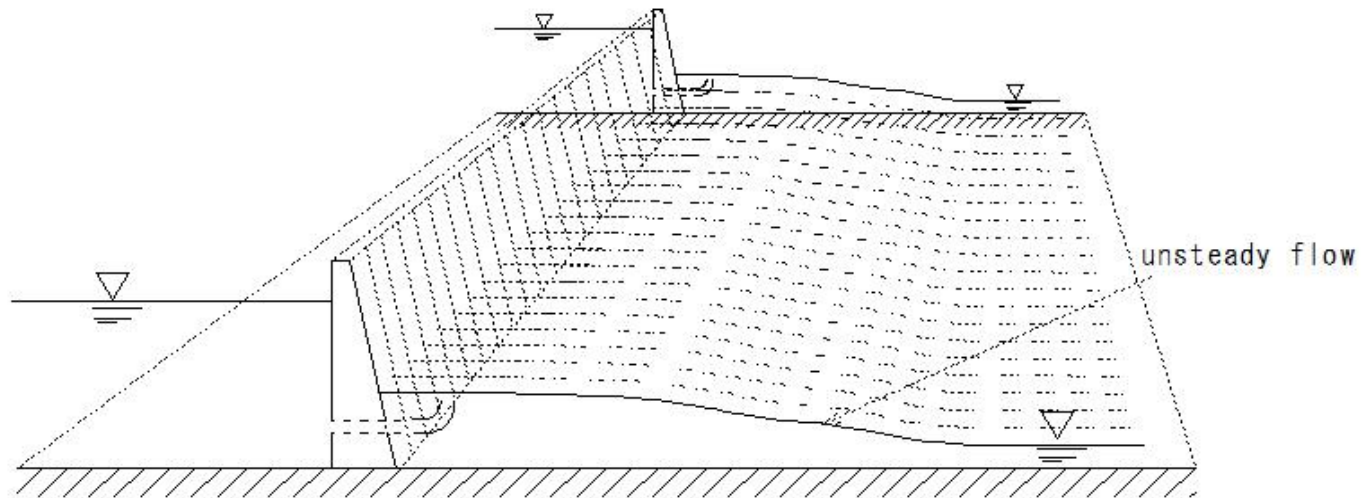
(I726)Unsteady flow

Unsteady flow

waterway

flow: volume and velocity change over time

dam discharge

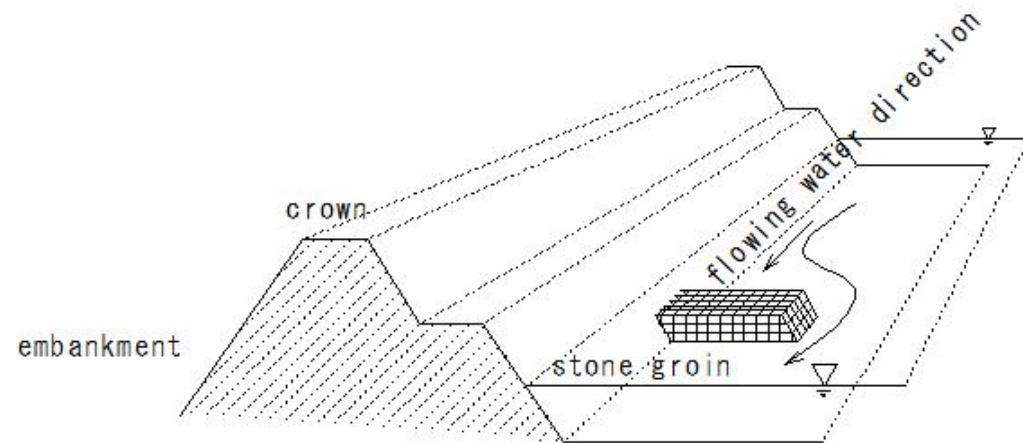


(I727) Impermeable groin (solid spur)

(I727) Impermeable groin (solid spur)

Impermeable water system

Water system that water cannot pass through



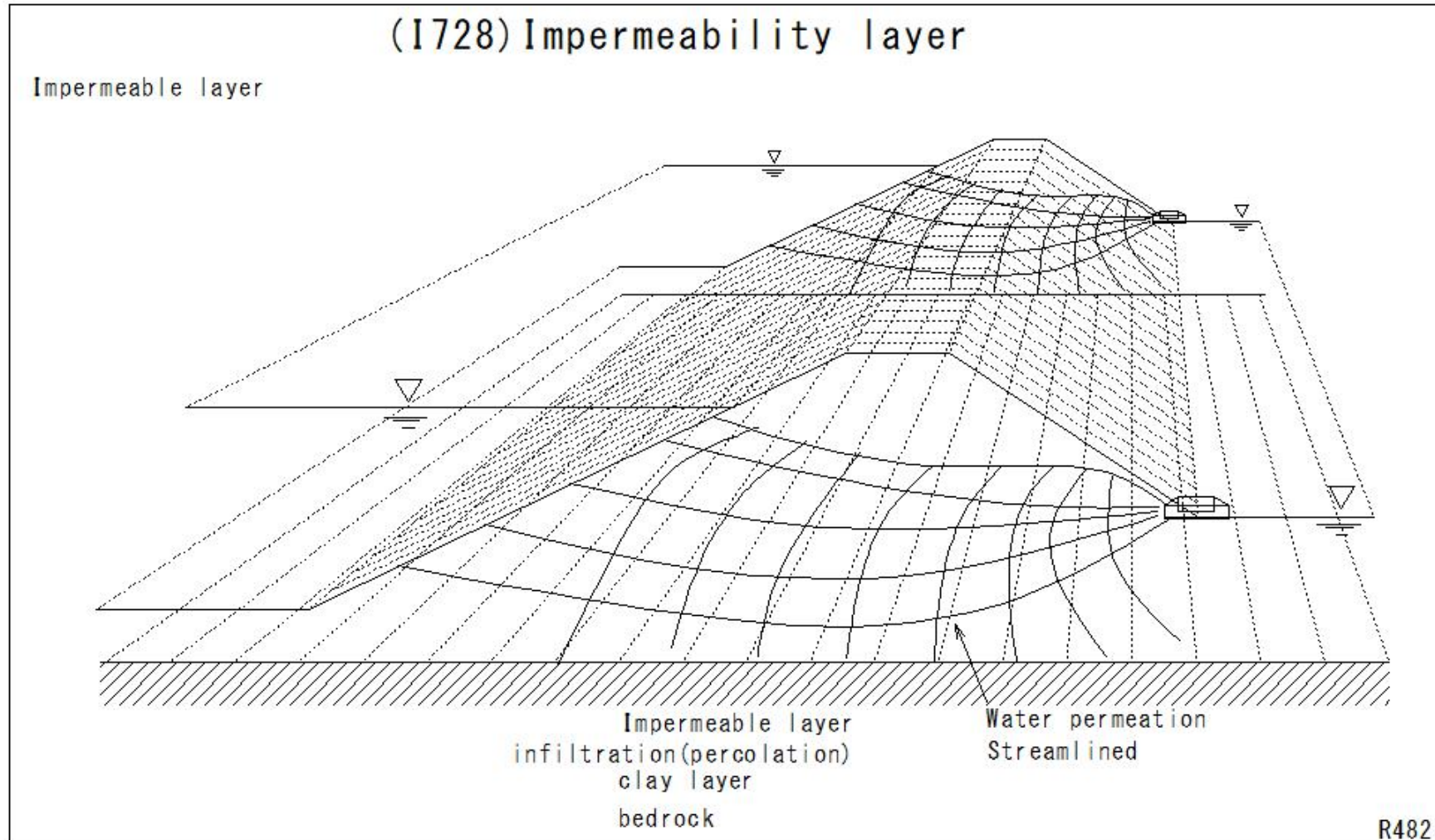
Resistance - large

Scouring - big

Water control effect - large

R298

(I728) Impermeability layer



(I729)Non-uniform flow

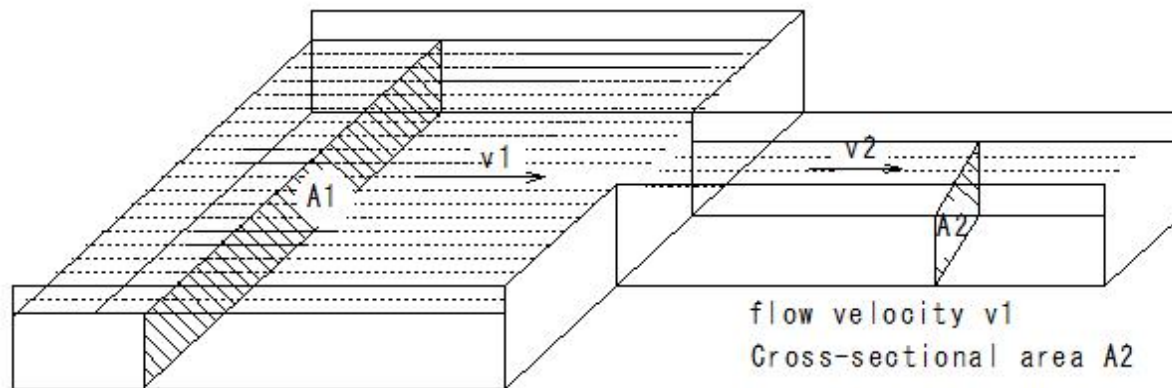
(I729)Non-uniform flow

Non-uniform flow

Constant discharge

waterway

flow with changing flow velocity and volume



flow velocity v_1

Cross-sectional area A_2

Q : discharge

$$Q = A_1 v_1 = A_2 v_2$$

R483

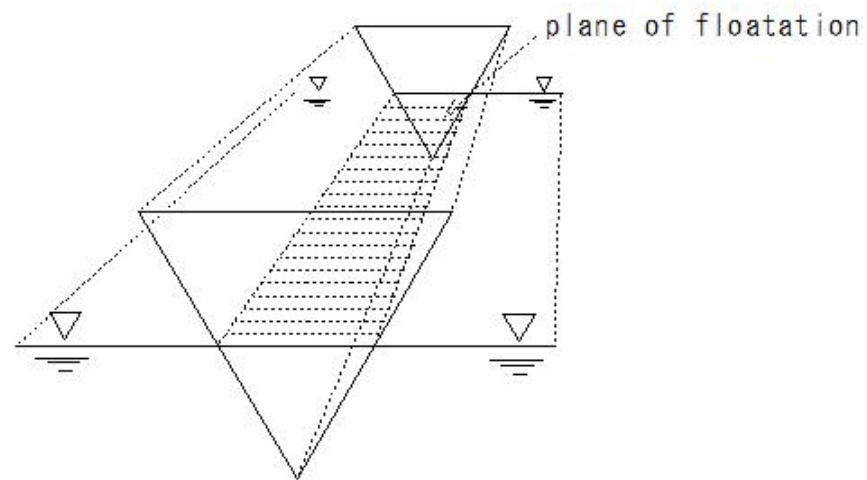
(I730)Plane of floatation

(I730)Plane of floatation

Plane of floatation

objects floating in water

Virtual cross section : cut by the water surface



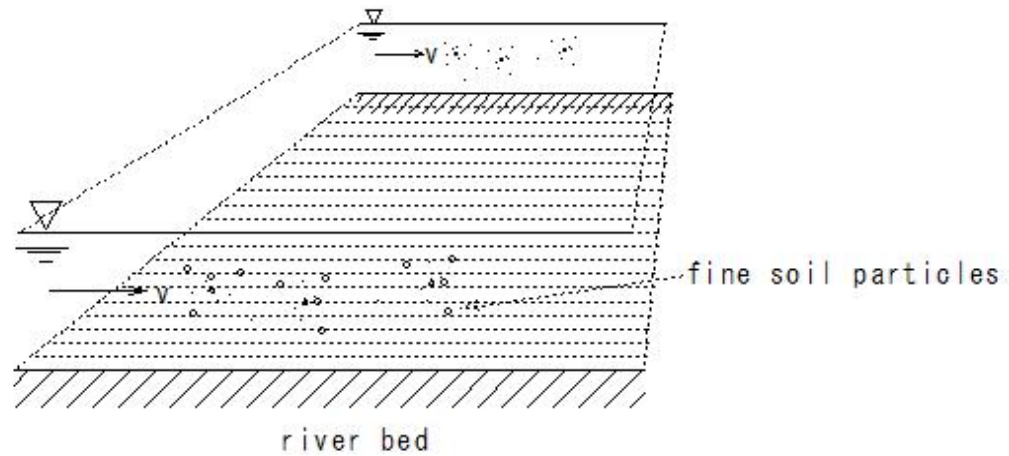
(I731)Suspended load

(I731)Suspended load

Suspended load

suspended load: floating and flowing in water

A phenomenon in which fine soil particles leave the river bed and float in the water.

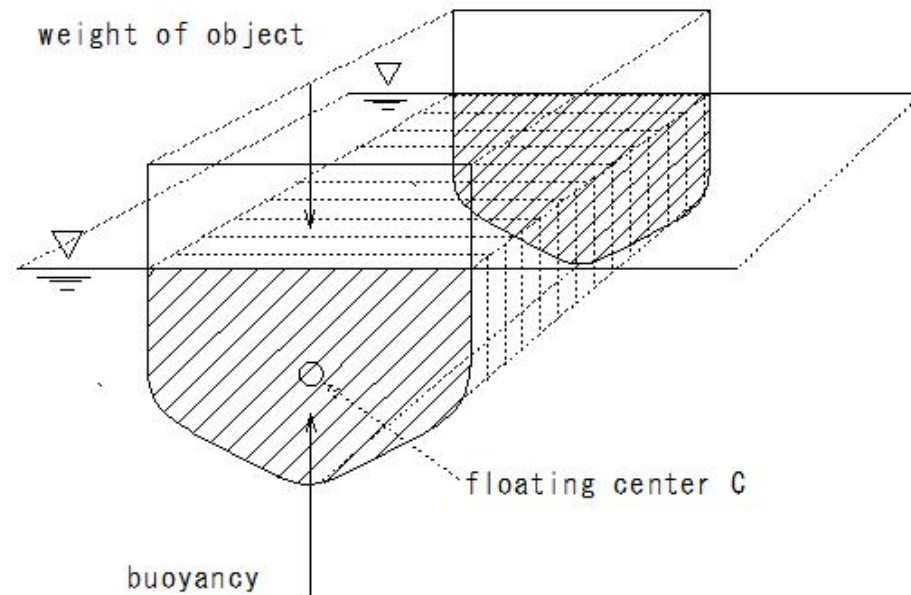


(I732)Buoyancy

(I732) Buoyancy

Buoyancy

Buoyancy: Volume of object below the water line: Weight of water: Buoyancy



(1733)Froude number

(1733)Froude number

Froude number

open channel

Flow velocity v

Wave propagation speed $v_o (= \sqrt{gh})$

Froude number $Fr = v/v_o = v/\sqrt{gh}$

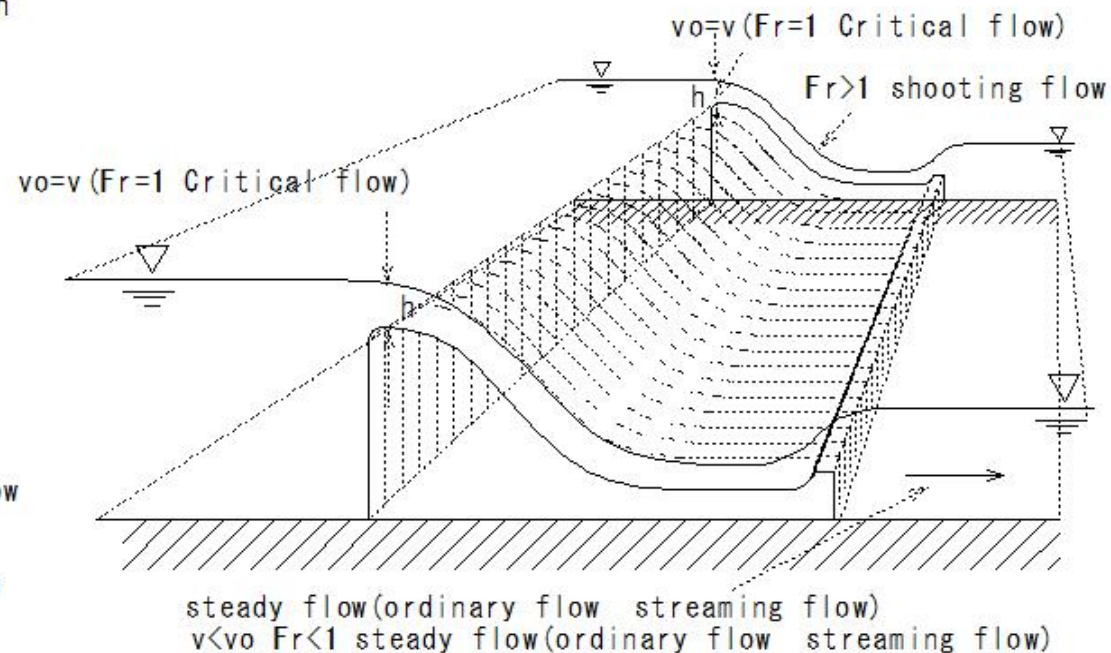
$Fr > 1$ shooting flow

$Fr = 1$ Critical flow

$Fr < 1$ steady flow (ordinary flow
streaming flow)

g : gravitational acceleration

h : water depth

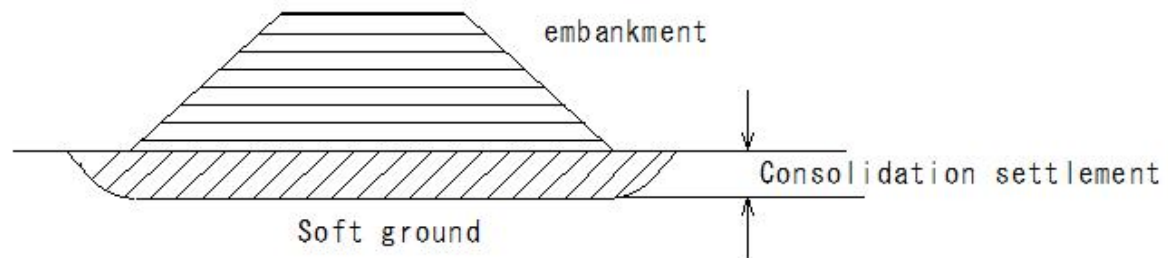


(I734)Preloading

(I734)Pre loading

Preloading

Promotion of consolidation settlement



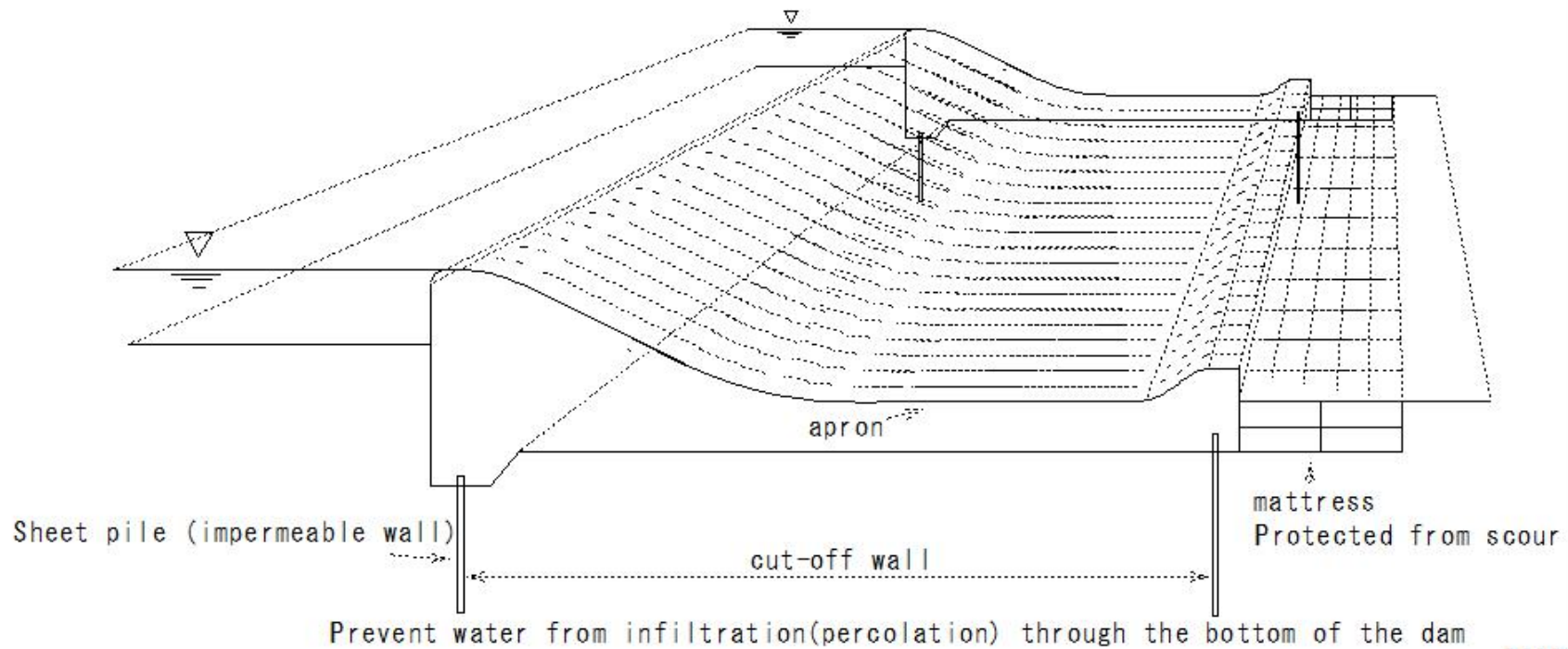
(I735) Floating dam

(I735) Floating dam

Floating dam

A type of intake dam

Dams built on permeable foundations such as gravel layers



D239

R488

(I736)Watershed

(I736)Watershed

watershed

Boundary where the basins of each river meet

Upper river area, mountainous area, watershed - clear

The flatland part of the downstream part is not clear

River A basin

River B basin

River A

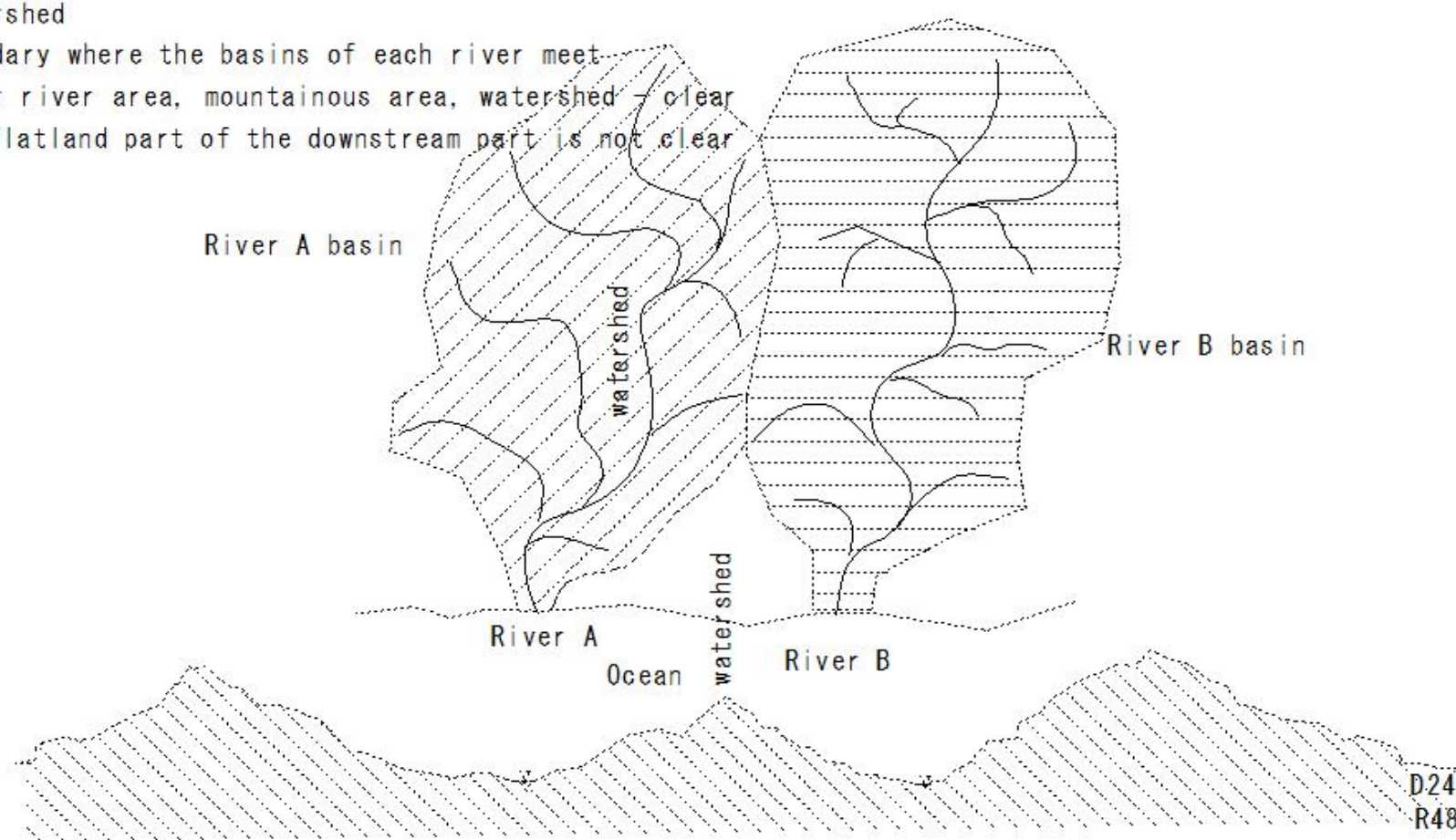
Ocean

River B

watershed

watershed

D240
R489

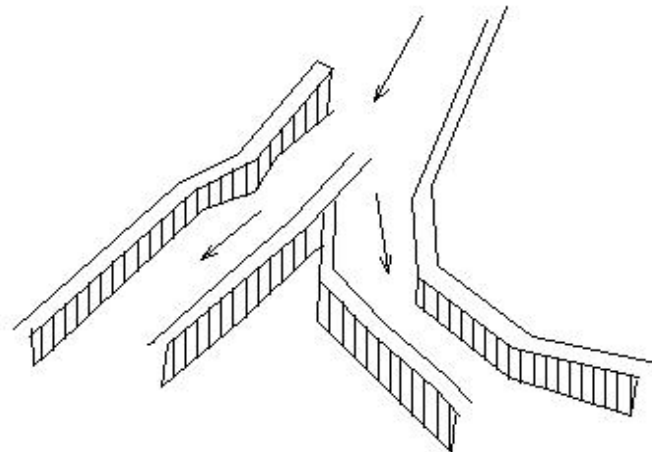


(I737) Diversion works

(I737) Diversion works

Diversion works

A structure that divides irrigation water according to the irrigated area.



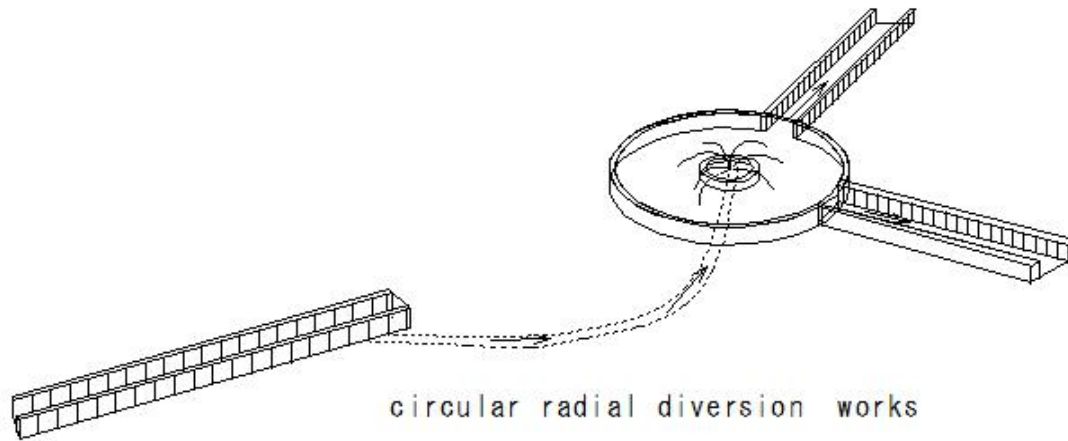
shooting flow diversion works

(I738)Diversion works

(I738)Diversion works

diversion works

A structure that divides irrigation water according to the irrigated area.

