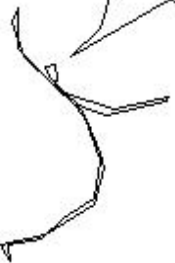


(01)River works(Illustration) in Africa(1-634)

(01)River works(Illustration) in Africa(1-634)



Only You !



Who teach, who build ?

只野敏夫
TADANO TOSHIO

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只野敏夫
Tadano Toshio

1 (R1)river survey	river survey
2 (R2)hydrostatic pressure	hydrostatic pressure
3 (R3)total water pressure	water pressure
4 (R4)total water pressure:Point of action	water pressure
5 (R5)Type of water flow:steady flow(normal flow)	Type of water flow
6 (R6)Type of water flow:unsteady flow	Type of water flow
7 (R7)Type of water flow : laminar flow	Type of water flow
8 (R8)Type of water flow : Turbulence	Type of water flow
9 (R9)Type of water flow : uniform flow	Type of water flow
10 (R10)Type of water flow : non-uniform flow	Type of water flow
11 (R11)Type of water flow : ordinary flow/shooting flow	Type of water flow
12 (R12)Type of water flow : hydraulic jump and backwater	Type of water flow
13 (R13)Phenomena associated with water flow(Water hammer (water hammer effect))	Water hammer
14 (R14)Phenomena associated with water flow(cavitation)	cavitation
15 (R15)Phenomena associated with water flow(piping)	piping
16 (R16)Phenomena associated with water flow(Penetration path length)	Penetration path length
17 (R17)Phenomena associated with water flow(average flow velocity)	average flow velocity
18 (R18)River channel excavation and dredging work	River channel excavation and dredging work
19 (R19)Excavation machine selection	Excavation machine selection
20 (R20)Excavation machine selection/Shovel type excavation machine>Loading shovel)	Loading shovel
21 (R21)Excavation machine selection/Shovel type excavation machine(Backhoe)	Excavation machine
22 (R22)Excavation machine selection/Shovel type excavation machine(Drag line)	Excavation machine
23 (R23)Excavation machine selection/Shovel type excavation machine(Clamshell)	Excavation machine
24 (R24)Selection of dredging vessel/Sediment dredging(Pump dredger)	dredging vessel
25 (R25)Selection of dredging vessel/Sediment dredging(Bucket dredger)	dredging vessel
26 (R26)Selection of dredging vessel/Sediment dredging(Grab dredger)	dredging vessel
27 (R27)Selection of dredging vessel/Sediment dredging(Dipper dredger)	dredging vessel
28 (R28)embankment(type of embankment)	embankment
29 (R29)embankment(Main embankment)	embankment
0 (R30)embankment(training levee)	embankment
31 (R31)embankment(open levee)	embankment
32 (R32)embankment(levee : close the gap between mountains)	embankment
33 (R33)embankment(separation levee)	embankment
34 (R34)embankment(circle levee)	embankment

35 (R35)embankment(cultivated land - protection)	embankment
36 (R36)embankment(closing dyke)	embankment
37 (R37)embankment(deversoir)	embankment
38 (R38)embankment(secondary levee)	embankment
39 (R39)embankment(Horizontal levee)	embankment
40 (R40)Embankment cross section	Embankment cross section
41 (R41)Embankment cross section	Embankment cross section
42 (R42)Embankment cross section	Embankment cross section
43 (R43)Embankment cross section	Embankment cross section
44 (R44)Embankment cross section	Embankment cross section
45 (R45)Embankment cross section	Embankment cross section
46 (R46)Embankment cross section	Embankment cross section
47 (R47)Embankment cross section	Embankment cross section
48 (R48)Embankment line(levee normal)	Embankment cross section
49 (R49)Embankment materials	Embankment materials
50 (R50)Embankment materials	Embankment materials
51 (R51)Embankment ground	embankment
52 (R52)Countermeasures for soft ground	Countermeasures for soft ground
53 (R53)Countermeasures for soft ground(Replacement method)	Countermeasures for soft ground
54 (R54)Countermeasures for soft ground>Loading embankment method)	Countermeasures for soft ground
55 (R55)Countermeasures for soft ground(Sand drain method)	Countermeasures for soft ground
56 (R56)Countermeasures for soft ground(Embankment work)	Countermeasures for soft ground
57 (R57)Countermeasures for soft ground(Preparation work)	Countermeasures for soft ground
58 (R58)Countermeasures for soft ground(Construction cross section and extra layer)	Countermeasures for soft ground
59 (R59)Countermeasures for soft ground(Embankment/compaction)	Countermeasures for soft ground
60 (R60)Countermeasures for soft ground(Freshly built: Embankment work)	Countermeasures for soft ground
61 (R61)Destruction of embankments and countermeasures(Overflow)	countermeasures(Overflow)
62 (R62)Destruction of embankments and countermeasures(Scouring)	countermeasures(Scouring)
63 (R63)Destruction of embankments and countermeasures(Seepage/leakage)	countermeasures(Seepage/leakage)
64 (R64)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
65 (R65)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
66 (R66)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
67 (R67)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
68 (R68)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)

69 (R69)Destruction of embankments and countermeasures(Measures for foundation ground)	countermeasures(Measures for foundation ground)
70 (R70)Destruction of embankments and countermeasures(Measures for foundation ground)	countermeasures(Measures for foundation ground)
71 (R71)Destruction of embankments and countermeasures(Measures for foundation ground)	countermeasures(Measures for foundation ground)
72 (R72)Types of bank protection	bank protection
73 (R73)Types of bank protection	bank protection
74 (R74)Types of bank protection	bank protection
75 (R75)Types of bank protection	bank protection
76 (R76)Structure and design of bank protection	bank protection
77 (R77)Structure and design of bank protection	bank protection
78 (R78)Structure and design of bank protection	bank protection
79 (R79)Structure and design of bank protection	bank protection
80 (R80)Structure and design of bank protection	bank protection
81 (R81)Structure and design of bank protection	bank protection
82 (R82)Structure and design of bank protection	bank protection
83 (R83)Structure and design of bank protection	bank protection
84 (R84)Structure and design of bank protection	bank protection
85 (R85)Structure and design of bank protection	bank protection
86 (R86)Structure and design of bank protection	bank protection
87 (R87)Construction of Slope lining work(willow branch works)	Construction of Slope lining work
88 (R88)Construction of Slope lining work(Masonry/stone masonry)	Construction of Slope lining work
89 (R89)Construction of Slope lining work(Stone filling method frame work)	Construction of Slope lining work
90 (R90)Construction of Slope lining work(Concrete lining)	Construction of Slope lining work
91 (R91)Construction of Slope lining work(Concrete lining)	Construction of Slope lining work
92 (R92)Construction of Slope lining work(Concrete lining)	Construction of Slope lining work
93 (R93)Construction of Slope lining work	Construction of Slope lining work
94 (R94)Construction of Slope lining work	Construction of Slope lining work
95 (R95)Construction of Slope lining work	Construction of Slope lining work
96 (R96)Foundation work/slope work (sure-footing)	slope work (sure-footing)
97 (R97)Foundation work/slope work (sure-footing)	slope work (sure-footing)
98 (R98)Foundation work/slope work (sure-footing)	slope work (sure-footing)
99 (R99)Foundation work/slope work (sure-footing)	slope work (sure-footing)
100 (R100)Foundation work/slope work (sure-footing)	slope work (sure-footing)
101 (R101)Foundation work/slope work (sure-footing)	slope work (sure-footing)
102 (R102)Foundation work/slope work (sure-footing)	slope work (sure-footing)

103 (R103)Foundation work/slope work (foot protection)	slope work (sure-footing)
104 (R104)Foundation work/slope work (foot protection)	slope work (sure-footing)
105 (R105)Foundation work/slope work (foot protection)	slope work (sure-footing)
106 (R106)Foundation work/slope work (foot protection)	slope work (sure-footing)
107 (R107)Foundation work/slope work (foot protection)	slope work (sure-footing)
108 (R108)Foundation work/slope work (foot protection)	slope work (sure-footing)
109 (R109)Foundation work/slope work (foot protection)	slope work (sure-footing)
110 (R110)Foundation work/slope work (foot protection)	slope work (sure-footing)
111 (R111)Foundation work/slope work (foot protection)	slope work (sure-footing)
112 (R112)Foundation work/slope work (foot protection)	slope work (sure-footing)
113 (R113)Foundation work/slope work (foot protection)	slope work (sure-footing)
114 (R114)Foundation work/slope work (foot protection)	slope work (sure-footing)
115 (R115)Foundation work/slope work (foot protection)	slope work (sure-footing)
116 (R116)Foundation work/slope work (foot protection)	slope work (sure-footing)
117 (R117)Foundation work/slope work (foot protection)	slope work (sure-footing)
118 (R118)groin	groin
119 (R119)groin	groin
120 (R120)groin	groin
121 (R121)groin	groin
122 (R122)groin	groin
123 (R123)groin	groin
124 (R124)groin	groin
125 (R125)groin	groin
126 (R126)groin	groin
127 (R127)groin	groin
128 (R128)groin	groin
129 (R129)groin	groin
130 (R130)groin	groin
131 (R131)groin	groin
132 (R132)groin	groin
133 (R133)groundsill	groundsill
134 (R134)groundsill	groundsill
135 (R135)groundsill	groundsill
136 (R136)groundsill	groundsill

205 (R205)Groin	Groin
206 (R206)deversoir(overflow)	deversoir(overflow)
207 (R207)levee widening	levee widening
208 (R208)groin	groin
209 (R209)embankment(open levee)	embankment(open levee)
210 (R210)river	river
211 (R211)River embankment	River embankment
212 (R212)River embankment	River embankment
213 (R213)River embankment	River embankment
214 (R214)River embankment	River embankment
215 (R215)River embankment	River embankment
216 (R216)River embankment	River embankment
217 (R217)River embankment	River embankment
218 (R218)River embankment	River embankment
219 (R219)River embankment	River embankment
220 (R220)River earthworks	River earthworks
221 (R221)River earthworks	River earthworks
222 (R222)River earthworks	River earthworks
223 (R223)River earthworks	River earthworks
224 (R224)River earthworks	River earthworks
225 (R225)River earthworks	River earthworks
226 (R226)River earthworks	River earthworks
227 (R227)groin	groin
228 (R228)groin	groin
229 (R229)Embankment(major bed)	Embankment
230 (R230)Embankment(high waterway)	Embankment
231 (R231)Embankment(bank protection)	Embankment
232 (R232)Embankment(bank protection)	Embankment
233 (R233)bank protection slope covering(lining) works	slope covering(lining) works
234 (R234)bank protection slope covering(lining) works	slope covering(lining) works
235 (R235)bank protection slope covering(lining) works	slope covering(lining) works
236 (R236)bank protection slope covering(lining) works	slope covering(lining) works
237 (R237)bank protection slope covering(lining) works	slope covering(lining) works
238 (R238)bank protection slope covering(lining) works	slope covering(lining) works

239 (R239)bank protection slope covering(lining) works	slope covering(lining) works
240 (R240)Embankment(berm)	Embankment
241 (R241)bank protection(concrete crib work)	bank protection
242 (R242)bank protection(concrete block)	bank protection
243 (R243)groin (concrete block groin)	bank protection
244 (R244) bank protection (concrete block pitching)	bank protection
245 (R245)slope covering(lining) works (fence work)	slope covering(lining) works
246 (R246)slope covering(lining) works (wire cylinder masonry work(gabion))	slope covering(lining) works
247 (R247)sluice (impermeable wall)	sluice
248 (R248)wetted perimeter	wetted perimeter
249 (R249)receiving waterway	River
250 (R250)Embankment(seepage line infiltration line)	Embankment
251 (R251)Embankment(Construction cross section)	Embankment
252 (R252)Embankment(separation levee)	Embankment
253 (R253)foot protection(mattress)	foot protection
254 (R254)embankment	Embankment
255 (R255)embankment(Embankment crown)	Embankment
256 (R256)embankment(margin height /extra embankment)	Embankment
257 (R257)permeable groin	groin
258 (R258)permeable groin	groin
259 (R259)embankment(training levee)	Embankment
260 (R260)embankment(training levee)	Embankment
261 (R261)bank protection(ground sill consolidation)	bank protection
262 (R262)temporary cofferdam(ground sill consolidation)	Embankment
263 (R263)riverbed (penetration depth)	River
264 (R264)foot protection	foot protection
265 (R265)foot protection(groin)	foot protection
266 (R266)stone masonry	bank protection
267 (R267)foot protection(slope foot protection)	foot protection
268 (R268)slope crib work	slope crib work
269 (R269)slope crib work	slope crib work
270 (R270)sluice	sluice
271 (R271)siphon culvert	siphon culvert
272 (R272)Impermeable groin	groin

273 (R273)pump dredger	pump dredger
274 (R274)Concrete pitching bank protection(Joint spacing)	bank protection
275 (R275) foot protection(wood mattress)	foot protection
276 (R276)Horizontal levee	embankment
277 (R277)margin height (extra embankment/extra-banking)	embankment
278 (R278)margin height (extra embankment)	embankment
279 (R279)embankment (circle levee)	embankment
280 (R280)amenity	River
281 (R281)stone dyke(groin)	groin
282 (R282)stone masonry	bank protection
283 (R283)rock crib work	slope protection
284 (R284)stone pitching work	slope protection
285 (R285)embankment(berm)	embankment
286 (R286)groin(skeleton)	groin
287 (R287)groin(skeleton)-wire cylinder masonry work(gabion)	groin
288 (R288)slope protection(backing mat method)	slope protection
289 (R289)groin towards up stream	groin
290 (R290)carrying operation	carrying operation
291 (R291)lock	lock
292 (R292)works for overflow	works for overflow
293 (R293)works for overflow	works for overflow
294 (R294)works for overflow(wire cylinder masonry work(gabion))	works for overflow
295 (R295)works for overflow(board work)	works for overflow
296 (R296)overflow pipe	overflow pipe
297 (R297)groin over the water	groin
298 (R298)Impermeable groin(solid spur)	groin
299 (R299)scour	scour
300 (R300)overflow weir	weir
301 (R301)triangular weir	weir
302 (R302)weir	weir
303 (R303)deversoir(overflow)	deversoir(overflow)
304 (R304)riverbed girdle	riverbed girdle
305 (R305)consolidation works	consolidation works
306 (R306)consolidation works	consolidation works

307 (R307)lapel method	lapel method
308 (R308)stop log	stop log
309 (R309)estuary improvement	estuary improvement
310 (R310)Semi-permeable groin -wire cylinder masonry work(gabion)	gabion
311 (R311)Semi-permeable groin -wire cylinder masonry work(gabion)	gabion
312 (R312)embankment(raising)	embankment
313 (R313)embankment(raising)	embankment
314 (R314)shape of river	River
315 (R315)center of stream in the river	River
316 (R316)open levee	embankment
317 (R317)specific discharge	River
318 (R318)run-off coefficient	River
319 (R319)thalweg	River
320 (R320)cross sectional area of stream	River
321 (R321)stream line	River
322 (R322)flow net	River
323 (R323)river works	River
324 (R324)equilibrated grade of river	River
325 (R325)equilibrated grade of river	River
326 (R326)embankment(over compaction)	embankment
327 (R327)river channel	River
328 (R328)river channel improvement	River
329 (R329)movable weir(stop log)	weir
330 (R330)movable weir(Sluice gate)	weir
331 (R331)movable weir(Stoney Weir)	weir
332 (R332)movable weir(Rolling gate)	weir
333 (R333)movable weir(Tentergate)	weir
334 (R334)movable weir(Drum gate)	weir
335 (R335)movable weir(Overturning weir)	weir
336 (R336)embankment-drainage method(hooping)	embankment
337 (R337)masonry (dry masonry)	masonry
338 (R338)gully erosion	gully erosion
339 (R339)culvert	culvert
340 (R340)embankment (wood sinking)	embankment

341 (R341)environment irrigation water	environment irrigation water
342 (R342)reclamation in water area	reclamation in water area
343 (R343)draft	draft
344 (R344)cavitation	cavitation
345 (R345)fishladder	fishladder
346 (R346)weir(notch)	weir
347 (R347)pile dyke(groin)	groin
348 (R348)spur dyke(groin)	groin
349 (R349)grab dredger	grab dredger
350 (R350)estimated high-water level,Designed high water level (H.W.L)	estimated high-water level
351 (R351)estimated high-water discharge,design high-water discharge	estimated high-water discharge
352 (R352)design flood discharge	design flood discharge
353 (R353)quicksand	quicksand
354 (R354)flood control	flood control
355 (R355)flood protection works	flood protection works
356 (R356)embankment(major bed)	embankment
357 (R357)flood control	flood control
358 (R358)time of concenration of flood	time of concenration of flood
359 (R359)broad-crested weir	weir
360 (R360)control section	control section
361 (R361)cofferdam	cofferdam
362 (R362)cofferdam	cofferdam
363 (R363)cofferdam	cofferdam
364 (R364)cofferdam	cofferdam
365 (R365)closing dyke	cofferdam
366 (R366)wire cylinder(gabion)	groin
367 (R367)plantable bank protection	bank protection
368 (R368)supercritical flow(shooting flow /rapid flow)	supercritical flow
369 (R369)boat way	boat way
370 (R370)free outflow	free outflow
371 (R371)water intake	intake
372 (R372)intake	intake
373 (R373)intake dam	intake
374 (R374)intake tower	intake

375 (R375)vadose water(circulating water)	circulating water
376 (R376)dredging(Pump dredger)	dredging
377 (R377)dredging(Bucket dredger)	dredging
378 (R378)dredging(Grab dredger)	dredging
379 (R379)dredging(Dipper dredger)	dredging
380 (R380)intercepting drain	intercepting drain
381 (R381)slope crib work	bank protection
382 (R382)river (cut-off)	river
383 (R383)hydraulic pressure	hydraulic pressure
384 (R384)penstock root	penstock root
385 (R385)stage(water level)	stage(water level)
386 (R386)water-level recorder	water-level recorder
387 (R387)water hammer	water hammer
388 (R388)water pollution	water pollution
389 (R389)hydraulic turbine	hydraulic turbine
390 (R390)gate	gate
391 (R391)Hydraulic water depth	Hydraulic water depth
392 (R392)conduct type water power	conduct type water power
393 (R393)diversion of water channel	diversion of water channel
394 (R394)Preventing water leakage from embankments	water leakage
395 (R395)stoney gate weir	weir
396 (R396)sluice gate	sluice gate
397 (R397)productive green tract of land	productive green tract of land
398 (R398)seepage line	seepage line
399 (R399)works for overflow(board work)	overflow
400 (R400)stone levee	embankment
401 (R401)cellular sheet pile	cellular sheet pile
402 (R402)separation levee	embankment
403 (R403)fan	river
404 (R404)summer dyke	embankment
405 (R405)undercurrent	undercurrent
406 (R406)sodding	bank protection
407 (R407)traction	river
408 (R408)laminar flow	laminar flow

409 (R409)fascine	fascine
410 (R410)flowing through capability	river
411 (R411)deposition	deposition
412 (R412)meandering	river
413 (R413)Vertical wire cylinder masonry work(gabion)	groin
414 (R414)prevent water leakage	water leakage
415 (R415)ground water level	ground water level
416 (R416)embankment	embankment
417 (R417)rift valley	rift valley
418 (R418)hydraulic jump	hydraulic jump
419 (R419)finishing stake	embankment
420 (R420)Bank protection(mattress)	Bank protection
421 (R421)Bank protection(patch up method)	Bank protection
422 (R422)prevent water leakage(hooping)	prevent water leakage
423 (R423)Bank protection(back slope protection)	Bank protection
424 (R424)slope foot protection(Filling pile work)	slope foot protection
425 (R425)embankment(riverside land)	embankment
426 (R426)flow(drop down curve(backwater))	flow
427 (R427)flow(steady flow)	flow
428 (R428)low water channel work	river
429 (R429)low-water channel	river
430 (R430)low -water discharge	river
431 (R431)infiltration(percolation) of levee	infiltration(percolation)
432 (R432)dipper dredger	dredging
433 (R433)section of levee	embankment
434 (R434)Embankment(levee normal)	embankment
435 (R435)dam(deflector)	dam(deflector)
436 (R436)weir(tainter gate)	weir
437 (R437)embankment(crown/surface)	embankment
438 (R438)weir(head works)	weir
439 (R439)penstock (alluvium)	hydraulics
440 (R440)coefficient of permeability	hydraulics
441 (R441)Downward groin	groin
442 (R442)uniform flow	flow

443 (R443)training dyke	embankment
444 (R444)training levee	embankment
445 (R445)special bank	embankment
446 (R446)jetty	embankment
447 (R447)slope tamping	tool
448 (R448)nappe	hydraulics
449 (R449)interflow	hydraulics
450 (R450)foot protection	foot protection
451 (R451)foot protection	foot protection
452 (R452)foot protection	foot protection
453 (R453)foot protection	foot protection
454 (R454)foot protection	foot protection
455 (R455)embankment(slope)	embankment
456 (R456)stability of the slope(slope pile)	stability of the slope
457 (R457)embankment(slope gradient)	embankment
458 (R458)bank protection(sure-footing)	bank protection
459 (R459)bank protection(slope covering(lining) works)	bank protection
460 (R460)bank protection(sodding works)	bank protection
461 (R461)bank protection(concrete pitching)	bank protection
462 (R462)bank protection(slope protection)	bank protection
463 (R463)weir(dentated sill)	weir
464 (R464)weir(sharp crested weir)	weir
465 (R465)river(branch river)	river
466 (R466)dam(baffle pier)	dam
467 (R467)embankment(sodding)	embankment
468 (R468)hydraulics(confined ground water)	hydraulics
469 (R469)embankment(secondary levee)	embankment
470 (R470)sluice	sluice
471 (R471)embankment(setting back of levee)	embankment
472 (R472)flow (unsteady flow)	flow
473 (R473)sluice	sluice
474 (R474)surface impermeable wall	hydraulics
475 (R475)composite drainage basin	river
476 (R476)auxiliary dam	dam

477 (R477)secondary levee	embankment
478 (R478)river bed water	hydraulics
479 (R479)twin float	hydraulics
480 (R480)normal water gauge	hydraulics
481 (R481)unsteady flow	flow
482 (R482)impermeability layer	hydraulics
483 (R483)non-uniform flow	flow
484 (R484)plane of floatation	hydraulics
485 (R485)suspended load	hydraulics
486 (R486)buoyancy	hydraulics
487 (R487)Froude number	hydraulics
488 (R488)floating dam	dam
489 (R489)watershed	river
490 (R490)diversion works	hydraulics
491 (R491)diversion works	hydraulics
492 (R492)mean velocity	hydraulics
493 (R493)equilibrium slope	flow
494 (R494)parallel drainage	river
495 (R495)radial drainage	river
496 (R496)flood-way	river
497 (R497)suction dredger(pump dredger)	dredging
498 (R498)spatter's effect(water splash effect)	dam
499 (R499)leveling	survey
500 (R500)shoulder sodding	embankment
501 (R501)submerged orifice	hydraulics
502 (R502)submerged discharge	hydraulics
503 (R503)banking	embankment
504 (R504)retarding basin,flood storage basin	river
505 (R505)spillway	dam
506 (R506)extra-banking	embankment
507 (R507)freeboard-margin height (extra embankment)	embankment
508 (R508)turbulent flow -Laminar flow	flow
509 (R509)Diffusion effect of turbulent flow	flow
510 (R510)sand flash gate	dam

511 (R511)basin coefficient	river
512 (R512)automatic water gauge	survey
513 (R513)velocity of flow	flow
514 (R514)discharge	hydraulics
515 (R515)hydrometry	hydraulics
516 (R516)water course	river
517 (R517)method of average end areas	survey
518 (R518)Reynoldsnumber	hydraulics
519 (R519)sounding lead	survey
520 (R520)rate of filtration	hydraulics
521 (R521)filter film	hydraulics
522 (R522)filter material	hydraulics
523 (R523)cribwork	bank protection
524 (R524)rain drop erosion	hydraulics
525 (R525)apron	dam
526 (R526)rock fill dam	dam
527 (R527)water warming facilities	hydraulics
528 (R528)water warming facilities	hydraulics
529 (R529)river mouth improvement	river
530 (R530)river mouth improvement	river
531 (R531)river mouth improvement	river
532 (R532)river mouth improvement	river
533 (R533)stream order	river
534 (R534)river	river
535 (R535)levee burst prevention (hurdle work)	bank protection
536 (R536)river channel	river
537 (R537)temporary cofferdam	temporary cofferdam
538 (R538)temporary cofferdam	temporary cofferdam
539 (R539)temporary cofferdam	temporary cofferdam
540 (R540)flood control	hydraulics
541 (R541)revetment	revetment
542 (R542)hurdle work(bank protection work)	bank protection
543 (R543)retarding basin	river
544 (R544)jet flow gate	gate