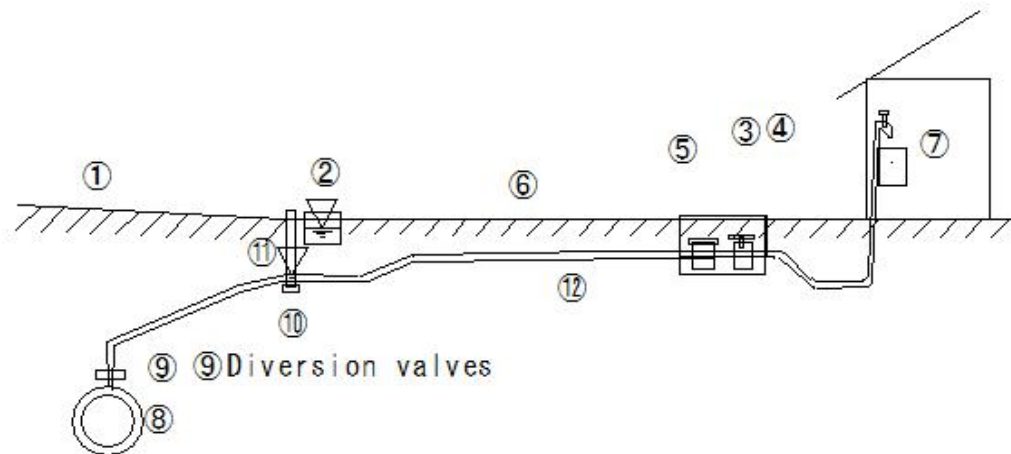


(I739)Sewerage(Water distribution valve(ferrule))

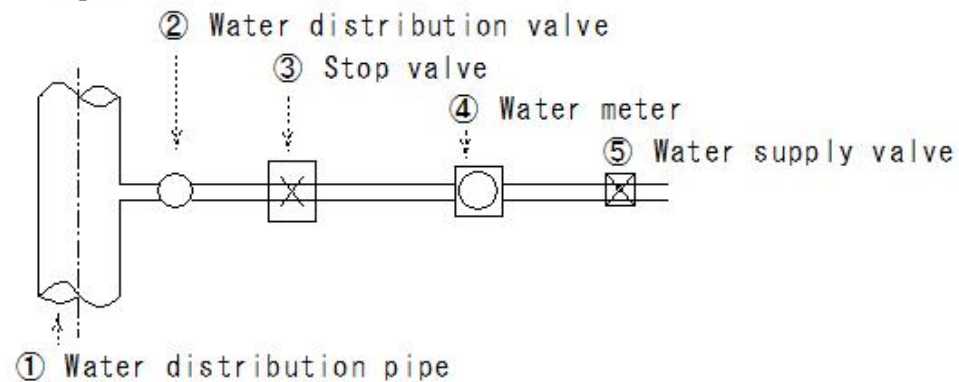
(I739) Sewerage (Water distribution valve(ferrule))

Water distribution valve(ferrule)

A device is installed in case of branching off a water supply pipe from a distribution pipe



W49, 50



W182

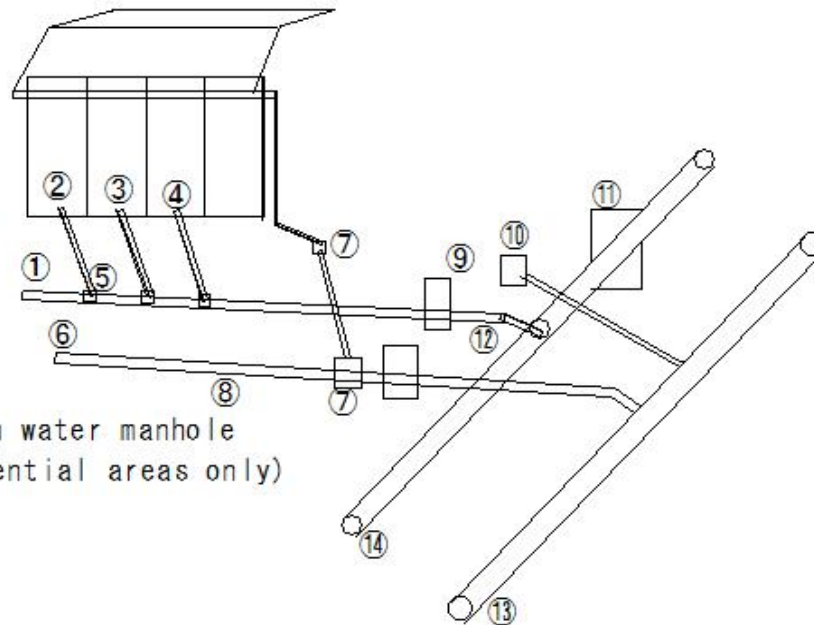
(I740)Sewerage(separate system)

(I740) Sewerage (separate system)

Sewerage

Separate type

- ① Water distribution pipe (sewage pipe)
- ② Kitchen
- ③ Bathroom
- ④ Toilet
- ⑤ Sewage manhole
- ⑥ Drainage pipe (storm water pipe) Storm water manhole
- ⑦ Public storm water manhole (for residential areas only)
- ⑧ Rainwater attachment pipe
- ⑨ Public sewage manhole
- ⑩ Public storm water manhole
- ⑪ Sewage manhole
- ⑫ Sewage attachment pipe
- ⑬ Sewer pipes (rain water pipes)
- ⑭ Sewer pipes (sewage pipes)



(I741)Sewerage(Combined type/ Separate type)

(I741)Sewerage(Combined type/ Separate type)

Sewerage

Sewerage planning

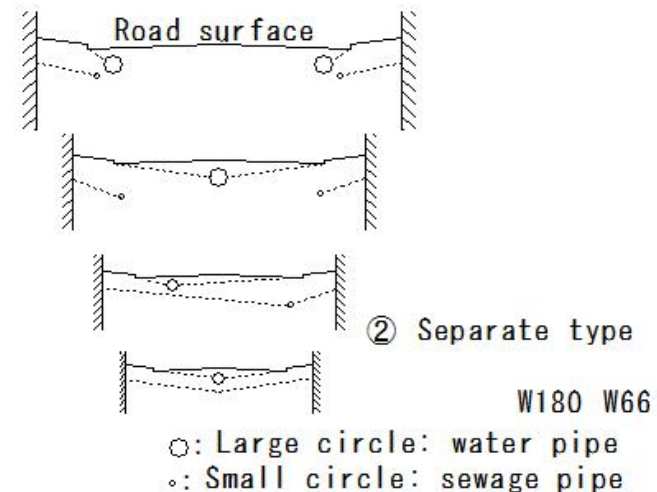
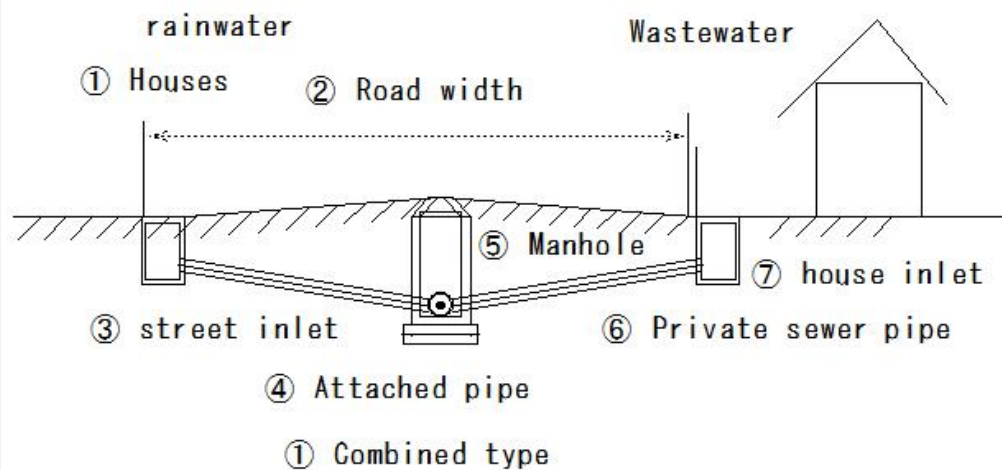
⑤ Wastewater removal method

① Combined type

Wastewater and rainwater are discharged through the same pipe
in case of there is a lot of rainfall → Discharged without treatment

② Separate type

Wastewater and rainwater are discharged through separate pipes
Wastewater is treated and then discharged → Water quality is maintained Cost → High



(I742)Mean velocity

(I742)Mean velocity

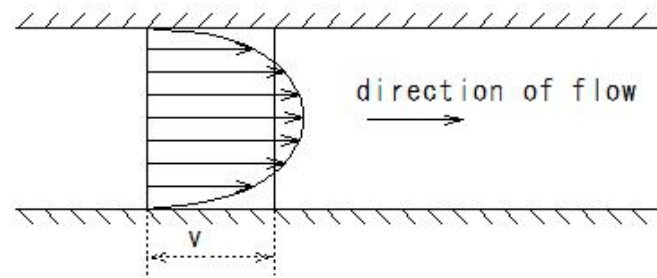
Mean velocity

flow velocity v_1 v_2 v_3

mean velocity $V=Q/A$

Q : discharge

A : cross sectional area of stream

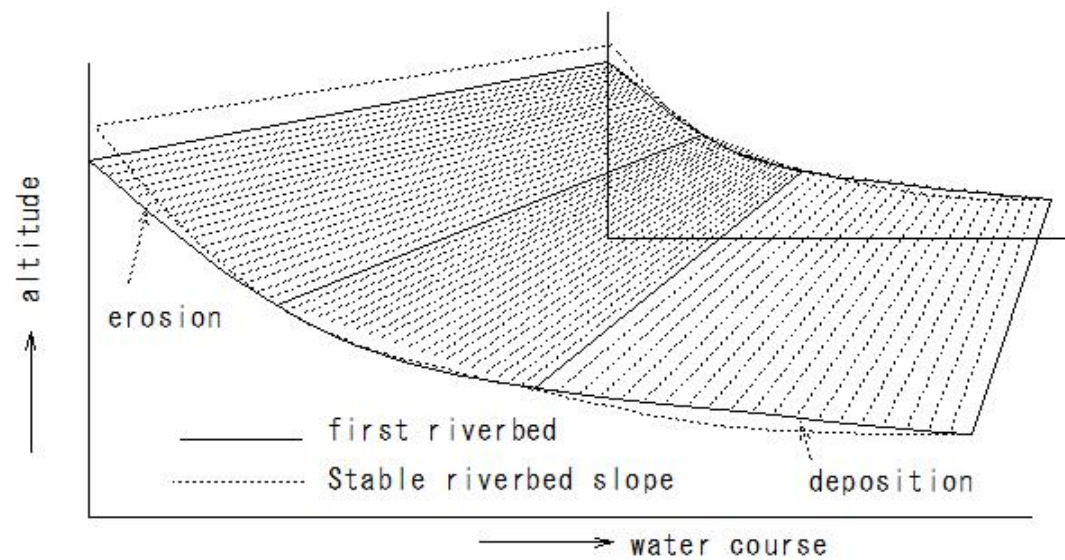


(1743)Equilibrium slope

(1743)Equilibrium slope

Equilibrium slope

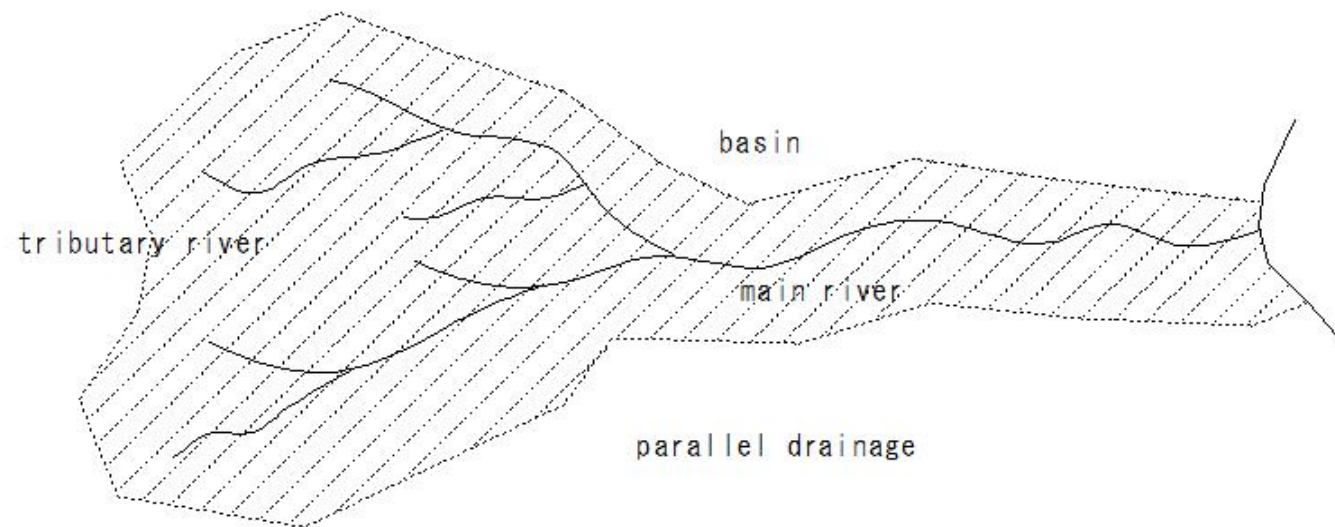
In a river with an equilibrium gradient, neither sedimentation nor scouring occurs.
River water flow, erosion, transportation, deposition



(I744)Parallel drainage

(I744)Parallel drainage

Parallel drainage



R494

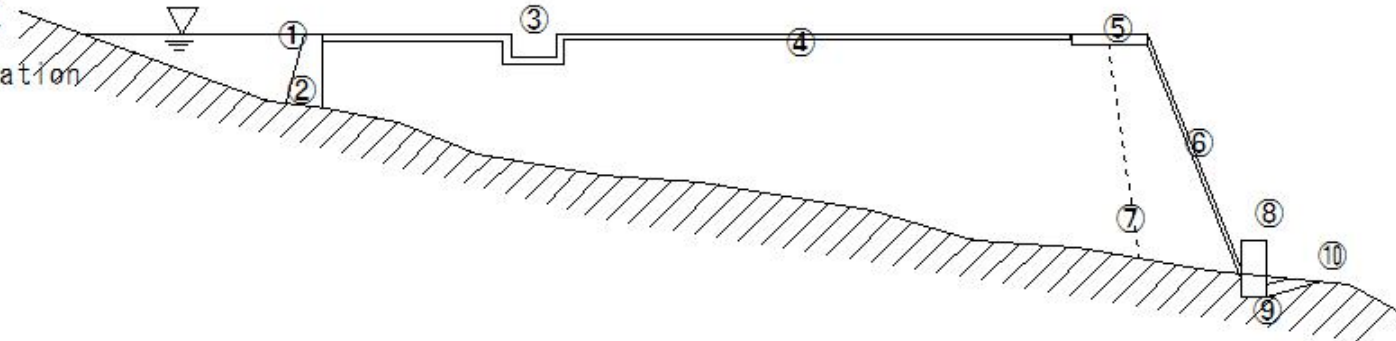
(1745)Head tank

(1745)Head tank

Head tank

- A head tank is a water tank located between the waterway and the penstock at a hydroelectric power plant
- A water tank located between the waterway and the penstock
- Prevents water hammer caused by load fluctuations
- For short-term water volume adjustment, overflow of surplus water, and removal of obstacles such as sediment

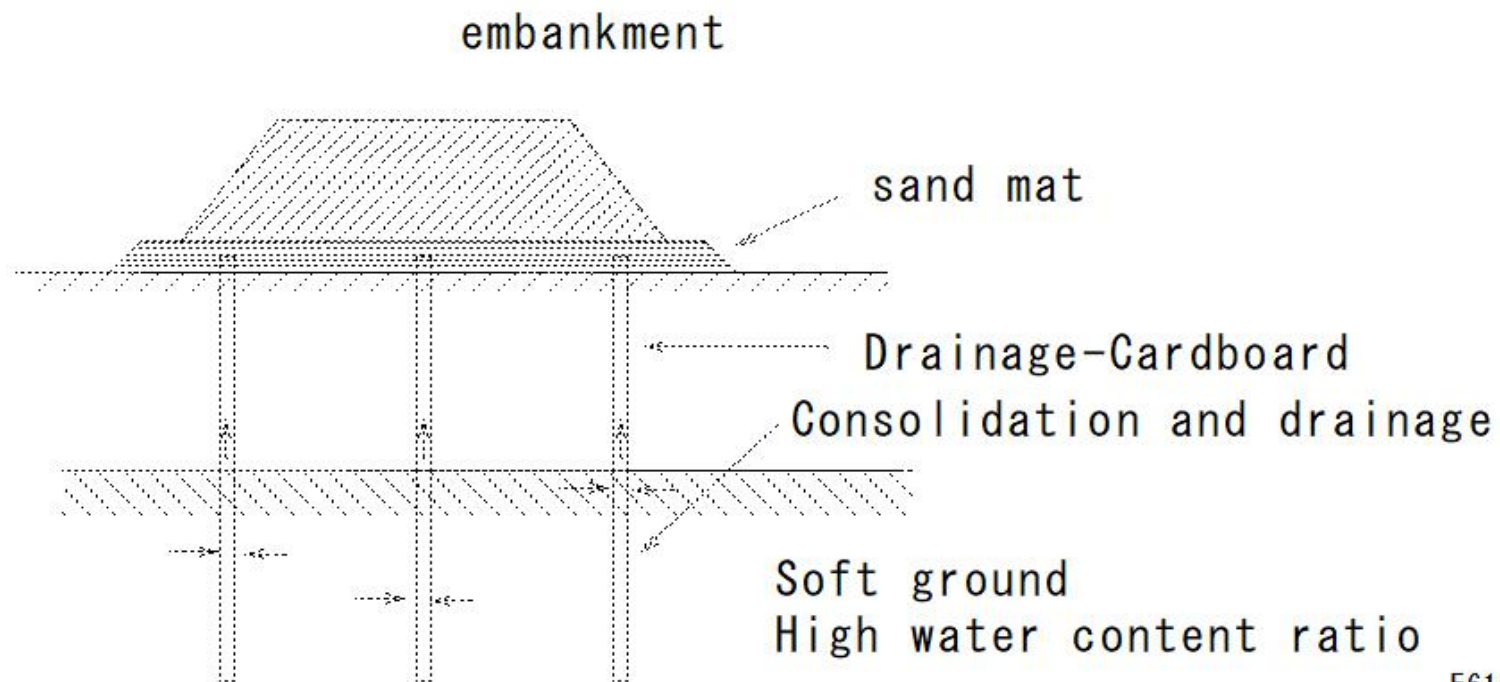
- ① Intake
- ② Dam
- ③ Settling basin (Grit chamber)
- ④ Conduit
- ⑤ Head tank
- ⑥ Penstock
- ⑦ Spillway
- ⑧ Power station
- ⑨ Outlet
- ⑩ Outlet



(I746)Card-board wicks method

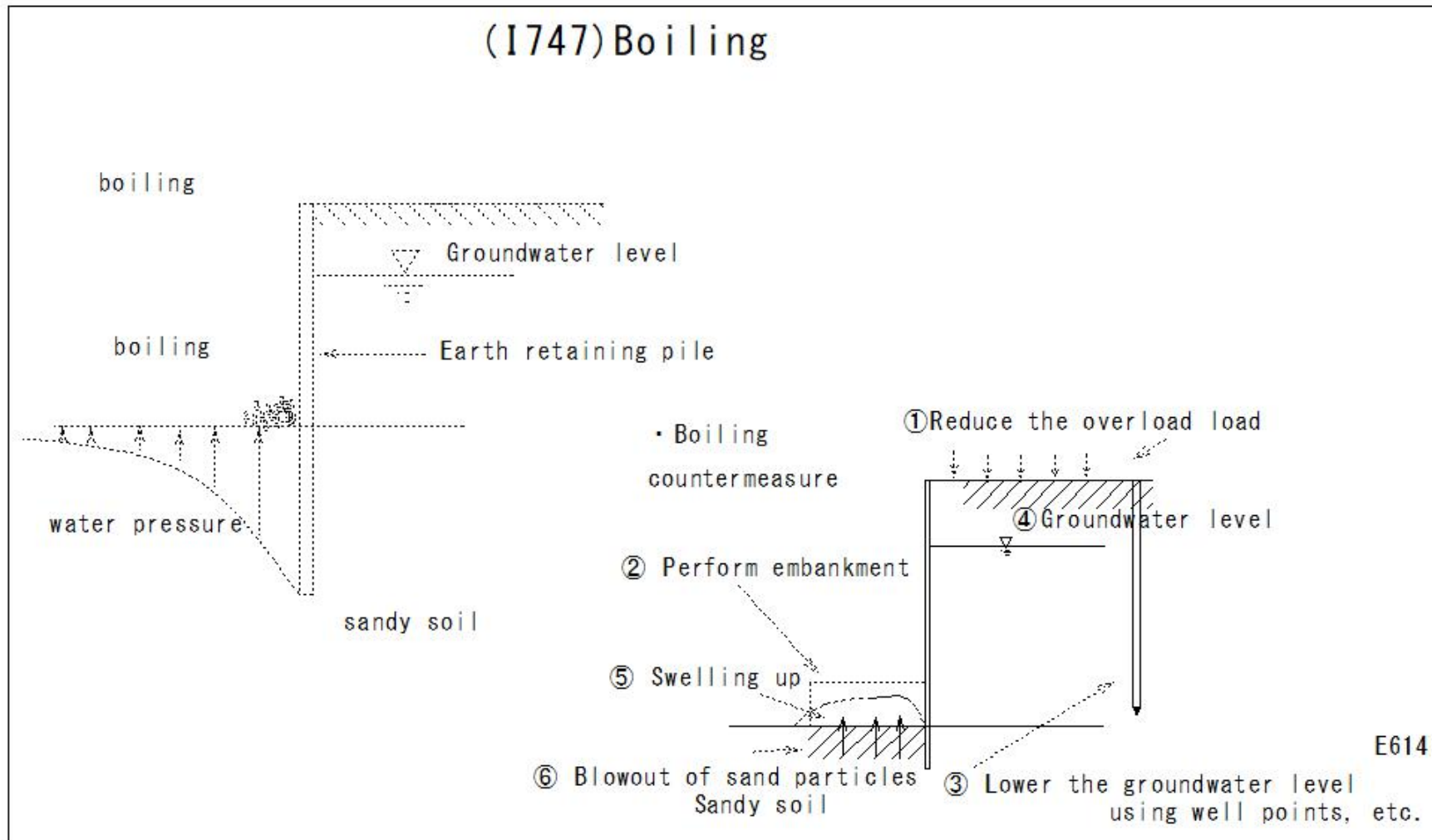
(I746)Card-board wicks method

Card-board wicks method



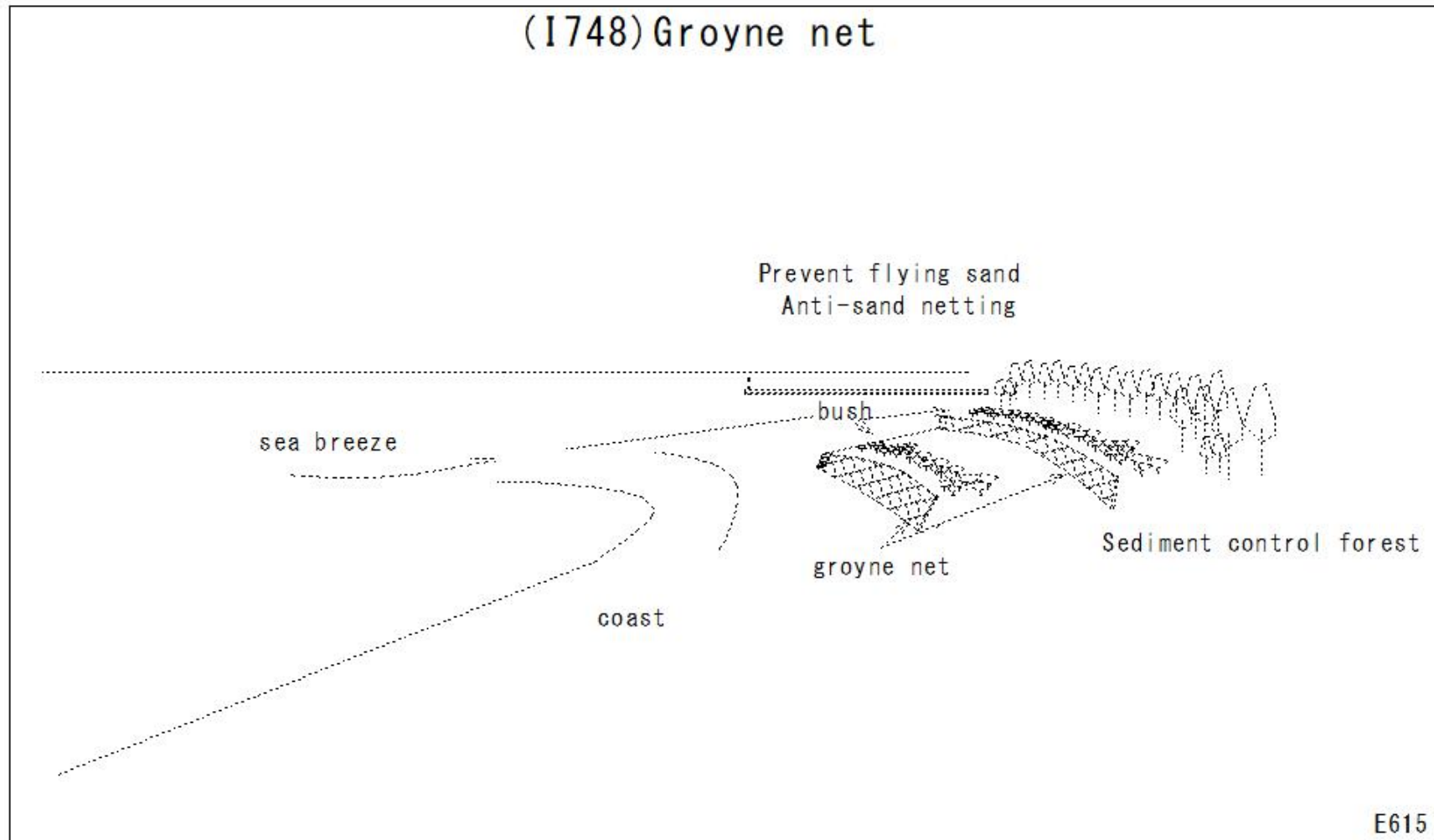
E612

(I747)Boiling



(I748)Groyne net

(I748)Groyne net



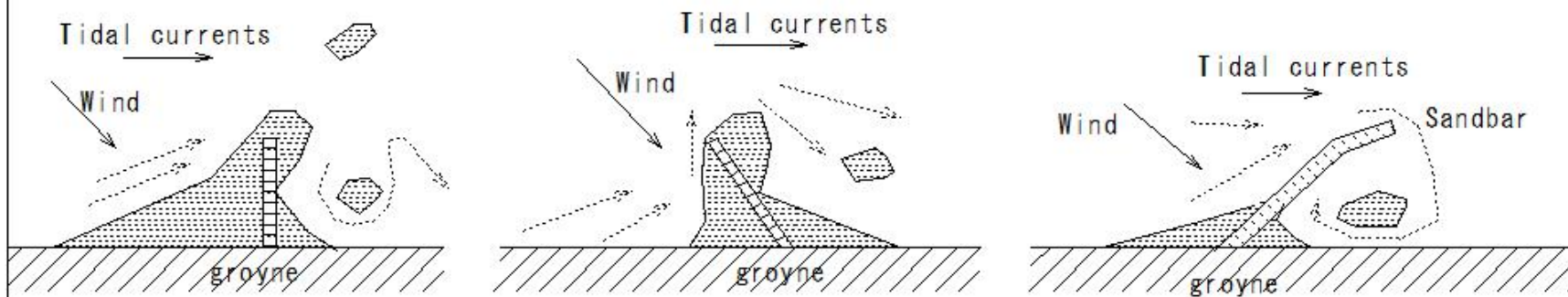
(1749)Groyne net

(1749)Groyne net

groyne

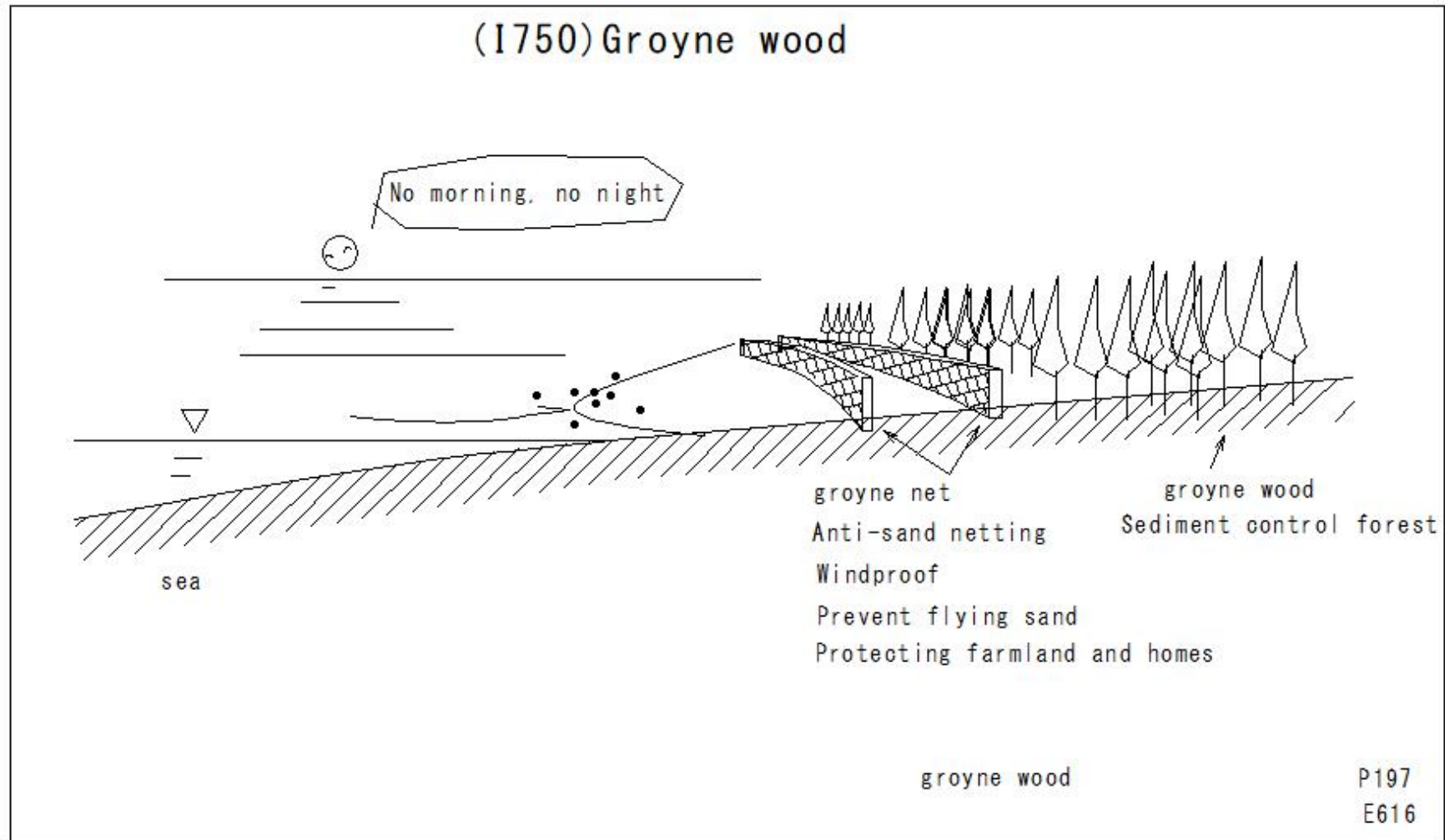
Preventing drift sand

Coastline - Preventing shallowing



The direction of groyne (sand barriers)
the movement and accumulation of sand

(1750)Groyne wood

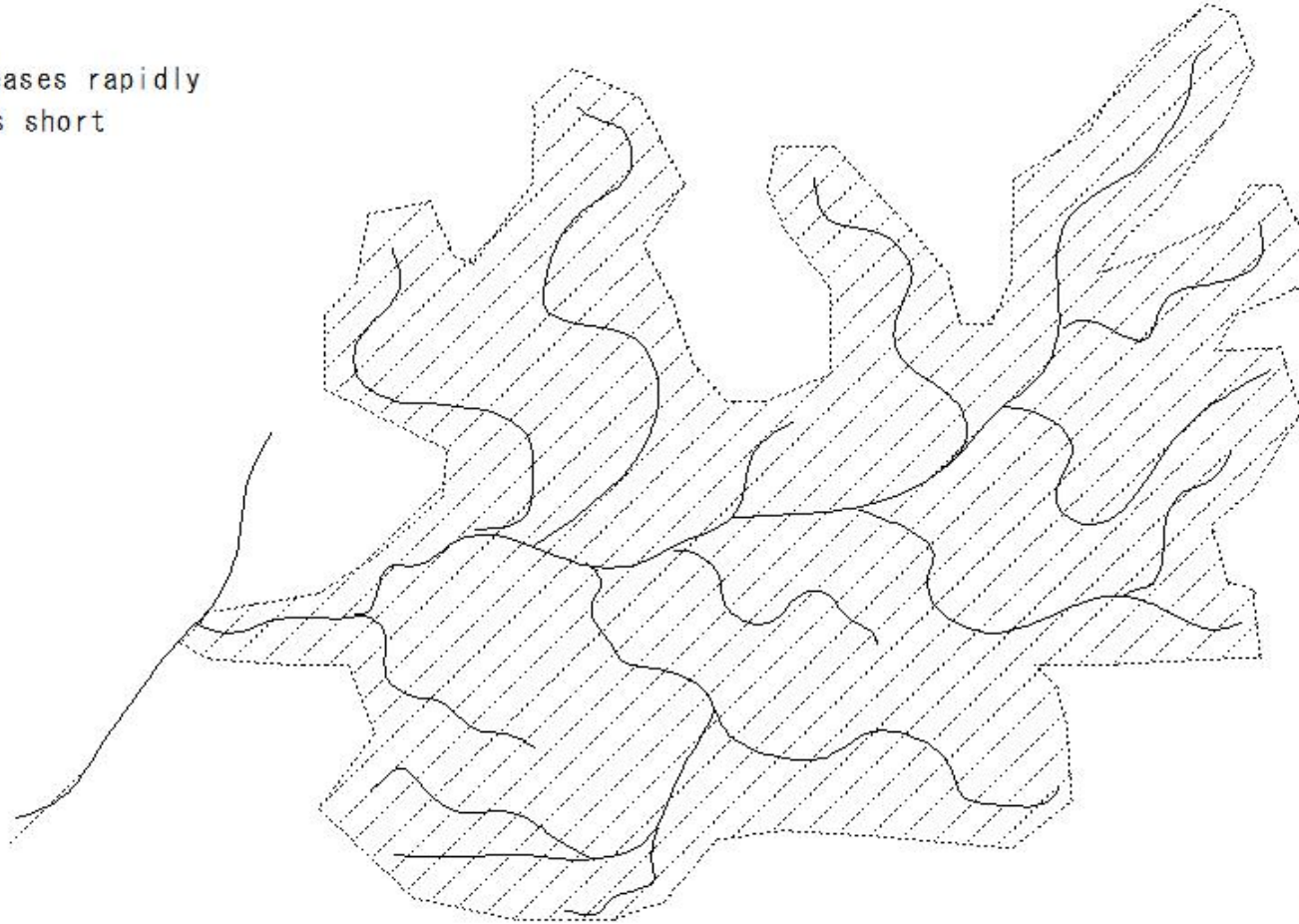


(I751)Radial drainage

(I751)Radial drainage

Radial drainage

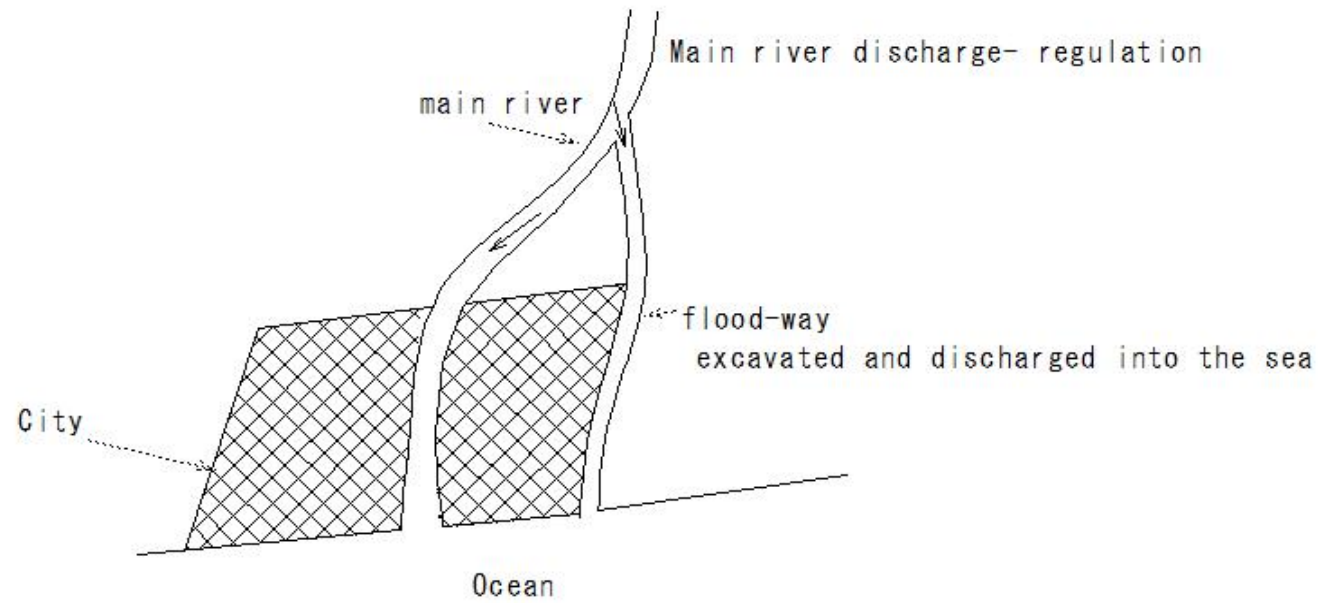
discharge increases rapidly
water season is short



R495

(1752)Flood-way

(1752) Flood-way

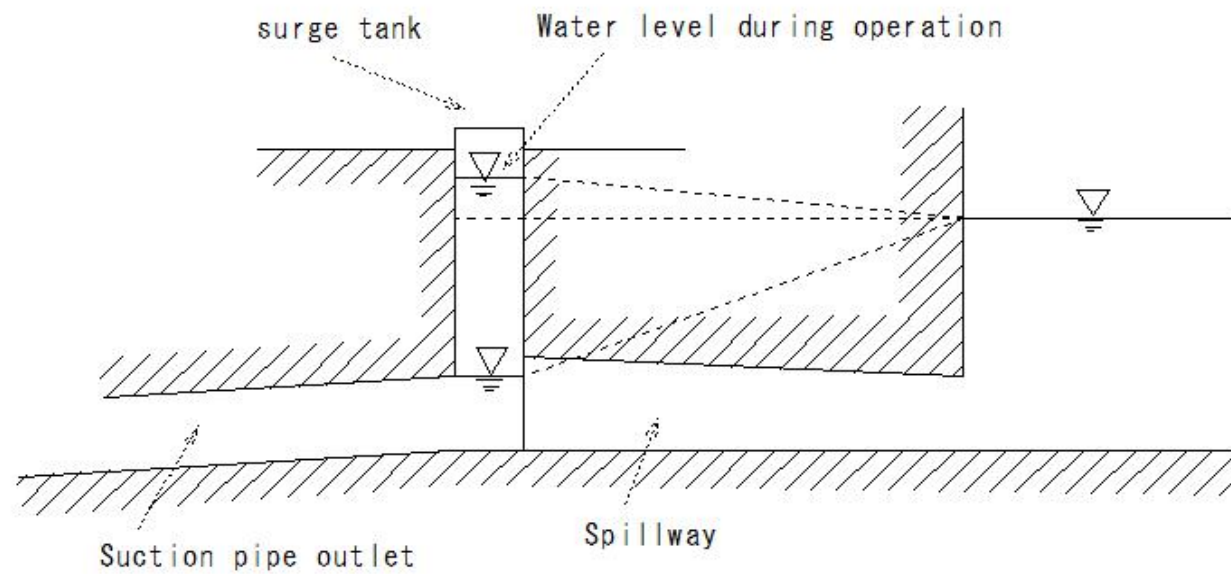


(I753)Tail-race surge tank

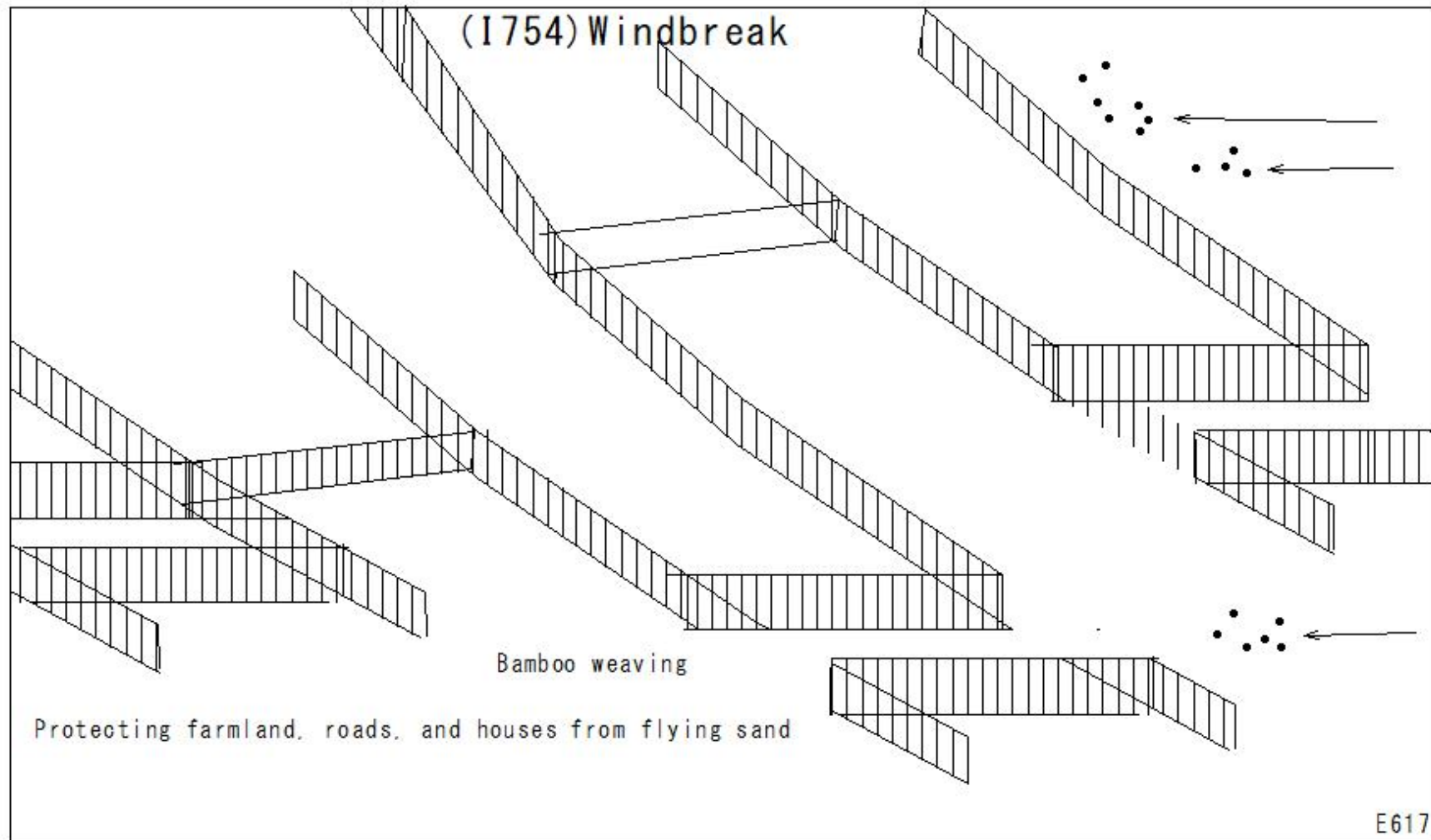
(I753)Tail-race surge tank

Tail-race surge tank

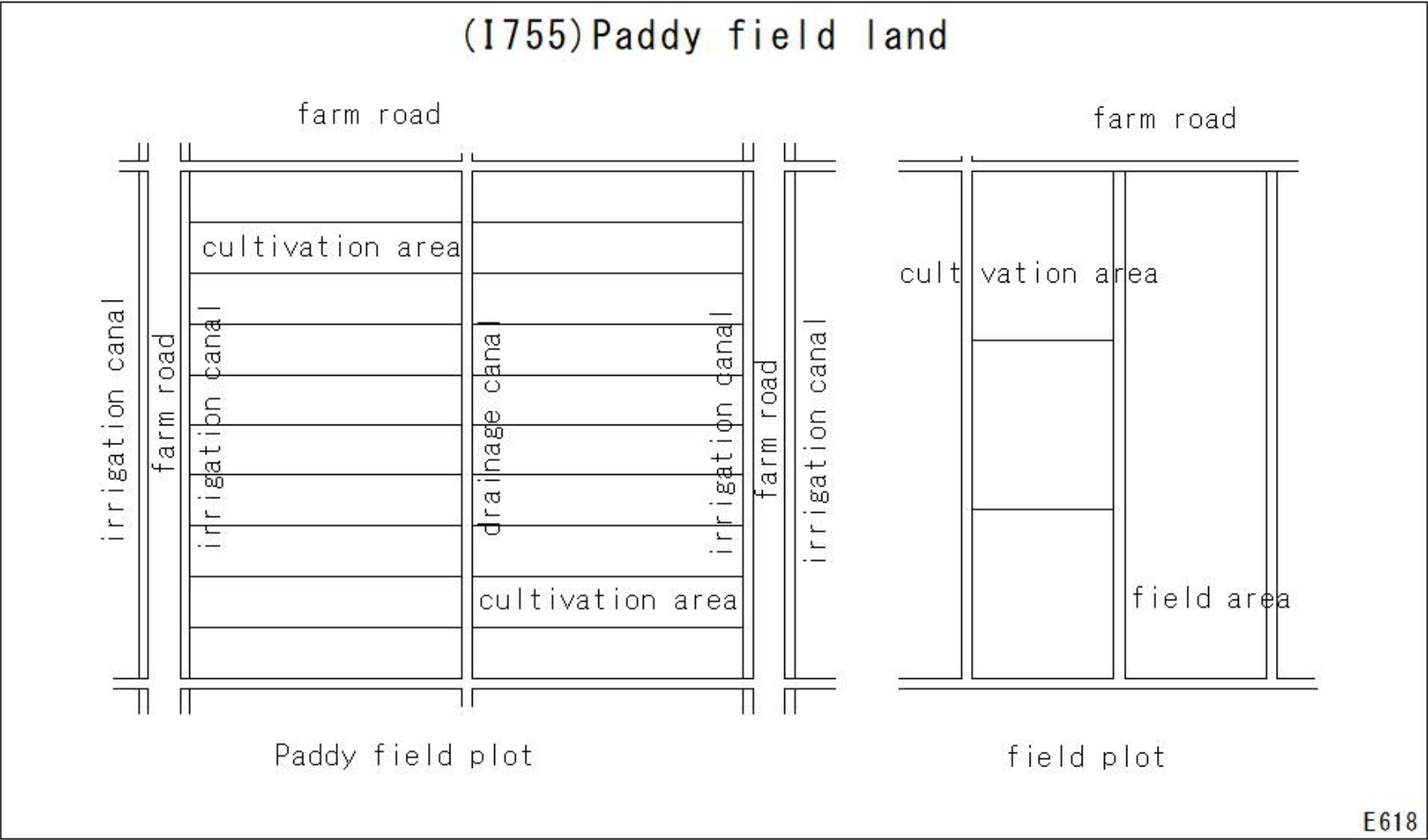
Surge tank: softens water hammer



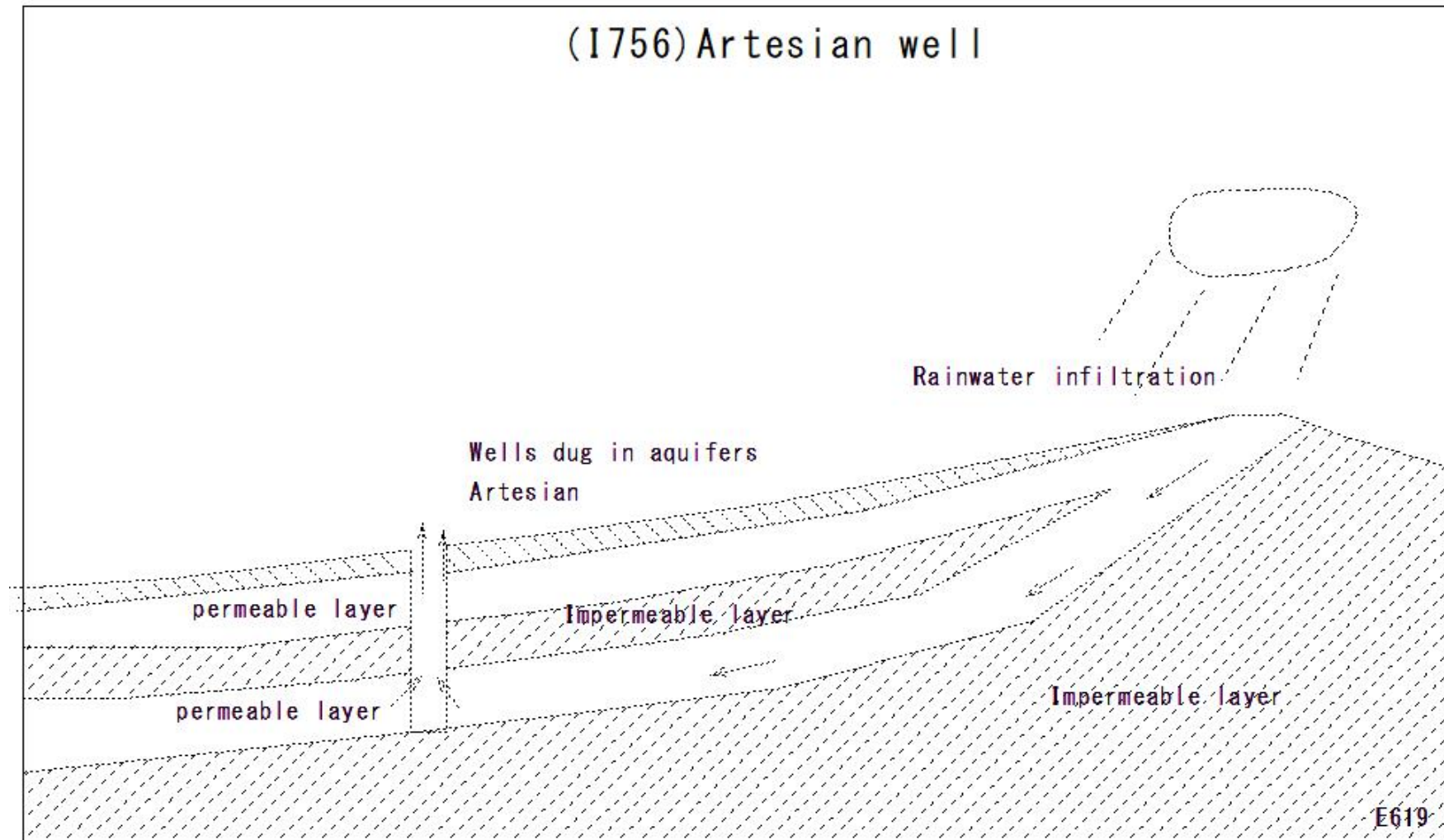
(I754)Windbreak



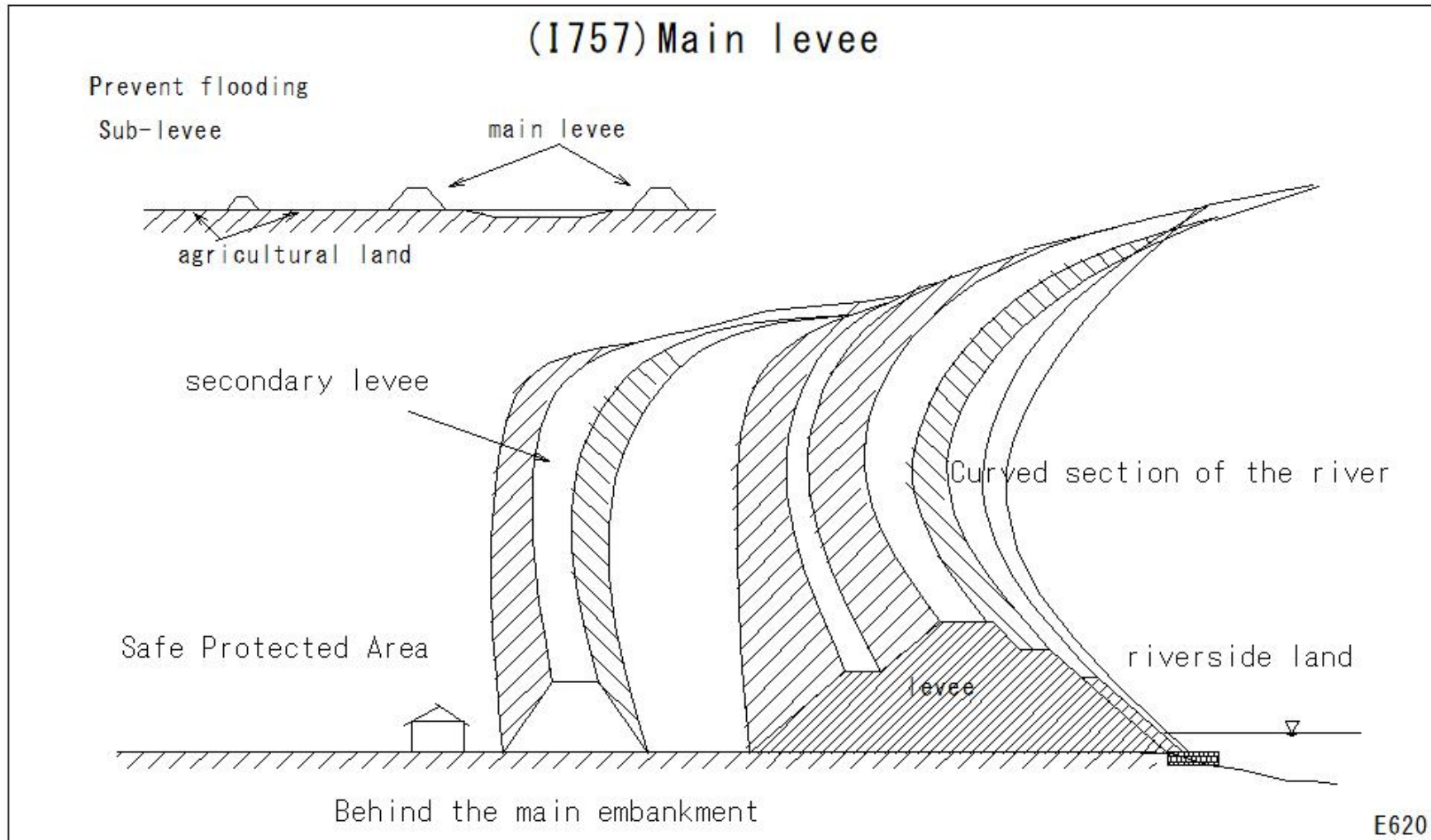
(I755)Paddy field land



(1756)Artesian well



(I757)Main levee

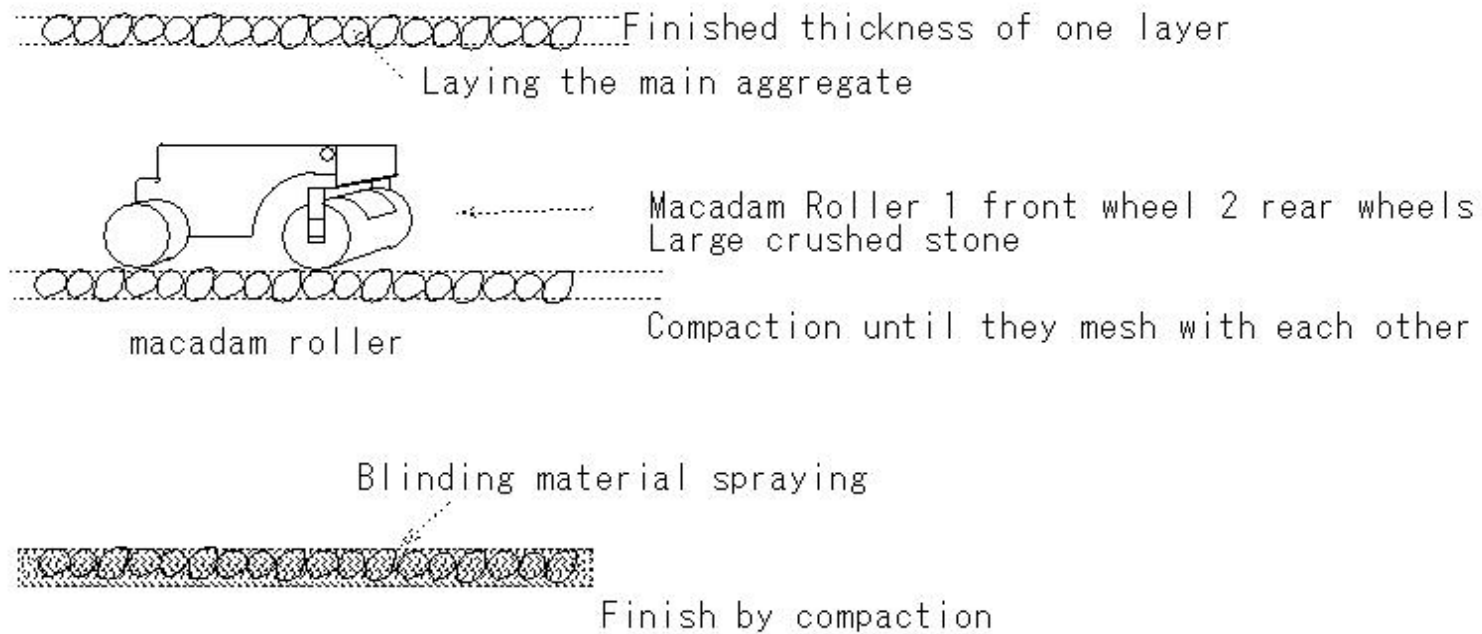


(1758)Macadam

(1758)Macadam

Macadam

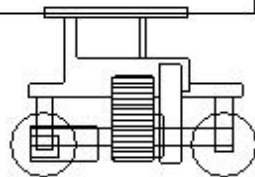
Road-roadbed construction method



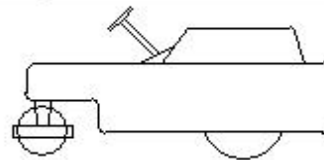
(I759)Earthworks-Characteristics of Earthmoving Machinery

(I759)Earthworks-Characteristics of Earthmoving Machinery

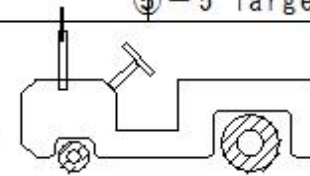
Characteristics of Earthmoving Machinery				
①Work	②model	③Transportation	④Soil quality	⑤Work conditions
①-5 static pressure				
	②-5 macadam roller			
		③-5 Working speed	2km/h	
			④-5 Rock mass, gravel, sand, sandy soil	
				⑤-5 large work area
①-5 static pressure				
	②-5 tandem roller			
		③-5 Working speed	2.5km/h	
			④-5 Rock mass, gravel, sand, sandy soil	
				⑤-5 narrow workplace space
①-5 static pressure				
	②-5 tire roller			
		③-5 Working speed	3km/h	
			④-5 sandy soil clayey soil	
				⑤-5 large work area



macadam roller



tandem roller



tire roller

E186

(I760)Earthmoving machinery-Compaction machines

(I760)Earthmoving machinery-Compaction machines

Earthmoving machinery

Compaction machines

• Types of compaction machines

①Compaction machine

21Macadam roller

⑤Iron wheel (road roller) ⑫Self-propelled 22Tandem roller

②Static

23 3-axis tandem roller

⑥Tire (tire roller)

⑬Towed style

⑭Self-propelled

⑮Towed style

⑦Iron wheel + tire (combined roller)