545 (R545)automatic cross regulator	gate
546 (R546)automatic cross regulator	gate
547 (R547)inlet works(water intake facility)	inlet works
548 (R548)groin(groyne · spur dike)	groin
549 (R549)groin(groyne · spur dike)	groin
550 (R550)groin(groyne · spur dike)	groin
551 (R551)groin(groyne · spur dike)	groin
552 (R552)groin(groyne · spur dike)	groin
553 (R553)groin(groyne · spur dike)	groin
554 (R554)slide gate	gate
555 (R555)laminar flow · laminar flow	hydraulics
556 (R556)Concrete block groin (water control)	groin
557 (R557)groundwater	groundwater
558 (R558)groundwater	groundwater
559 (R559)subsurface dam	dam
560 (R560)alluvium	river
561 (R561)mattress	bank protection
562 (R562)alignment of dike	embankment
563 (R563)levee(dike · embankment)	embankment
564 (R564)levee(dike · embankment)	embankment
565 (R565)isohyetal method	hydraulics
566 (R566)head works	head works
567 (R567)head works(Intake weir)	head works
568 (R568)head works(Intake weir)	head works
569 (R569)ground sill consolidation works	ground sill consolidation works
570 (R570)ground sill consolidation works	ground sill consolidation works
571 (R571)ground sill consolidation works	ground sill consolidation works
572 (R572)ground sill consolidation works	ground sill consolidation works
573 (R573)ground sill consolidation works	ground sill consolidation works
574 (R574)soil stabilization	soil stabilization
575 (R575)soil stabilization	soil stabilization
576 (R576)transition	channel
577 (R577)inside water level	river
578 (R578)nappe	hydraulics

579 (R579)nappe
580 (R580)slope crib work
581 (R581)slope crib work
582 (R582)slope crib work
583 (R583)slope crib work
584 (R584)slope crib work
585 (R585)hydrograph
586 (R586)fixed weir
587 (R587)surface runoff
588 (R588)hinge type gate
589 (R589)miter gate
590 (R590)fill-type dam
591 (R591)fill-type dam
592 (R592)fill-type dam
593 (R593)fill-type dam
594 (R594)retarding basin(flood storage basin)
595 (R595)spillway
596 (R596)sediment(sediment load)
597 (R597)flow net
598 (R598)flow net
599 (R599)head-fall-drop
600 (R600)fixed wheel gate(roller gate)
601 (R601)River (grade)
602 (R602)lining cannal
603 (R603)loading bank
604 (R604)displacement method
605 (R605)creep ratio
606 (R606)head creep ratio
607 (R607)wash load
608 (R608)underground dam
609 (R609)Groundwater · well
610 (R610)alluvial deposit
611 (R611)cross-levee(Horizontal levee)
612 (R612)siphon culvert

hydraulics
slope crib work
slope crib work
slope crib work
slope crib work
slope crib work
hydraulics
weir
hydraulics
gate
gate
fill-type dam
fill-type dam
fill-type dam
fill-type dam
river
dam
hydraulics
hydraulics
hydraulics
weir
gate
river
cannal
embankment
embankment
hydraulics
hydraulics
hydraulics
topographic
groundwater
culvert
gate
Foot protection

613 (R613)Sluice gate(water gate)
614 (R614)Foot protection
615 (R615)Foot protection
616 (R616)Foot protection
617 (R617)Foot protection
618 (R618)Foot protection
619 (R619)Foot protection
620 (R620)Foot protection
621 (R621)slope work (sure-footing)
622 (R622)slope work (sure-footing)
623 (R623)slope work (sure-footing)
624 (R624)slope work (sure-footing)
625 (R625)slope work (sure-footing)
626 (R626)slope work (sure-footing)
627 (R627)Slope protection(Pitching concrete/ crib work)
628 (R628)Slope protection(concrete block)
629 (R629)Slope protection(Connected concrete block)
630 (R630)Slope protection(pile/gabion)
631 (R631)Slope protection(concrete block pitching)
632 (R632)Slope protection(concrete crib work)
633 (R633)Baffle pier
634 (R634)Sluice gate, sluice pipe

Foot protection
Foot protection
Foot protection
Foot protection
Foot protection
Foot protection
Foot protection
Foot protection
slope work (sure-footing)
slope work (sure-footing)
slope work (sure-footing)
slope work (sure-footing)
slope work (sure-footing)
slope work (sure-footing)
Slope protection
Slope protection
Slope protection
Slope protection
Slope protection
Slope protection
weir
gate

63 (R63)Destruction of embankments and countermeasures(Seepage/leakage)	countermeasures(Seepage/leakage)
140 (R140)apron/bed protection work	apron/bed protection work
17 (R17)Phenomena associated with water flow(average flow velocity)	average flow velocity
72 (R72)Types of bank protection	bank protection
73 (R73)Types of bank protection	bank protection
74 (R74)Types of bank protection	bank protection
75 (R75)Types of bank protection	bank protection
76 (R76)Structure and design of bank protection	bank protection
77 (R77)Structure and design of bank protection	bank protection
78 (R78)Structure and design of bank protection	bank protection
79 (R79)Structure and design of bank protection	bank protection
80 (R80)Structure and design of bank protection	bank protection
81 (R81)Structure and design of bank protection	bank protection
82 (R82)Structure and design of bank protection	bank protection
83 (R83)Structure and design of bank protection	bank protection
84 (R84)Structure and design of bank protection	bank protection
85 (R85)Structure and design of bank protection	bank protection
86 (R86)Structure and design of bank protection	bank protection
241 (R241)bank protection(concrete crib work)	bank protection
242 (R242)bank protection(concrete block)	bank protection
243 (R243)groin (concrete block groin)	bank protection
244 (R244) bank protection (concrete block pitching)	bank protection
261 (R261)bank protection(ground sill consolidation)	bank protection
266 (R266)stone masonry	bank protection
274 (R274)Concrete pitching bank protection(Joint spacing)	bank protection
282 (R282)stone masonry	bank protection
367 (R367)plantable bank protection	bank protection
381 (R381)slope crib work	bank protection
406 (R406)sodding	bank protection
420 (R420)Bank protection(mattress)	Bank protection
421 (R421)Bank protection(patch up method)	Bank protection
423 (R423)Bank protection(back slope protection)	Bank protection
458 (R458)bank protection(sure-footing)	bank protection
459 (R459)bank protection(slope covering(lining) works)	bank protection

460 (R460)bank protection(sodding works)	bank protection
461 (R461)bank protection(concrete pitching)	bank protection
462 (R462)bank protection(slope protection)	bank protection
523 (R523)cribwork	bank protection
535 (R535)levee burst prevention (hurdle work)	bank protection
542 (R542)hurdle work(bank protection work)	bank protection
561 (R561)mattress	bank protection
369 (R369)boat way	boat way
602 (R602)lining cannal	cannal
290 (R290)carrying operation	carrying operation
14 (R14)Phenomena associated with water flow(cavitation)	cavitation
344 (R344)cavitation	cavitation
401 (R401)cellular sheet pile	cellular sheet pile
576 (R576)transition	channel
375 (R375)vadose water(circulating water)	circulating water
361 (R361)cofferdam	cofferdam
362 (R362)cofferdam	cofferdam
363 (R363)cofferdam	cofferdam
364 (R364)cofferdam	cofferdam
365 (R365)closing dyke	cofferdam
392 (R392)conduct type water power	conduct type water power
305 (R305)consolidation works	consolidation works
306 (R306)consolidation works	consolidation works
87 (R87)Construction of Slope lining work(willow branch works)	Construction of Slope lining work
88 (R88)Construction of Slope lining work(Masonry/stone masonry)	Construction of Slope lining work
89 (R89)Construction of Slope lining work(Stone filling method frame work)	Construction of Slope lining work
90 (R90)Construction of Slope lining work(Concrete lining)	Construction of Slope lining work
91 (R91)Construction of Slope lining work(Concrete lining)	Construction of Slope lining work
92 (R92)Construction of Slope lining work(Concrete lining)	Construction of Slope lining work
93 (R93)Construction of Slope lining work	Construction of Slope lining work
94 (R94)Construction of Slope lining work	Construction of Slope lining work
95 (R95)Construction of Slope lining work	Construction of Slope lining work
360 (R360)control section	control section
52 (R52)Countermeasures for soft ground	Countermeasures for soft ground

53 (R53)Countermeasures for soft ground(Replacement method)	Countermeasures for soft ground
54 (R54)Countermeasures for soft ground>Loading embankment method)	Countermeasures for soft ground
55 (R55)Countermeasures for soft ground(Sand drain method)	Countermeasures for soft ground
56 (R56)Countermeasures for soft ground(Embankment work)	Countermeasures for soft ground
57 (R57)Countermeasures for soft ground(Preparation work)	Countermeasures for soft ground
58 (R58)Countermeasures for soft ground(Construction cross section and extra layer)	Countermeasures for soft ground
59 (R59)Countermeasures for soft ground(Embankment/compaction)	Countermeasures for soft ground
60 (R60)Countermeasures for soft ground(Freshly built: Embankment work)	Countermeasures for soft ground
69 (R69)Destruction of embankments and countermeasures(Measures for foundation ground)	countermeasures(Measures for foundation ground)
70 (R70)Destruction of embankments and countermeasures(Measures for foundation ground)	countermeasures(Measures for foundation ground)
71 (R71)Destruction of embankments and countermeasures(Measures for foundation ground)	countermeasures(Measures for foundation ground)
64 (R64)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
65 (R65)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
66 (R66)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
67 (R67)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
68 (R68)Destruction of embankments and countermeasures(Measures for the levee body)	countermeasures(Measures for the levee body)
61 (R61)Destruction of embankments and countermeasures(Overflow)	countermeasures(Overflow)
62 (R62)Destruction of embankments and countermeasures(Scouring)	countermeasures(Scouring)
339 (R339)culvert	culvert
610 (R610)alluvial deposit	culvert
466 (R466)dam(baffle pier)	dam
476 (R476)auxiliary dam	dam
488 (R488)floating dam	dam
498 (R498)spatter's effect(water splash effect)	dam
505 (R505)spillway	dam
510 (R510)sand flash gate	dam
525 (R525)apron	dam
526 (R526)rock fill dam	dam
559 (R559)subsurface dam	dam
595 (R595)spillway	dam
435 (R435)dam(deflector)	dam(deflector)
411 (R411)deposition	deposition
352 (R352)design flood discharge	design flood discharge
206 (R206)deversoir(overflow)	deversoir(overflow)

303 (R303)deversoir(overflow)	deversoir(overflow)
393 (R393)diversion of water channel	diversion of water channel
343 (R343)draft	draft
376 (R376)dredging(Pump dredger)	dredging
377 (R377)dredging(Bucket dredger)	dredging
378 (R378)dredging(Grab dredger)	dredging
379 (R379)dredging(Dipper dredger)	dredging
432 (R432)dipper dredger	dredging
497 (R497)suction dredger(pump dredger)	dredging
24 (R24)Selection of dredging vessel/Sediment dredging(Pump dredger)	dredging vessel
25 (R25)Selection of dredging vessel/Sediment dredging(Bucket dredger)	dredging vessel
26 (R26)Selection of dredging vessel/Sediment dredging(Grab dredger)	dredging vessel
27 (R27)Selection of dredging vessel/Sediment dredging(Dipper dredger)	dredging vessel
28 (R28)embankment(type of embankment)	embankment
29 (R29)embankment(Main embankment)	embankment
0 (R30)embankment(training levee)	embankment
31 (R31)embankment(open levee)	embankment
32 (R32)embankment(levee: close the gap between mountains)	embankment
33 (R33)embankment(separation levee)	embankment
34 (R34)embankment(circle levee)	embankment
35 (R35)embankment(cultivated land - protection)	embankment
36 (R36)embankment(closing dyke)	embankment
37 (R37)embankment(deversoir)	embankment
38 (R38)embankment(secondary levee)	embankment
39 (R39)embankment(Horizontal levee)	embankment
51 (R51)Embankment ground	embankment
171 (R171)embankment	embankment
172 (R172)embankment	embankment
173 (R173)embankment	embankment
174 (R174)embankment	embankment
229 (R229)Embankment(major bed)	Embankment
230 (R230)Embankment(high waterway)	Embankment
231 (R231)Embankment(bank protection)	Embankment
232 (R232)Embankment(bank protection)	Embankment

240 (R240)Embankment(berm)	Embankment
250 (R250)Embankment(seepage line infiltration line)	Embankment
251 (R251)Embankment(Construction cross section)	Embankment
252 (R252)Embankment(separation levee)	Embankment
254 (R254)embankment	Embankment
255 (R255)embankment(Embankment crown)	Embankment
256 (R256)embankment(margin height /extra embankment)	Embankment
259 (R259)embankment(training levee)	Embankment
260 (R260)embankment(training levee)	Embankment
262 (R262)temporary cofferdam(ground sill consolidation)	Embankment
276 (R276)Horizontal levee	embankment
277 (R277)margin height (extra embankment/extra-banking)	embankment
278 (R278)margin height (extra embankment)	embankment
279 (R279)embankment (circle levee)	embankment
285 (R285)embankment(berm)	embankment
312 (R312)embankment(raising)	embankment
313 (R313)embankment(raising)	embankment
316 (R316)open levee	embankment
326 (R326)embankment(over compaction)	embankment
336 (R336)embankment-drainage method(hooping)	embankment
340 (R340)embankment (wood sinking)	embankment
356 (R356)embankment(major bed)	embankment
400 (R400)stone levee	embankment
402 (R402)separation levee	embankment
404 (R404)summer dyke	embankment
416 (R416)embankment	embankment
419 (R419)finishing stake	embankment
425 (R425)embankment(riverside land)	embankment
433 (R433)section of levee	embankment
434 (R434)Embankment(levee normal)	embankment
437 (R437)embankment(crown/surface)	embankment
443 (R443)training dyke	embankment
444 (R444)training levee	embankment
445 (R445)special bank	embankment

446 (R446)jetty	embankment
455 (R455)embankment(slope)	embankment
457 (R457)embankment(slope gradient)	embankment
467 (R467)embankment(sodding)	embankment
469 (R469)embankment(secondary levee)	embankment
471 (R471)embankment(setting back of levee)	embankment
477 (R477)secondary levee	embankment
500 (R500)shoulder sodding	embankment
503 (R503)banking	embankment
506 (R506)extra-banking	embankment
507 (R507)freeboard-margin height (extra embankment)	embankment
562 (R562)alignment of dike	embankment
563 (R563)levee (dike · embankment)	embankment
564 (R564)levee (dike · embankment)	embankment
603 (R603)loading bank	embankment
604 (R604)displacement method	embankment
40 (R40)Embankment cross section	Embankment cross section
41 (R41)Embankment cross section	Embankment cross section
42 (R42)Embankment cross section	Embankment cross section
43 (R43)Embankment cross section	Embankment cross section
44 (R44)Embankment cross section	Embankment cross section
45 (R45)Embankment cross section	Embankment cross section
46 (R46)Embankment cross section	Embankment cross section
47 (R47)Embankment cross section	Embankment cross section
48 (R48)Embankment line(levee normal)	Embankment cross section
49 (R49)Embankment materials	Embankment materials
50 (R50)Embankment materials	Embankment materials
209 (R209)embankment(open levee)	embankment(open levee)
341 (R341)environment irrigation water	environment irrigation water
351 (R351)estimated high-water discharge,design high-water discharge	estimated high-water discharge
350 (R350)estimated high-water level,Designed high water level (H.W.L)	estimated high-water level
309 (R309)estuary improvement	estuary improvement
21 (R21)Excavation machine selection/Shovel type excavation machine(Backhoe)	Excavation machine
22 (R22)Excavation machine selection/Shovel type excavation machine(Drag line)	Excavation machine

23 (R23)Excavation machine selection/Shovel type excavation machine(Clamshell)	Excavation machine
19 (R19)Excavation machine selection	Excavation machine selection
409 (R409)fascine	fascine
590 (R590)fill-type dam	fill-type dam
591 (R591)fill-type dam	fill-type dam
592 (R592)fill-type dam	fill-type dam
593 (R593)fill-type dam	fill-type dam
345 (R345)fishladder	fishladder
354 (R354)flood control	flood control
357 (R357)flood control	flood control
355 (R355)flood protection works	flood protection works
426 (R426)flow(drop down curve(backwater))	flow
427 (R427)flow(steady flow)	flow
442 (R442)uniform flow	flow
472 (R472)flow (unsteady flow)	flow
481 (R481)unsteady flow	flow
483 (R483)non-uniform flow	flow
493 (R493)equilibrium slope	flow
508 (R508)turbulent flow -Laminar flow	flow
509 (R509)Diffusion effect of turbulent flow	flow
513 (R513)velocity of flow	flow
253 (R253)foot protection(mattress)	foot protection
264 (R264)foot protection	foot protection
265 (R265)foot protection(groin)	foot protection
267 (R267)foot protection(slope foot protection)	foot protection
275 (R275) foot protection(wood mattress)	foot protection
450 (R450)foot protection	foot protection
451 (R451)foot protection	foot protection
452 (R452)foot protection	foot protection
453 (R453)foot protection	foot protection
454 (R454)foot protection	foot protection
612 (R612)siphon culvert	Foot protection
613 (R613)Sluice gate(water gate)	Foot protection
614 (R614)Foot protection	Foot protection

615 (R615)Foot protection	Foot protection
616 (R616)Foot protection	Foot protection
617 (R617)Foot protection	Foot protection
618 (R618)Foot protection	Foot protection
619 (R619)Foot protection	Foot protection
620 (R620)Foot protection	Foot protection
370 (R370)free outflow	free outflow
310 (R310)Semi-permeable groin -wire cylinder masonry work(gabion)	gabion
311 (R311)Semi-permeable groin -wire cylinder masonry work(gabion)	gabion
390 (R390)gate	gate
544 (R544)jet flow gate	gate
545 (R545)automatic cross regulator	gate
546 (R546)automatic cross regulator	gate
554 (R554)slide gate	gate
588 (R588)hinge type gate	gate
589 (R589)miter gate	gate
600 (R600)fixed wheel gate(roller gate)	gate
611 (R611)cross-levee(Horizontal levee)	gate
634 (R634)Sluice gate, sluice pipe	gate
349 (R349)grab dredger	grab dredger
118 (R118)groin	groin
119 (R119)groin	groin
120 (R120)groin	groin
121 (R121)groin	groin
122 (R122)groin	groin
123 (R123)groin	groin
124 (R124)groin	groin
125 (R125)groin	groin
126 (R126)groin	groin
127 (R127)groin	groin
128 (R128)groin	groin
129 (R129)groin	groin
130 (R130)groin	groin
131 (R131)groin	groin

501 (R501)submerged orifice	hydraulics
502 (R502)submerged discharge	hydraulics
514 (R514)discharge	hydraulics
515 (R515)hydrometry	hydraulics
518 (R518)Reynoldsnumber	hydraulics
520 (R520)rate of filtration	hydraulics
521 (R521)filter film	hydraulics
522 (R522)filter material	hydraulics
524 (R524)rain drop erosion	hydraulics
527 (R527)water warming facilities	hydraulics
528 (R528)water warming facilities	hydraulics
540 (R540)flood control	hydraulics
555 (R555)laminar flow · laminar flow	hydraulics
565 (R565)isohyetal method	hydraulics
578 (R578)nappe	hydraulics
579 (R579)nappe	hydraulics
585 (R585)hydrograph	hydraulics
587 (R587)surface runoff	hydraulics
596 (R596)sediment(sediment load)	hydraulics
597 (R597)flow net	hydraulics
598 (R598)flow net	hydraulics
605 (R605)creep ratio	hydraulics
606 (R606)head creep ratio	hydraulics
607 (R607)wash load	hydraulics
2 (R2)hydrostatic pressure	hydrostatic pressure
431 (R431)infiltration(percolation) of levee	infiltration(percolation)
547 (R547)inlet works(water intake facility)	inlet works
371 (R371)water intake	intake
372 (R372)intake	intake
373 (R373)intake dam	intake
374 (R374)intake tower	intake
380 (R380)intercepting drain	intercepting drain
408 (R408)laminar flow	laminar flow
307 (R307)lapel method	lapel method

207 (R207)levee widening	levee widening
20 (R20)Excavation machine selection/Shovel type excavation machine>Loading shovel)	Loading shovel
291 (R291)lock	lock
337 (R337)masonry (dry masonry)	masonry
203 (R203)Masonry work	Masonry work
197 (R197)Multi-natural river creation	Multi-natural river creation
198 (R198)Multi-natural river creation	Multi-natural river creation
199 (R199)Multi-natural river creation	Multi-natural river creation
200 (R200)Multi-natural river creation	Multi-natural river creation
201 (R201)Multi-natural river creation	Multi-natural river creation
202 (R202)Multi-natural river creation	Multi-natural river creation
399 (R399)works for overflow(board work)	overflow
296 (R296)overflow pipe	overflow pipe
16 (R16)Phenomena associated with water flow(Penetration path length)	Penetration path length
384 (R384)penstock root	penstock root
15 (R15)Phenomena associated with water flow(piping)	piping
422 (R422)prevent water leakage(hooping)	prevent water leakage
397 (R397)productive green tract of land	productive green tract of land
273 (R273)pump dredger	pump dredger
353 (R353)quicksand	quicksand
342 (R342)reclamation in water area	reclamation in water area
541 (R541)revetment	revetment
417 (R417)rift valley	rift valley
181 (R181)River	River
182 (R182)River	River
183 (R183)River	River
184 (R184)River	River
185 (R185)River	River
186 (R186)River	River
187 (R187)River	River
188 (R188)River	River
189 (R189)River	River
190 (R190)River	River
191 (R191)River	River

192 (R192)River	River
210 (R210)river	river
249 (R249)receiving waterway	River
263 (R263)riverbed (penetration depth)	River
280 (R280)amenity	River
314 (R314)shape of river	River
315 (R315)center of stream in the river	River
317 (R317)specific discharge	River
318 (R318)run-off coefficient	River
319 (R319)thalweg	River
320 (R320)cross sectional area of stream	River
321 (R321)stream line	River
322 (R322)flow net	River
323 (R323)river works	River
324 (R324)equilibrated grade of river	River
325 (R325)equilibrated grade of river	River
327 (R327)river channel	River
328 (R328)river channel improvement	River
403 (R403)fan	river
407 (R407)traction	river
410 (R410)flowing through capability	river
412 (R412)meandering	river
428 (R428)low water channel work	river
429 (R429)low-water channel	river
430 (R430)low -water discharge	river
465 (R465)river(branch river)	river
475 (R475)composite drainage basin	river
489 (R489)watershed	river
494 (R494)parallel drainage	river
495 (R495)radial drainage	river
496 (R496)flood-way	river
504 (R504)retarding basin,flood storage basin	river
511 (R511)basin coefficient	river
516 (R516)water course	river