⑧Iron ring (vibration roller) ⑯Self-propelled

⑰Towed style

③Dynamic

⑱Band guide type

⑨Tire (vibrating roller) ⑲Self-propelled

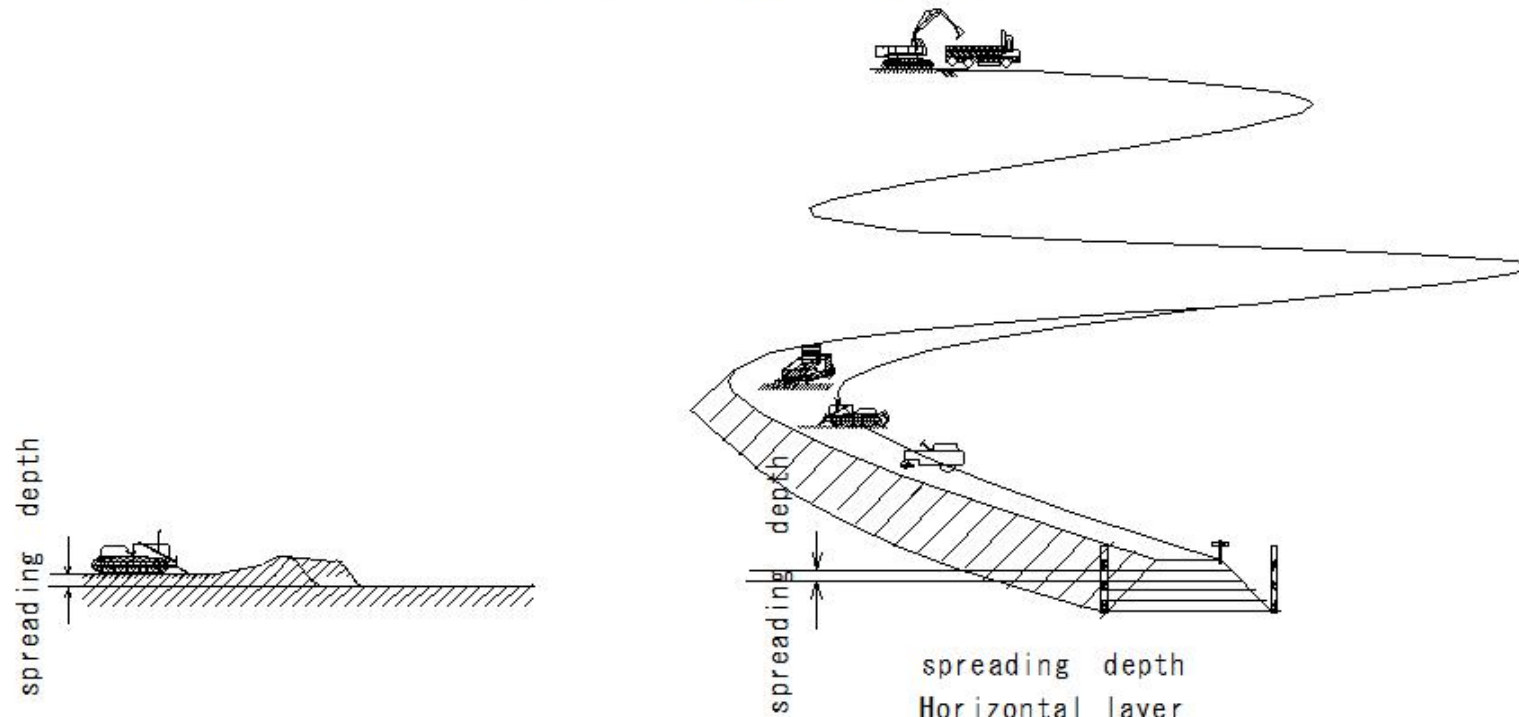
⑳Towed style

⑩Flat plate (vibrating compactor)

④Shocking ⑪Flat plate (tamper, rammer)

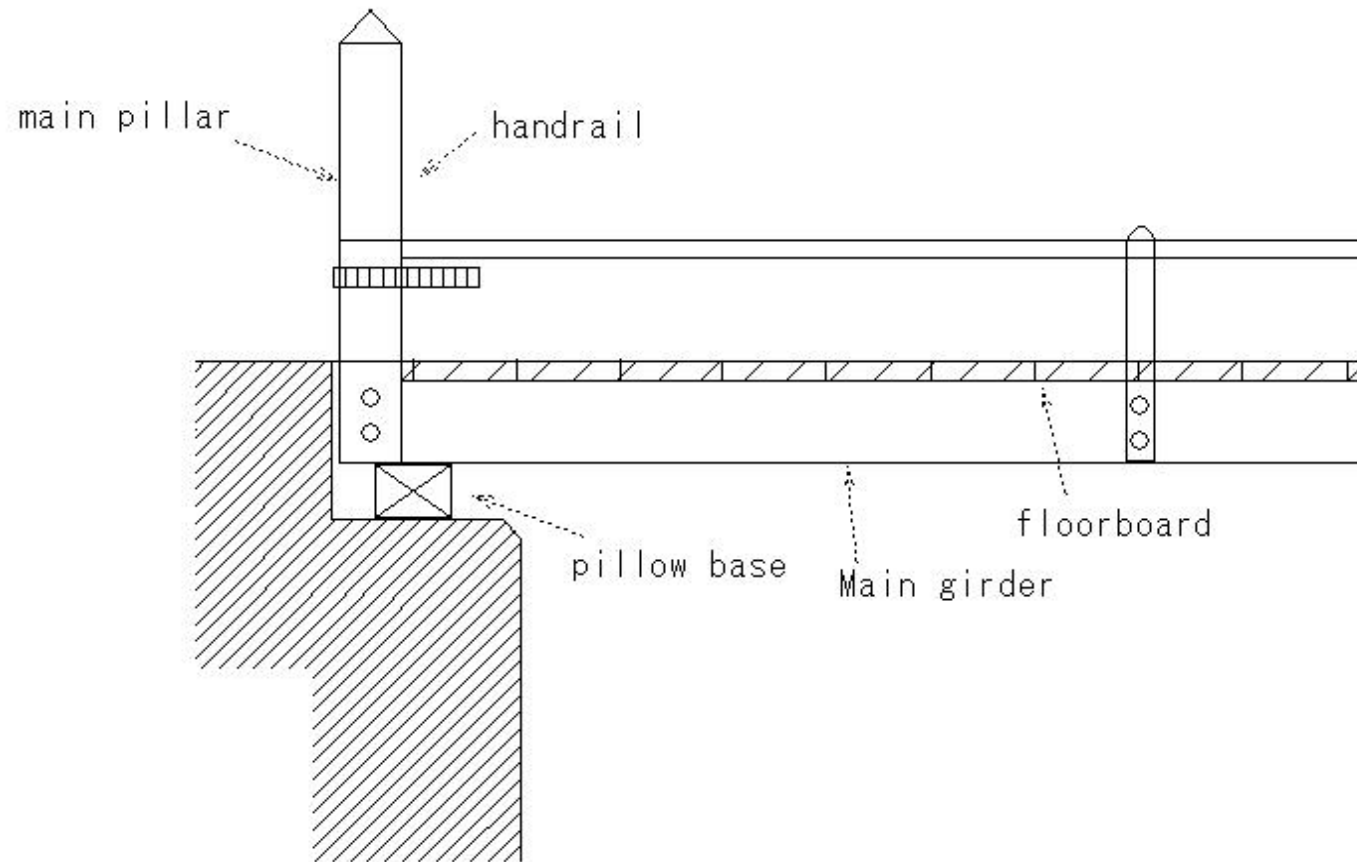
(I761)Spreading depth

(I761)Spreading depth



(1762) Wooden bridge

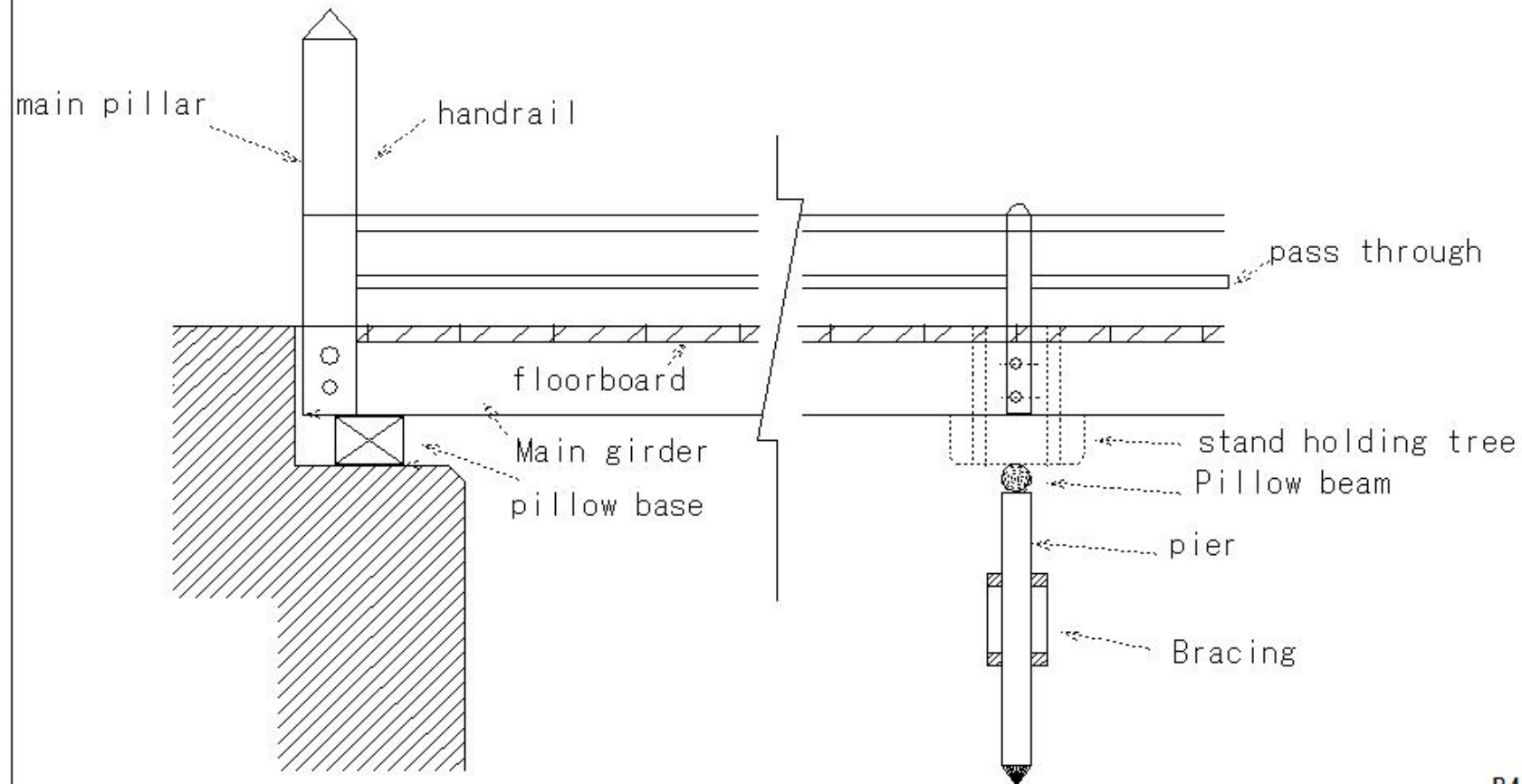
(1762) Wooden bridge



B425

(1763) Wooden bridge

(1763) Wooden bridge



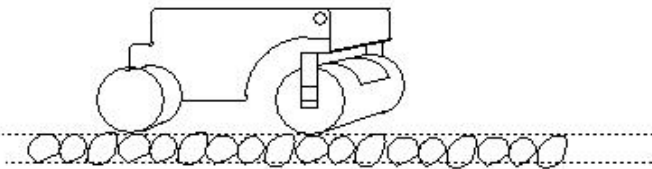
B426

(I764)Water bound macadam

(I764)Water bound macadam

Water bound macadam

Macadam method



macadam roller



Water + crushed stone mixture - spraying

Laying the main aggregate

Crushed stone (diameter 20 mm or less)

Compaction poured with water

Last-5-13mm crushed stone spraying finish

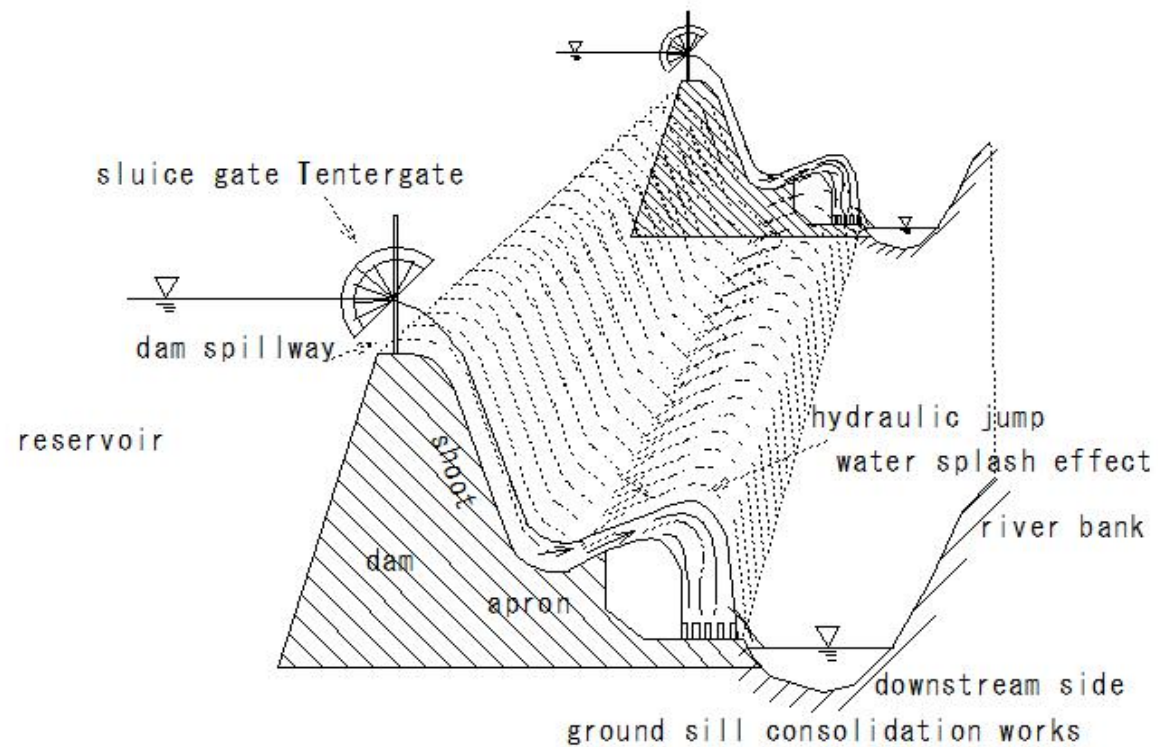
Compaction with macadam rollers

(1765) Spatter's effect (water splash effect)

(1765) Spatter's effect (water splash effect)

Spatter's effect (water splash effect)

Diminishing effect



R498

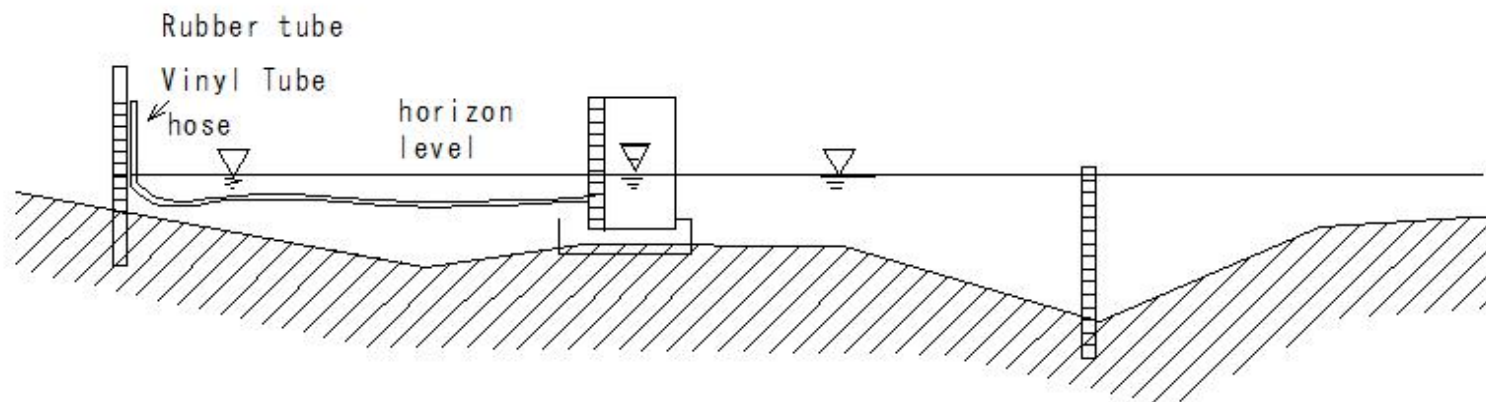
(I766)Leveling

(I766)Leveling

Leveling

Decide on the level

Putting out a horizontal surface

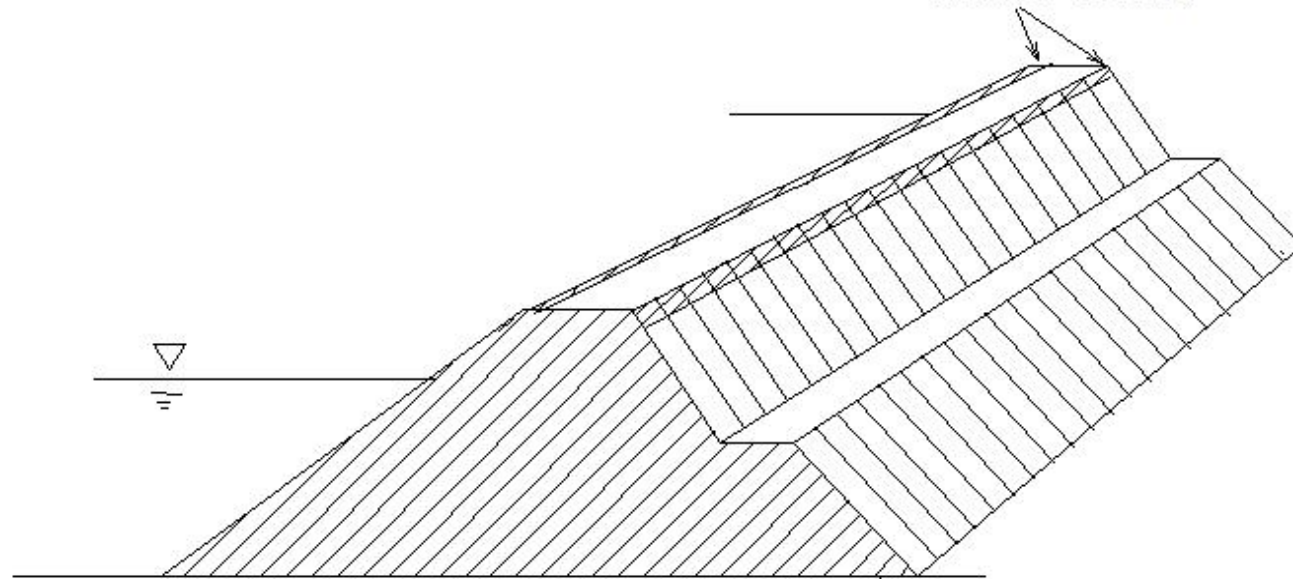


(I767)Shoulder sodding

(I767) Shoulder sodding

Embankment-slope lining

shoulder sodding



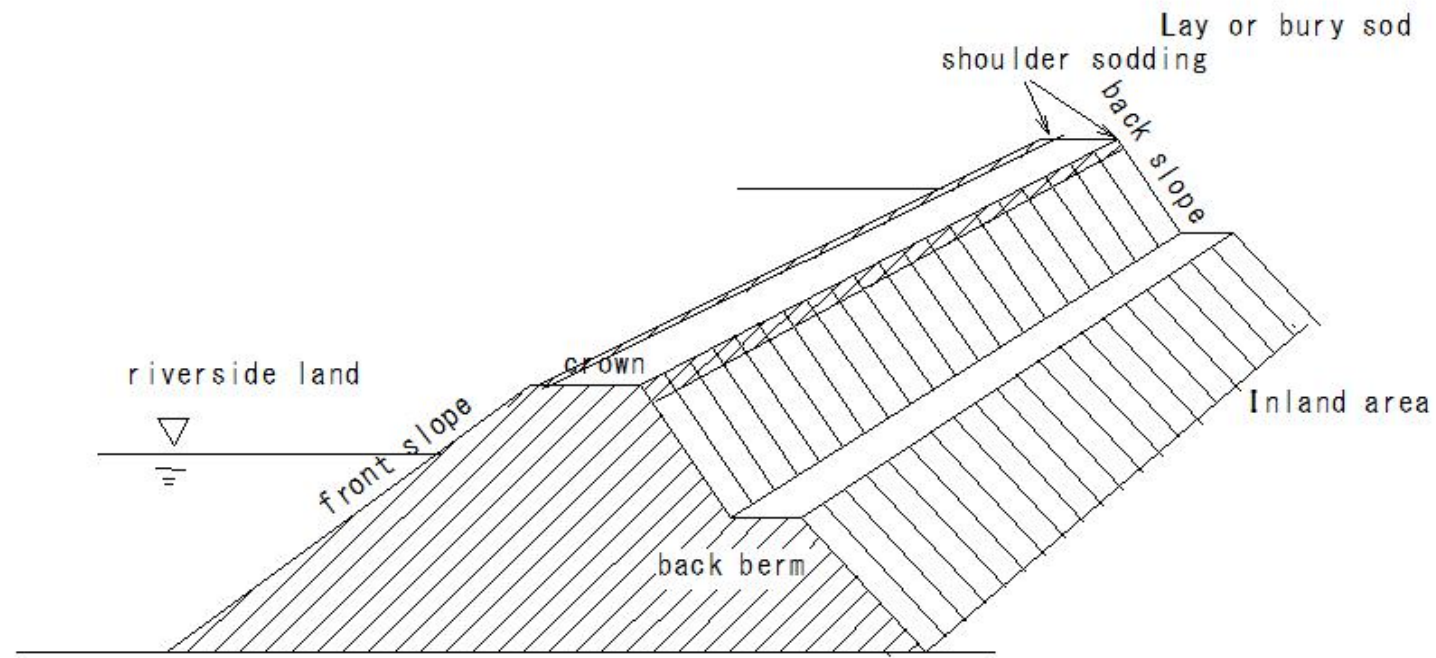
Embankment cross-section

E628

(I768)Shoulder sodding

(I768) Shoulder sodding

Embankment-slope lining

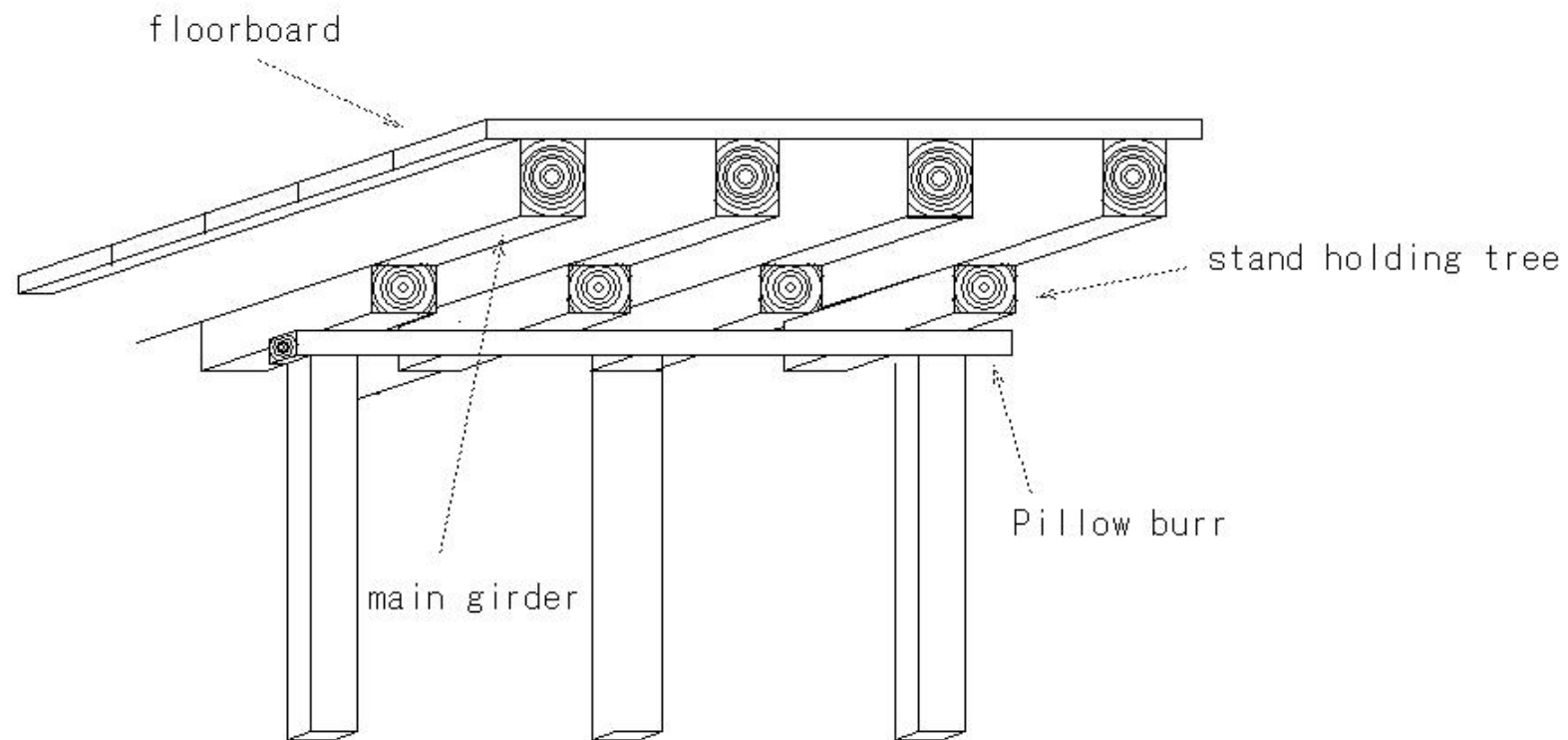


Embankment cross-section

R500

(I769) Wooden beam bridge

(I769) Wooden beam bridge



B435

(I770)Submerged orifice

(I770)Submerged orifice

Submerged orifice

$$Q = C_d a \sqrt{2g(H_1 - H_2)}$$

a: Cross-sectional area of orifice

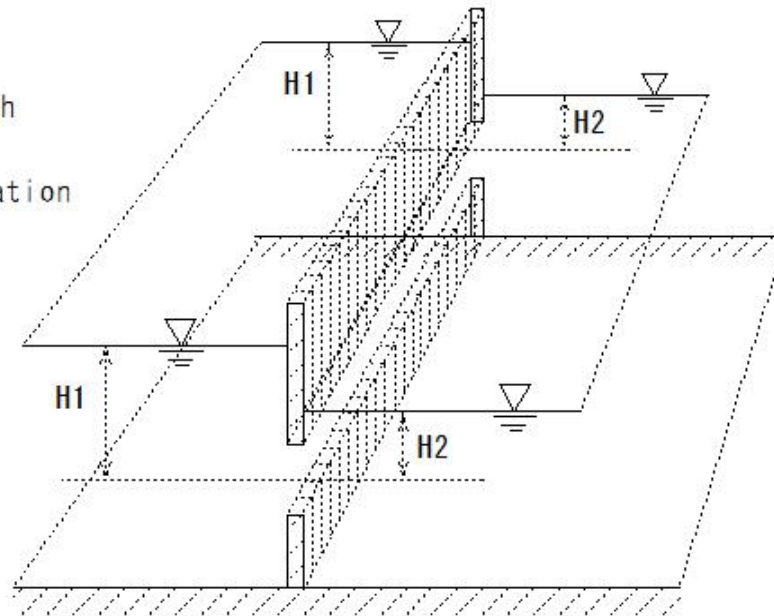
C: discharge coefficient

H₁: Upstream water depth

H₂: Downstream water depth

Q: discharge

g: gravitational acceleration



(I771)Submerged discharge

(I771)Submerged discharge

Submerged discharge

Condition of the flowing out of the gate

case of the water depth on the downstream side is deep

Leaked while submerged in water

$$Q = C_a B \sqrt{2g(H_1 - H_2)}$$

Q: submerged discharge

C: submerged discharge coefficient

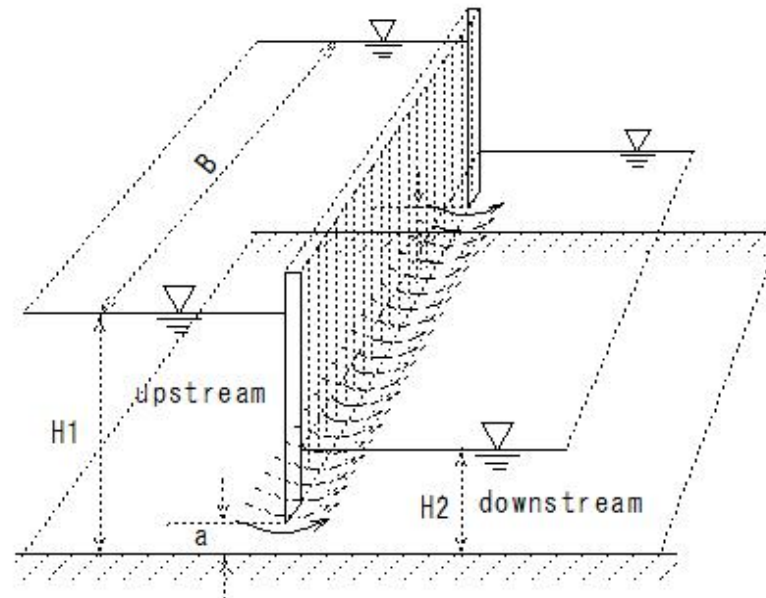
a: Gate opening

B: Channel width

H1: Upstream water depth

H2: Downstream water depth

g: gravitational acceleration



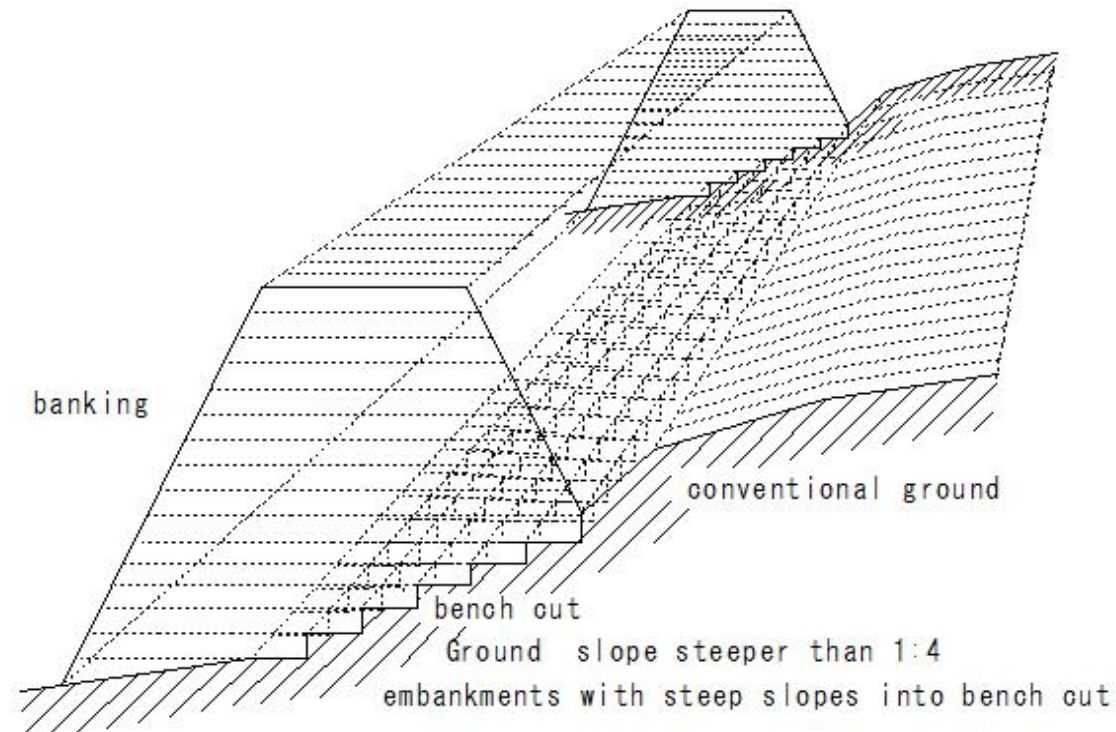
(1772)Banking

(1772)Banking

Banking

put earth and sand on the ground

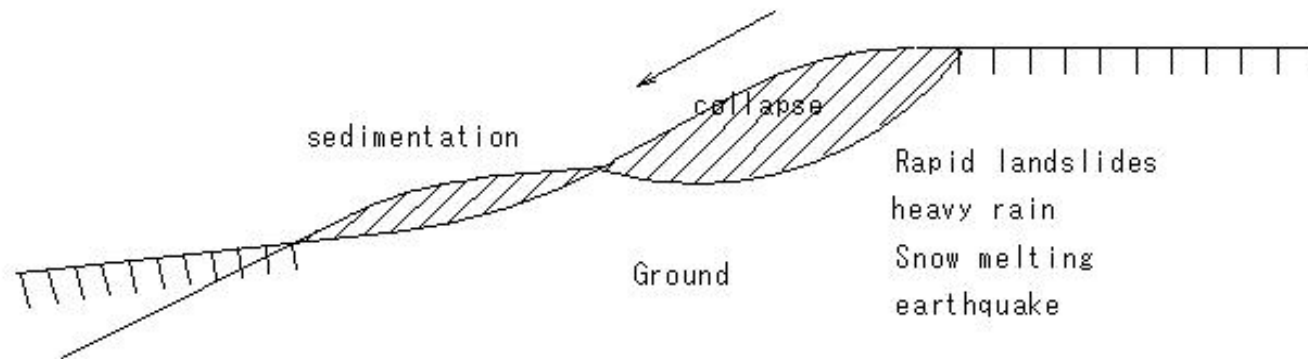
Embankment on sloped ground



R503

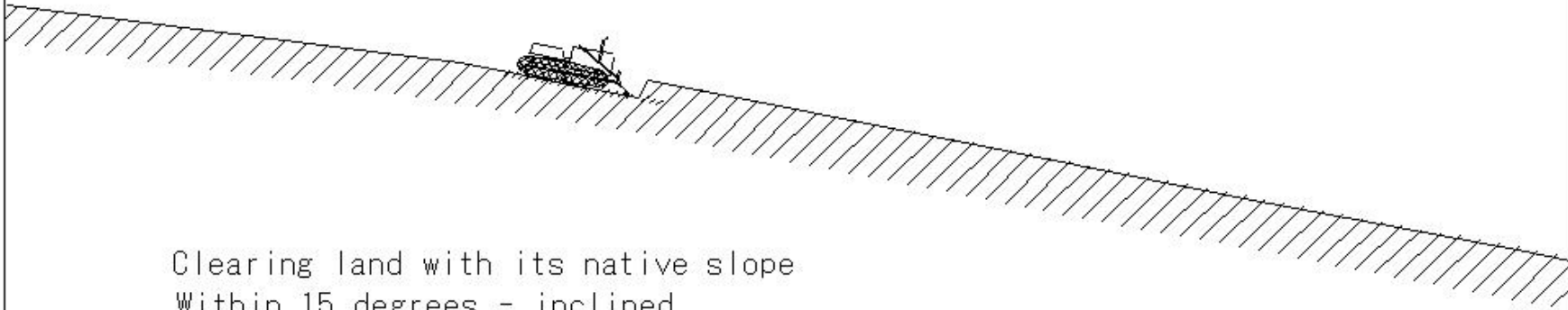
(1773)Landslide

(1773)Landslide



(I774)Land reclamation in natural slope

(I774)Land reclamation in natural slope



Clearing land with its native slope

Within 15 degrees - inclined

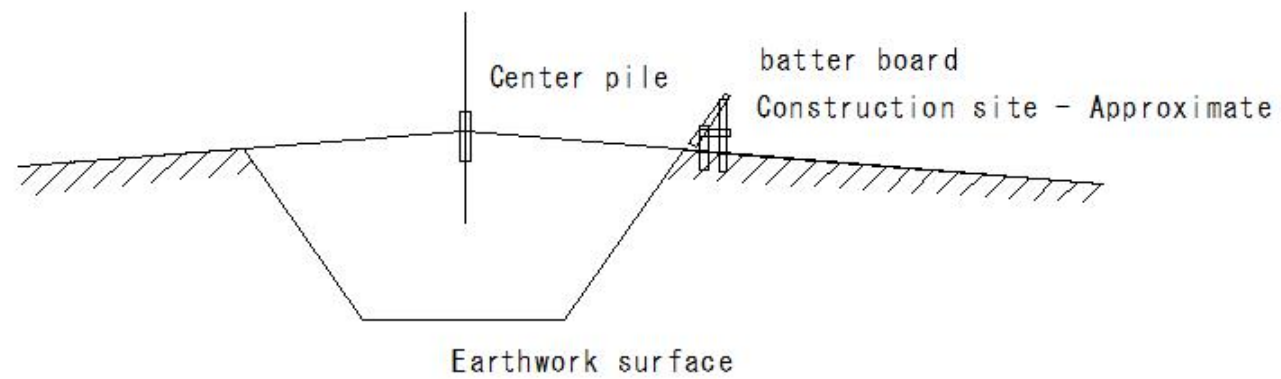
Logging, cutting, burning, rooting, weed tree removal

Loosening the ground

E632

(I775) Batter board

(I775) Batter board



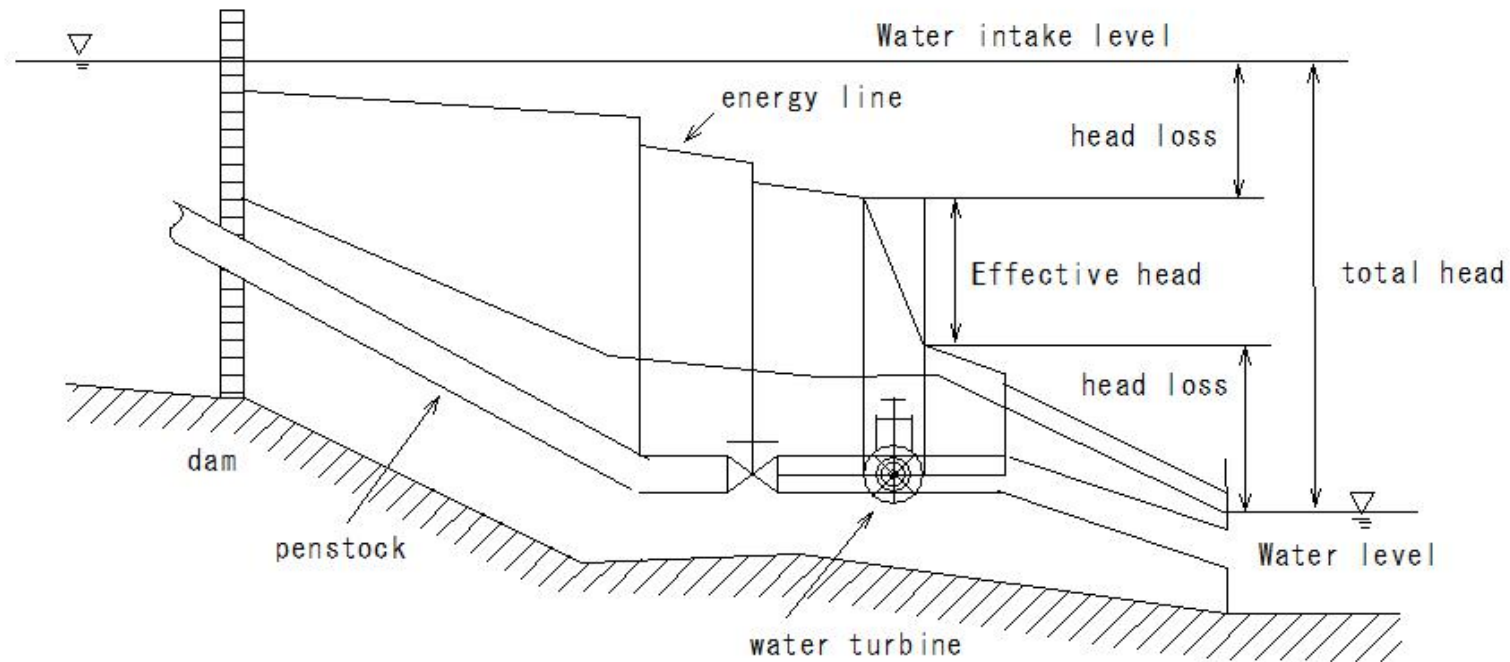
E633

(I776)Effective head

Effective head

- Can be used for power generation

(I776)Effective head



(1777)Retarding basin,flood storage basin

(1777)Retarding basin,flood storage basin

Retarding basin,flood storage basin

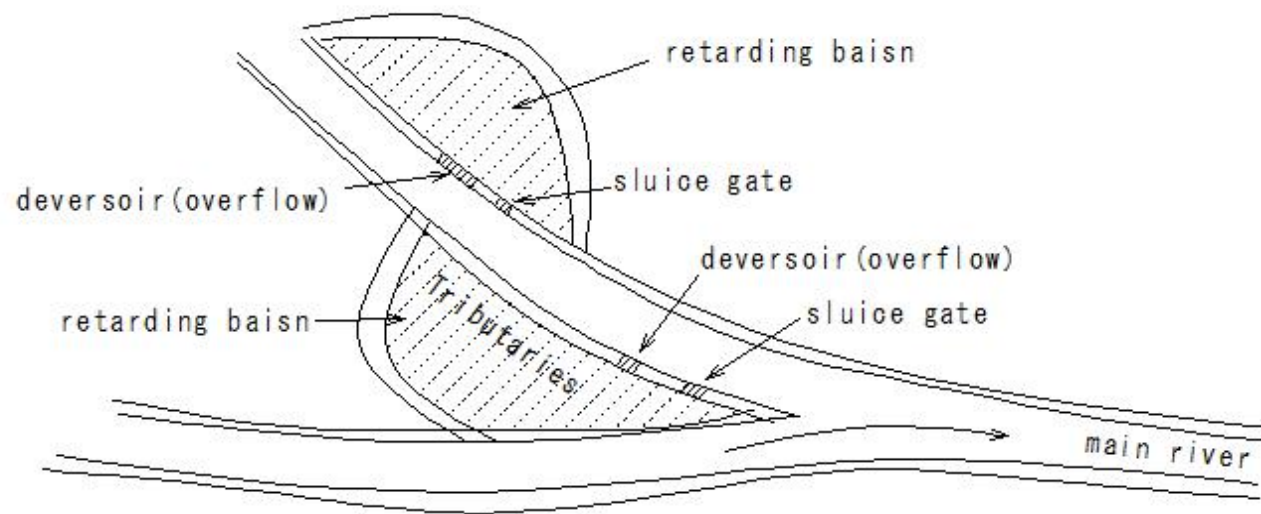
river confluence

Temporarily stored to prevent flood waters from merging at the same time.

A pond that releases water at a later date

deversoir(overflow) dam is installed on a part of the embankment.

Drainage is done through the drain gate.



R504

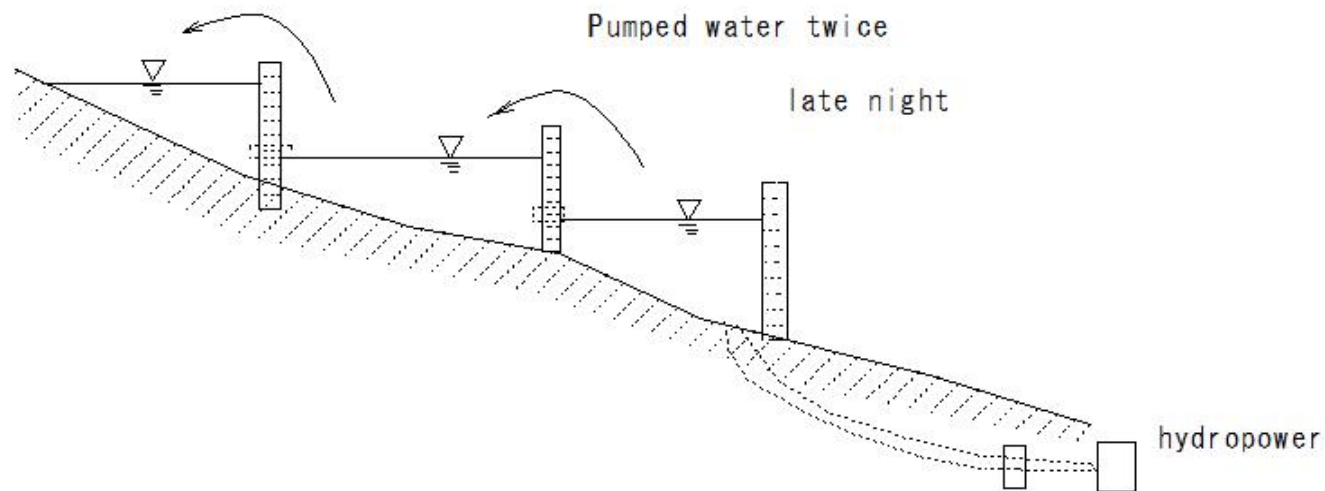
(1778)Pumped storage power

(1778)Pumped storage power

Pumped storage power

- Water storage downstream of the dam
- electricity is available
- Uses electricity and pumps water

Generate electricity by letting water flow when there is a power shortage

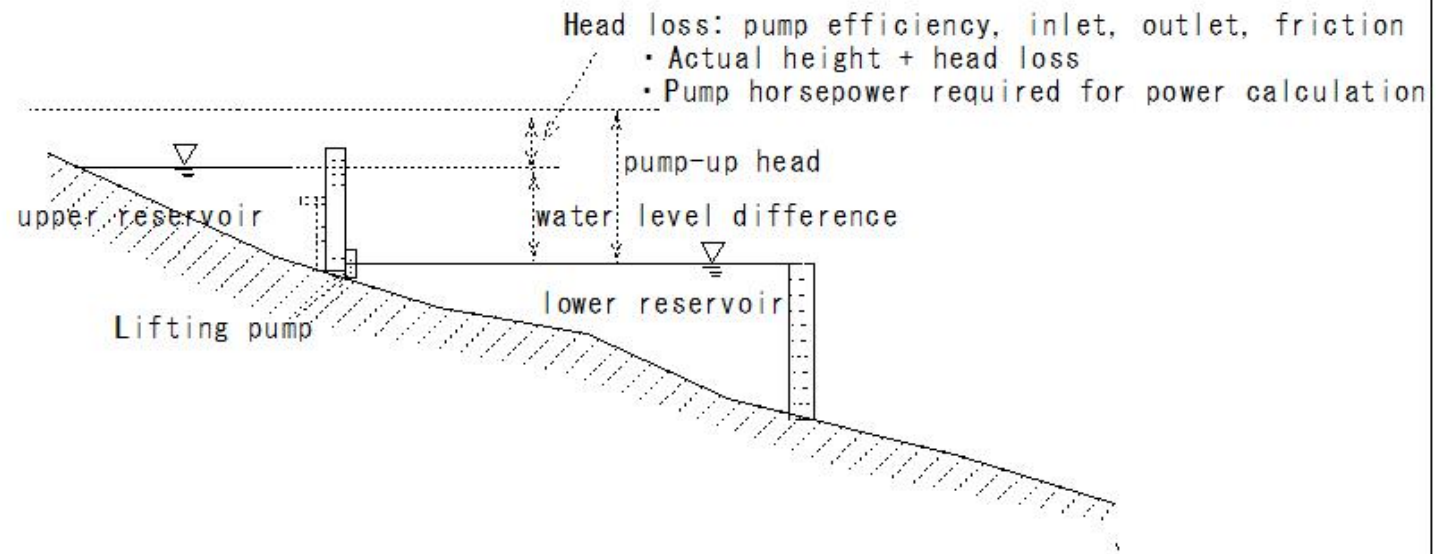


(I779) Pump-up head

(I779) Pump-up head

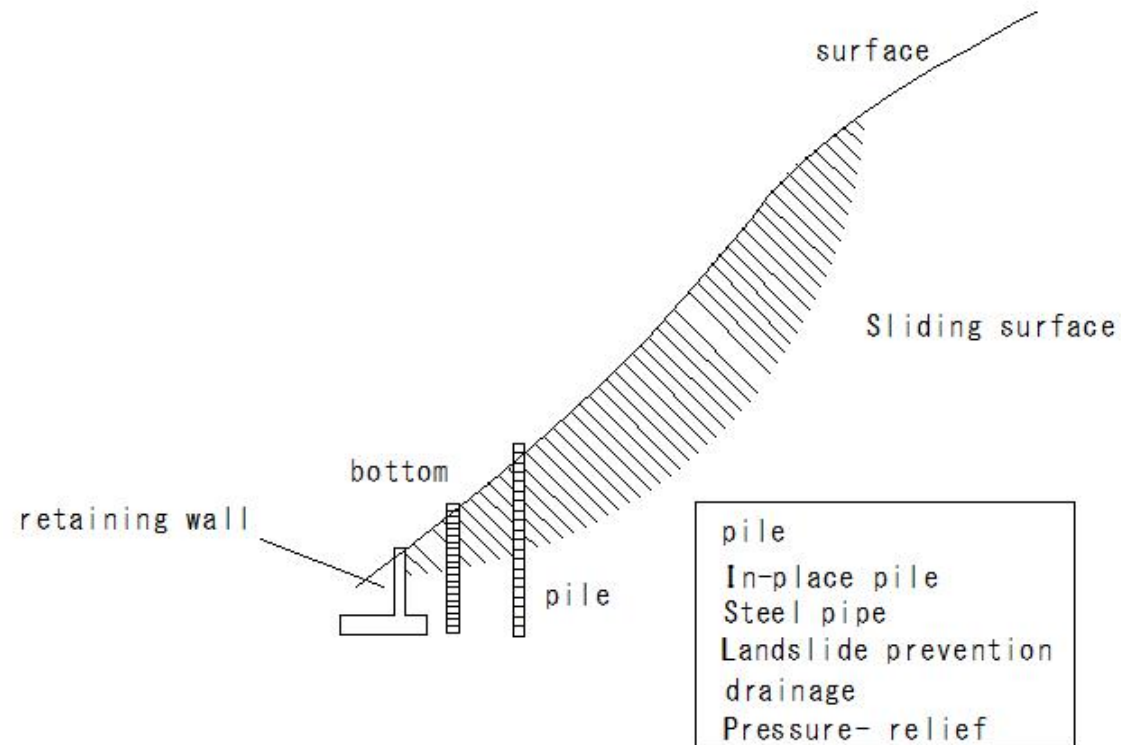
Pump-up head

- Pump water
- height considering loss



(I780)Landslide restraining works

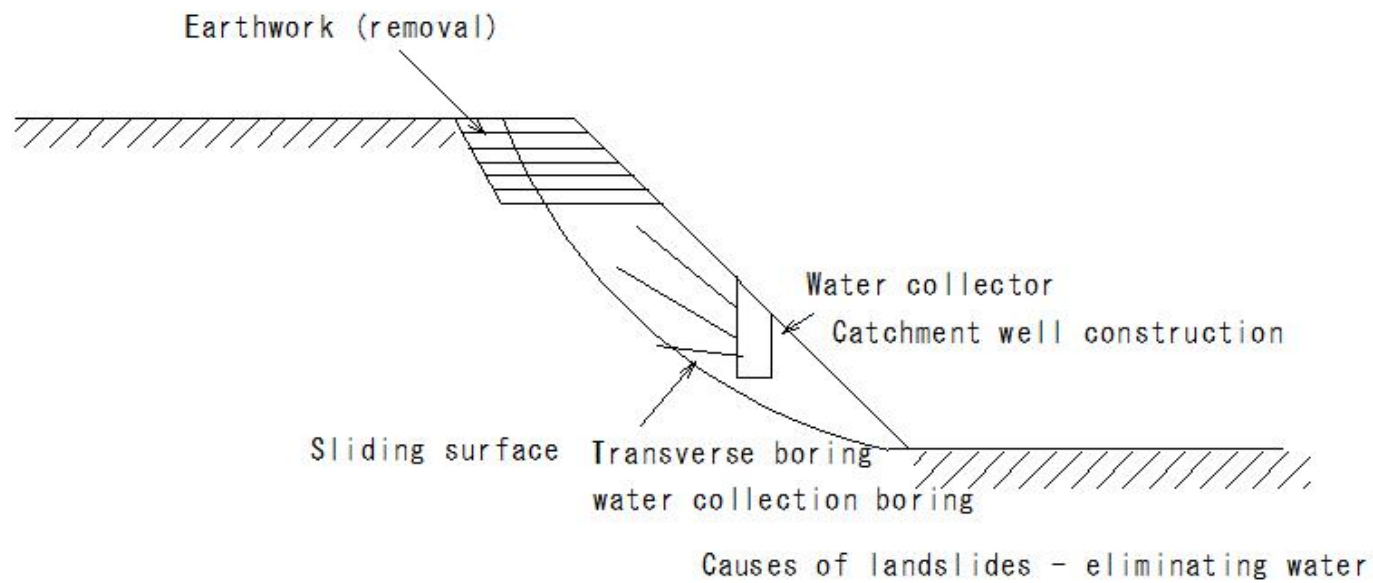
(I780)Landslide restraining works



E635

(I781)Landslide control works

(I781)Landslide control works

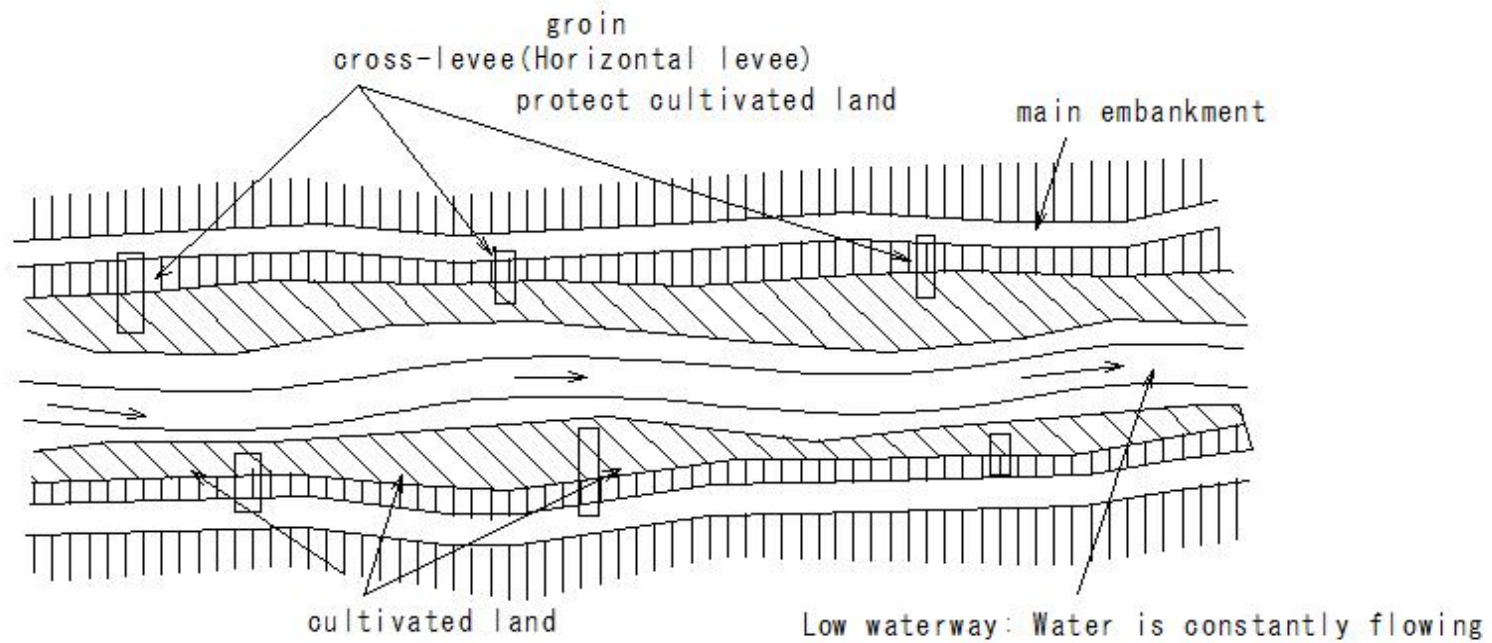


(1782)Cross-levee(Horizontal levee)

(1782) Cross-levee (Horizontal levee)

Cross-levee(Horizontal levee)