529 (R529)river mouth improvement	river
530 (R530)river mouth improvement	river
531 (R531)river mouth improvement	river
532 (R532)river mouth improvement	river
533 (R533)stream order	river
534 (R534)river	river
536 (R536)river channel	river
543 (R543)retarding basin	river
560 (R560)alluvium	river
577 (R577)inside water level	river
594 (R594)retarding basin(flood storage basin)	river
601 (R601)River (grade)	river
382 (R382)river (cut-off)	river
18 (R18)River channel excavation and dredging work	River channel excavation and dredging work
220 (R220)River earthworks	River earthworks
221 (R221)River earthworks	River earthworks
222 (R222)River earthworks	River earthworks
223 (R223)River earthworks	River earthworks
224 (R224)River earthworks	River earthworks
225 (R225)River earthworks	River earthworks
226 (R226)River earthworks	River earthworks
211 (R211)River embankment	River embankment
212 (R212)River embankment	River embankment
213 (R213)River embankment	River embankment
214 (R214)River embankment	River embankment
215 (R215)River embankment	River embankment
216 (R216)River embankment	River embankment
217 (R217)River embankment	River embankment
218 (R218)River embankment	River embankment
219 (R219)River embankment	River embankment
193 (R193)River structures	River structures
194 (R194)River structures	River structures
195 (R195)River structures	River structures
196 (R196)River structures	River structures

1 (R1)river survey	river survey
304 (R304)riverbed girdle	riverbed girdle
299 (R299)scour	scour
398 (R398)seepage line	seepage line
271 (R271)siphon culvert	siphon culvert
233 (R233)bank protection slope covering(lining) works	slope covering(lining) works
234 (R234)bank protection slope covering(lining) works	slope covering(lining) works
235 (R235)bank protection slope covering(lining) works	slope covering(lining) works
236 (R236)bank protection slope covering(lining) works	slope covering(lining) works
237 (R237)bank protection slope covering(lining) works	slope covering(lining) works
238 (R238)bank protection slope covering(lining) works	slope covering(lining) works
239 (R239)bank protection slope covering(lining) works	slope covering(lining) works
245 (R245)slope covering(lining) works (fence work)	slope covering(lining) works
246 (R246)slope covering(lining) works (wire cylinder masonry work(gabion))	slope covering(lining) works
268 (R268)slope crib work	slope crib work
269 (R269)slope crib work	slope crib work
580 (R580)slope crib work	slope crib work
581 (R581)slope crib work	slope crib work
582 (R582)slope crib work	slope crib work
583 (R583)slope crib work	slope crib work
584 (R584)slope crib work	slope crib work
424 (R424)slope foot protection(Filling pile work)	slope foot protection
283 (R283)rock crib work	slope protection
284 (R284)stone pitching work	slope protection
288 (R288)slope protection(backing mat method)	slope protection
627 (R627)Slope protection(Pitching concrete/ crib work)	Slope protection
628 (R628)Slope protection(concrete block)	Slope protection
629 (R629)Slope protection(Connected concrete block)	Slope protection
630 (R630)Slope protection(pile/gabion)	Slope protection
631 (R631)Slope protection(concrete block pitching)	Slope protection
632 (R632)Slope protection(concrete crib work)	Slope protection
96 (R96)Foundation work/slope work (sure-footing)	slope work (sure-footing)
97 (R97)Foundation work/slope work (sure-footing)	slope work (sure-footing)
98 (R98)Foundation work/slope work (sure-footing)	slope work (sure-footing)

99 (R99)Foundation work/slope work (sure-footing)	slope work (sure-footing)
100 (R100)Foundation work/slope work (sure-footing)	slope work (sure-footing)
101 (R101)Foundation work/slope work (sure-footing)	slope work (sure-footing)
102 (R102)Foundation work/slope work (sure-footing)	slope work (sure-footing)
103 (R103)Foundation work/slope work (foot protection)	slope work (sure-footing)
104 (R104)Foundation work/slope work (foot protection)	slope work (sure-footing)
105 (R105)Foundation work/slope work (foot protection)	slope work (sure-footing)
106 (R106)Foundation work/slope work (foot protection)	slope work (sure-footing)
107 (R107)Foundation work/slope work (foot protection)	slope work (sure-footing)
108 (R108)Foundation work/slope work (foot protection)	slope work (sure-footing)
109 (R109)Foundation work/slope work (foot protection)	slope work (sure-footing)
110 (R110)Foundation work/slope work (foot protection)	slope work (sure-footing)
111 (R111)Foundation work/slope work (foot protection)	slope work (sure-footing)
112 (R112)Foundation work/slope work (foot protection)	slope work (sure-footing)
113 (R113)Foundation work/slope work (foot protection)	slope work (sure-footing)
114 (R114)Foundation work/slope work (foot protection)	slope work (sure-footing)
115 (R115)Foundation work/slope work (foot protection)	slope work (sure-footing)
116 (R116)Foundation work/slope work (foot protection)	slope work (sure-footing)
117 (R117)Foundation work/slope work (foot protection)	slope work (sure-footing)
621 (R621)slope work (sure-footing)	slope work (sure-footing)
622 (R622)slope work (sure-footing)	slope work (sure-footing)
623 (R623)slope work (sure-footing)	slope work (sure-footing)
624 (R624)slope work (sure-footing)	slope work (sure-footing)
625 (R625)slope work (sure-footing)	slope work (sure-footing)
626 (R626)slope work (sure-footing)	slope work (sure-footing)
247 (R247)sluice (impermeable wall)	sluice
270 (R270)sluice	sluice
470 (R470)sluice	sluice
473 (R473)sluice	sluice
396 (R396)sluice gate	sluice gate
142 (R142)sluice-sluice pipe-sluice gate- weir	sluice-sluice pipe-sluice gate- weir
143 (R143)sluice-sluice pipe-sluice gate- weir	sluice-sluice pipe-sluice gate- weir
144 (R144)sluice-sluice pipe-sluice gate- weir	sluice-sluice pipe-sluice gate- weir
145 (R145)sluice-sluice pipe-sluice gate- weir	sluice-sluice pipe-sluice gate- weir

146 (R146)sluice-sluice pipe-sluice gate- weir
147 (R147)sluice-sluice pipe-sluice gate- weir
148 (R148)sluice-sluice pipe-sluice gate- weir
149 (R149)sluice-sluice pipe-sluice gate- weir
150 (R150)sluice-sluice pipe-sluice gate- weir
151 (R151)sluice-sluice pipe-sluice gate- weir
152 (R152)sluice-sluice pipe-sluice gate- weir
153 (R153)sluice-sluice pipe-sluice gate- weir
574 (R574)soil stabilization
575 (R575)soil stabilization
456 (R456)stability of the slope(slope pile)
385 (R385)stage(water level)
308 (R308)stop log
175 (R175)Structures protect riverbanks and embankments
176 (R176)Structures protect riverbanks and embankments
177 (R177)Structures protect riverbanks and embankments
178 (R178)Structures protect riverbanks and embankments
179 (R179)Structures protect riverbanks and embankments
180 (R180)Structures protect riverbanks and embankments
368 (R368)supercritical flow(shooting flow /rapid flow)
499 (R499)leveling
512 (R512)automatic water gauge
517 (R517)method of average end areas
519 (R519)sounding lead
163 (R163)temporary cofferdam
164 (R164)temporary cofferdam
165 (R165)temporary cofferdam
166 (R166)temporary cofferdam
167 (R167)temporary cofferdam
168 (R168)temporary cofferdam
169 (R169)temporary cofferdam
170 (R170)temporary cofferdam
204 (R204)Temporary cofferdam
537 (R537)temporary cofferdam

sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
sluice-sluice pipe-sluice gate- weir
soil stabilization
soil stabilization
stability of the slope
stage(water level)
stop log
Structures protect riverbanks and embankments
Structures protect riverbanks and embankments
Structures protect riverbanks and embankments
Structures protect riverbanks and embankments
Structures protect riverbanks and embankments
Structures protect riverbanks and embankments
Structures protect riverbanks and embankments
supercritical flow
survey
survey
survey
survey
temporary cofferdam
temporary cofferdam
temporary cofferdam
temporary cofferdam
temporary cofferdam
temporary cofferdam
temporary cofferdam
temporary cofferdam
temporary cofferdam
Temporary cofferdam
temporary cofferdam

538 (R538)temporary cofferdam	temporary cofferdam
539 (R539)temporary cofferdam	temporary cofferdam
358 (R358)time of concentration of flood	time of concentration of flood
447 (R447)slope tamping	tool
608 (R608)underground dam	topographic
5 (R5)Type of water flow:steady flow(normal flow)	Type of water flow
6 (R6)Type of water flow:unsteady flow	Type of water flow
7 (R7)Type of water flow: laminar flow	Type of water flow
8 (R8)Type of water flow: Turbulence	Type of water flow
9 (R9)Type of water flow: uniform flow	Type of water flow
10 (R10)Type of water flow: non-uniform flow	Type of water flow
11 (R11)Type of water flow: ordinary flow/shooting flow	Type of water flow
12 (R12)Type of water flow: hydraulic jump and backwater	Type of water flow
405 (R405)undercurrent	undercurrent
13 (R13)Phenomena associated with water flow(Water hammer (water hammer effect))	Water hammer
387 (R387)water hammer	water hammer
414 (R414)prevent water leakage	water leakage
394 (R394)Preventing water leakage from embankments	water leakage
388 (R388)water pollution	water pollution
3 (R3)total water pressure	water pressure
4 (R4)total water pressure:Point of action	water pressure
386 (R386)water-level recorder	water-level recorder
154 (R154)weir	weir
155 (R155)weir	weir
156 (R156)weir	weir
157 (R157)weir	weir
158 (R158)weir	weir
159 (R159)weir	weir
160 (R160)weir	weir
161 (R161)weir	weir
162 (R162)weir	weir
300 (R300)overflow weir	weir
301 (R301)triangular weir	weir
302 (R302)weir	weir

329 (R329)movable weir(stop log)	weir
330 (R330)movable weir(Sluice gate)	weir
331 (R331)movable weir(Stoney Weir)	weir
332 (R332)movable weir(Rolling gate)	weir
333 (R333)movable weir(Tentergate)	weir
334 (R334)movable weir(Drum gate)	weir
335 (R335)movable weir(Overturning weir)	weir
346 (R346)weir(notch)	weir
359 (R359)broad-crested weir	weir
395 (R395)stoney gate weir	weir
436 (R436)weir(tainter gate)	weir
438 (R438)weir(head works)	weir
463 (R463)weir(dentated sill)	weir
464 (R464)weir(sharp crested weir)	weir
586 (R586)fixed weir	weir
599 (R599)head-fall-drop	weir
633 (R633)Baffle pier	weir
248 (R248)wetted perimeter	wetted perimeter
292 (R292)works for overflow	works for overflow
293 (R293)works for overflow	works for overflow
294 (R294)works for overflow(wire cylinder masonry work(gabion))	works for overflow
295 (R295)works for overflow(board work)	works for overflow

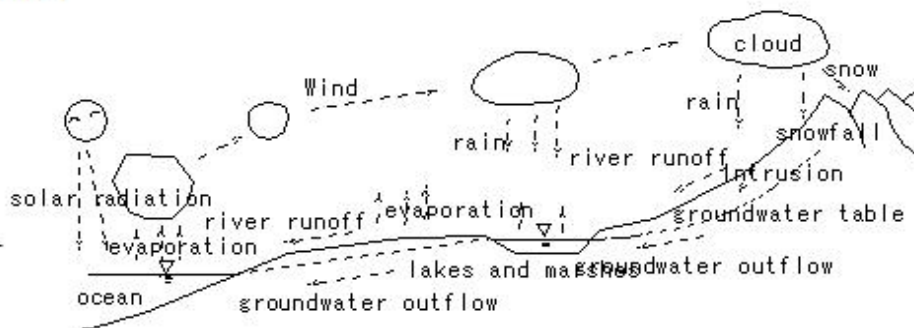
(R1)river survey

(R1)river survey

river survey

- ① Basin area
 - River formation status
 - River usage status
- ② Topography
 - How it flows
 - Erosion status
 - Embankment - bank protection method

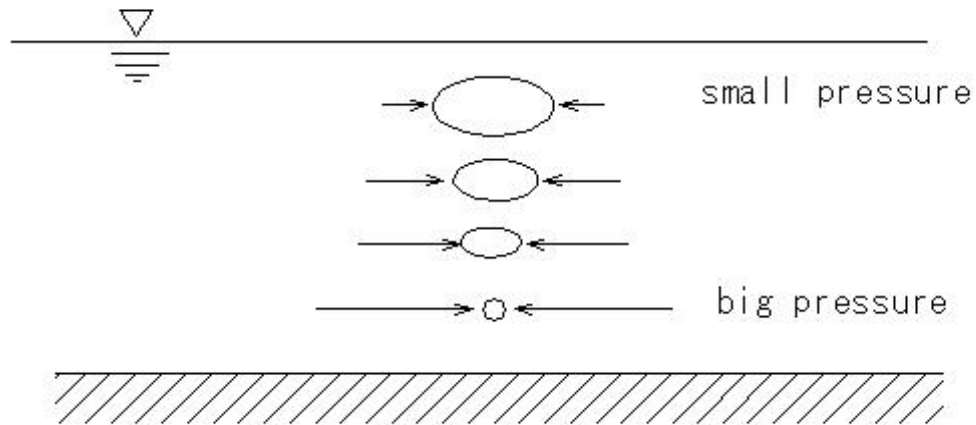
- ③ Rainfall
 - How it rains
 - Rainfall
 - Rain surface runoff
 - Groundwater/evaporated water
 - River - Planning cross section -
Determination



(R2)hydrostatic pressure

(R2)hydrostatic pressure

bubbles



hydrostatic pressure

Methane gas - bubbles - near the surface - large

Hydrostatic pressure proportional to depth

(R3)total water pressure

(R3) total water pressure

total water pressure

Rectangle, height 3m, width 2m

total water pressure

Point of action

Bottom horizontal water pressure depth 3m $3\text{t}/\text{m}^2$

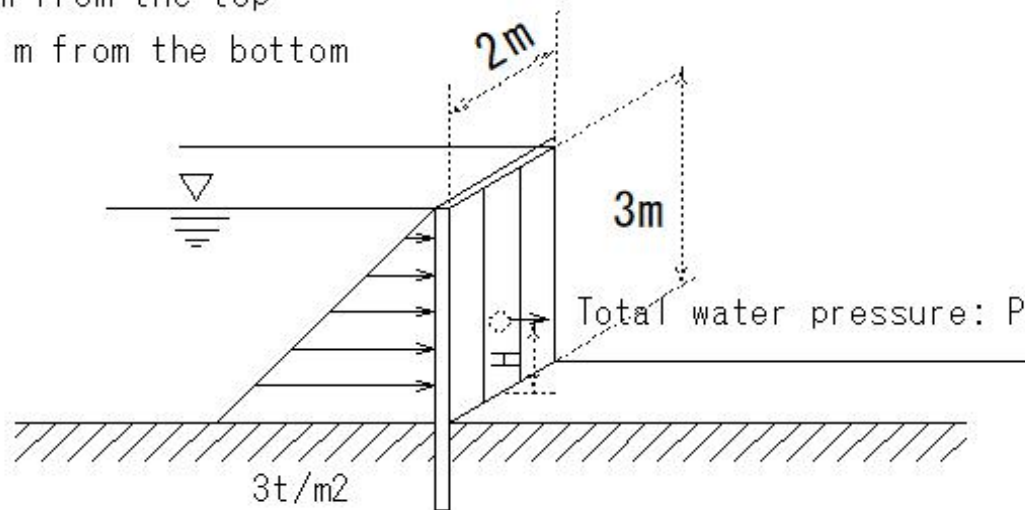
Total water pressure: $P =$ (triangular volume)

$$\frac{1}{2} \times 3\text{t}/\text{m}^2 \times 3\text{m} \times 2\text{m} = 9\text{t}$$

Point of action: Total water pressure acts on the centroid of the hydraulic diagram

2m from the top

1 m from the bottom



(R4)total water pressure:Point of action

(R4) total water pressure:Point of action

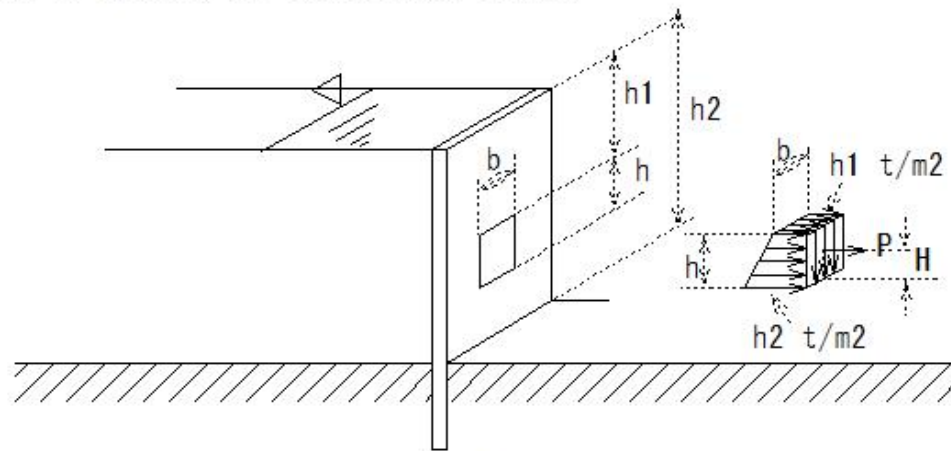
total water pressure

Point of action

Rectangular cross section: underwater

Water pressure: trapezoidal column

Point of action: Center of gravity of trapezoidal column

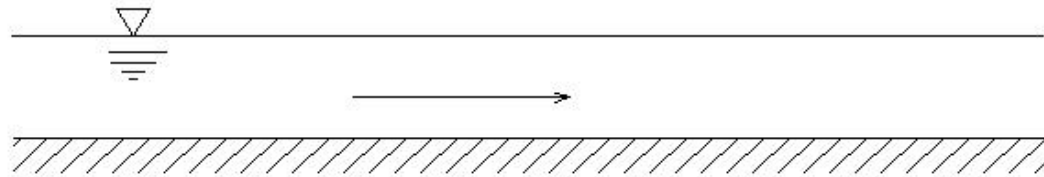


Total water pressure: $P = (\text{volume of trapezoidal column}) = h (h_1 + h_2) \times b \times b \cdot t/2$

Point of action $H = (\text{center of gravity of trapezoidal column}) = h(2h_1+h_2) \cdot m/3(h_1+h_2)$

(R5) Type of water flow: steady flow (normal flow)

(R5) Type of water flow: steady flow (normal flow)



① steady flow (normal flow)

constant water - flowing

(R6) Type of water flow: unsteady flow

(R6) Type of water flow: unsteady flow

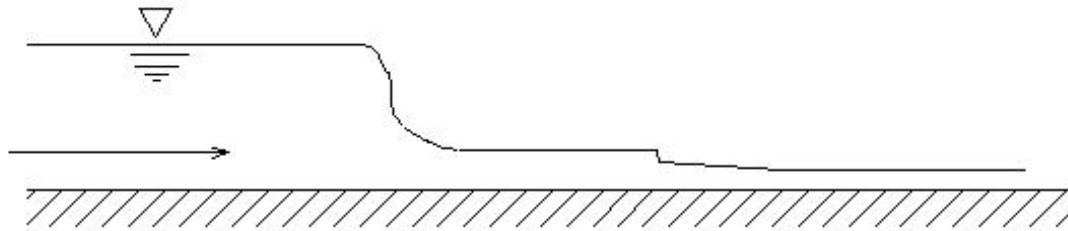
Type of water flow

② Unsteady flow

Dam collapse

the gate raised

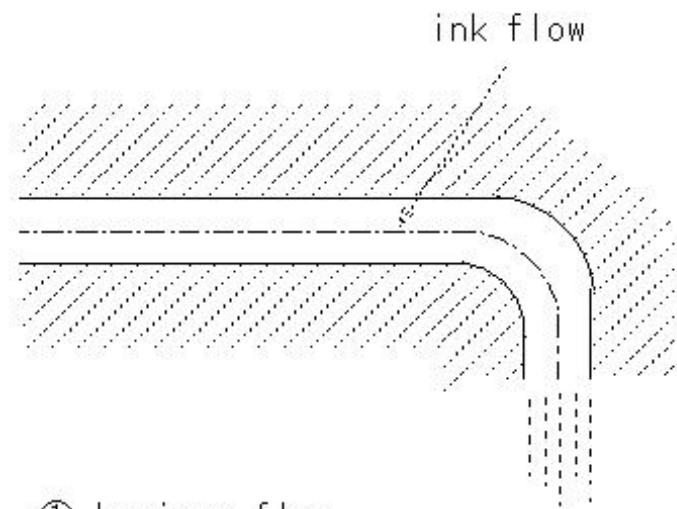
flow rate change



② Unsteady flow

(R7)Type of water flow:laminar flow

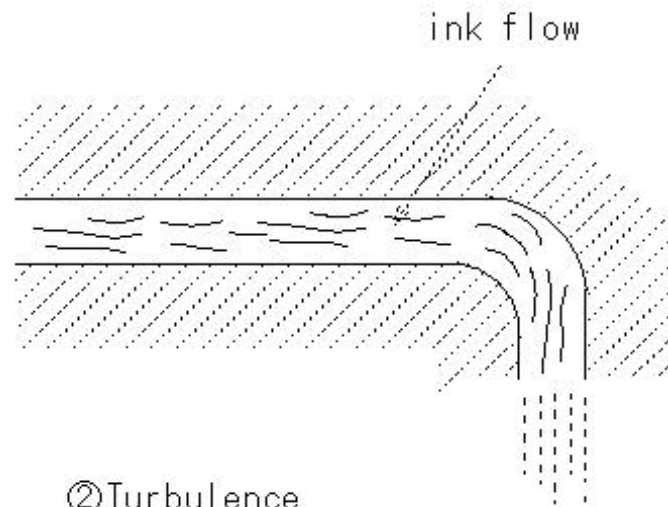
(R7)Type of water flow : laminar flow



① Laminar flow
generally does not occur

(R8)Type of water flow: Turbulence

(R8)Type of water flow : Turbulence



②Turbulence

General pipe line
water and sewage

River flow - turbulence

Caused by the viscosity of the pipe wall and water
Expressing with Reynolds number