Embankment parallel to the main embankment



(I783)Spillway

(I783) Spillway

Spillway

dam

Power plant rockfill dam

A waterway that drains water is not needed for power generation

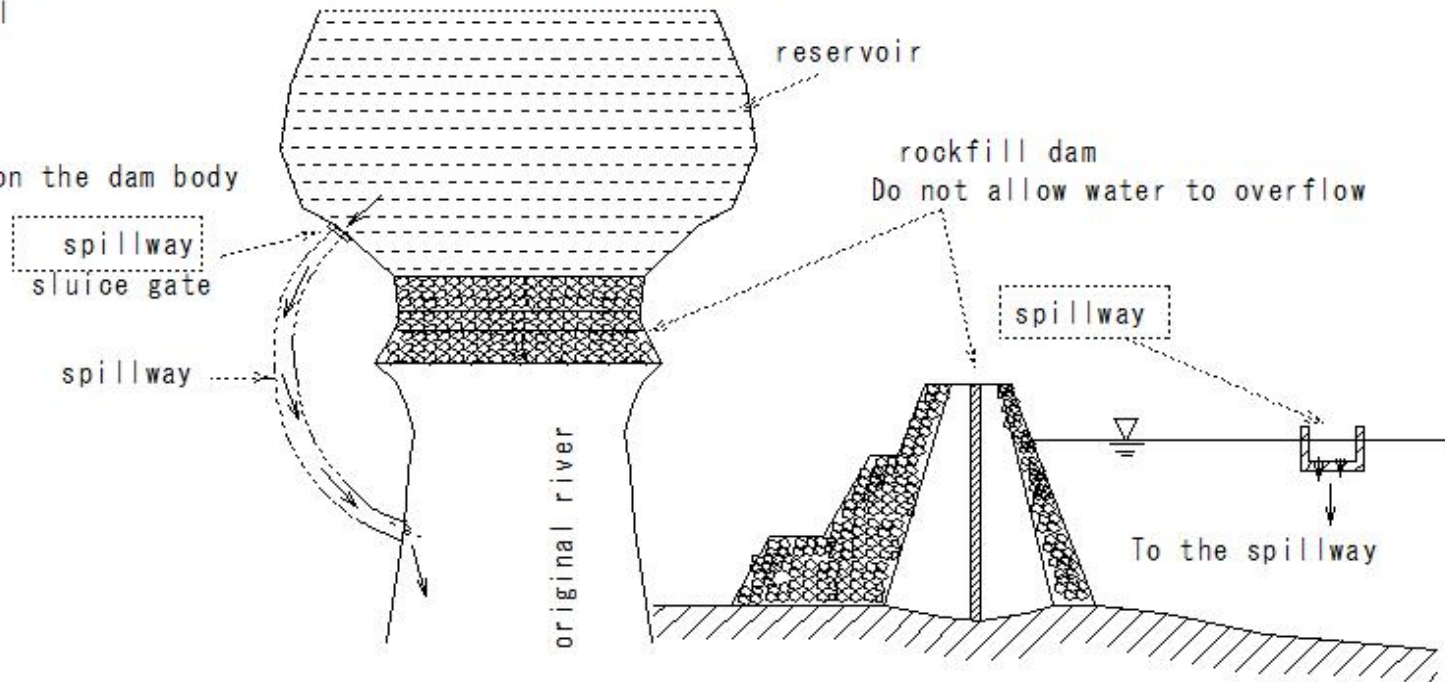
open channel

culvert

tunnel

steel pipe

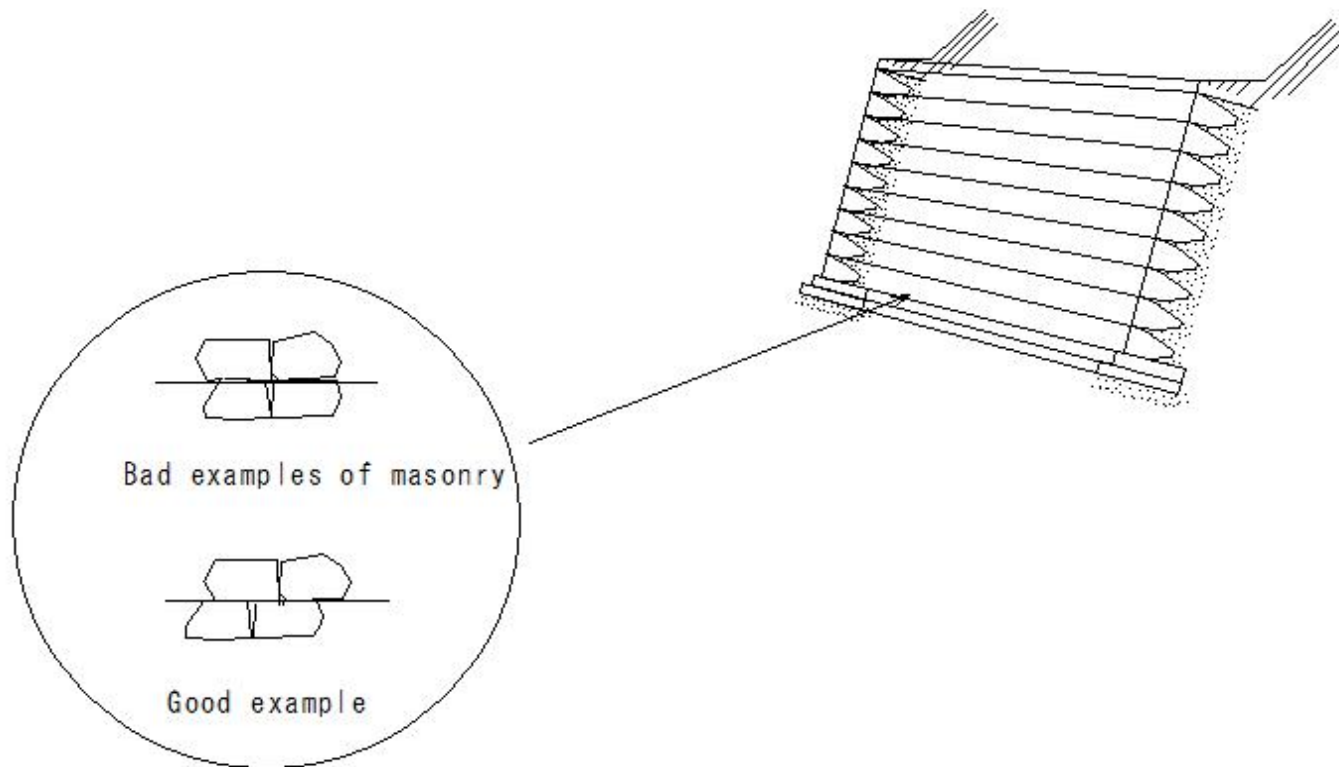
installed on the dam body



R505

(I784)Quarter crossing joint

(I784)Quarter crossing joint



E637

(I785)Extra-banking

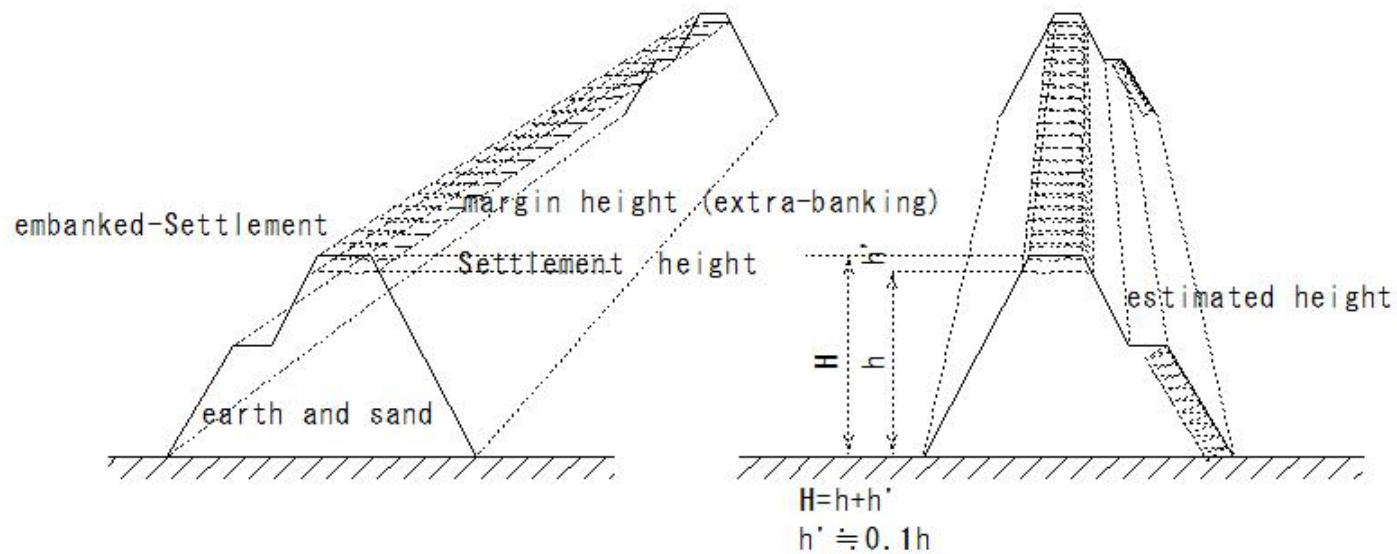
(I785)Extra-banking

Extra-banking

Estimating the amount of settlement due to the embankment
river embankment

Approximately 10% of the estimated high-water level

embanked-Settlement



(I786)Freeboard-margin height (extra embankment)

(I786)Freeboard-margin height (extra embankment)

freeboard-margin height (extra embankment)

the height of the embankment

Height with a margin above the estimated high-water level

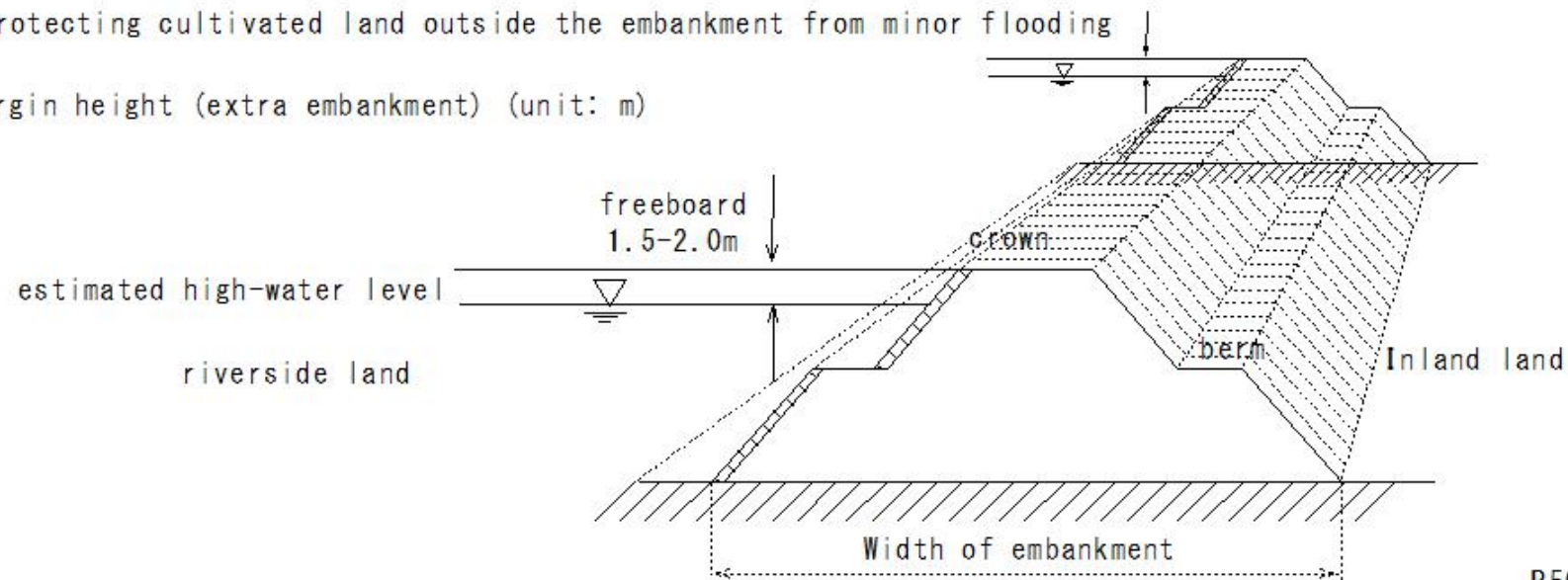
Large river 1.5-2.0m

Small and medium river 1.0m

estimated high-water level

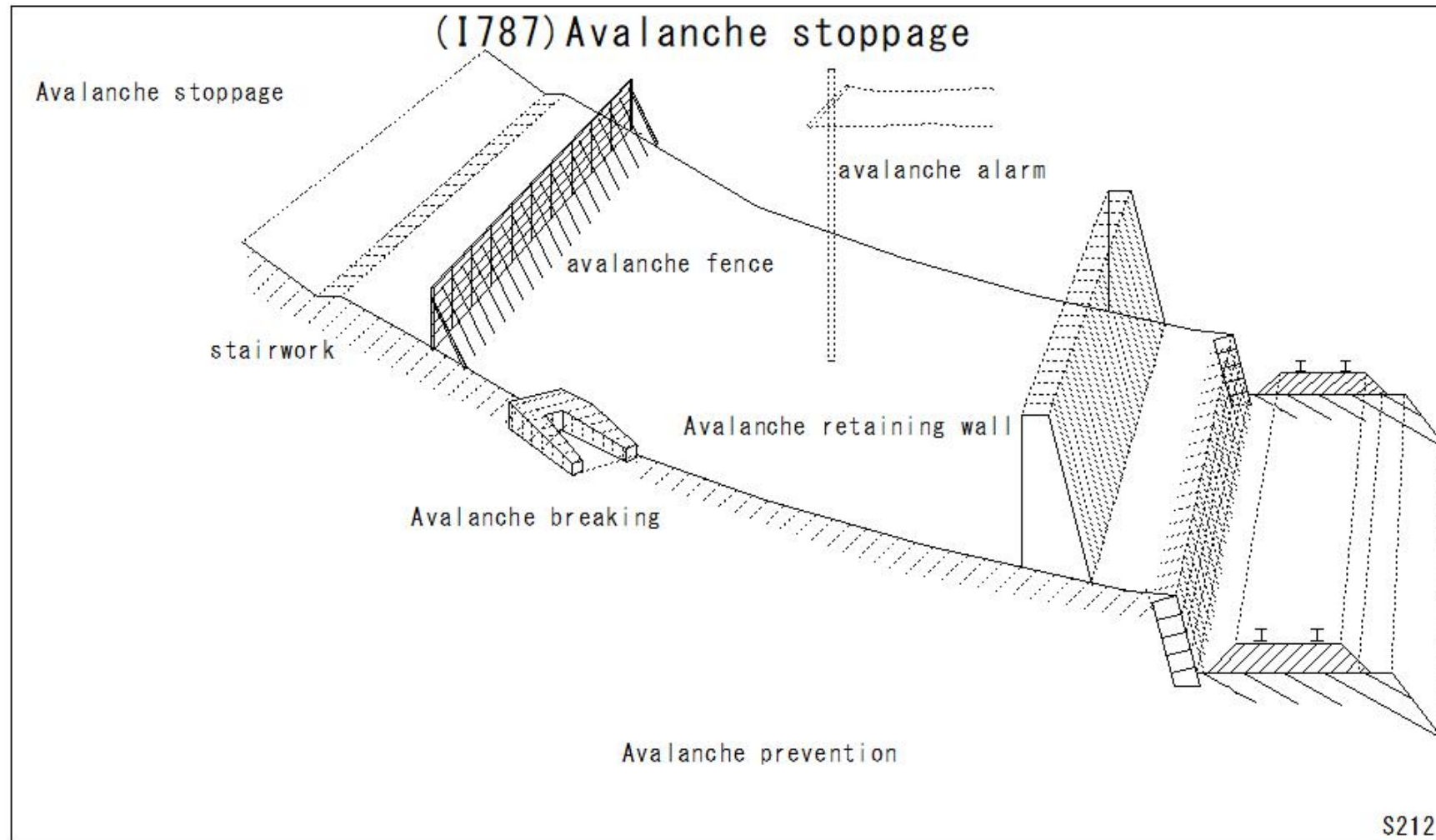
Protecting cultivated land outside the embankment from minor flooding

margin height (extra embankment) (unit: m)

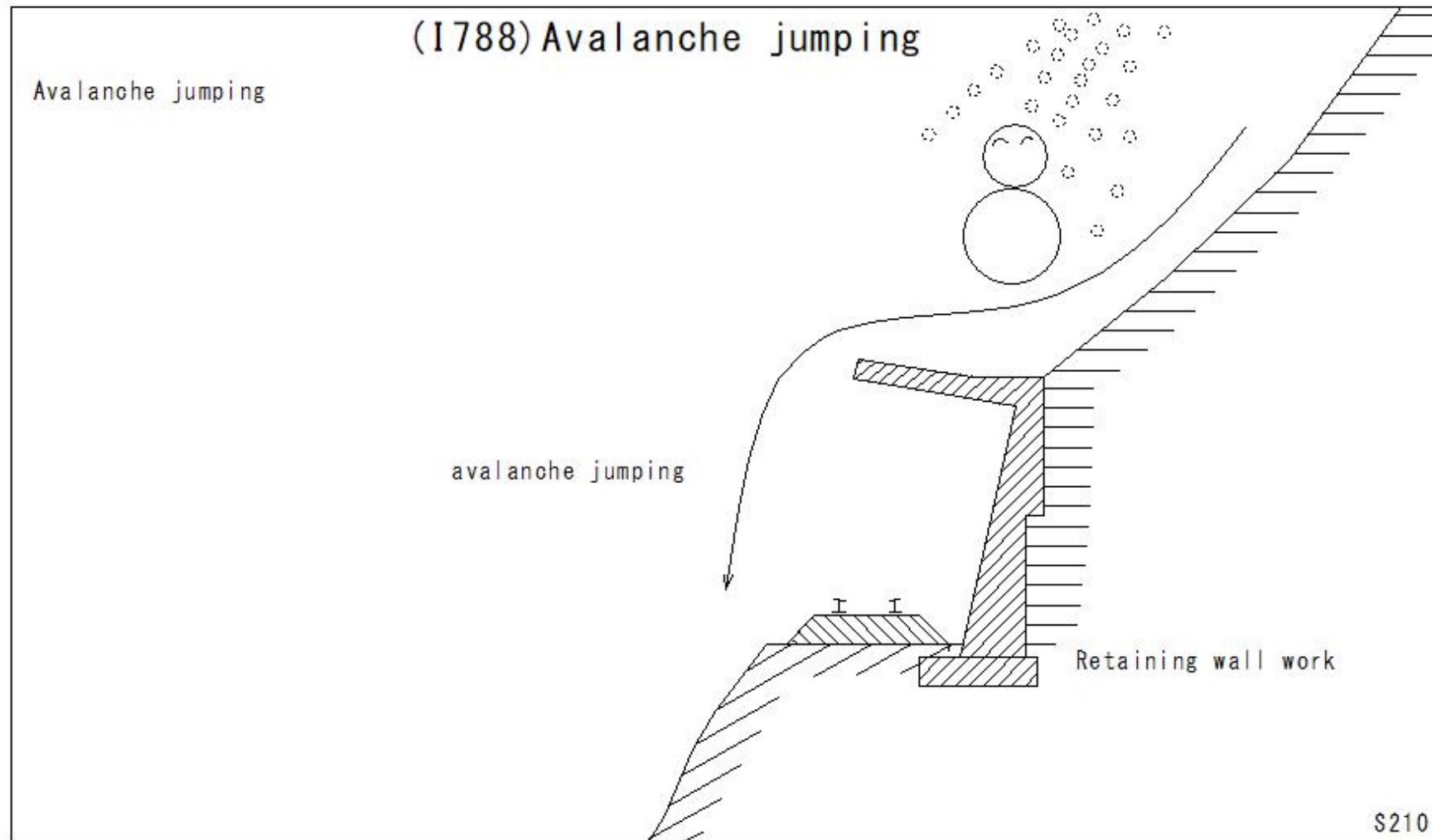


R507

(1787)Avalanche stoppage

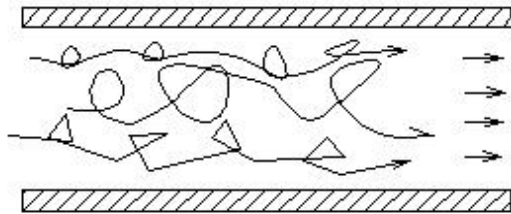


(1788)Avalanche jumping



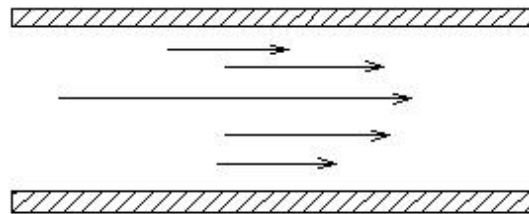
(I789)Turbulent flow -Laminar flow

(I789)Turbulent flow -Laminar flow



turbulent flow

A flow in which water molecules are turbulent



laminar flow

Laminar flow: A flow in which water molecules flow in a fixed direction

Expressing sexuality with Reynolds number

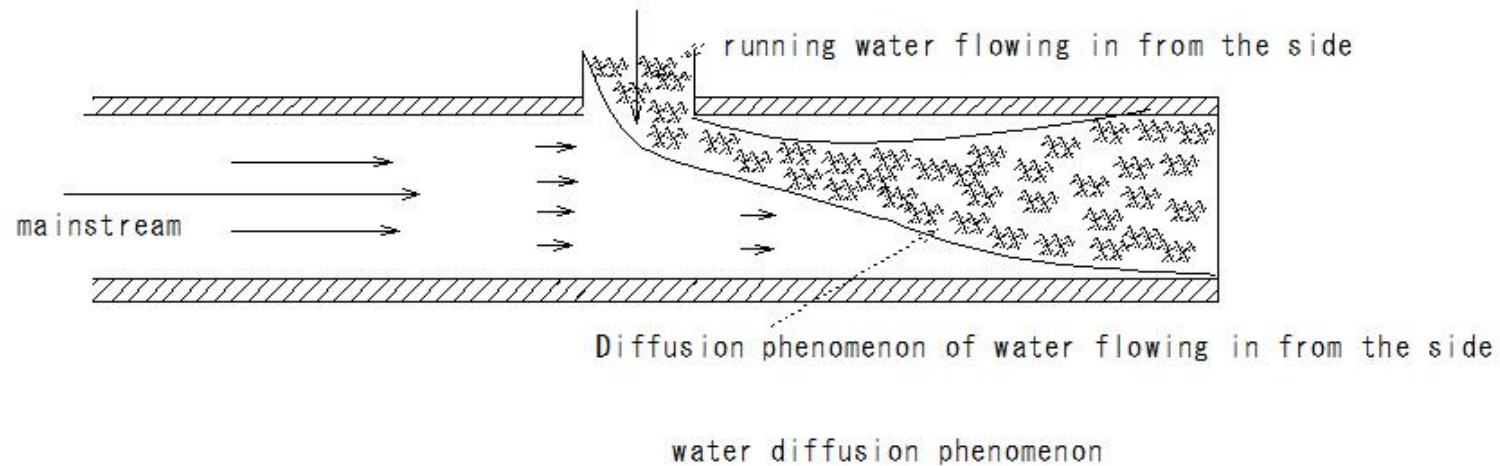
R508

(I790)Diffusion effect of turbulent flow

(I790)Diffusion effect of turbulent flow

Diffusion effect of turbulent flow

case of the flow changes from laminar to turbulent, the flows mix with each other and swirl.



(I791)Crawler

(I791) Crawler

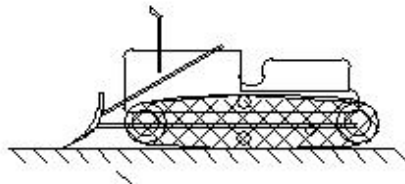
Crawler

Features

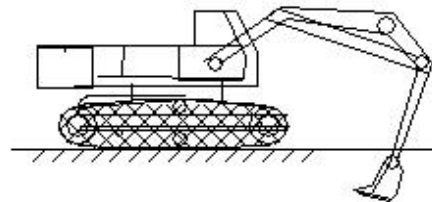
Ground pressure - small
soft ground
steep slope
uneven ground
snow work

Working speed - slow

a lot of wear and tear on the tracks.

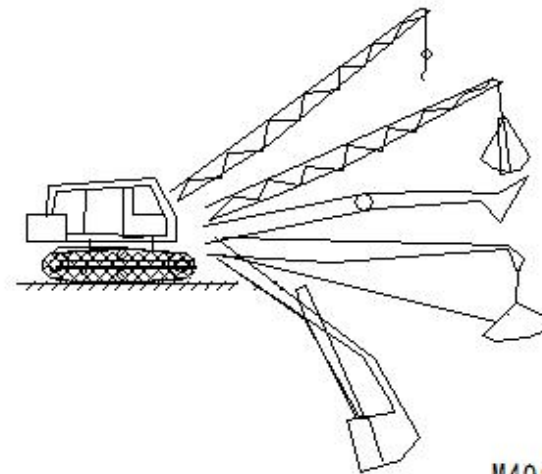


M11



Crawler type

M12



M409

(I792)Ripper

(I792) Ripper

Ripper

medium hard rock

excavation

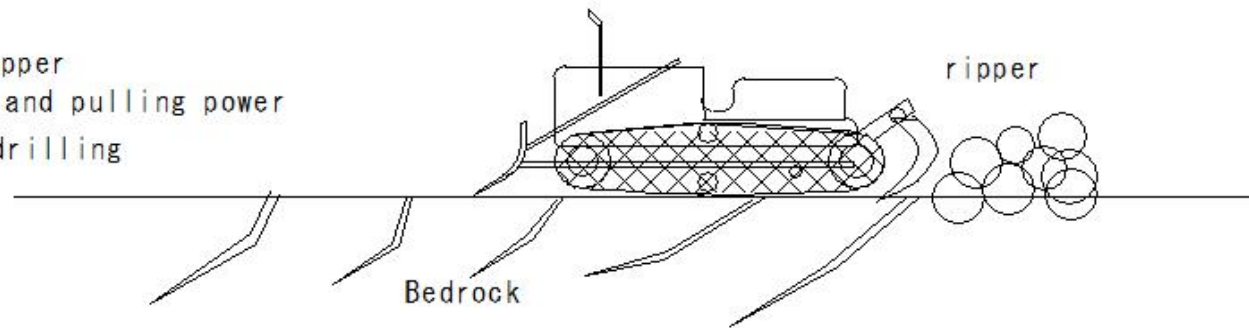
attachment

operator

hydraulic ripper

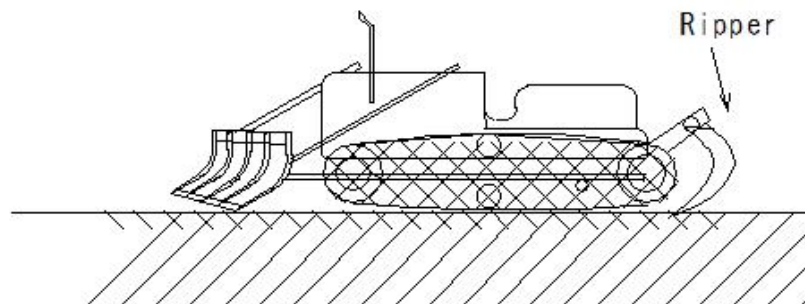
Dead weight and pulling power

continuous drilling



Rake dozer

E304



M410
E349

(I793)Ripper(rippability)

(I793)ripper(rippability)

rippability

Large bulldozer installed

rippability

Elastic wave velocity of the ground (m/sec)

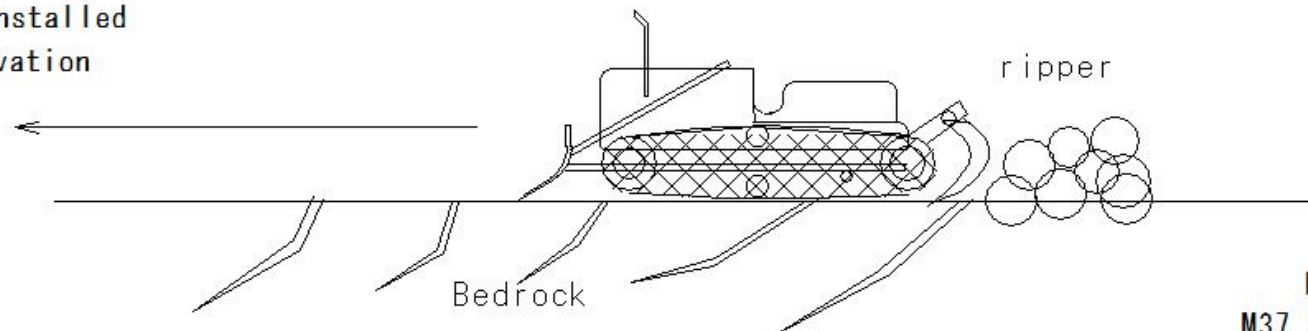
	A group of rocks	B group of rocks	21t class	31t class
	600below	900below	3	3
Number of claws	600-1000	900-1400	2	3
21t class	1000-1400	1400-1800	1	2
31t class	1400—1700	1800-2100		1

(I793) Ripper (rippability)

Rippability

Large bulldozer installed

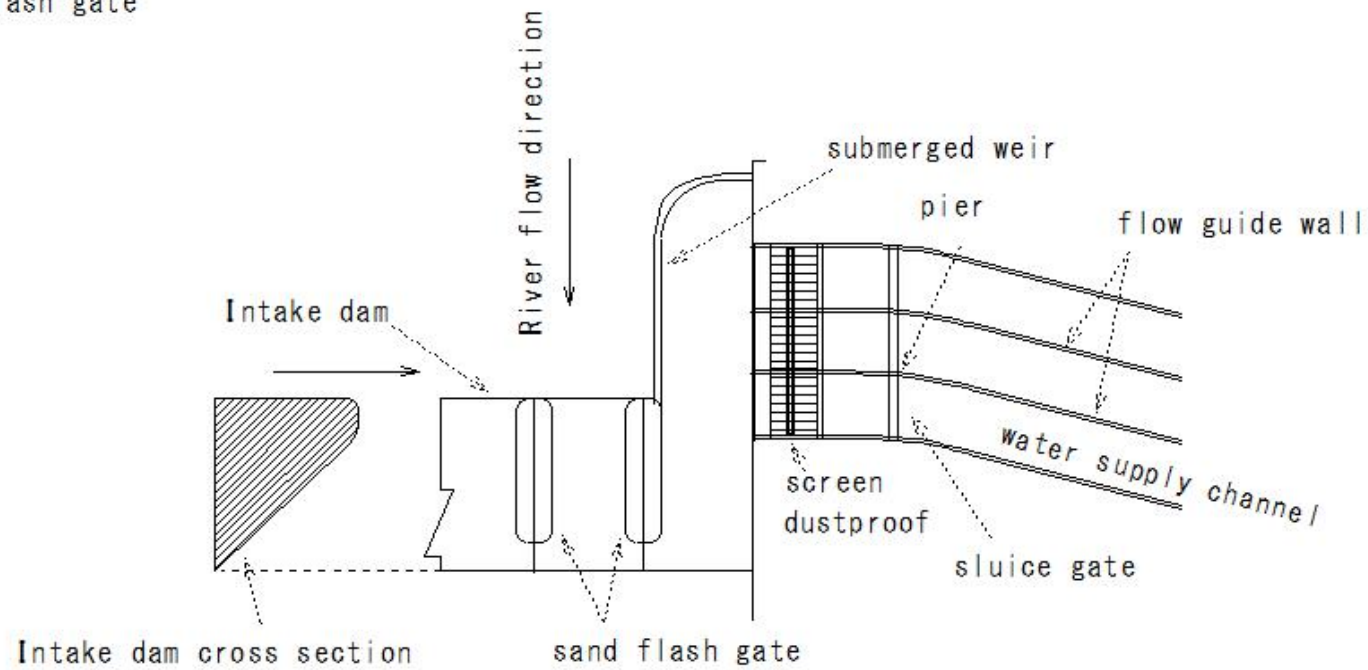
Ease of rock excavation



(I794)Sand flash gate

(I794)Sand flash gate

Sand flash gate



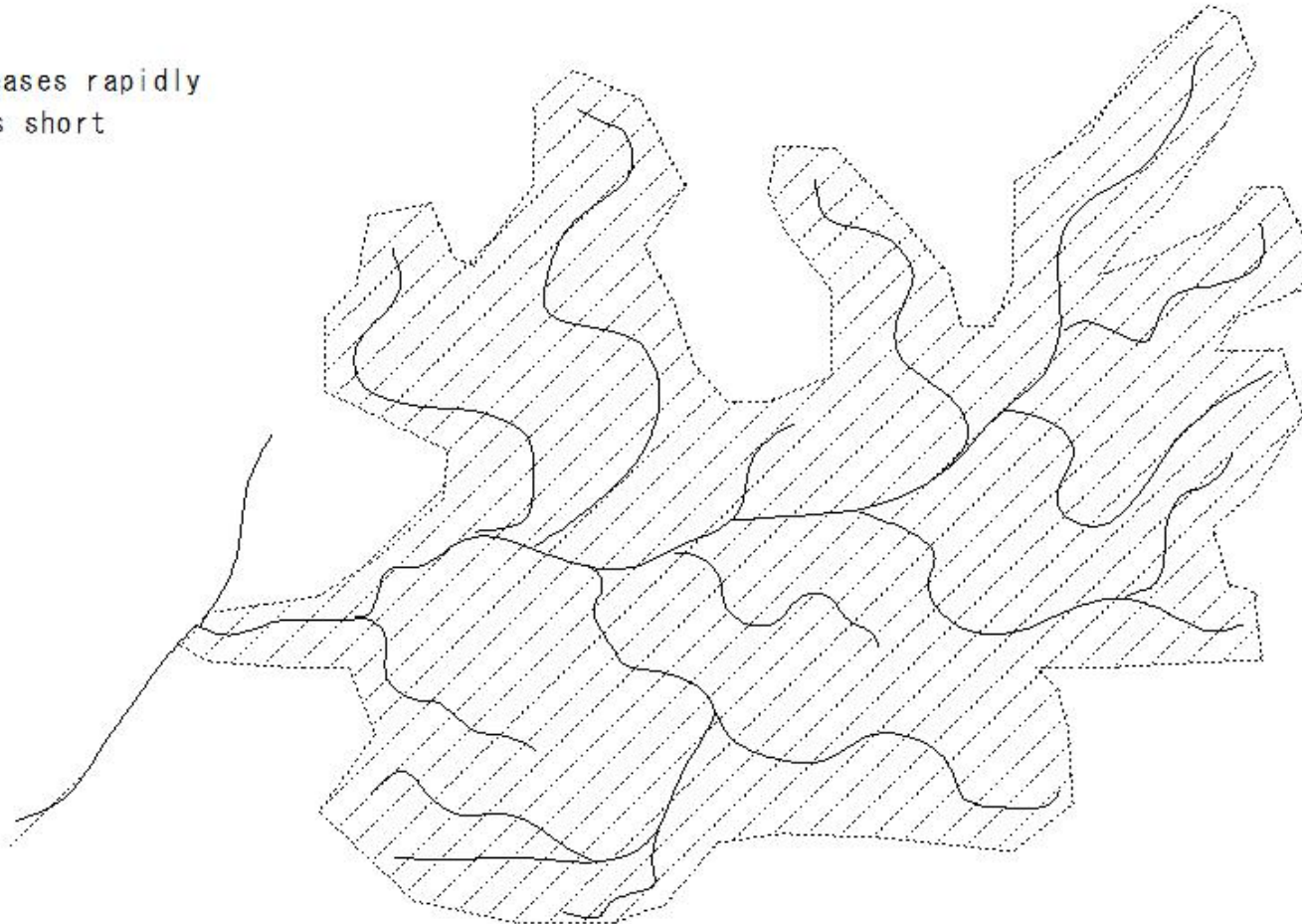
(I795)Radial drainage

(I795)Radial drainage

radial drainage

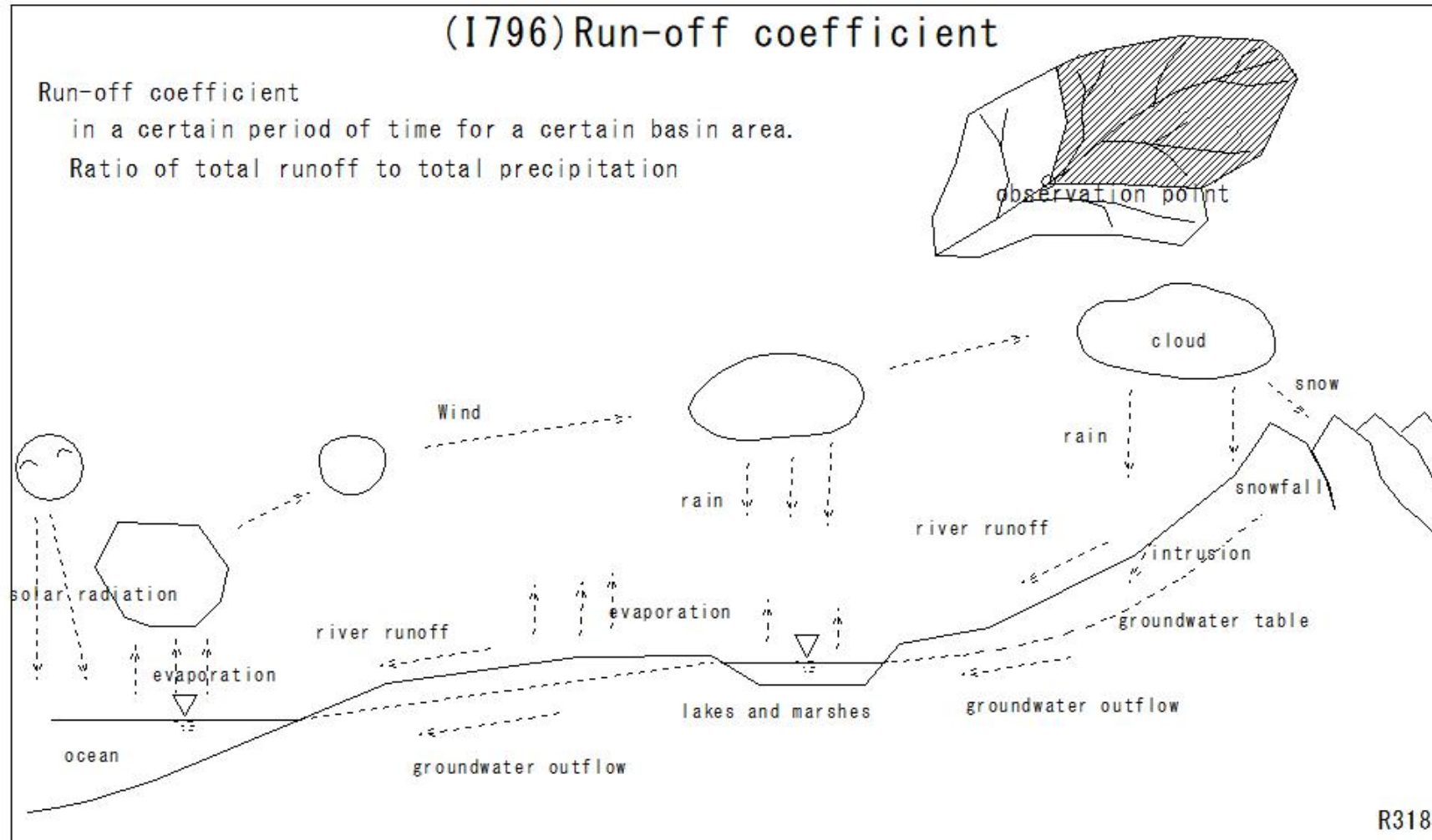
discharge increases rapidly

water season is short



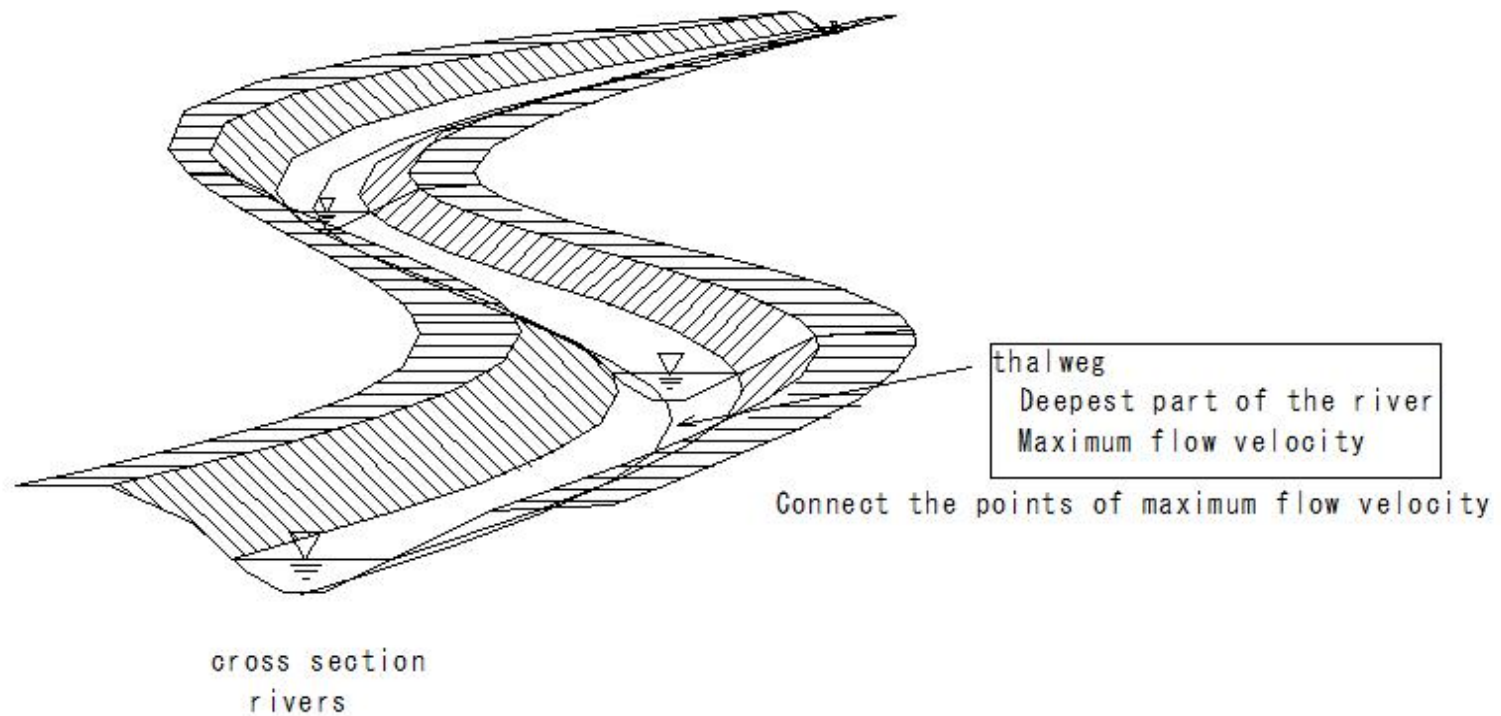
R495

(1796)Run-off coefficient



(1797)Thalweg

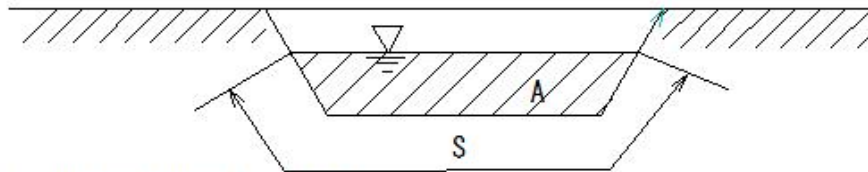
(1797) Thalweg



R319

(I798)Cross sectional area of stream

(I798)Cross sectional area of stream



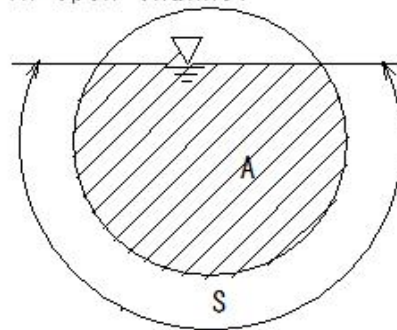
Cross sectional area of stream

Channel cross section

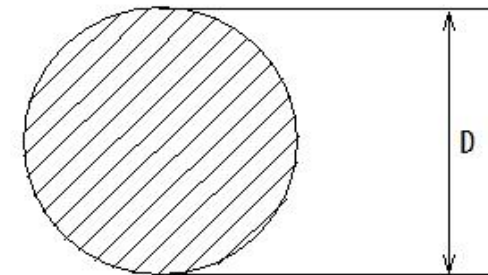
Area : water actually flows

Average flow velocity in open channel

pipe waterway



open channel



$$R = A/S = (\pi D^2/4) / (\pi D) = D/4$$

pipeline

Cross-sectional area of flow: A

Hydraulic radius: R

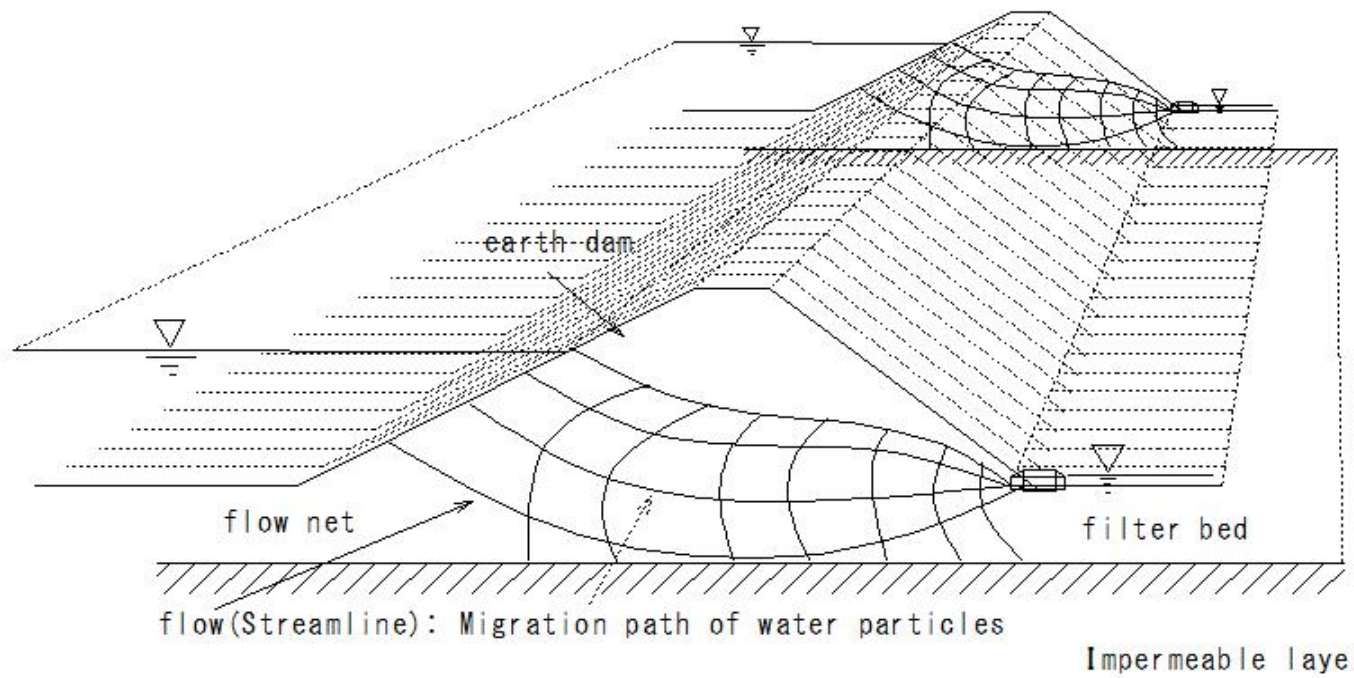
$$R = A/S$$

Wetted perimeter: S

R320

(I799)Flow net

(I799)Flow net



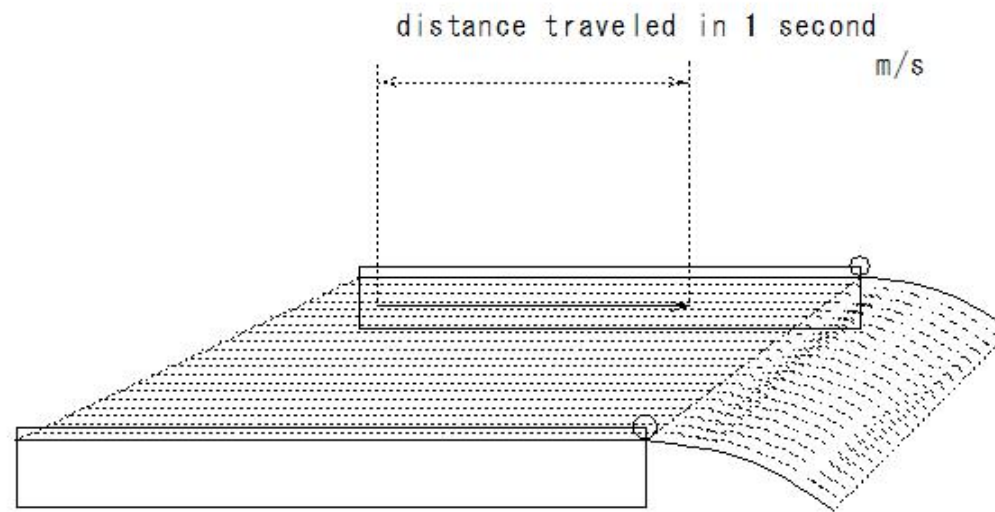
Equipotential: equal points in the head of the water