(R9)Type of water flow:uniform flow

(R9)Type of water flow : uniform flow

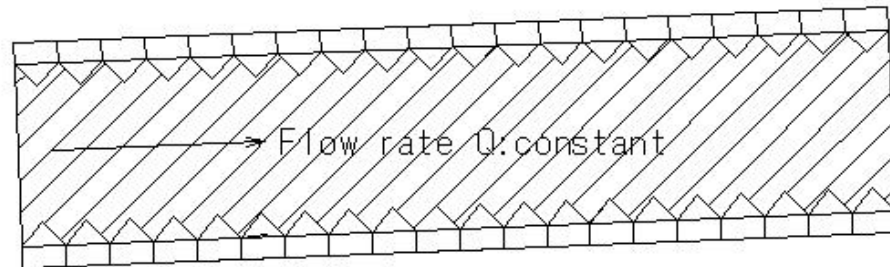
Type of water flow

① uniform flow

Constant amount of water - flowing

Flow velocity - equal
waterway

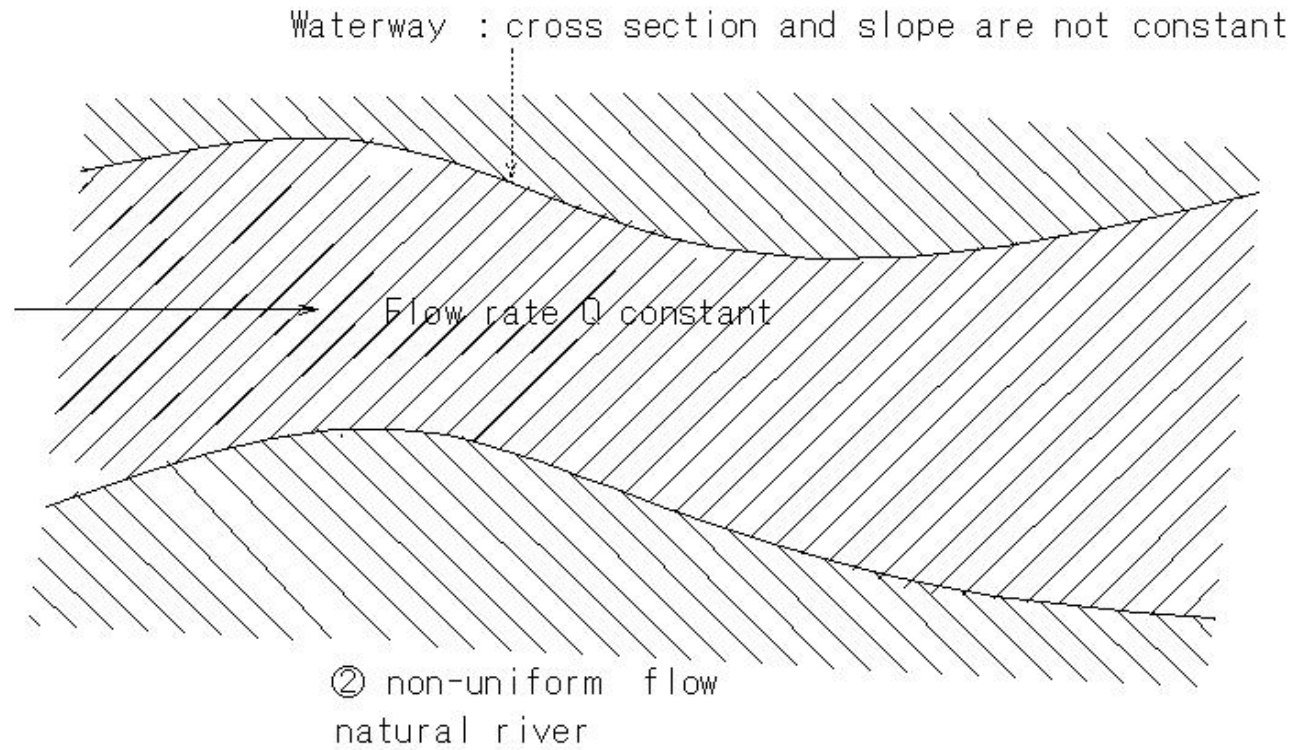
Constant cross section/slope - waterway



① uniform flow

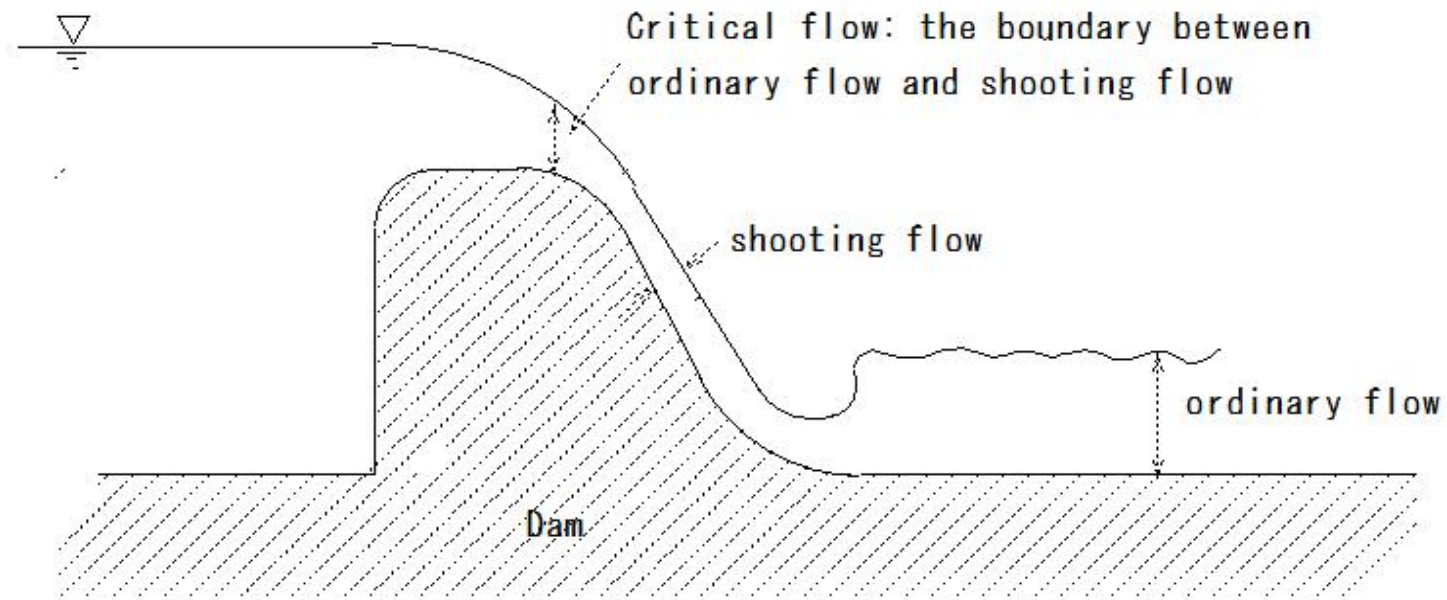
(R10) Type of water flow: non-uniform flow

(R10) Type of water flow : non-uniform flow



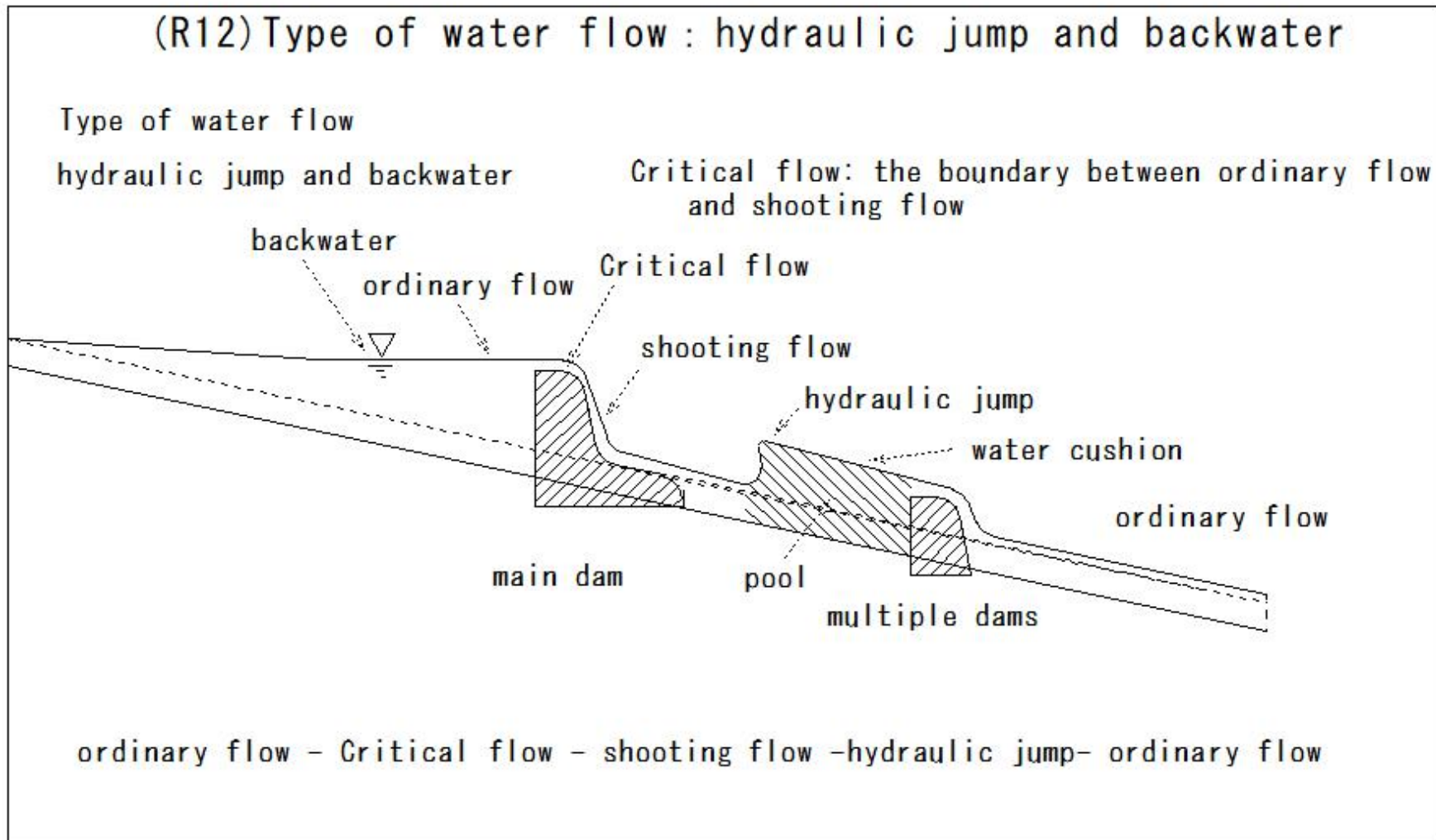
(R11)Type of water flow: ordinary flow/shooting flow

(R11)Type of water flow : ordinary flow/shooting flow



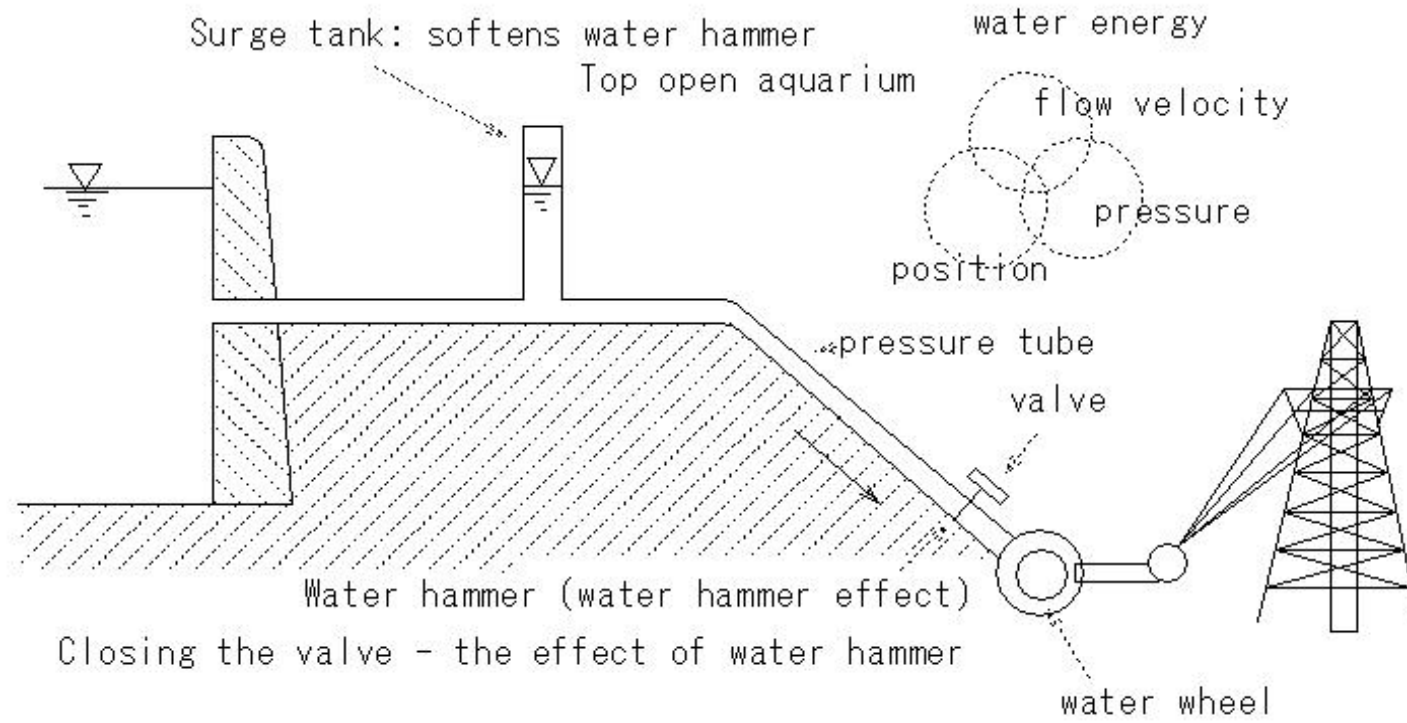
$$\text{Froude number} = \text{shooting flow speed} / \text{Critical flow}$$

(R12)Type of water flow:hydraulic jump and backwater



(R13)Phenomena associated with water flow(Water hammer (water hammer effect))

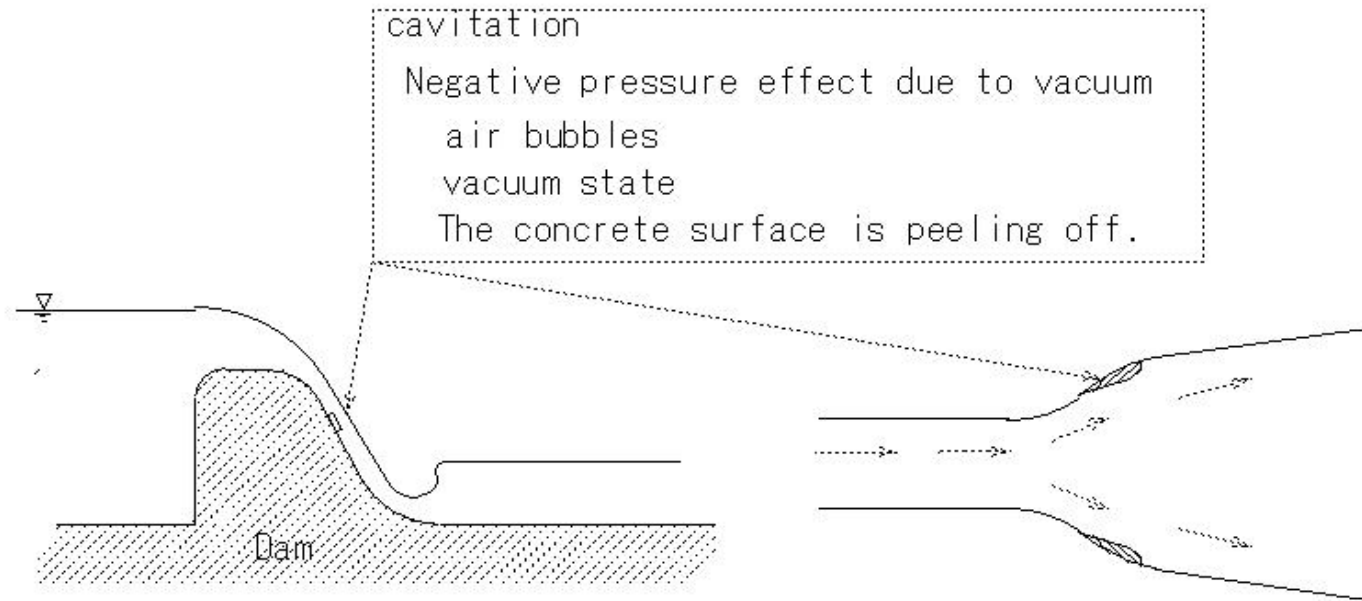
(R13)Phenomena associated with water flow(Water hammer (water hammer effect))



Phenomena associated with water flow

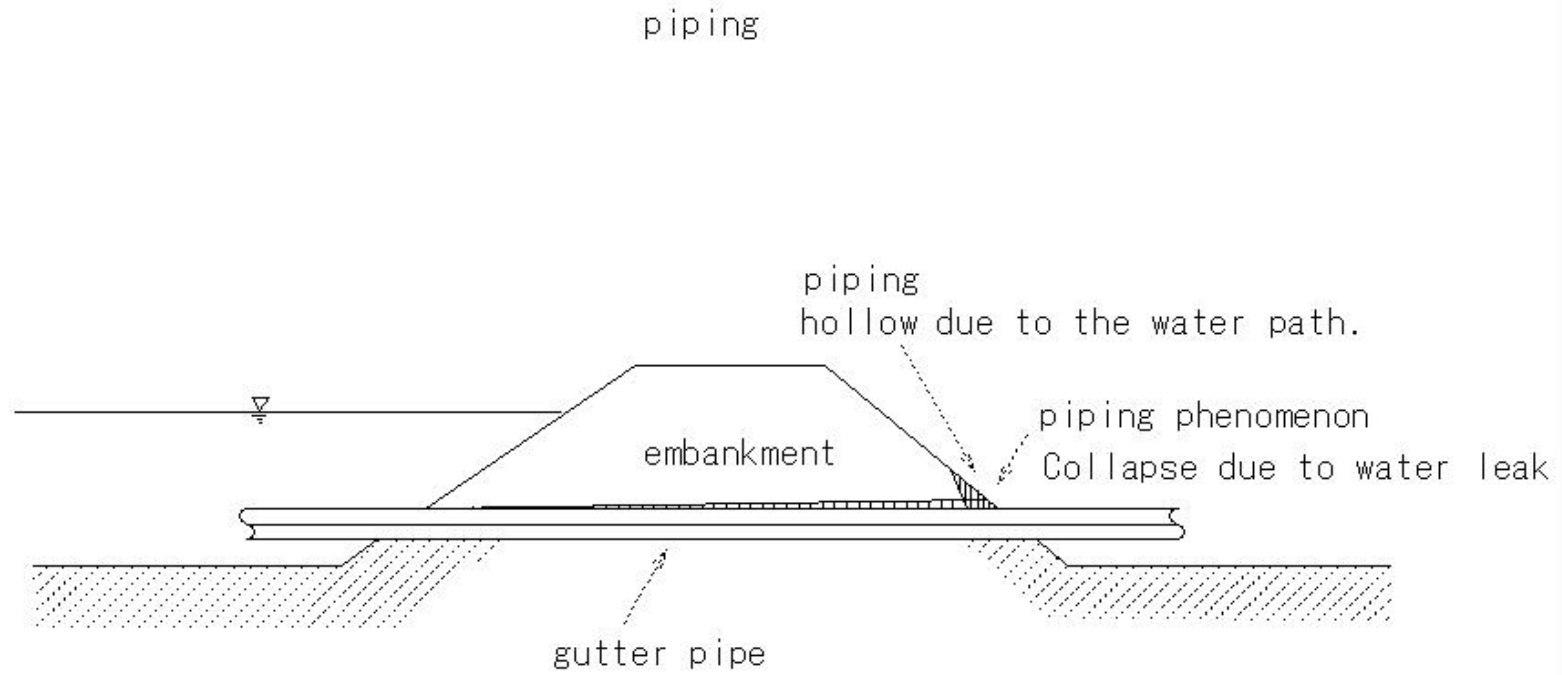
(R14)Phenomena associated with water flow(cavitation)

(R14)Phenomena associated with water flow(cavitation)



(R15)Phenomena associated with water flow(piping)

(R15)Phenomena associated with water flow(piping)



(R16)Phenomena associated with water flow(Penetration path length)

(R16)Phenomena associated with water flow(Penetration path length)

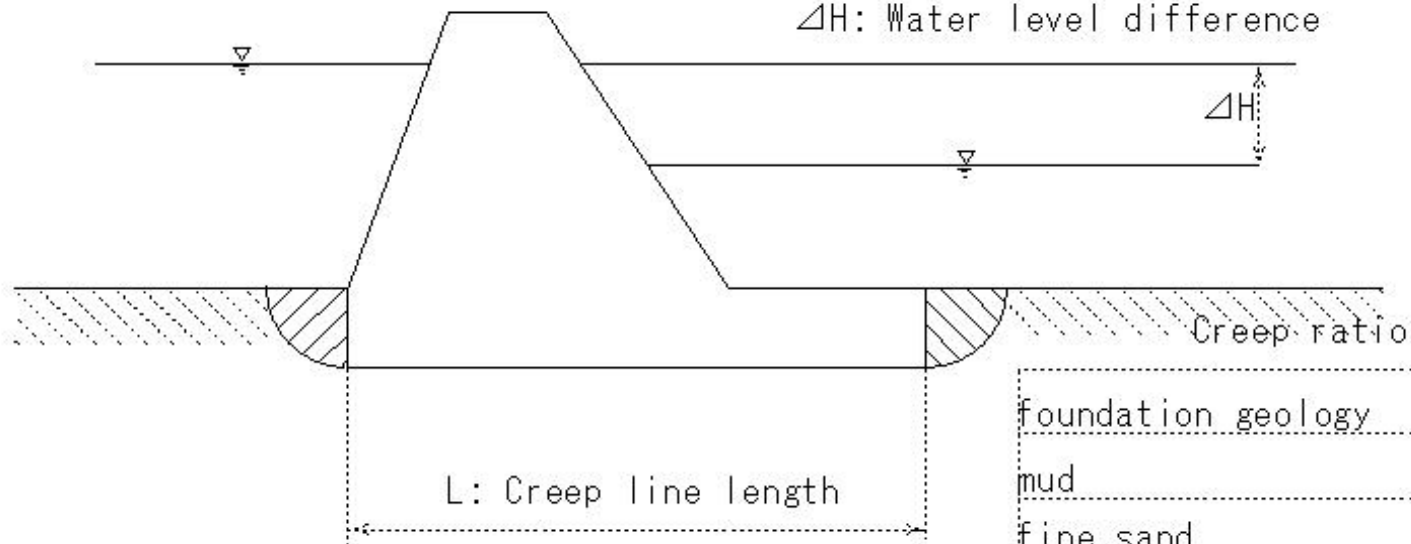
$$C = L / \Delta H$$

L: Creep line length

C: Coefficient: Creep ratio

L: Penetration path length

ΔH : Water level difference



L: Creep line length

The longer the safer

foundation geology	C
mud	18
fine sand	15
coarse sand	12
gravel mixed with sand	9-5

(R17)Phenomena associated with water flow(average flow velocity)

(R17)Phenomena associated with water flow(average flow velocity)

Phenomena associated with water flow
average flow velocity

①Chezy method

n: Roughness coefficient: Roughness of the surface of the waterway

v: average flow velocity

H: water depth

B: Channel width

I: Channel slope

S: wetted perimeter

A: Flowing water cross-sectional area

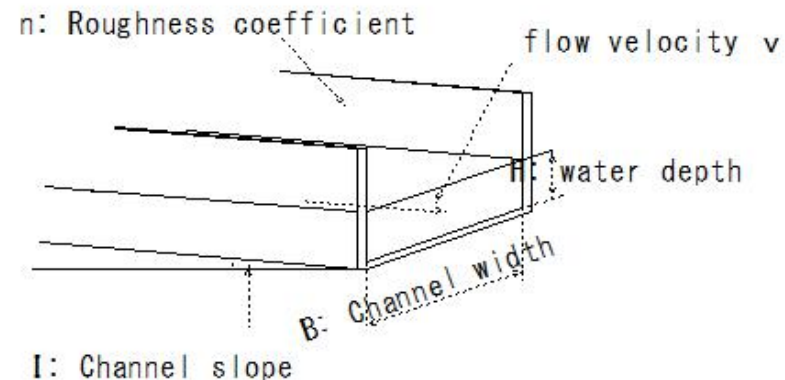
R: hydraulic radius

C: constant

$R=A/S$ =Flowing water cross-sectional area/wetted perimeter= $BH/(2H+B)$

$v=C\sqrt{RI}$

$C=(1/n+23+0.00155/I)/(1+(23+0.00155/I)n/\sqrt{R})$



②Manning's method

Average flow velocity in open channel

$v=1/nR^{2/3}I^{1/2}$

(R18)River channel excavation and dredging work

(R18)River channel excavation and dredging work

River channel excavation and dredging work

- ① Expansion of river channel cross-sectional area
- ② Adjustment of flow path
- ③ Excavation of spillway

- Excavated soil and dredged soil will be used for nearby embankments and reclamation.

(R19)Excavation machine selection

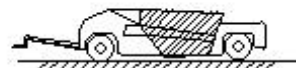
(R19)Excavation machine selection

Excavation machine selection

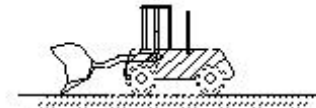
Excavation work: excavation machine + transport machine

- ① Short distance (less than 30m) - Bulldozer
- ② Medium distance (over 80-500m) - Scraper
- ③ Medium distance/long distance(500+) - Tractor excavator
- Excavator type excavator + dump truck

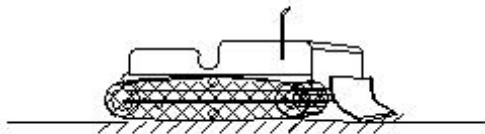
Tractor excavator: cutting height - low points



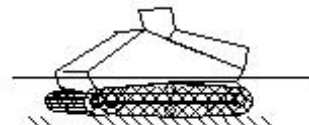
Towed scraper



tractor excavator



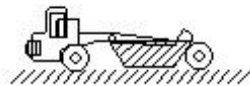
Bulldozer



scrape dozer



backhoe



motor scraper



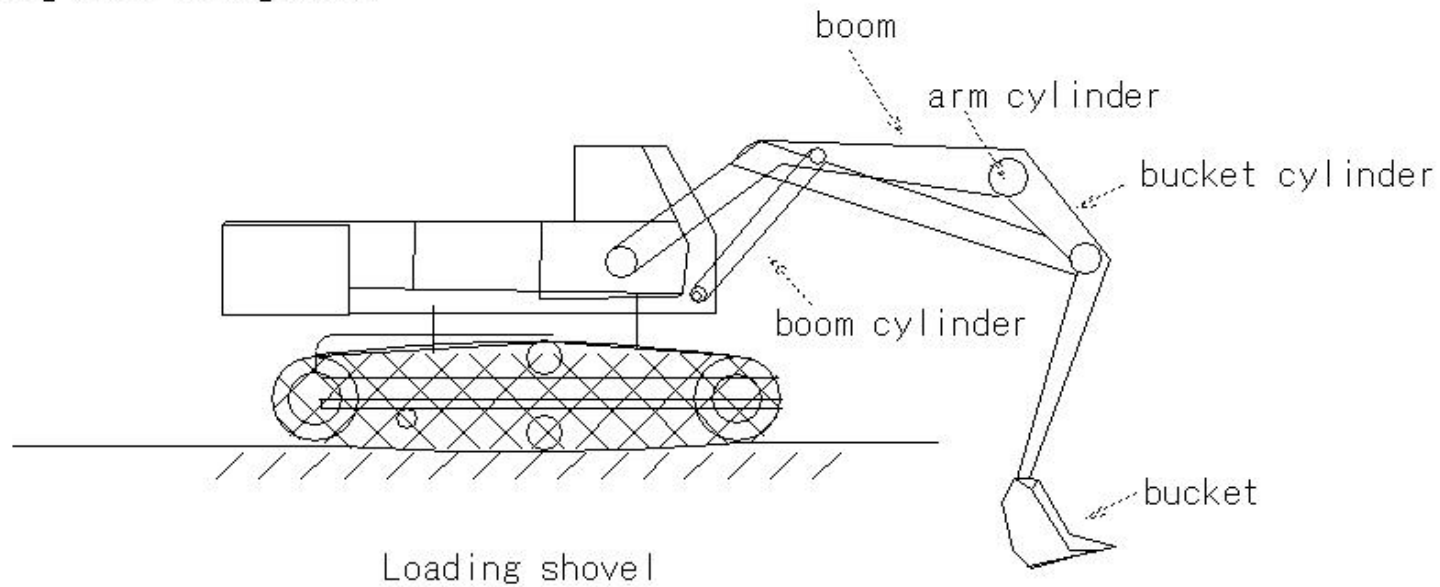
dump truck

(R20)Excavation machine selection/Shovel type excavation machine(Loading shovel)

(R20)Excavation machine selection/Shovel type excavation machine(Loading shovel)

Excavation machine selection
Shovel type excavation machine

- ①Loading shovel: Excavation above ground level
- Hard geology - excavable
- Cutting down the ground



(R21)Excavation machine selection/Shovel type excavation machine(Backhoe)

(R21)Excavation machine selection/Shovel type excavation machine(Backhoe)

Excavation machine selection

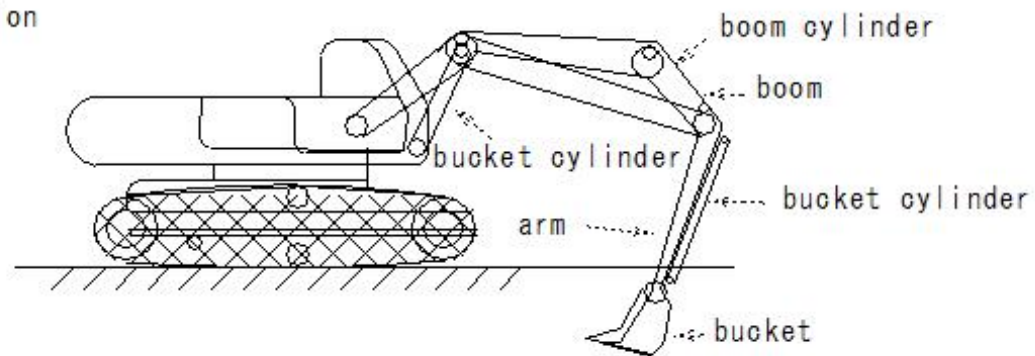
Shovel type excavation machine

②Backhoe

a place lower than the ground

underwater drilling

Trench/foundation excavation



(R22)Excavation machine selection/Shovel type excavation machine(Drag line)

(R22)Excavation machine selection/Shovel type excavation machine(Drag line)

Excavation machine selection

Shovel type excavation machine

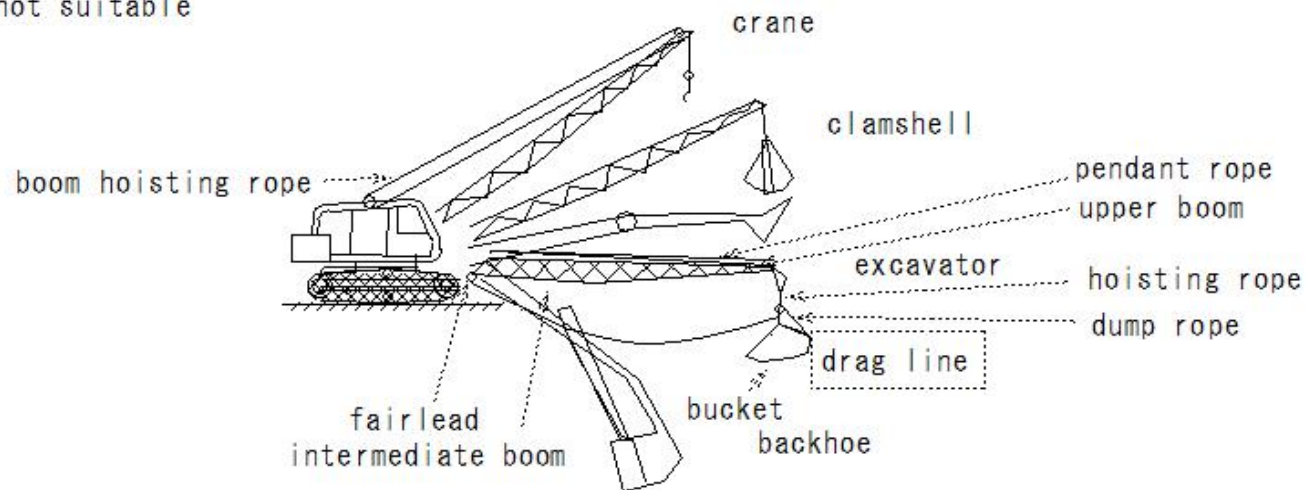
③Drag line

Excavation below ground level

Can be drilled underwater

Can drill far

Hard ground - not suitable



(R23)Excavation machine selection/Shovel type excavation machine(Clamshell)

(R23)Excavation machine selection/Shovel type excavation machine(Clamshell)

Excavation machine selection

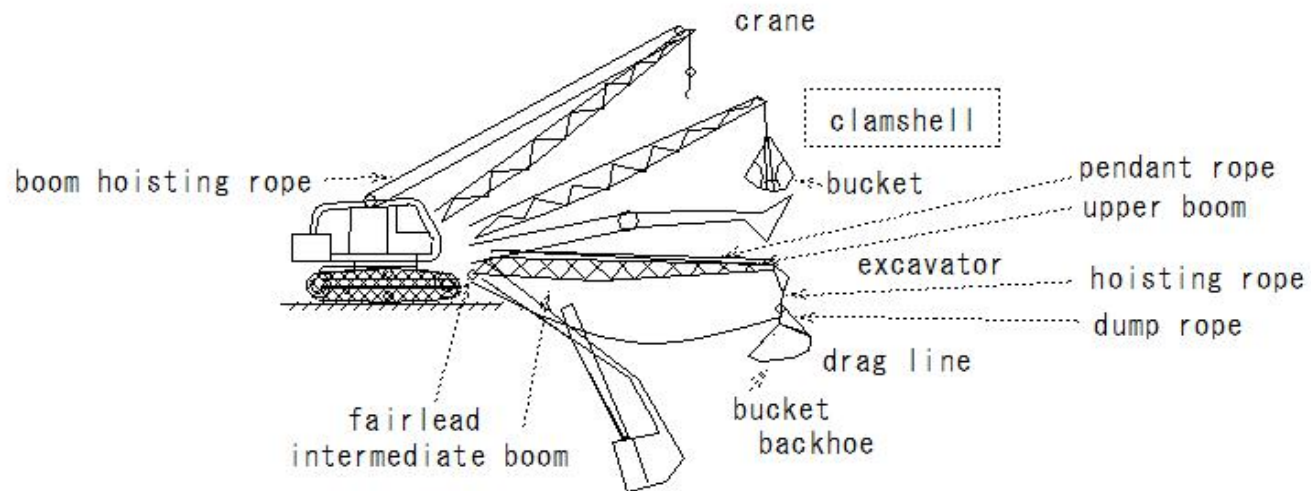
Shovel type excavation machine

④Clamshell

deep hole drilling

Underwater drilling possible

Hard ground - not suitable



(R24) Selection of dredging vessel/Sediment dredging(Pump dredger)

(R24) Selection of dredging vessel/Sediment dredging(Pump dredger)

Selection of dredging vessel

Sediment dredging

Dredging near bank protection and structures requires caution

① Pump dredger

Sediment: silt, clay, sand

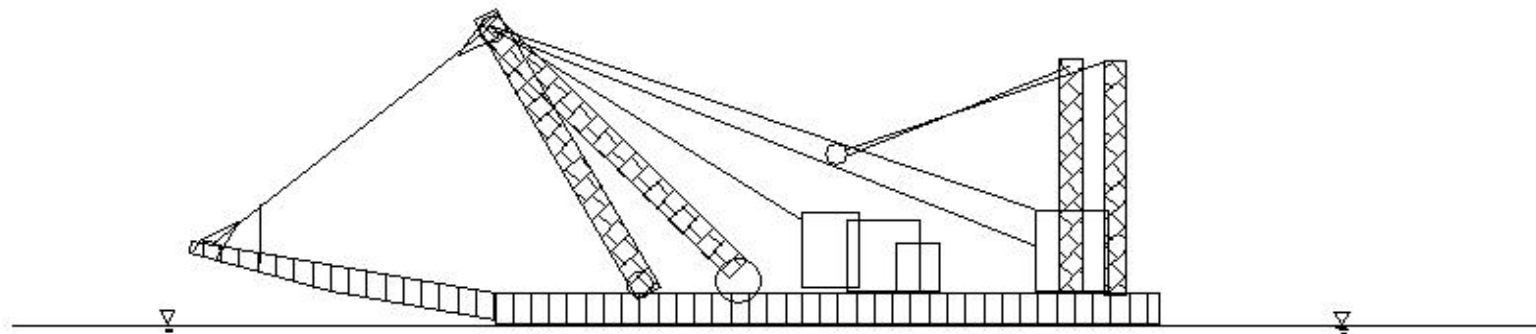
Large soil dump nearby

Good efficiency

Construction cost - cheap

Earth and sand transported by pipeline

Soil dumping site - large amount of surplus water treatment - caution required



• Pump dredger

(R25) Selection of dredging vessel/Sediment dredging(Bucket dredger)

(R25) Selection of dredging vessel/Sediment dredging(Bucket dredger)

Selection of dredging vessel

② Bucket dredger

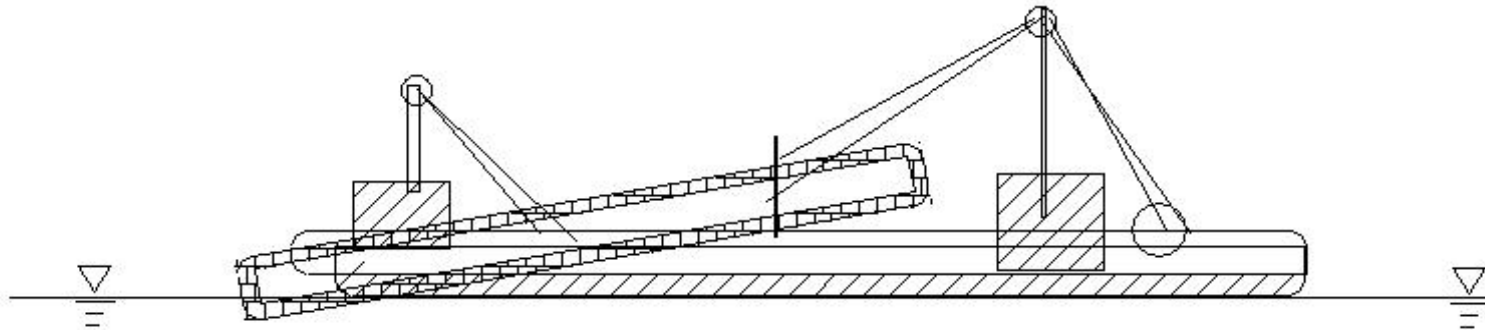
Dredging ability - large

Expenses - cheap

Hard and soft soil type - wide range of applications

Narrow areas/crowded areas - Not suitable

Dredging earth and sand - earth and sand transport ship



Bucket dredger

(R26) Selection of dredging vessel/Sediment dredging(Grab dredger)

(R26) Selection of dredging vessel/Sediment dredging(Grab dredger)

Selection of dredging vessel

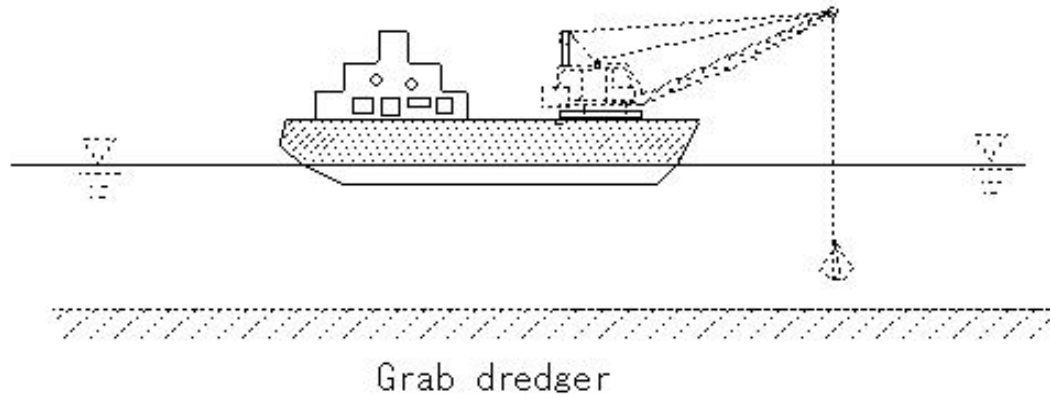
③ Grab dredger

Dredging in narrow spaces

Dredging depth - adjustable

Deep dredging - suitable

Suitable for dredging muddy clay and loose sand



(R27) Selection of dredging vessel/Sediment dredging(Dipper dredger)

(R27) Selection of dredging vessel/Sediment dredging(Dipper dredger)

Selection of dredging vessel

④ Dipper dredger

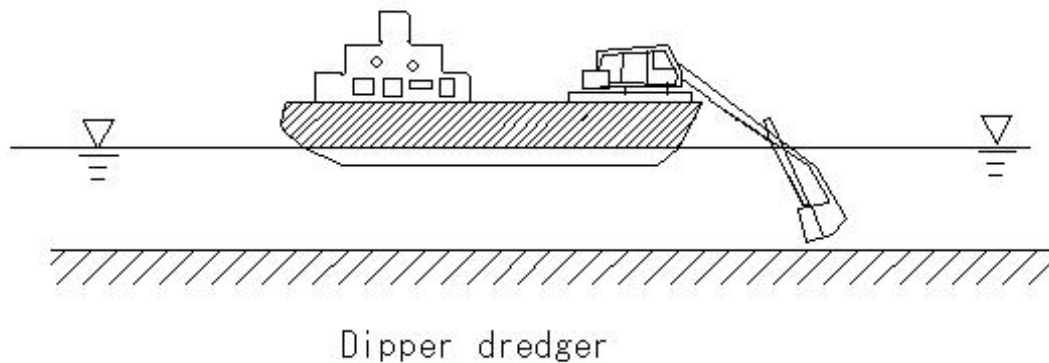
Place a land-based power shovel on top of a ship

Digging power - large
suitable for hard soil

soft rock dredging

Obstacle removal

Working water surface - narrow areas - dredging possible

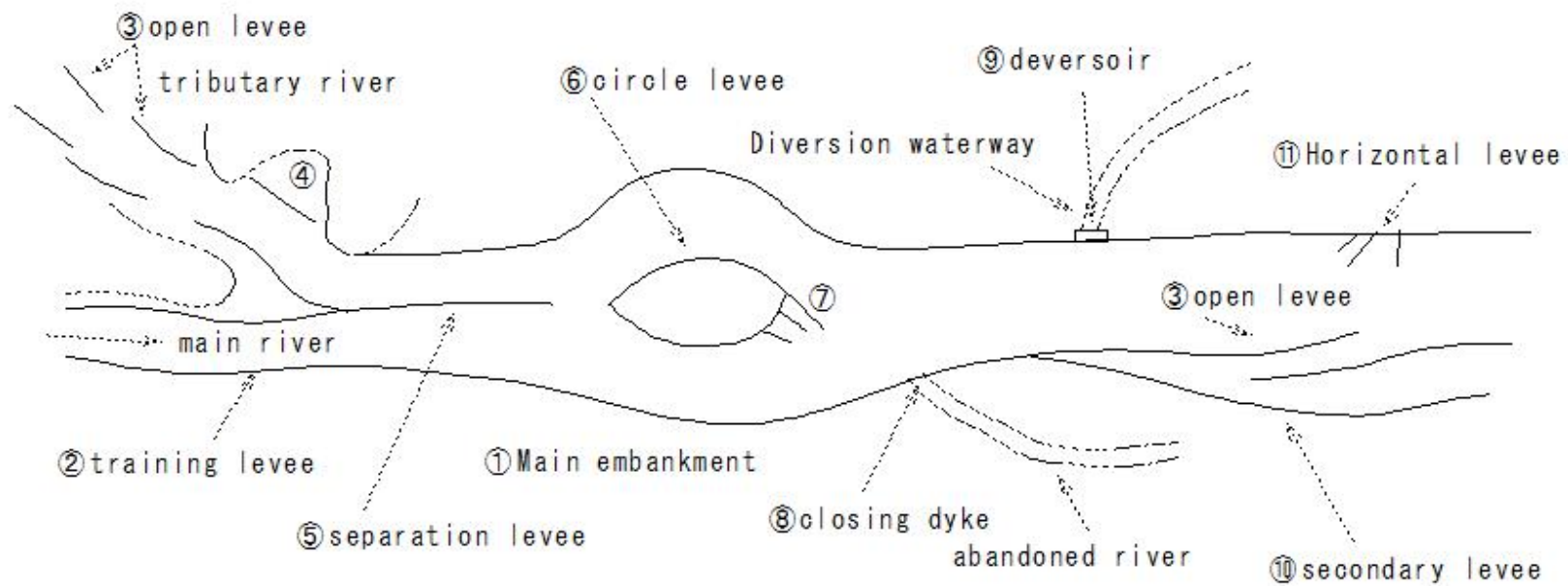


(R28)embankment(type of embankment)

(R28) embankment (type of embankment)

type of embankment

- ① Flood prevention
- ② Earth and sand - construction



(R29)embankment(Main embankment)

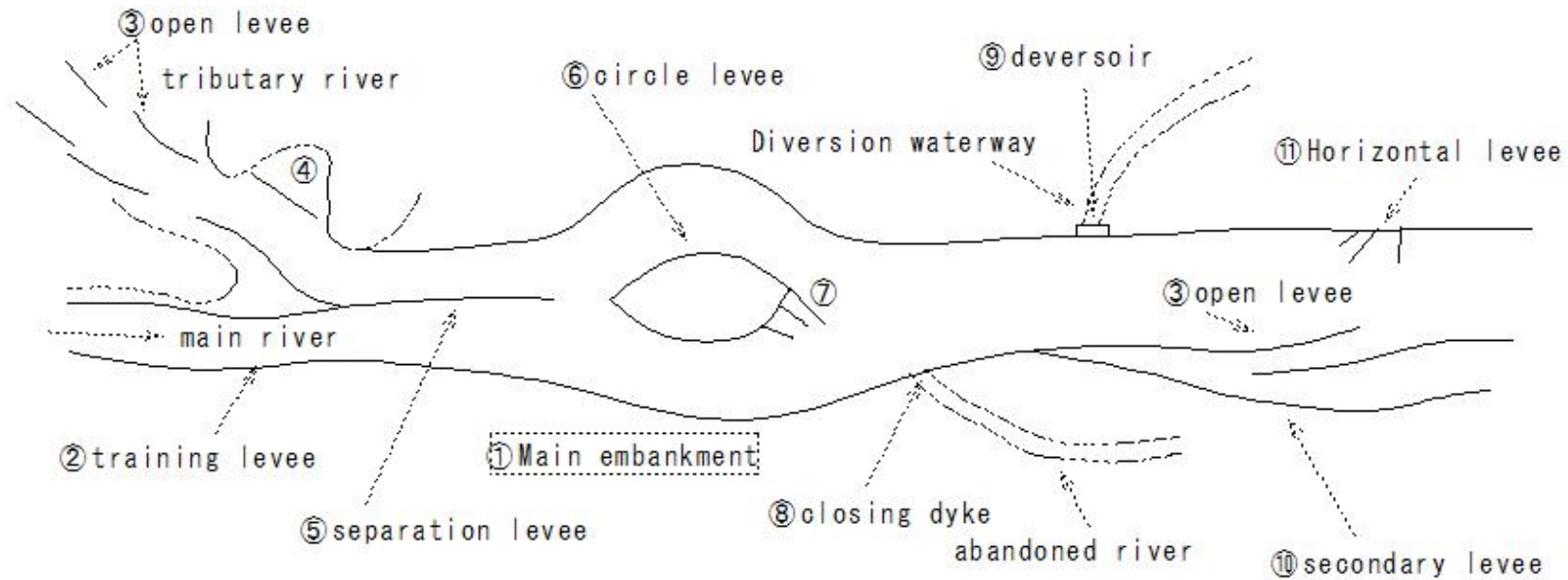
(R29)embankment(Main embankment)

embankment

type of embankment

① Main embankment

- Constructed at both ends of the river channel
- Flowing water - diversion



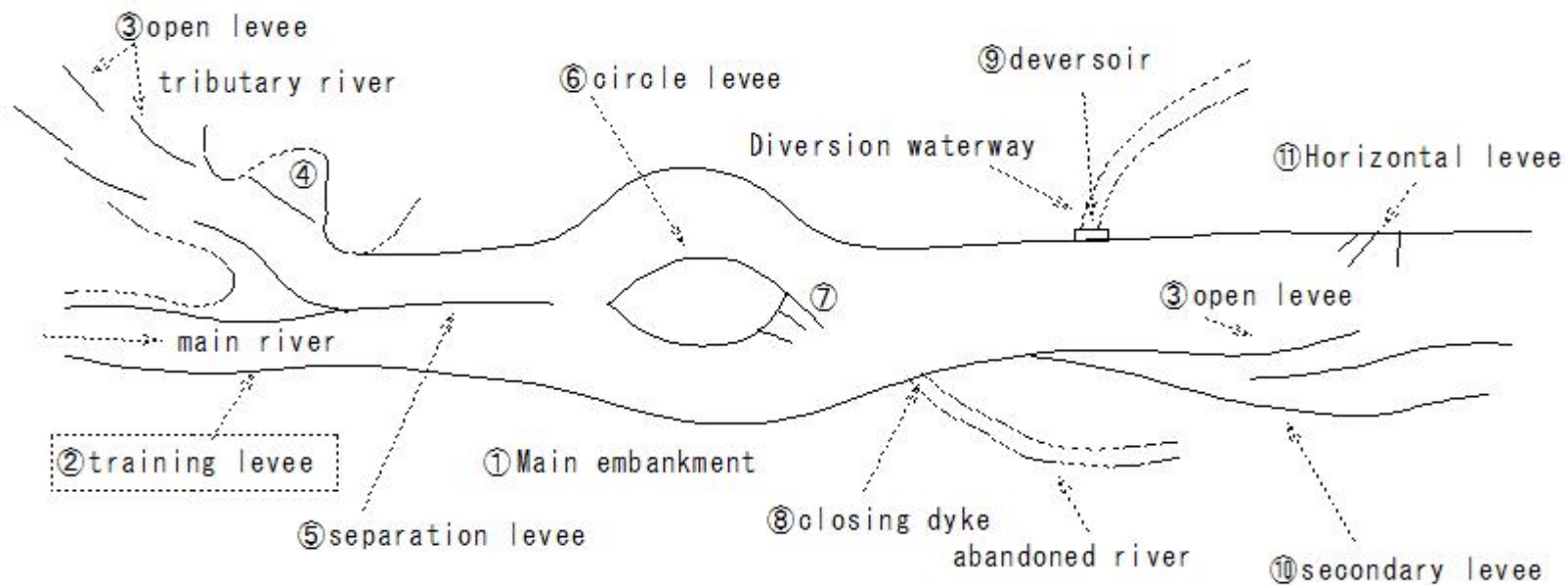
(R30)embankment(training levee)