R322

(1800)Velocity of flow

(1800)Velocity of flow

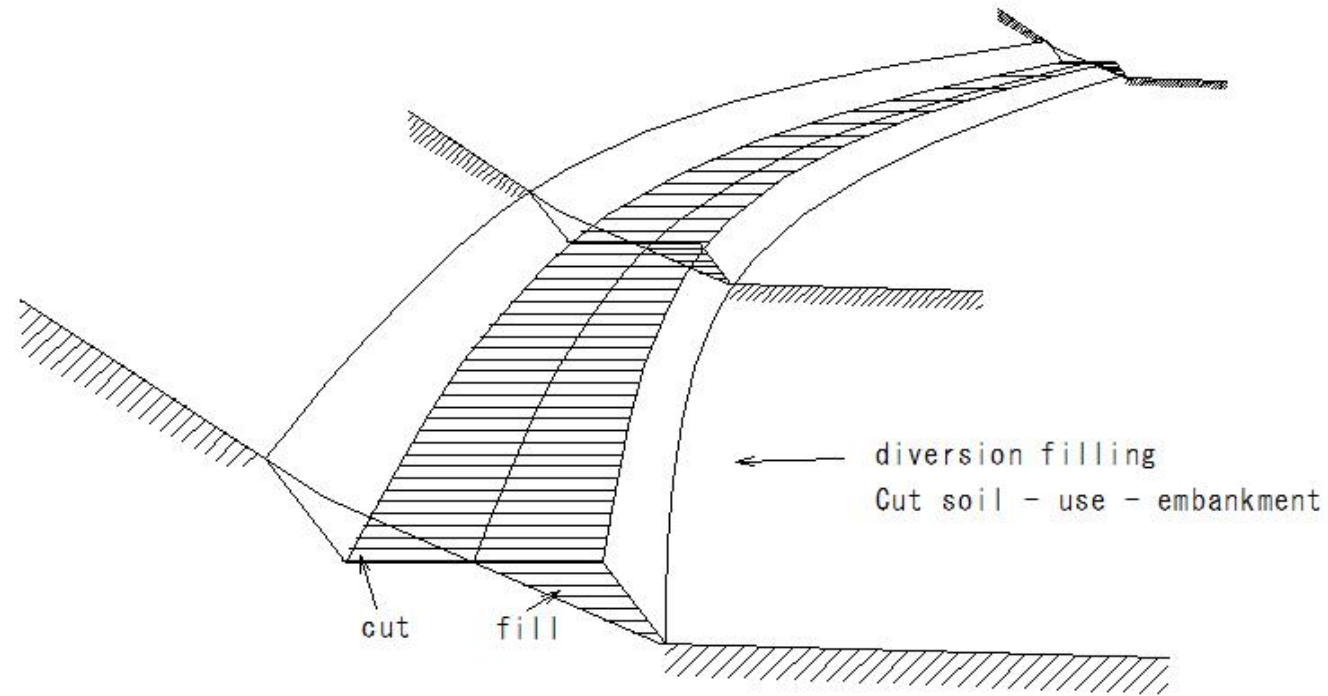
Velocity of flow



D254

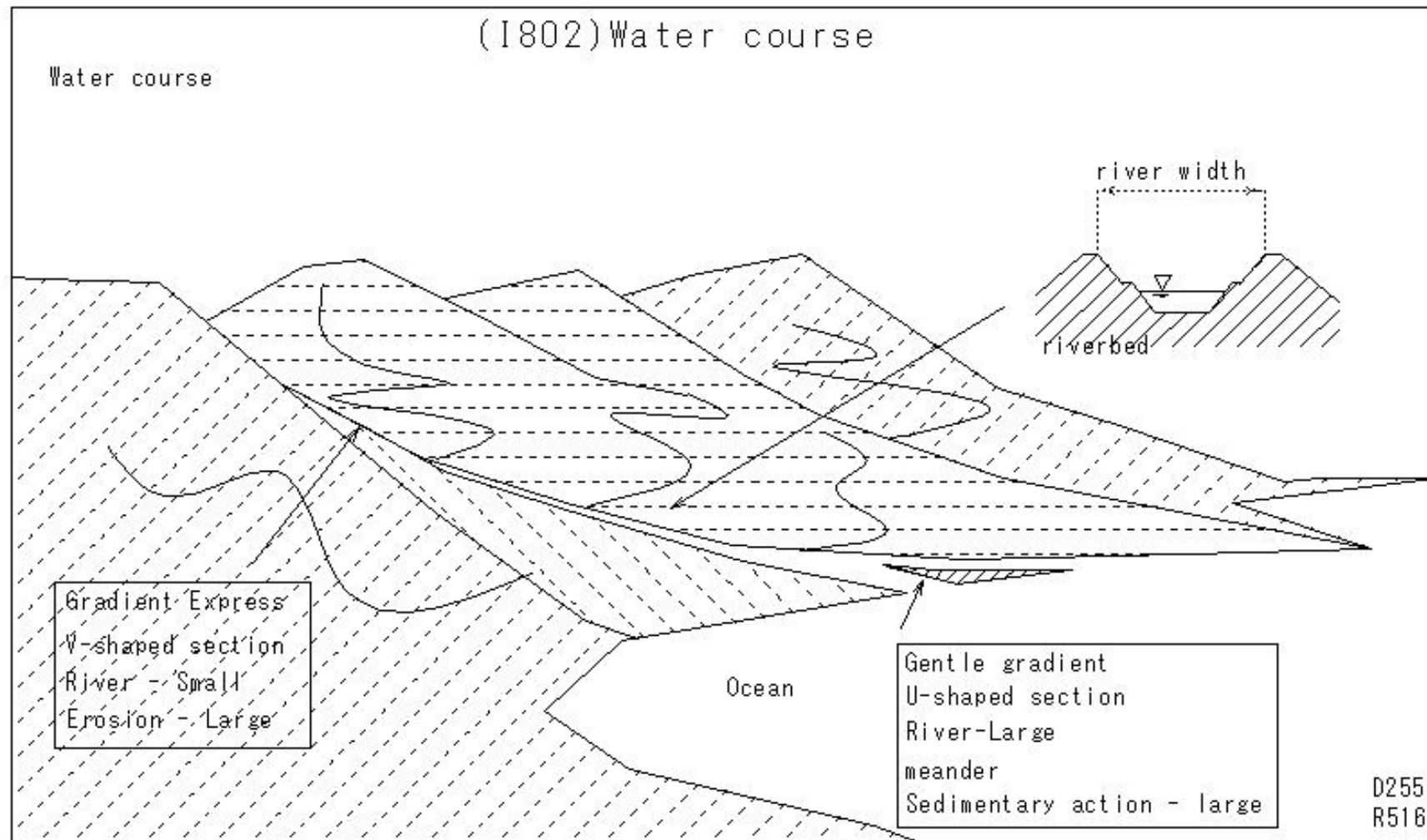
(I801)Diversion filling

(I801)Diversion filling



E650

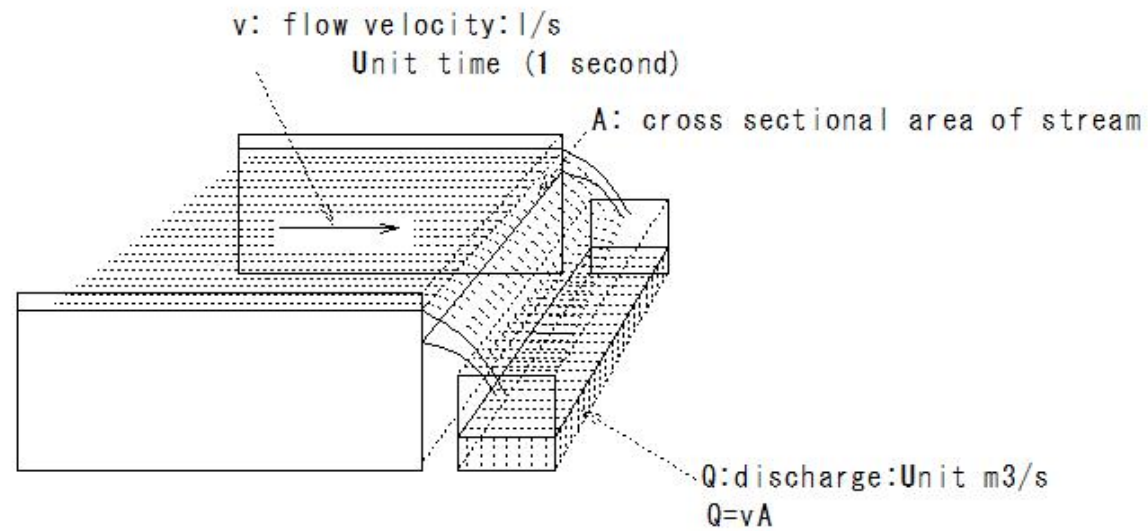
(1802)Water course



(I803)Discharge

(I803) Discharge

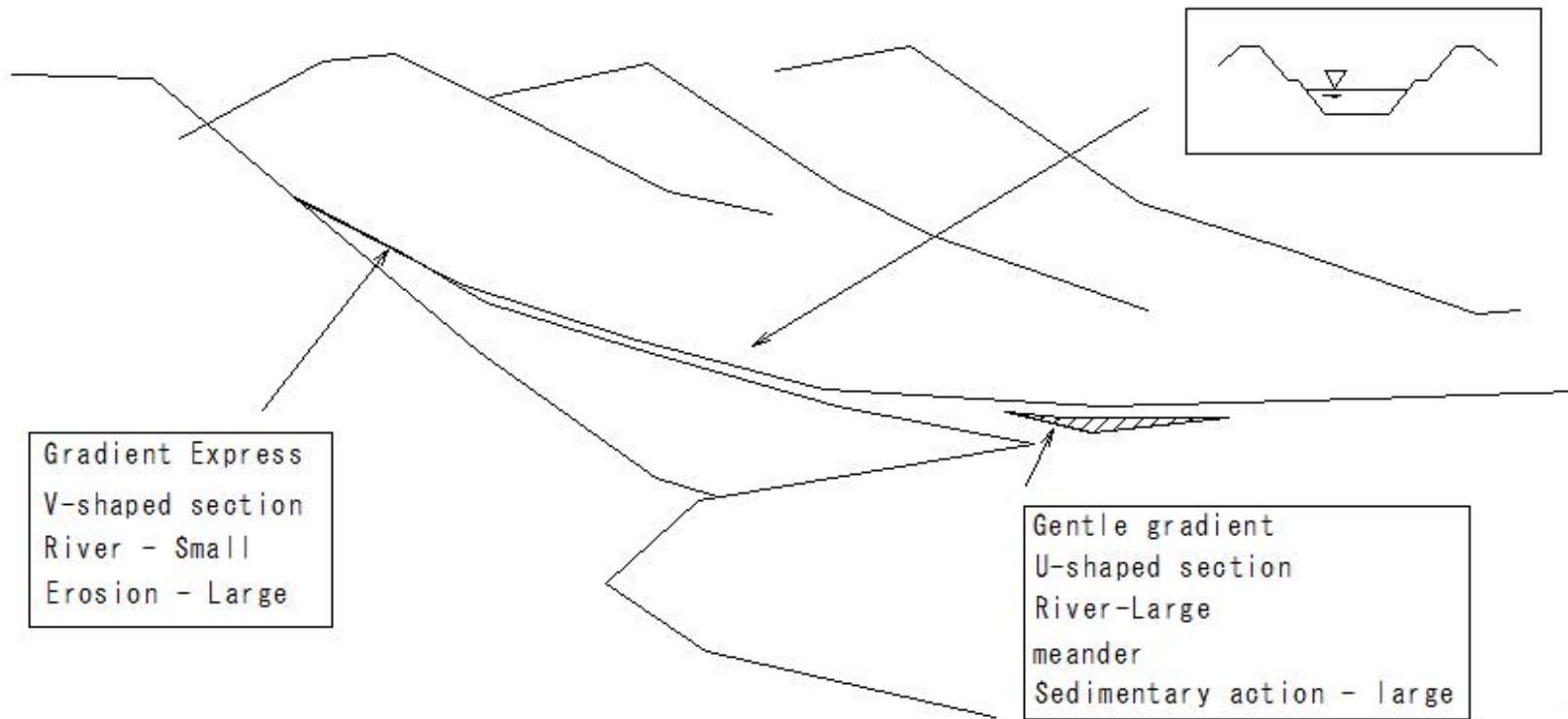
Discharge



(1804)Water course

(1804)Water course

Water course: Path flowing at a natural gradient

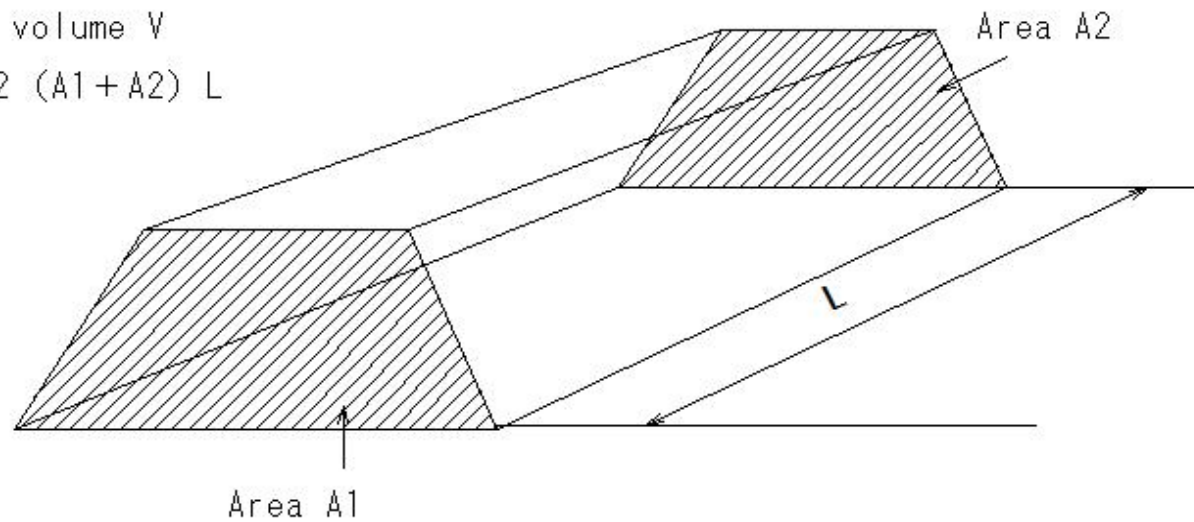


E643

(1805)Method of average end areas

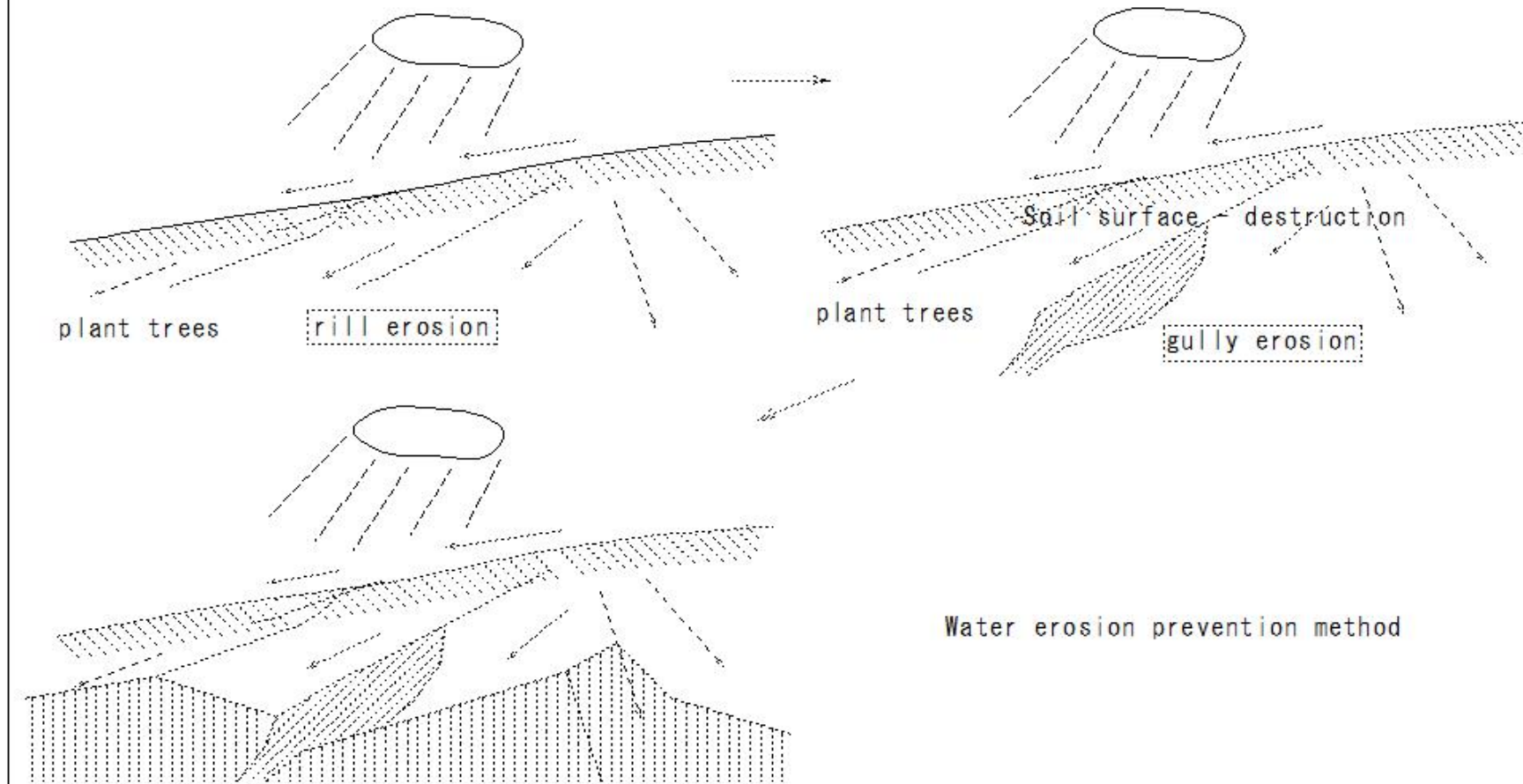
(1805)Method of average end areas

Soil volume V
 $V = \frac{1}{2} (A_1 + A_2) L$



(1806) Rill erosion

(1806) Rill erosion



Water erosion prevention method

(1807)Reynoldnumber

(1807)Reynoldnumber

Reynoldnumber

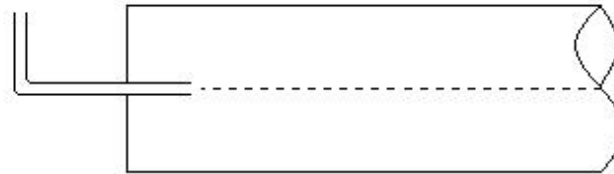
Determine whether fluid flow is laminar or turbulent

v1: flow velocity

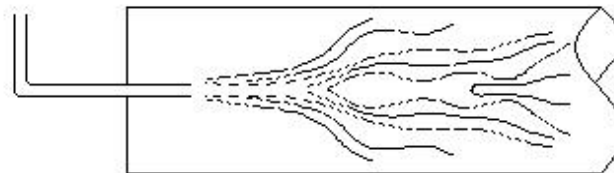
d: Pipe inner diameter

v2: Kinematic viscosity coefficient

$$Re = v1d/v2$$



laminar flow
 $Re \leq 2320$



turbulence
 $Re > 2320$

(1808)Sounding lead

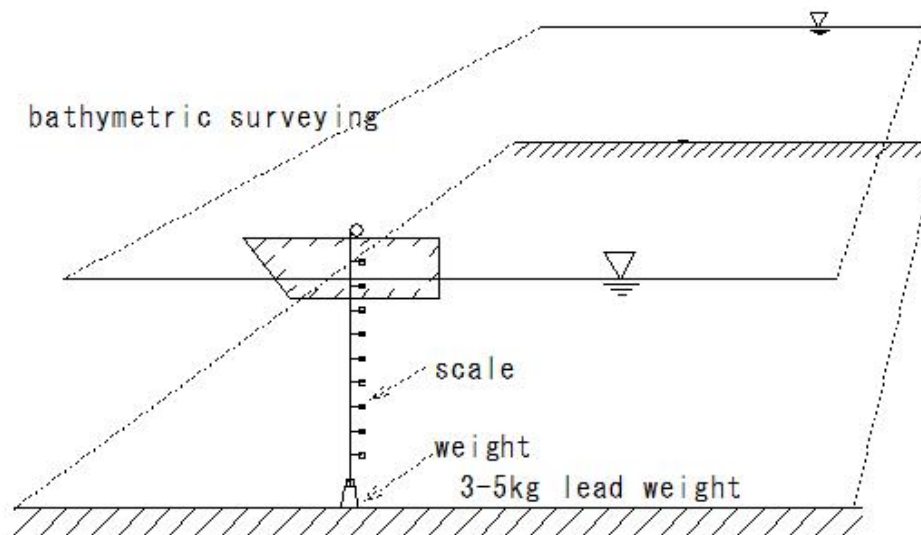
(1808) Sounding lead

Sounding lead

deep water

Flow velocity - small

Read the river water level on the scale



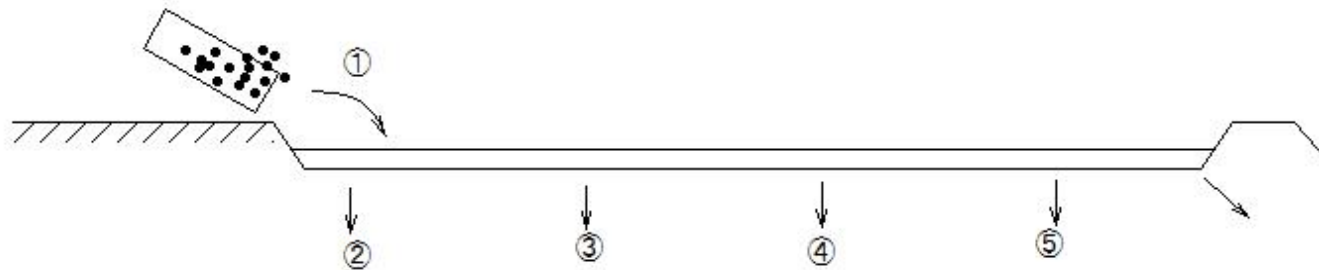
(I809) Degraded ferro-deficient paddy field

(I809) Degraded ferro-deficient paddy field

Degraded ferro-deficient paddy field

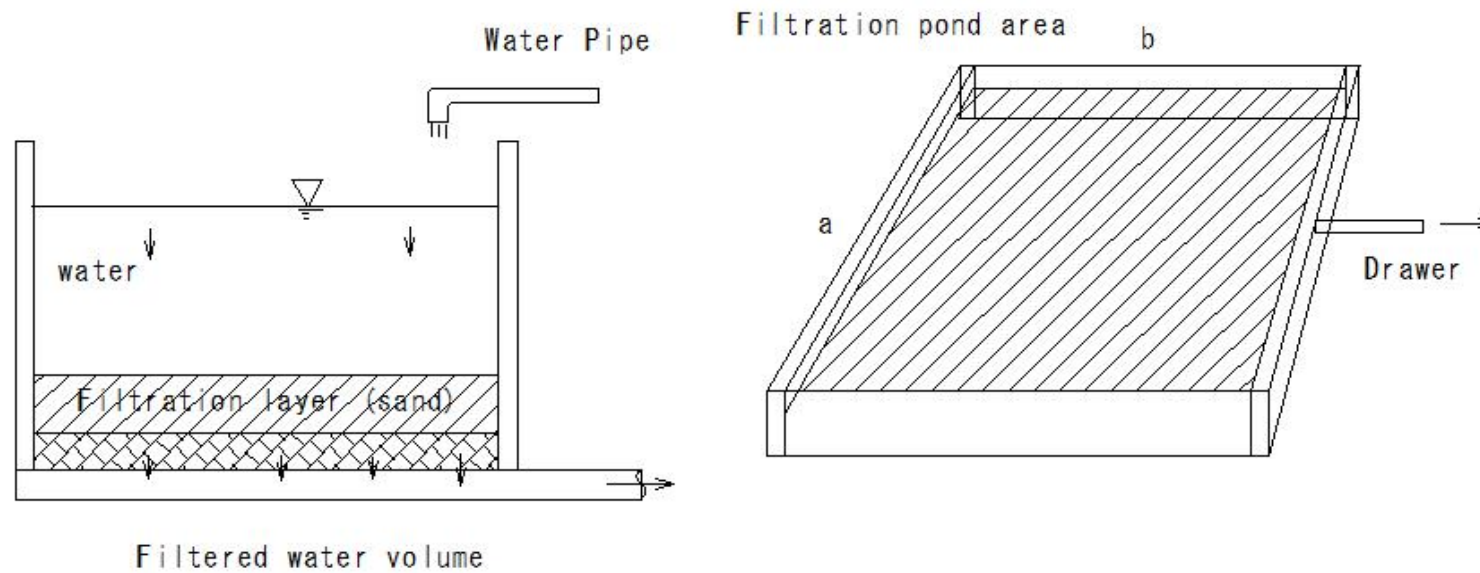
Degraded ferro-deficient paddy field are paddies where iron and other nutrients in the soil have leached out, adversely affecting rice growth.

- ① Soil addition
- ② Iron
- ③ Manganese
- ④ Lime
- ⑤ Magnesium



Degraded ferro-deficient paddy field

(I810)Rate of filtration



rate of filtration

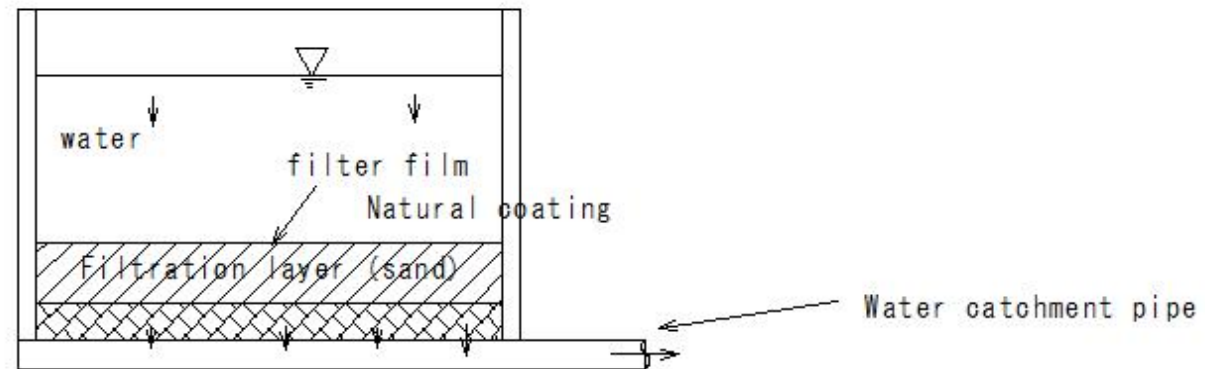
Unit: m³/day

rate of filtration = Daily filtration rate / Filtration pond area = Q/ab (m³/day)

(I811)Filter film

(I811)Filter film

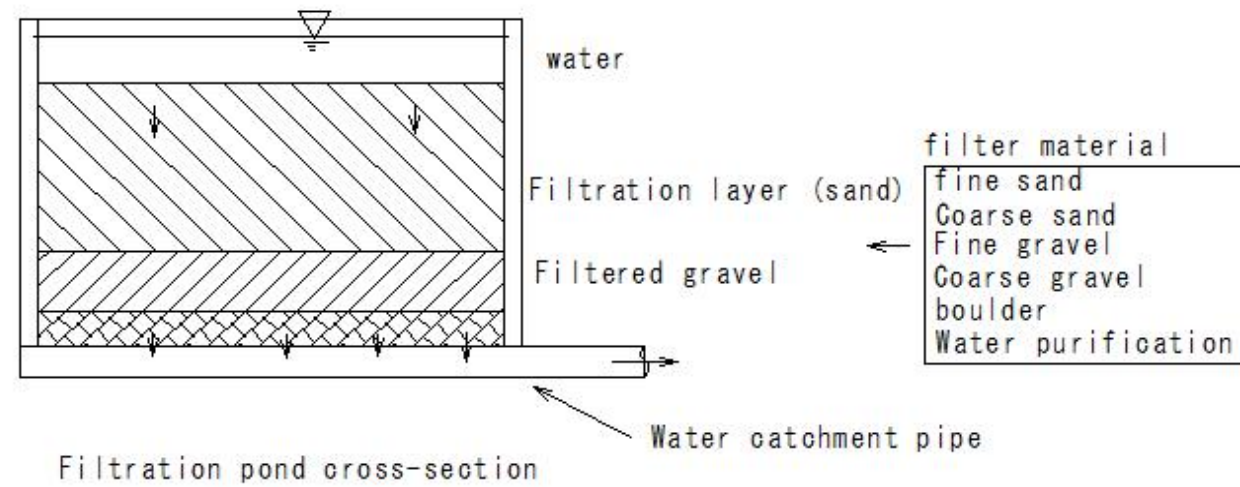
Filter film



Filtration pond cross-section

(I812)Filter material

(I812)Filter material



(1813)Mixing work on the way

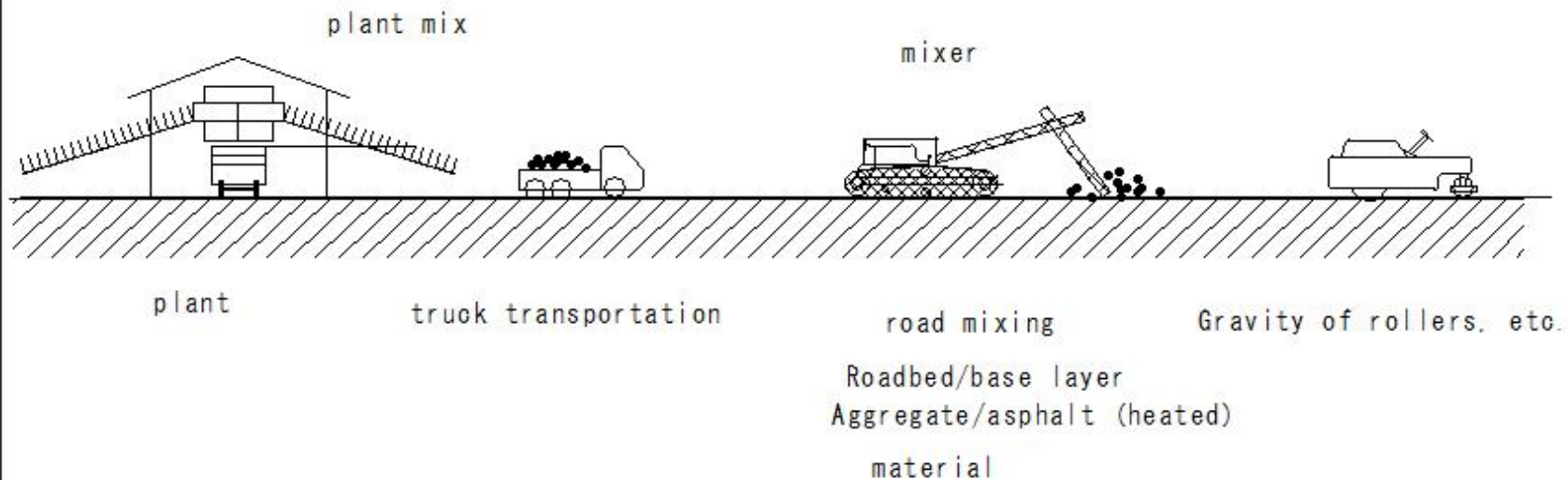
(1813)Mixing work on the way

Mixing work on the way

roadbed material

asphalt mixture

Directly on the roadbed - Mixing - Compaction



(I814)Water supply(return back of filtration(Filtered water backflow device))

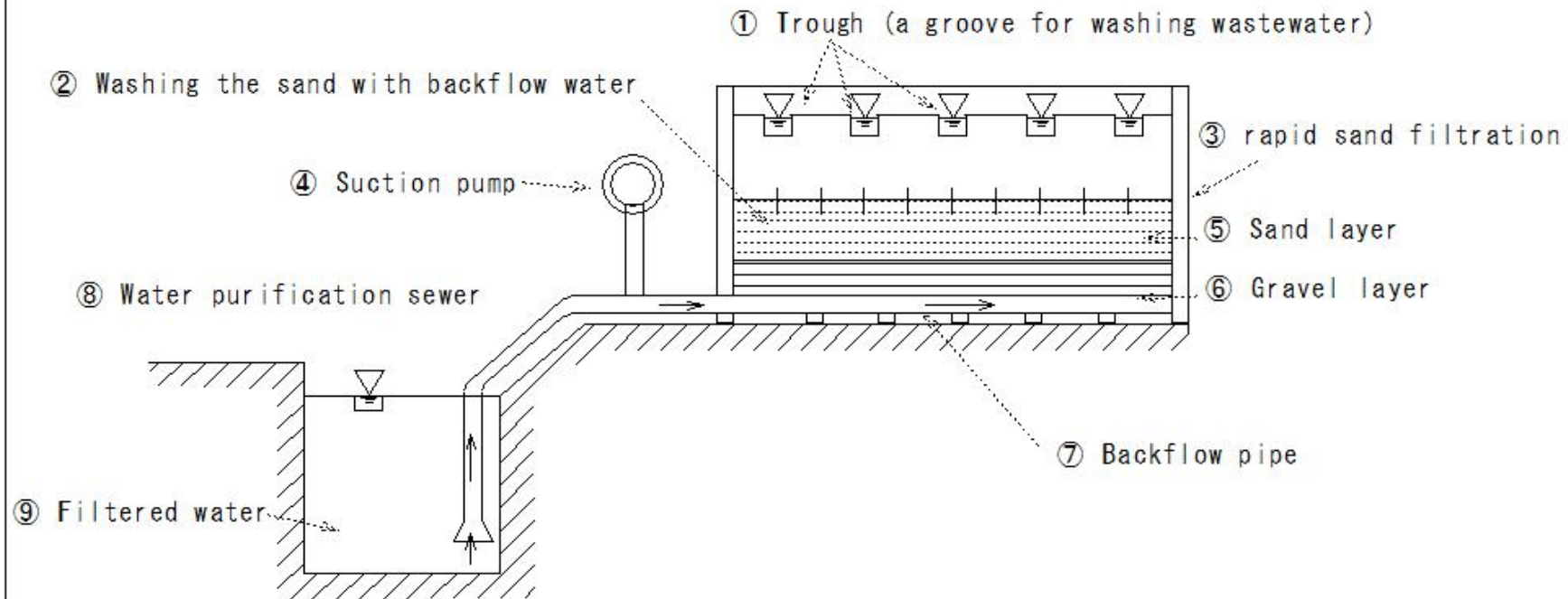
(I814)Water supply(return back of filtration(Filtered water backflow device))

Water supply

return back of filtration(Filtered water backflow device)

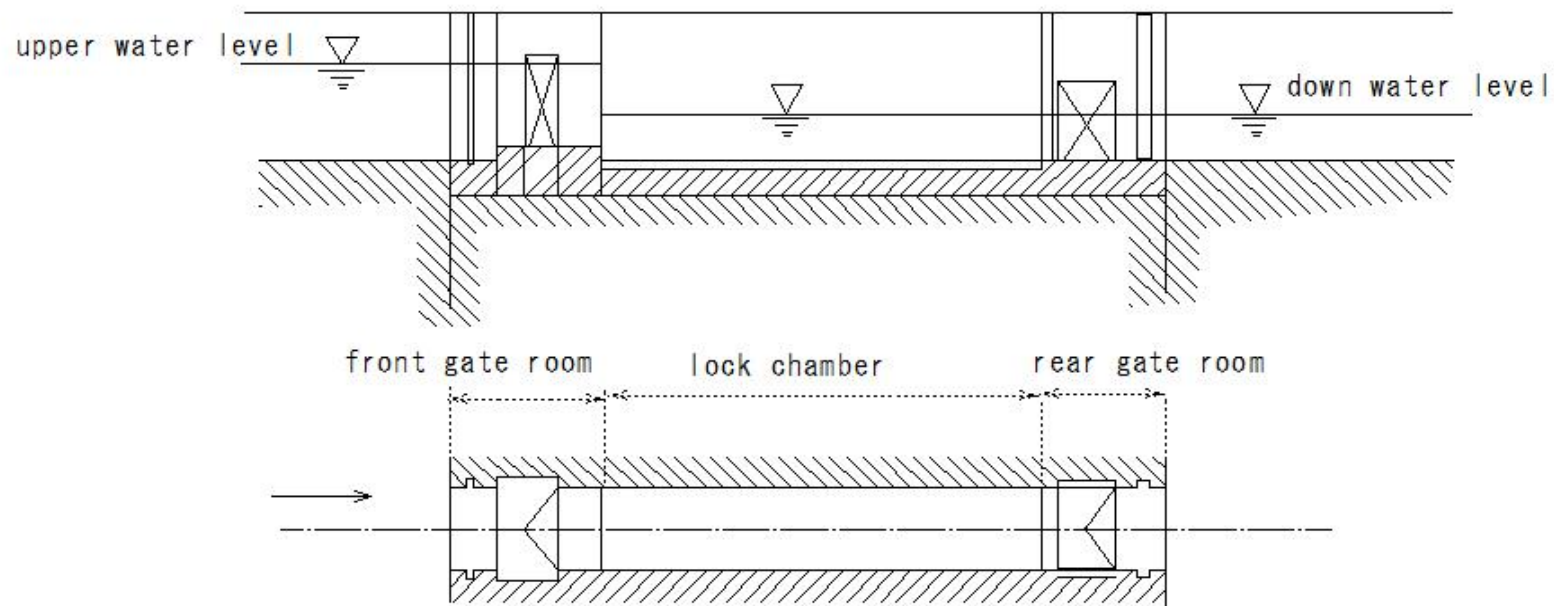
Rapid water filter for water supply

A device sends back filtered water to wash the filter sand



(I815)Lock

(I815) Lock



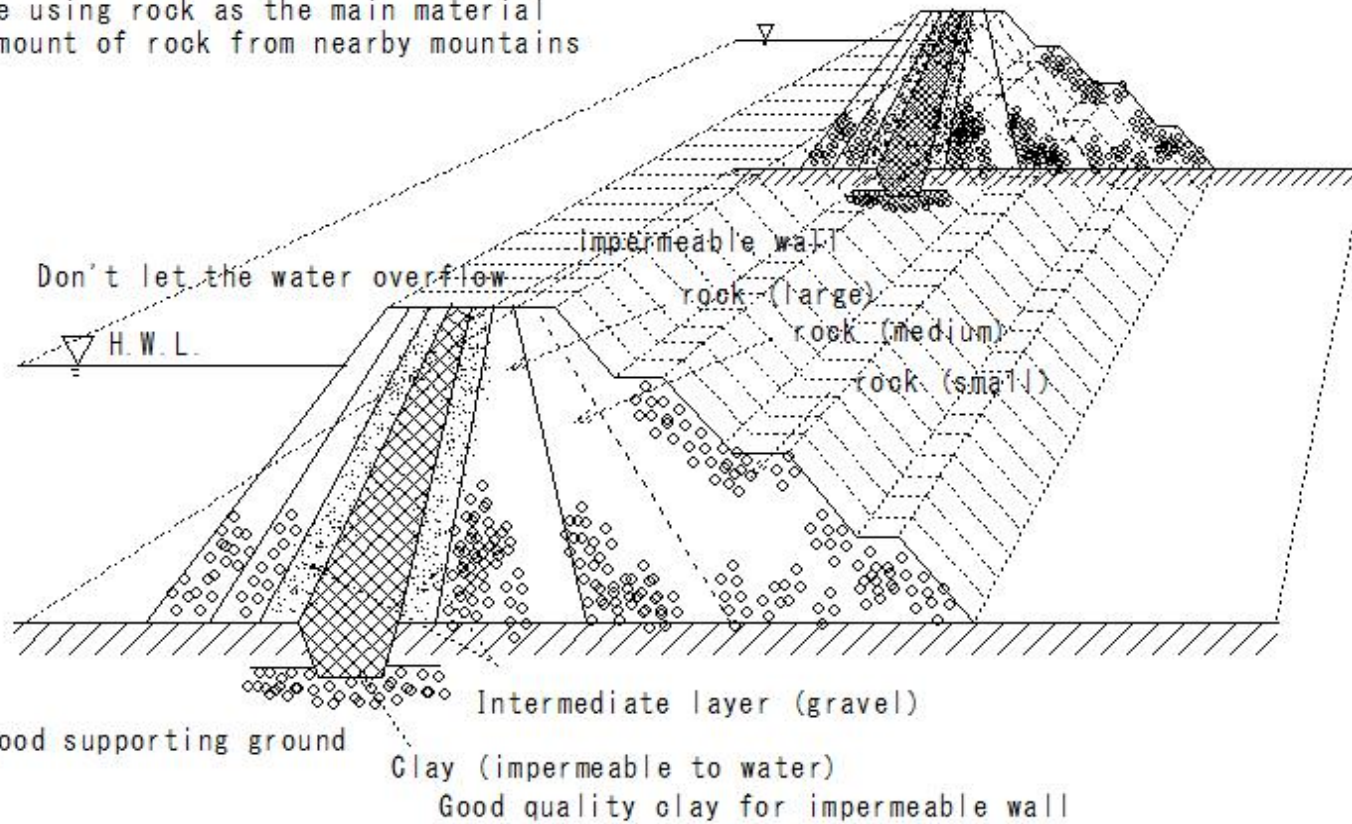
Sailing between two waters with a difference in head
lock

(I816)Rock fill dam

(I816)Rock fill dam

Rock fill dam

A dam made using rock as the main material
A large amount of rock from nearby mountains



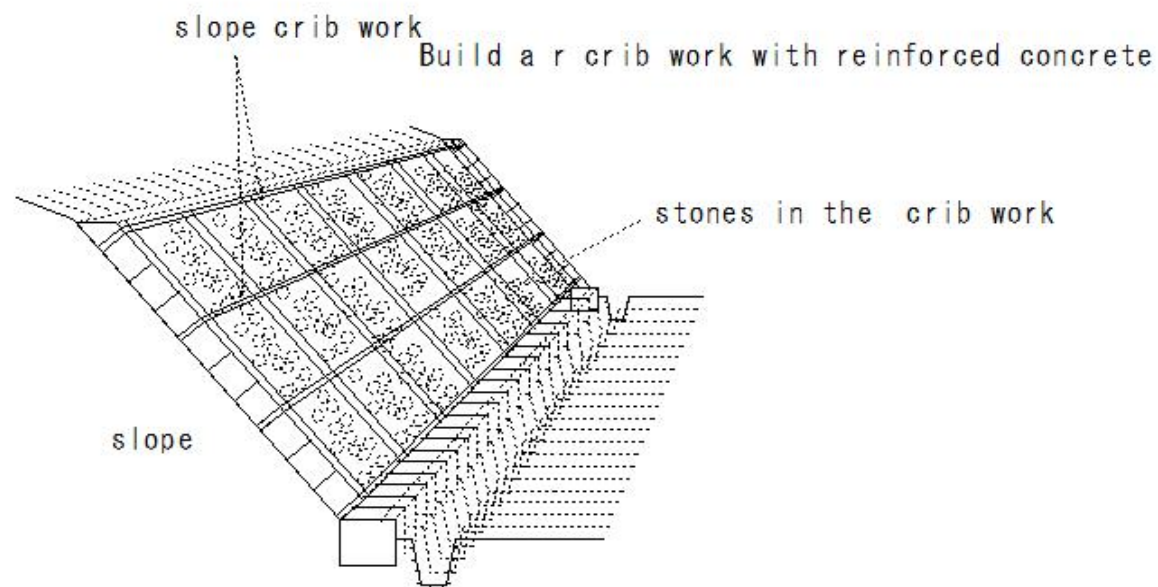
(I817)Cribwork

(I817) Cribwork

Cribwork

Embankment - slope reinforcement

Slope - crib work



R523