(R30) embankment(training levee)

Type of embankment

②training levee

- Flow path direction - difficult to stabilize
- Flow - constant direction



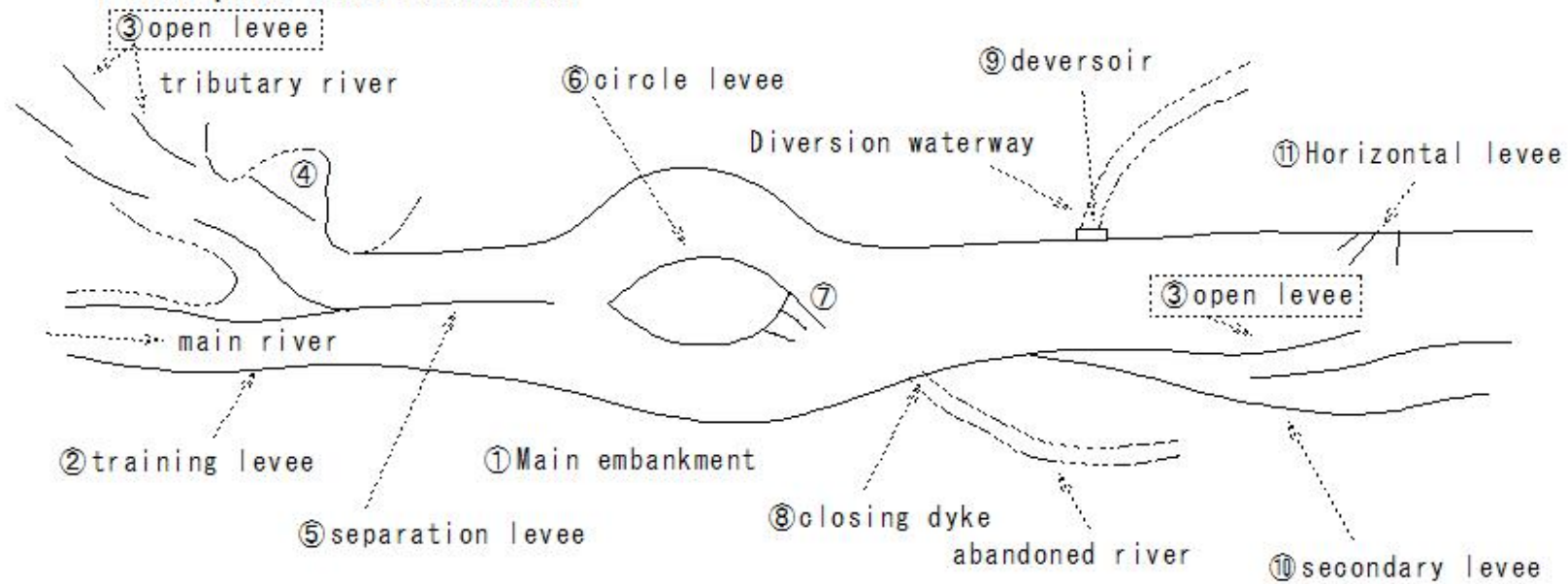
(R31)embankment(open levee)

(R31) embankment (open levee)

Type of embankment

③ open levee

- Rapid river
- Discontinuous embankment
- Part of the floodwaters flow into the land and remain
- Flood peak flow reduction



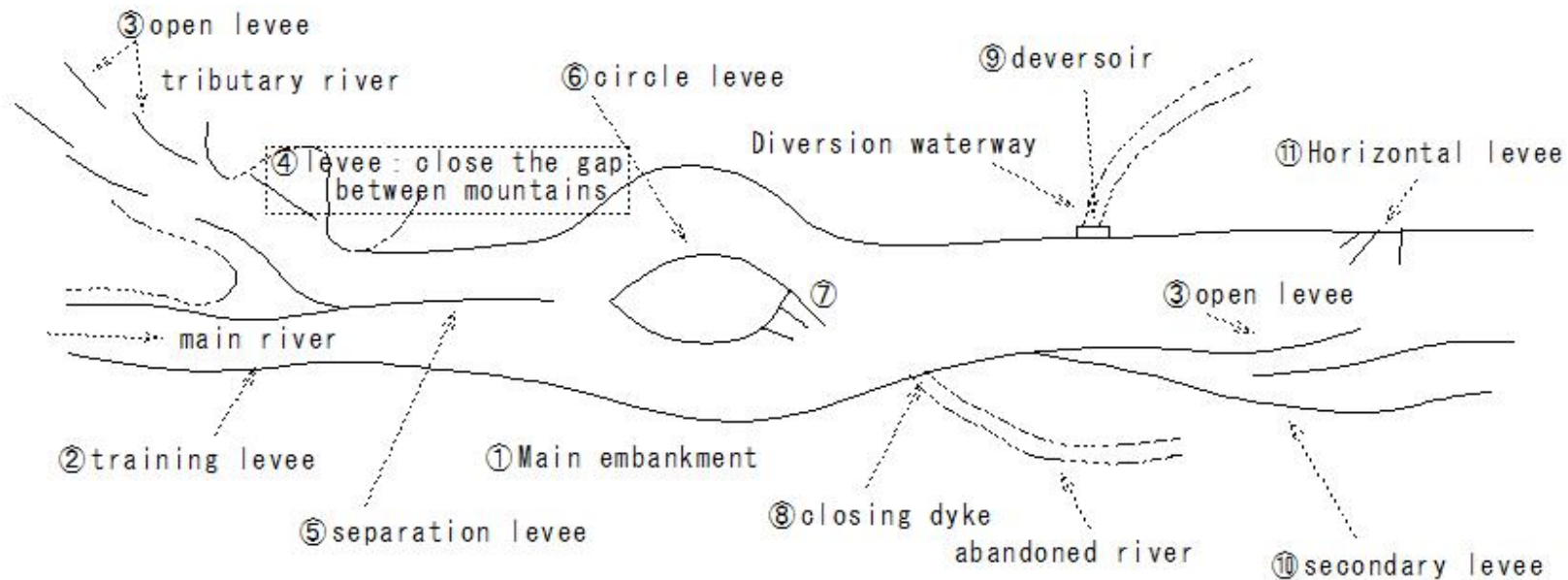
(R32)embankment(levee : close the gap between mountains)

(R32) embankment (levee : close the gap between mountains)

embankment

Type of embankment

④ levee : close the gap between mountains



(R33)embankment(separation levee)

(R33) embankment (separation levee)

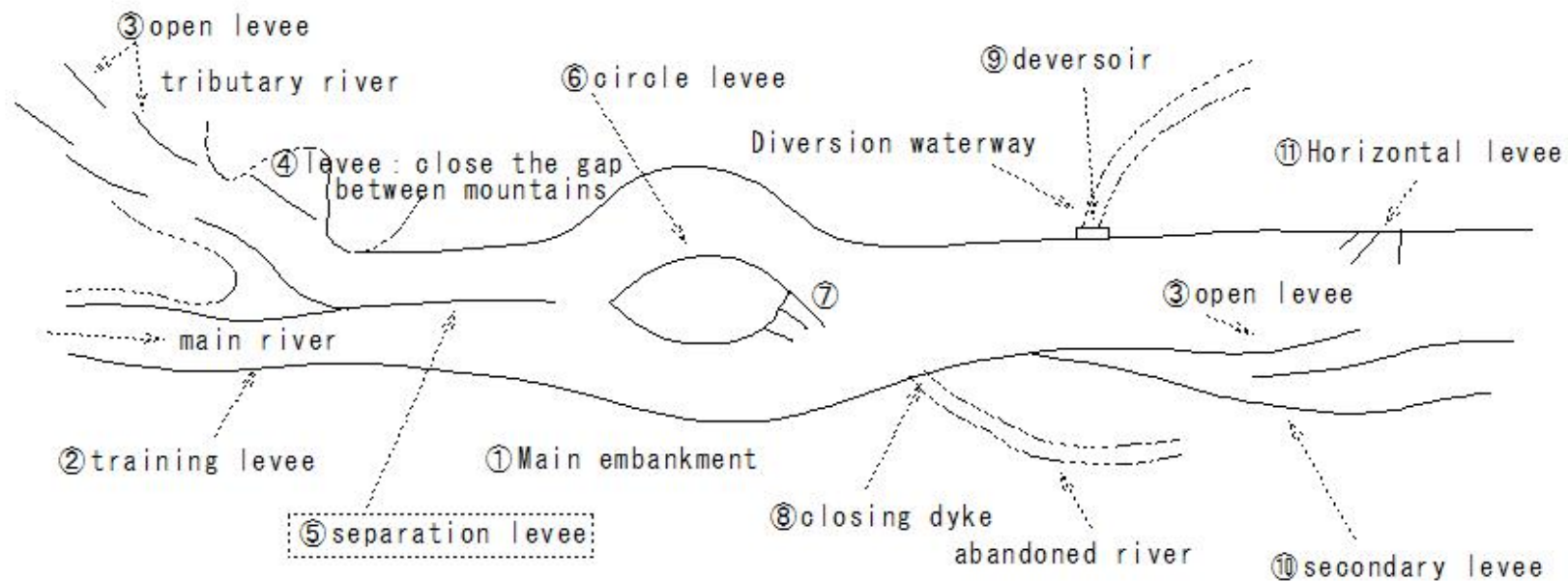
embankment

Type of embankment

⑤ separation levee

confluence of two rivers

- Flow turbulence – decrease
- Water level difference adjustment
- Flow direction – stable



(R34)embankment(circle levee)

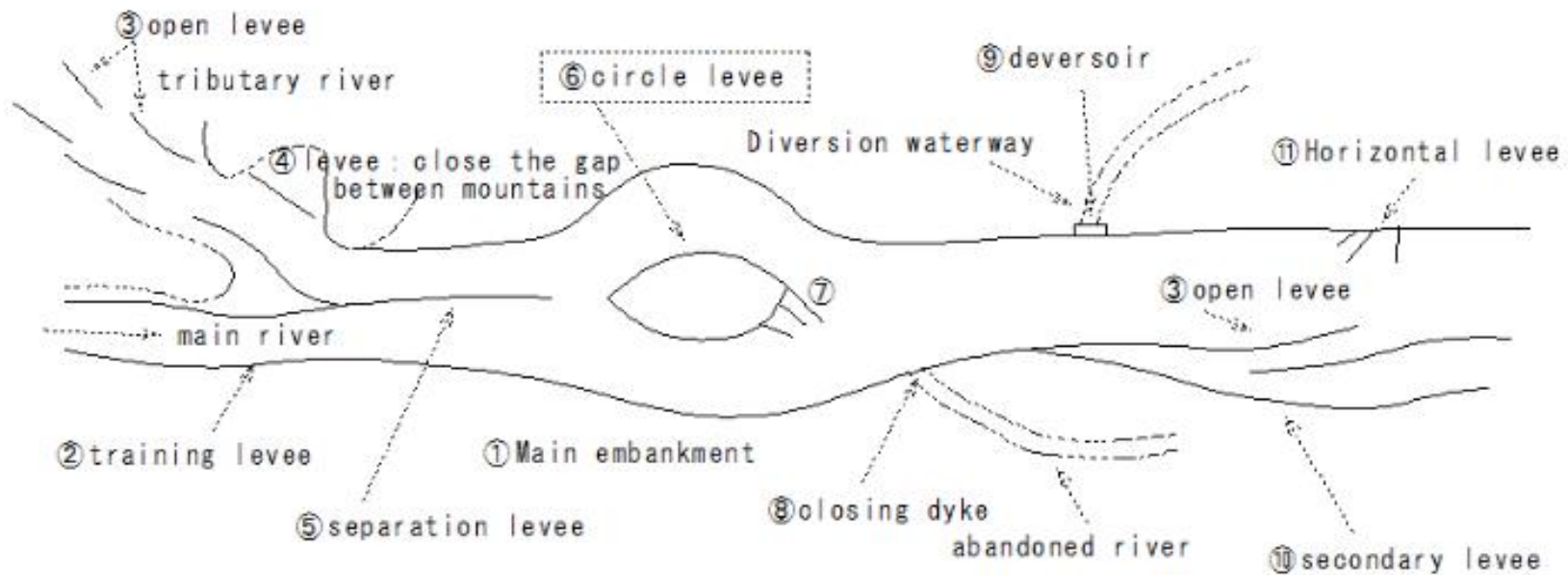
(R34) embankment(circle levee)

Embankment

Type of embankment

⑥ circle levee

- Protect certain areas from flooding
- Surroundings - Ring-shaped embankment



(R35)embankment(cultivated land - protection)

(R35) embankment(cultivated land - protection)

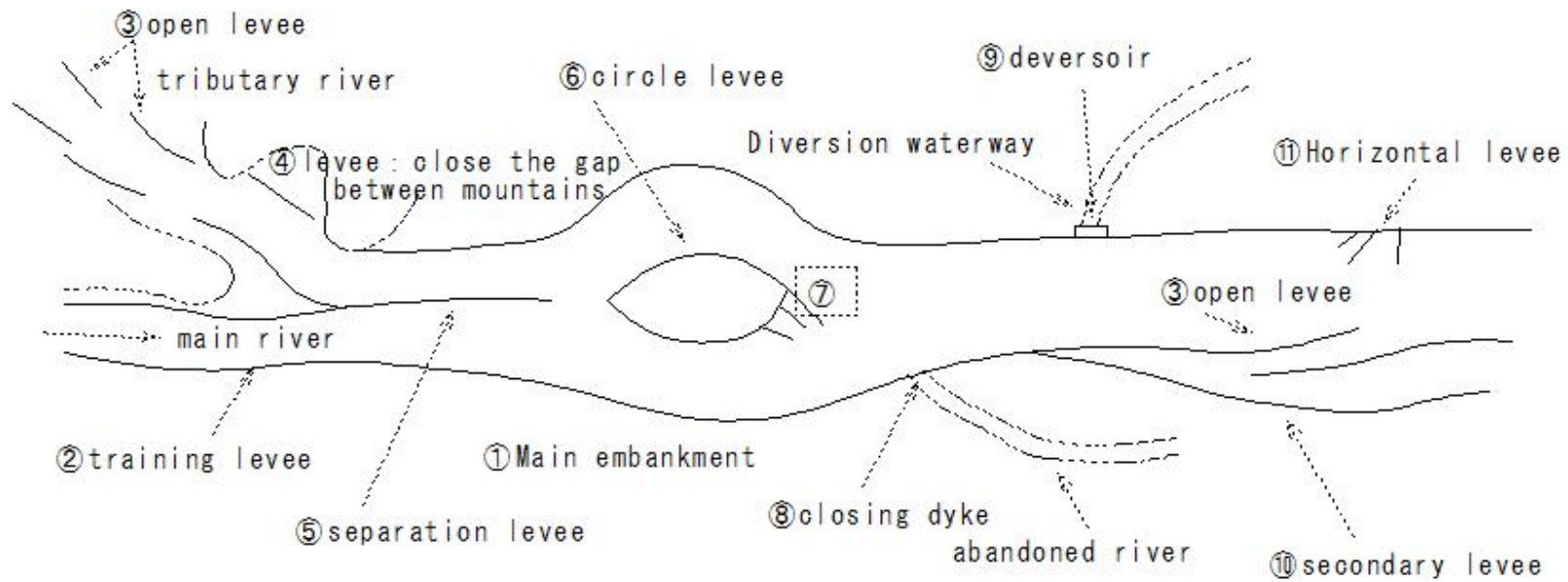
Embankment

Type of embankment

⑦Cultivated land - protection/Reservoir use

Cultivated land - protection

Reservoir use



(R36)embankment(closing dyke)

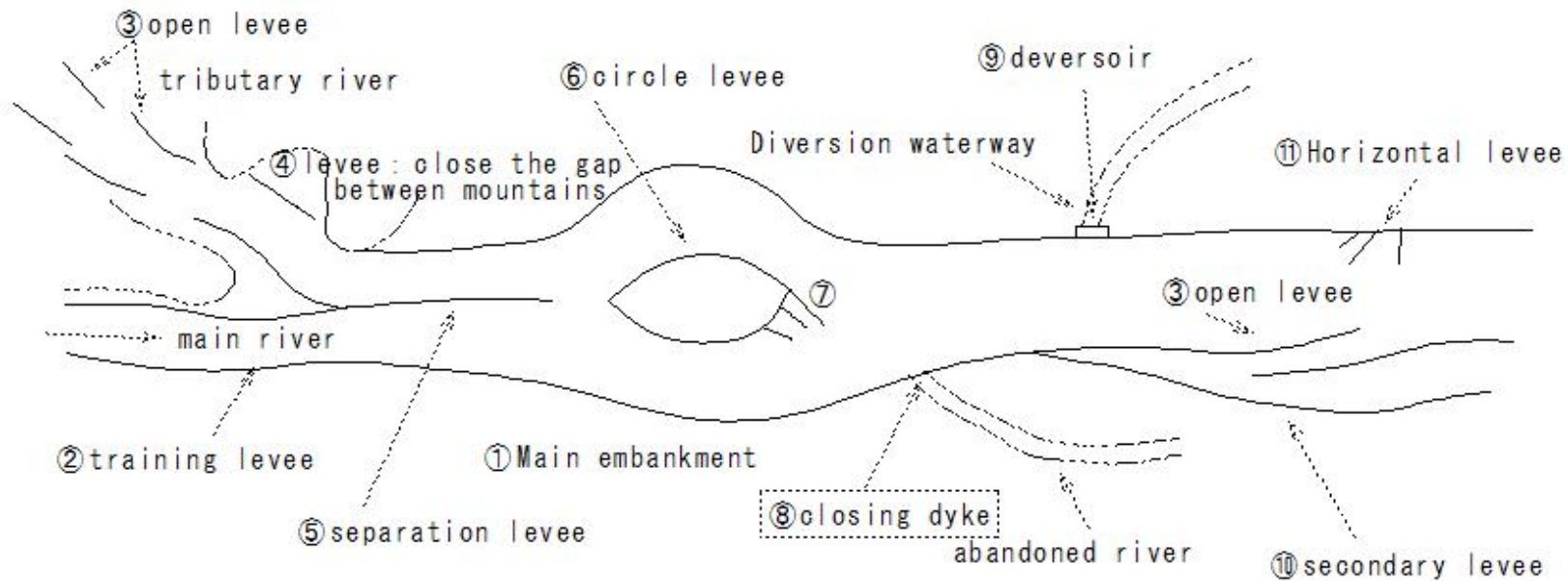
(R36) embankment(closing dyke)

embankment

Type of embankment

⑧closing dyke

old waterway - closing dyke



(R37)embankment(deversoir)

(R37) embankment (deversoir)

embankment

type of embankment

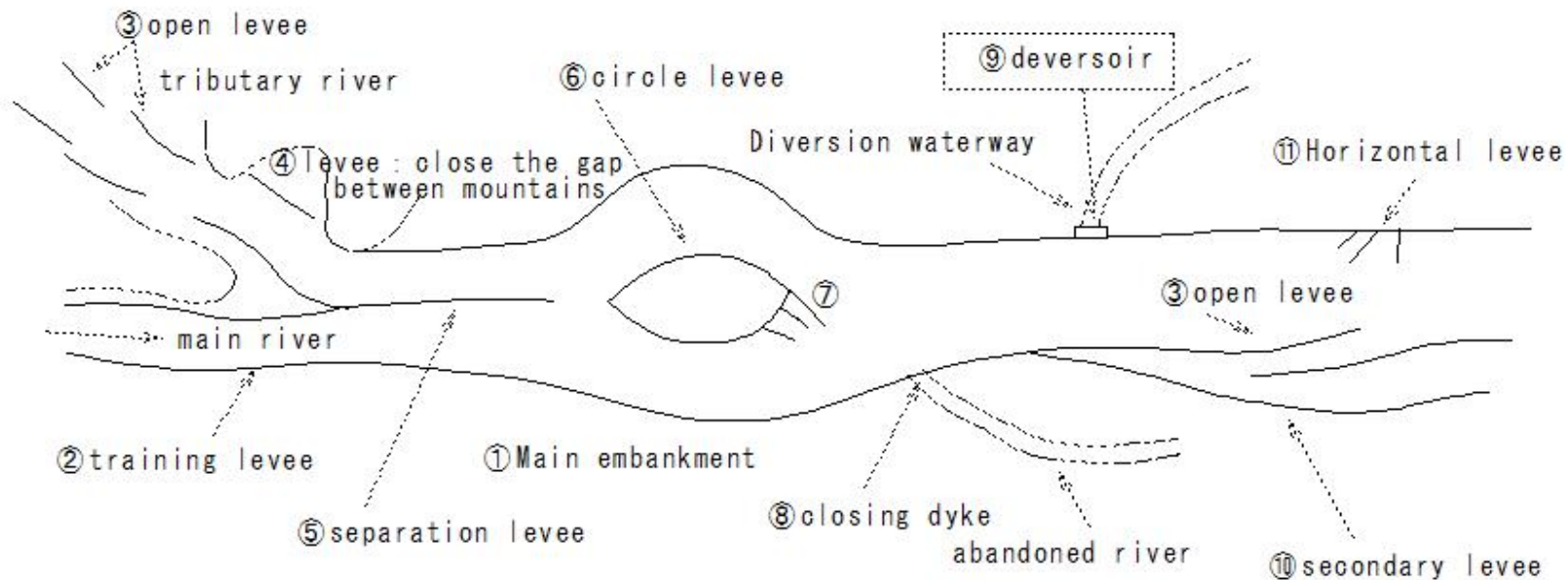
⑨deversoir

Part of the embankment - low

Flood - overflow

Flood control - retarding basin

Diversion channel - head of flow



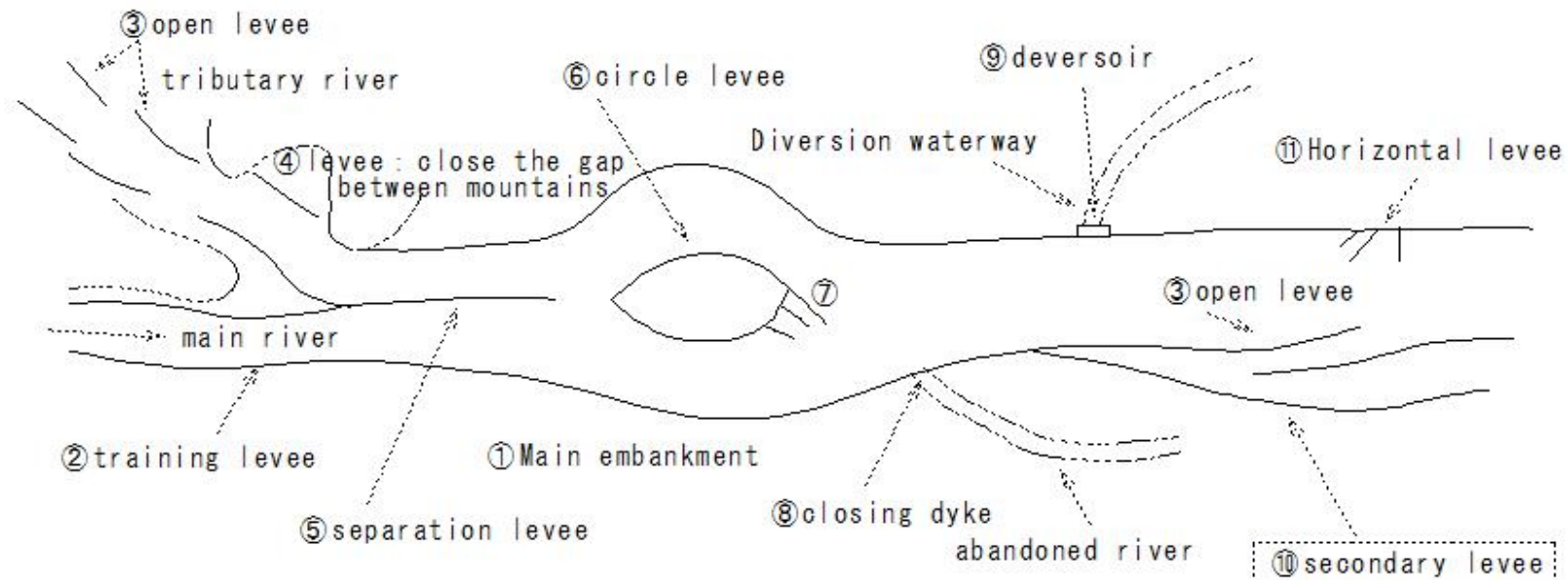
(R38)embankment(secondary levee)

(R38) embankment (secondary levee)

Embankment

Type of embankment

- ⑩ secondary levee
- riverside land- summer dyke
- inland area -secondary levee
- small embankment



(R39)embankment(Horizontal levee)

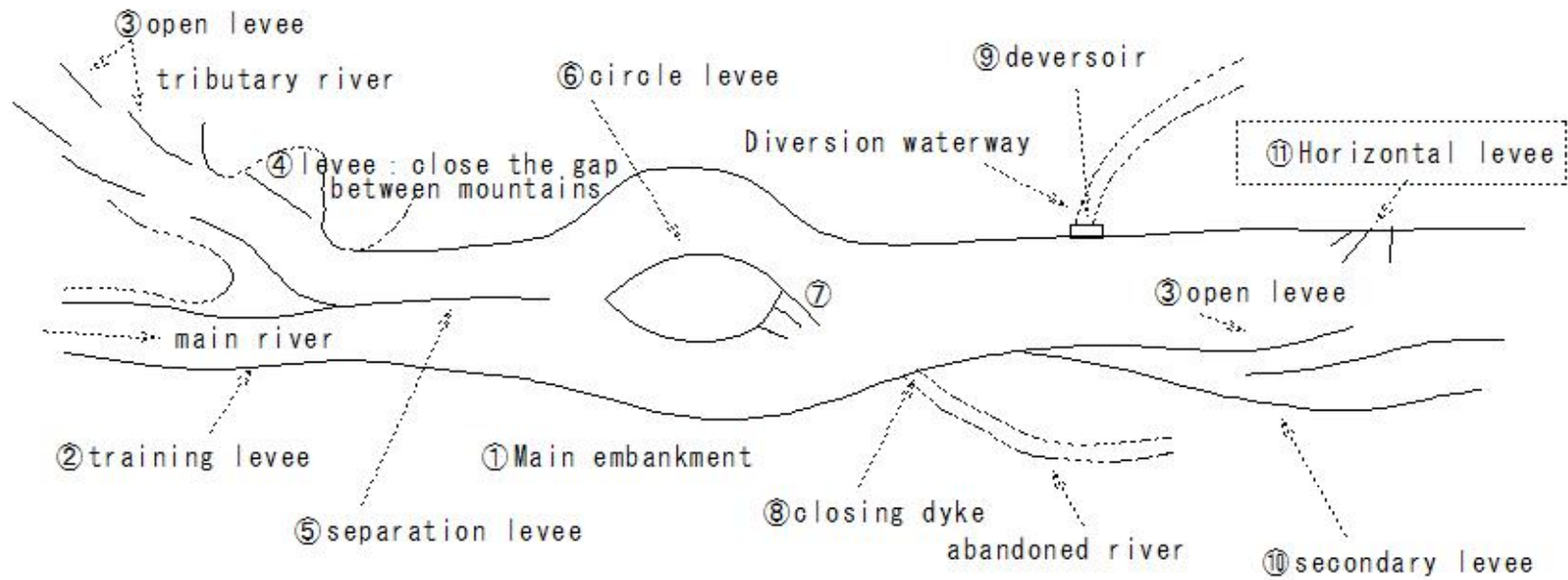
(R39) embankment (Horizontal levee)

Embankment

Type of embankment

⑪ Horizontal levee

River center - right angle



(R40)Embankment cross section

(R40)Embankment cross section

Embankment cross section

Flood - Flood prevention

Stable against external forces

Embankment height: Planned high water level + margin height (extra embankment)

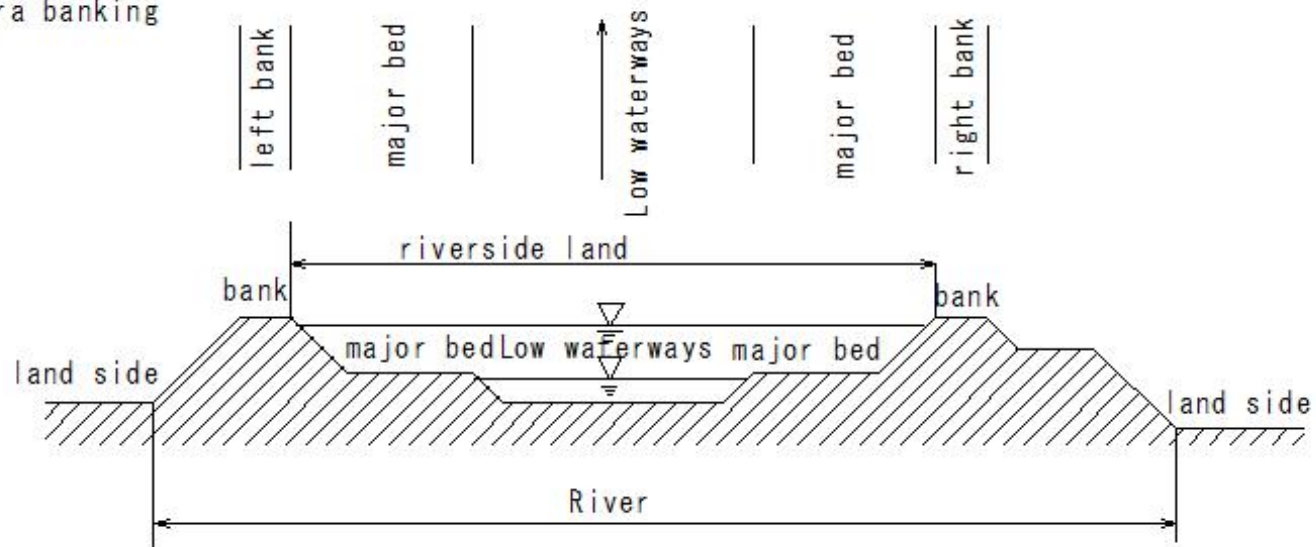
Remains: Embankment body consolidation settlement

Consolidation settlement of foundation ground

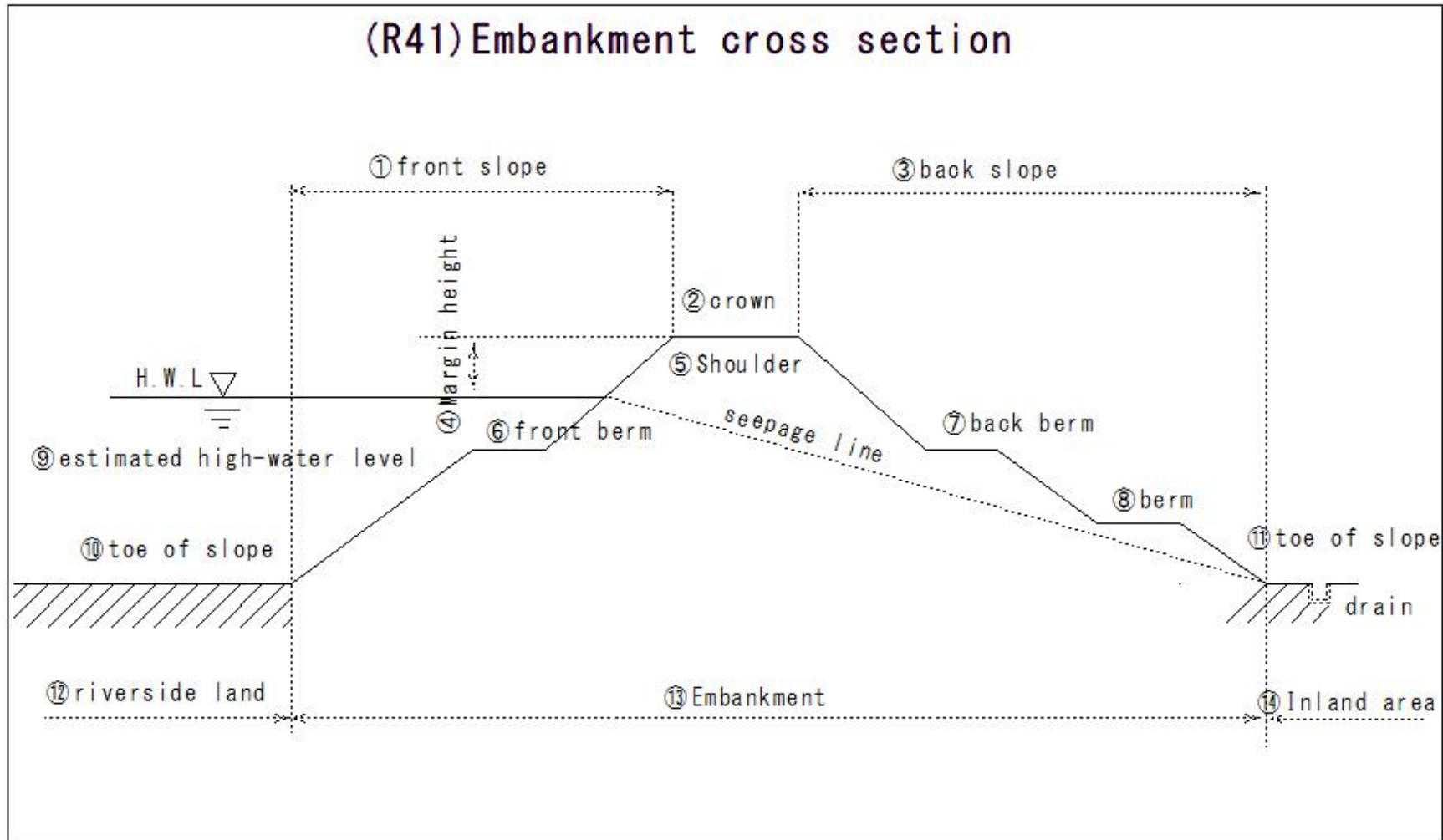
Damage to the top due to wind and rain, etc.

Future settlement prediction

slope/berm-extra banking



(R41)Embankment cross section



(R42)Embankment cross section

(R42)Embankment cross section

Embankment cross section

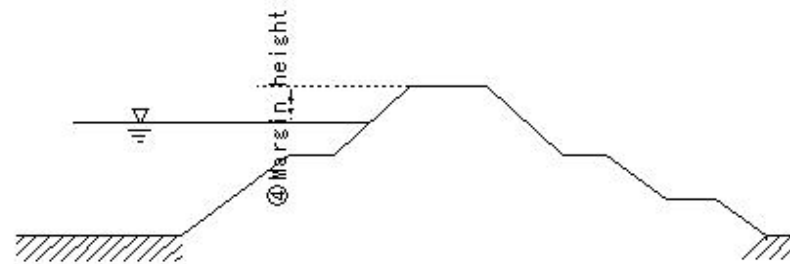
Embankment height/margin height

Margin height of embankment

estimated high water flow (unit: m ³ /s)	Extra height (unit: m)
less than 200	0.6
200-500	0.8
500-2000	1.0
2000-5000	1.2
5000-10000	1.5
10000-	2.0

Extra height for the free height of the embankment

- ① Important hinterland rivers
- ② Rivers with a lot of sediment runoff
- ③ Waves
- ④ Curved part of the river
- ⑤ Increase margin height



(R43) Embankment cross section

(R43) Embankment cross section

Embankment cross section

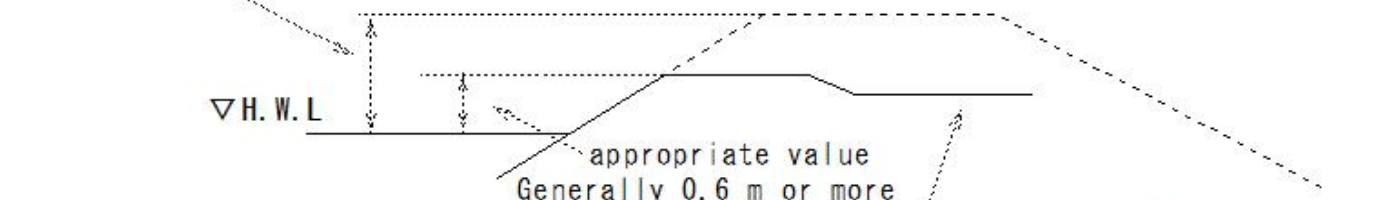
Embankment height/margin height

Extra height according to planned high water volume

∇ H. W. L

appropriate value
Generally 0.6 m or more

the back ground is higher than the planned high water level



(R44)Embankment cross section

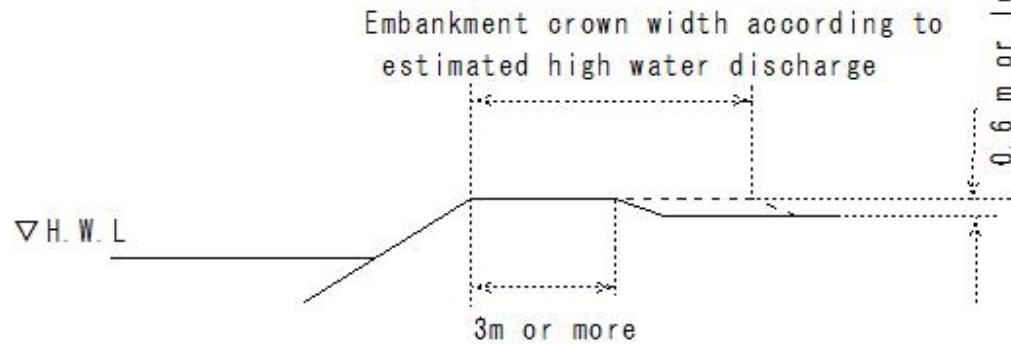
(R44) Embankment cross section

Embankment cross section

Embankment crown width
the ground height inside the embankment is higher than the estimated high water level
No flood control

Embankment top width

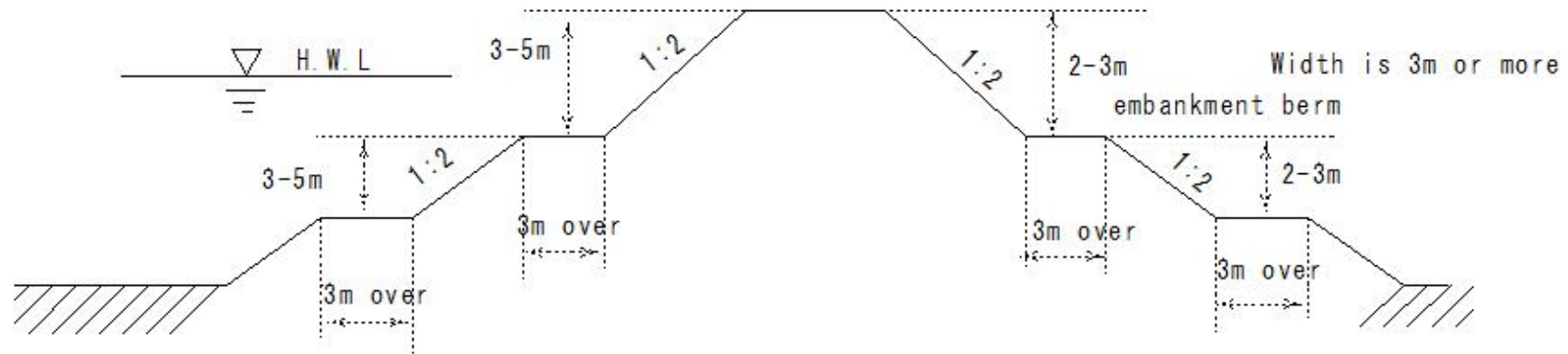
estimated high water discharge	crown width (unit: m)
less than 500	3
500-2000	4
2000-5000	5
5000-10000	6
10000-	7



(R45)Embankment cross section

(R45)Embankment cross section

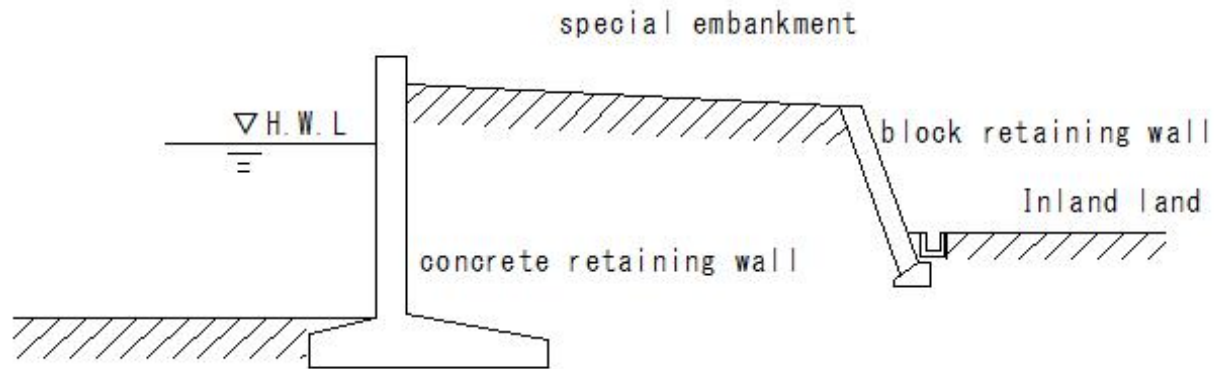
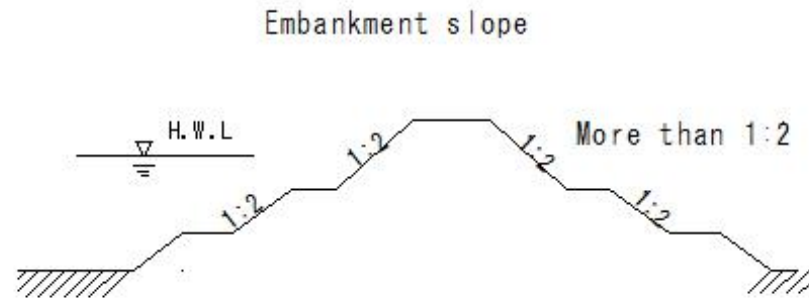
Embankment berm
crown according to estimated high water discharge
0.6m or more
the crown width can be reduced to -3m.



(R46) Embankment cross section

(R46) Embankment cross section

Embankment cross section
Embankment slope

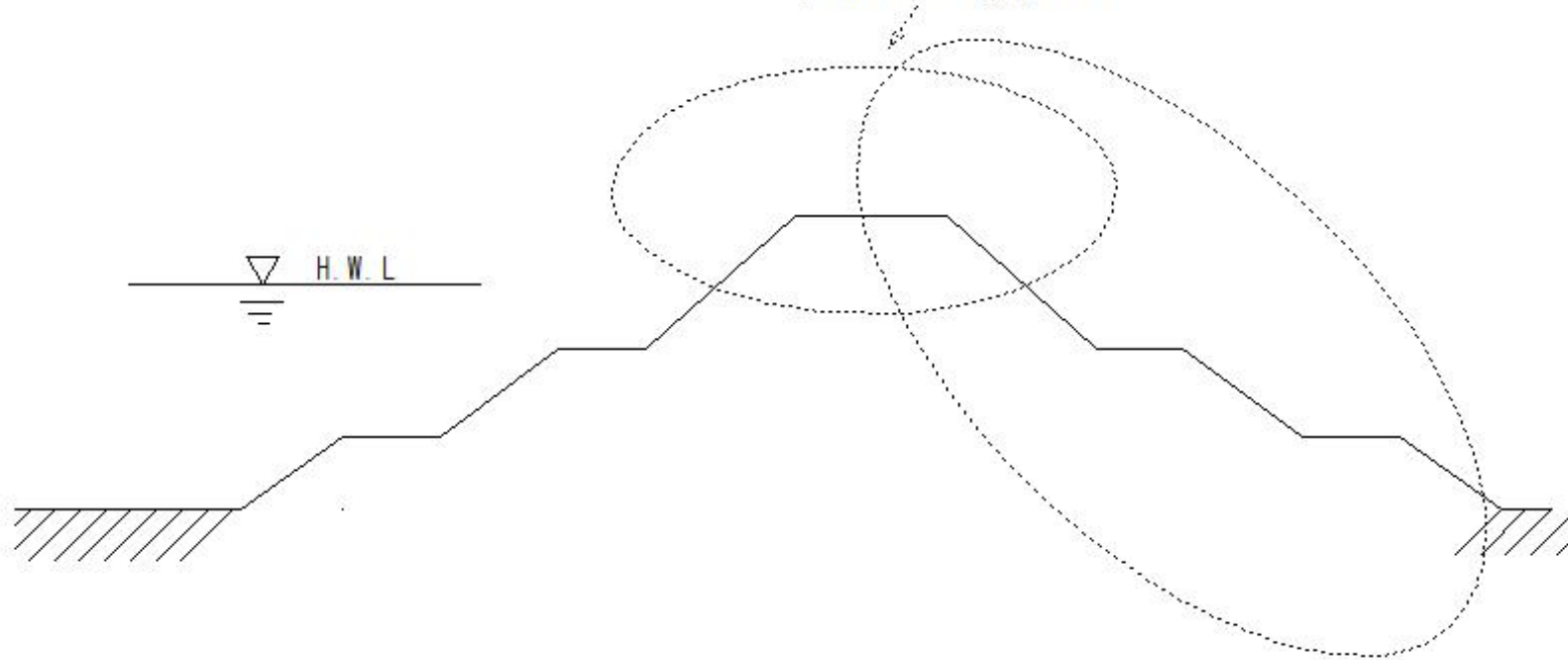


(R47) Embankment cross section

(R47) Embankment cross section

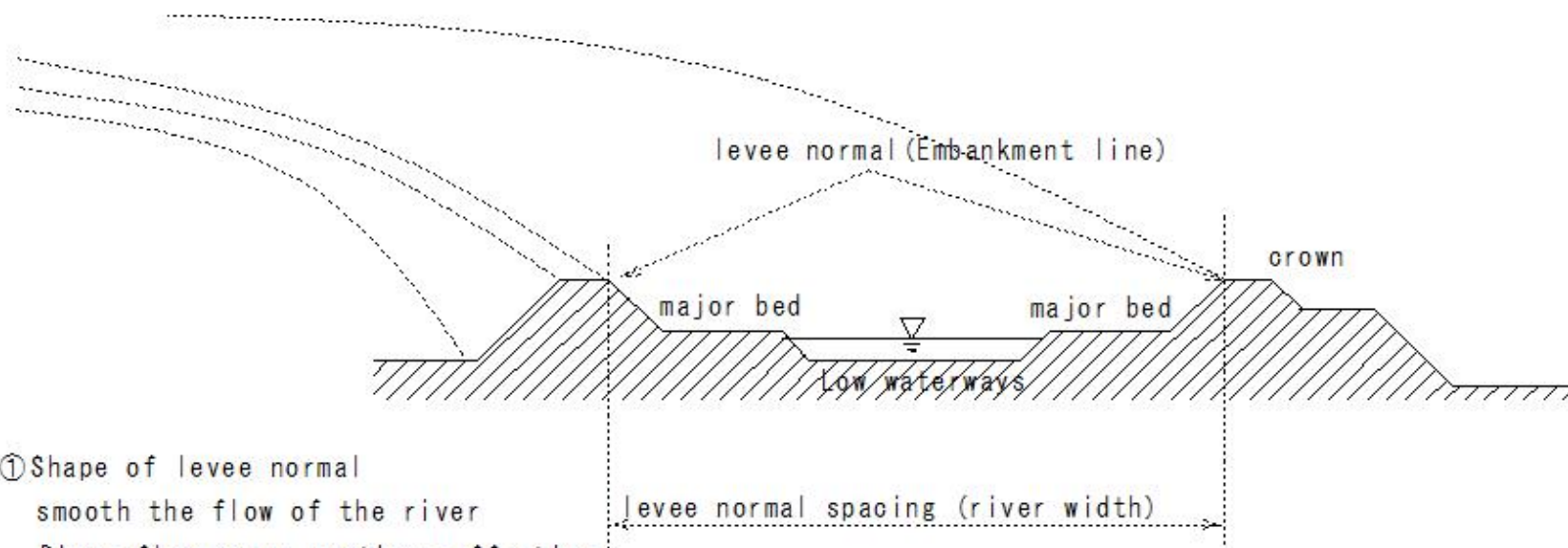
Embankment cross section

slope protection
Rainfall/running water - slope collapse
Scouring- safety
protected by grass



(R48) Embankment line (levee normal)

(R48) Embankment line (levee normal)



- ① Shape of levee normal
smooth the flow of the river
River flow cross section - effective
Floods - Areas that hit embankments - Constant
establish a groin
- ② Distance between levee normal
River width - inland drainage - advantageous
River width: Does not change suddenly

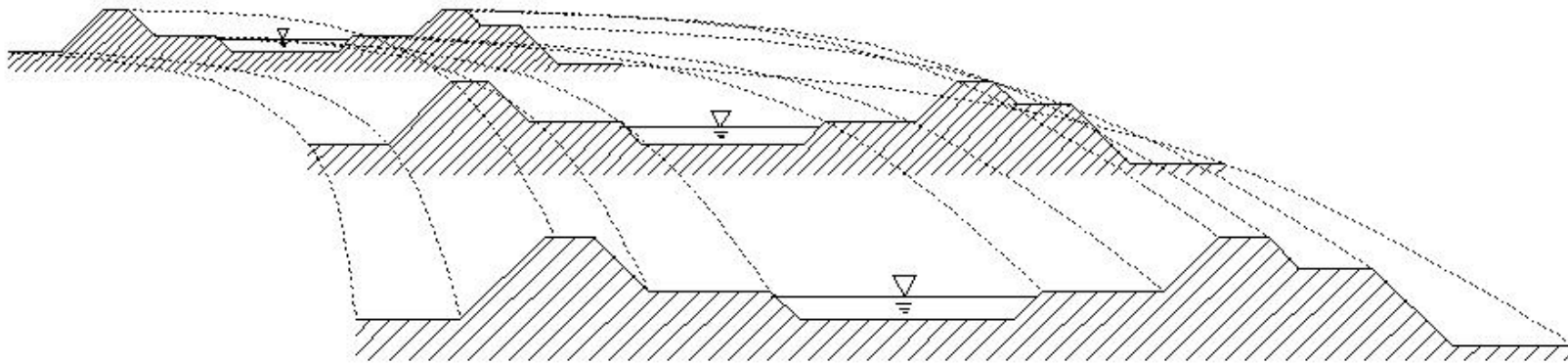
(R49) Embankment materials

(R49) Embankment materials

Embankment materials

Soil for embankment

- ① major bed- about 1-2.5m - use of excavated soil
- ② Riverbed excavated soil - use
- ③ River channel improvement
- ④ Use from short distance
- ⑤ Easy to obtain
- ⑥ Economy
- ⑦ Soil - settlement, cracks, destruction -
First aid/main recovery - easy, short term, safe



(R50) Embankment materials

(R50) Embankment materials

Embankment materials

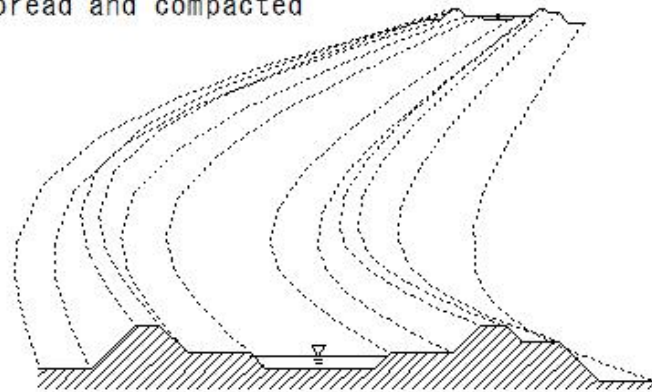
Material standards

- ① Slips on slopes are less likely to occur.
- ② Low Permeability coefficient (fine-grained soil)
- ③ Excavation, transportation, compaction: Easy construction
- ④ Internal friction angle -large
Proper mixing of sandy soil and sand with different particle sizes
- ⑤ Few cracks due to drying
- ⑥ Does not include grass or tree roots

Consider the cross section of the embankment and construction method

Constant thickness, thin layer, evenly spread and compacted

Embankment with uniform quality



(R51) Embankment ground

(R51) Embankment ground

Embankment ground

foundation ground

Sufficient bearing capacity

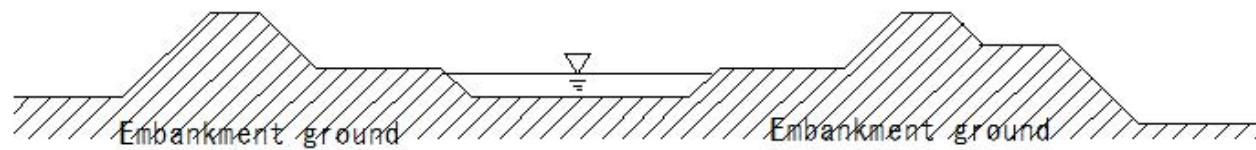
impermeable

along the riverbank - old river channel ruins - poor conditions

Embankment - Soil - Flexible

ground settlement - overfill - repair - easy

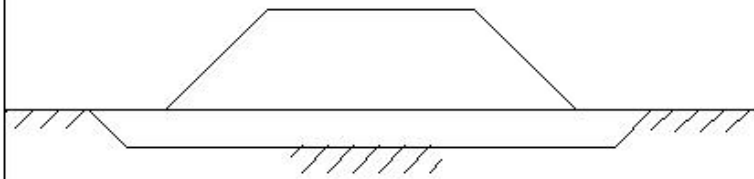
Foundation ground - settlement - pore water - exclusion - consolidation settlement



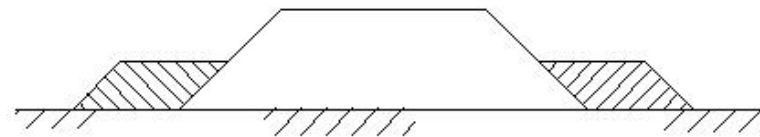
(R52)Countermeasures for soft ground

(R52) Countermeasures for soft ground

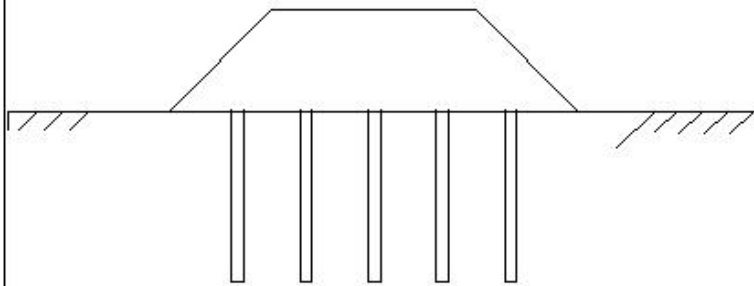
Countermeasures for soft ground



① Replace the soil in soft areas with better quality soil: Replacement method



② Apply load to the soil



③ Improve soil drainage

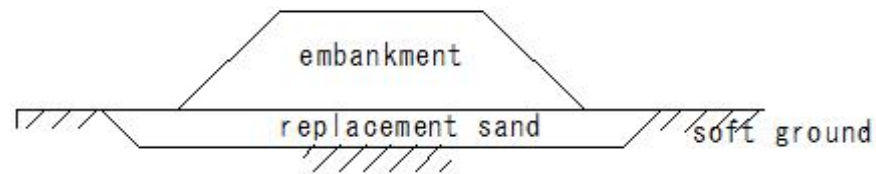
(R53)Countermeasures for soft ground(Replacement method)

(R53) Countermeasures for soft ground(Replacement method)

Countermeasures for soft ground

① Replacement method

- Difficult to secure soil dumping site
 - Construction costs - high
 - Partial improvements will be made.



- ① Replace the soil in soft areas with better quality soil: Replacement method

(R54)Countermeasures for soft ground(Loading embankment method)

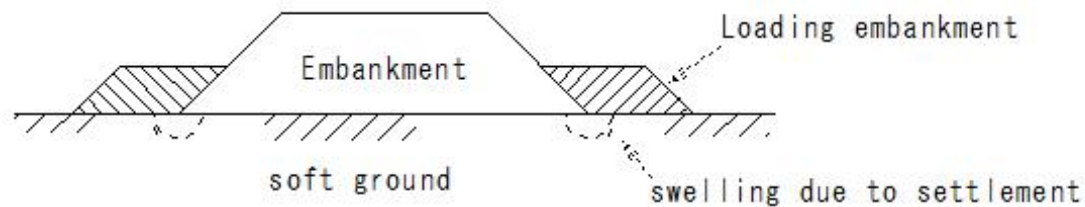
(R54) Countermeasures for soft ground(Loading embankment method)

Countermeasures for soft ground

② Loading embankment method

- Prevention of foundation ground sliding failure
- Avoid rapid and excessive embankment
- Consolidation takes a long time
- Embankment control method

Embankment height: Planned high water level + margin height (excess embankment)



(R55)Countermeasures for soft ground(Sand drain method)

(R55) Countermeasures for soft ground(Sand drain method)

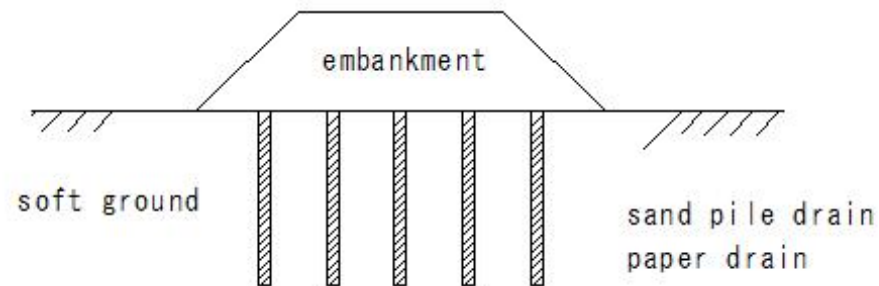
Countermeasures for soft ground

③ Sand drain method

Sand pile drain in soft ground

paper drain

- Rapidly eliminates pore water
- Prevent partial Settlement



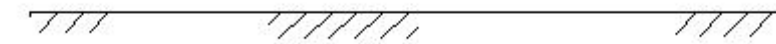
(R56)Countermeasures for soft ground(Embankment work)

(R56) Countermeasures for soft ground(Embankment work)

Embankment work

Expand river width-filling

New embankment - 3 years - Old and new coexist



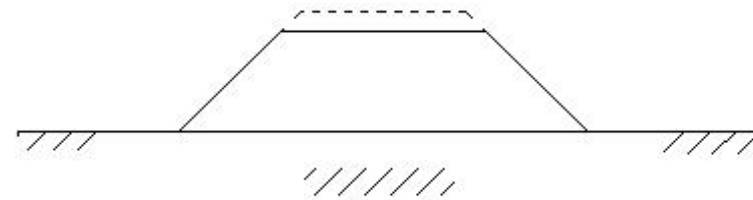
② River width expansion



① New embankment



③ Increase the height - raise the height



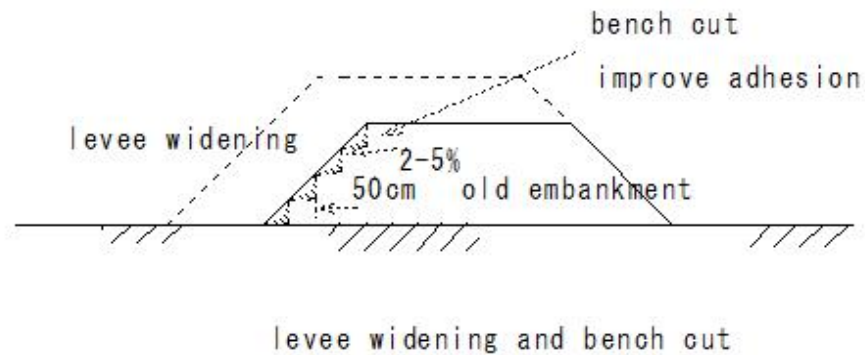
(R57)Countermeasures for soft ground(Preparation work)

(R57) Countermeasures for soft ground(Preparation work)

Embankment work

① Preparation work

- Water leak/infiltration prevention
- Remove weeds, tree roots, and organic matter
- levee widening and bench out



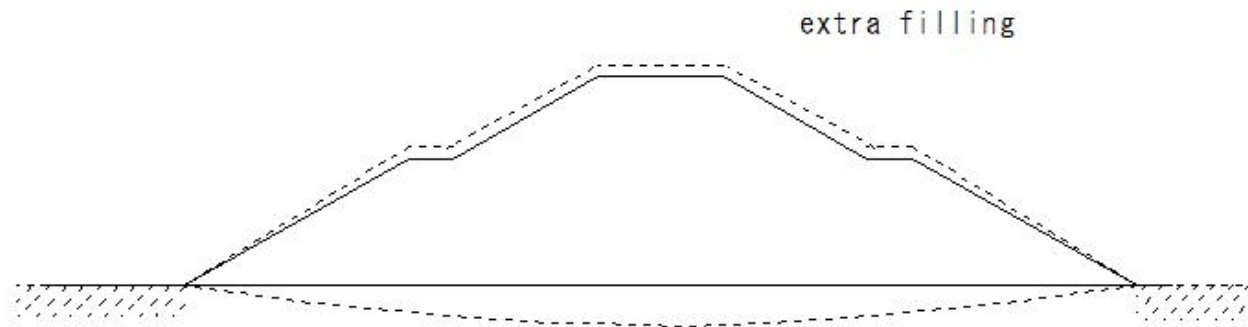
(R58)Countermeasures for soft ground(Construction cross section and extra filling)

(R58)Countermeasures for soft ground(Construction cross section and extra filling)

Embankment work

②Construction cross section and extra filling

- Embankment - Foundation ground - Consolidation settlement
- Embankment body - compression
- **New Embankment - extra filling - embankment height - (5-10%)**



(R59)Countermeasures for soft ground(Embankment/compaction)

(R59)Countermeasures for soft ground(Embankment/compaction)

Embankment work

③Embankment/compaction

embankment material

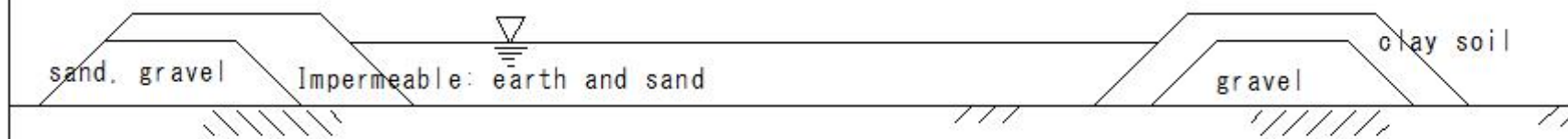
- Surface slope - impermeable soil
- Near the back end -large permeable gravel
- Sand and gravel - Embankment body - Permeability - Large sand and gravel

Surface - Clay layer - Grass - Surface protection

- Embankment - Strength - Strong Water permeability - Small
- Leveling the embankment soil thickness to about 30cm
- Bulldozer • Tire roller specified density
- Perform compaction

soil embankment

sand and gravel embankment



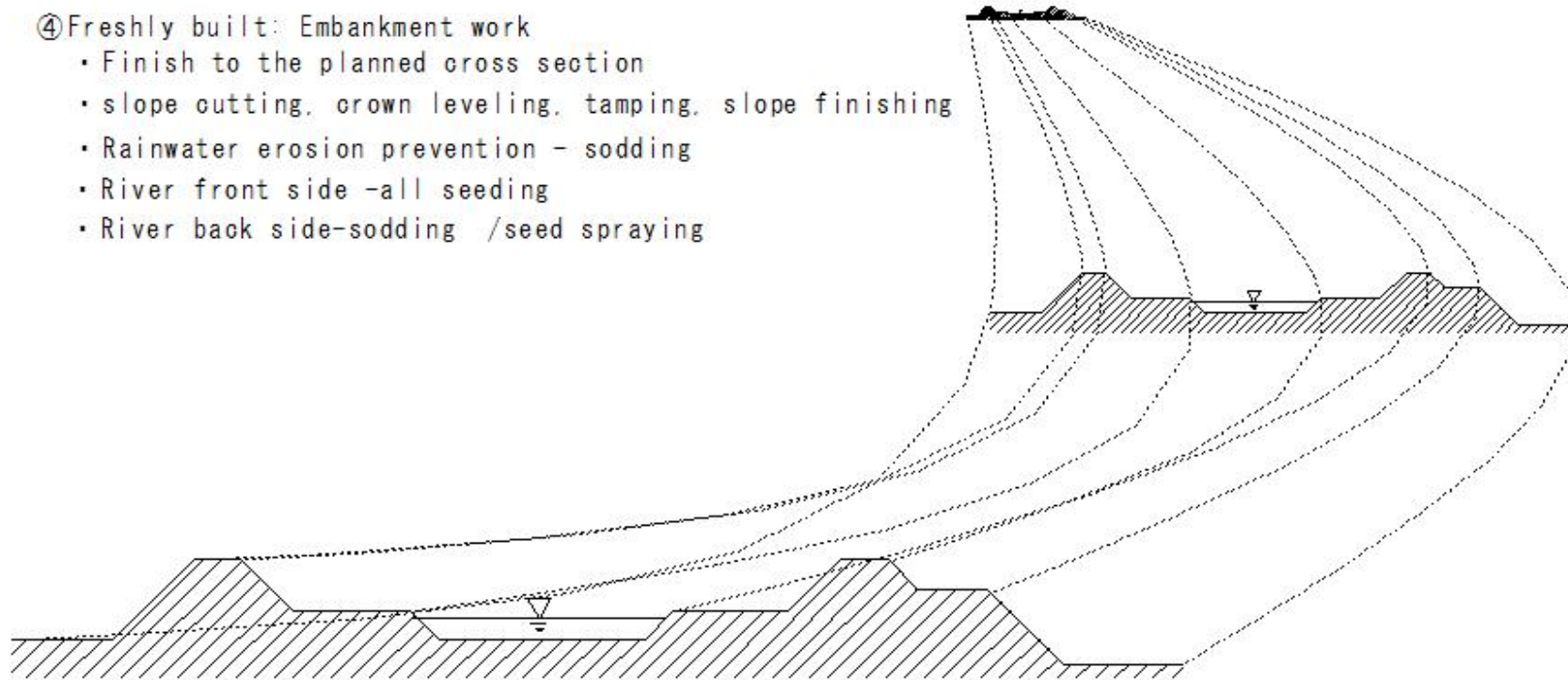
(R60)Countermeasures for soft ground(Freshly built: Embankment work)

(R60)Countermeasures for soft ground(Freshly built: Embankment work)

Embankment work

④ Freshly built: Embankment work

- Finish to the planned cross section
- slope cutting, crown leveling, tamping, slope finishing
- Rainwater erosion prevention - sodding
- River front side -all seeding
- River back side-sodding /seed spraying



Embankment work

(R61) Destruction of embankments and countermeasures(Overflow)

(R61) Destruction of embankments and countermeasures(Overflow)

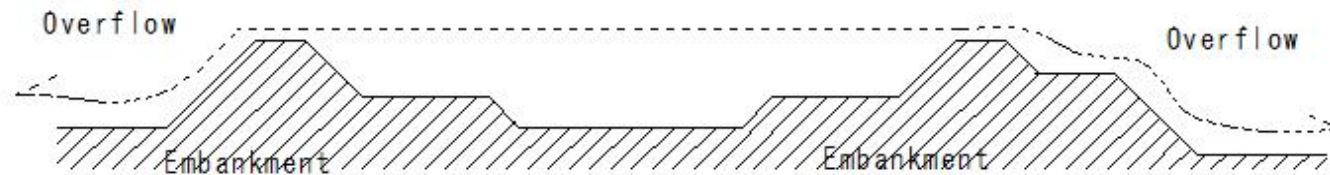
Destruction of embankments and countermeasures

① Overflow

Flood, high tide, overflowing the crown
crown, back slope, scouring, destruction

countermeasure

River channel capacity - safety
Upstream part - inflow control



(R62) Destruction of embankments and countermeasures(Scouring)

(R62) Destruction of embankments and countermeasures(Scouring)

Destruction of embankments and countermeasures

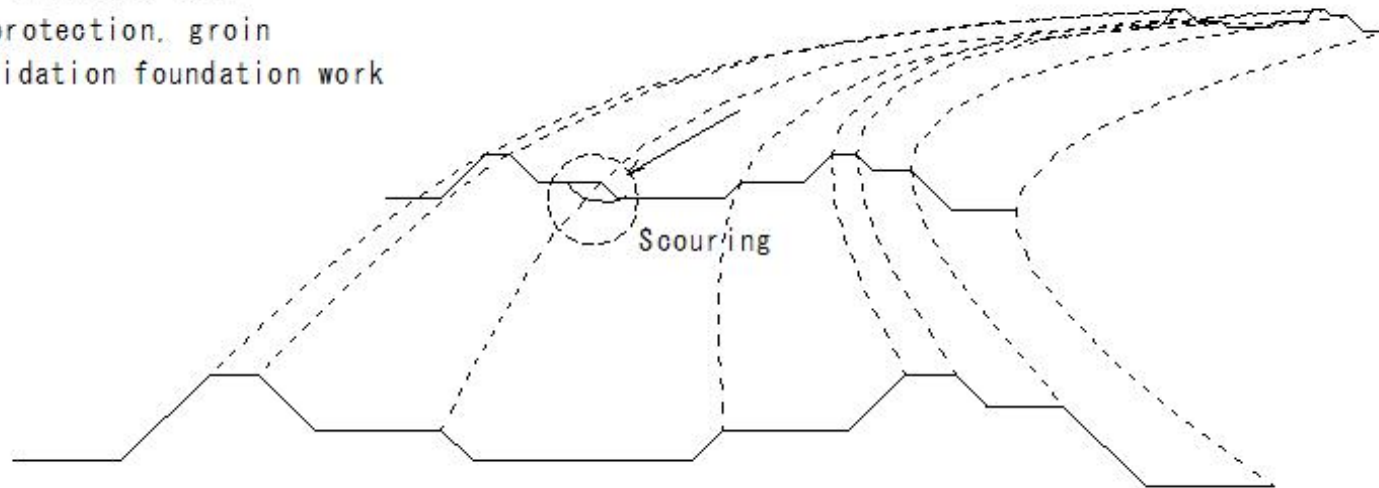
② Scouring

Water, flowing downstream object- crashes into embankment

Embankment slope - scour collapse

countermeasure

- water collision part
- bank protection, groin
- consolidation foundation work



(R63) Destruction of embankments and countermeasures (Seepage/leakage)

(R63) Destruction of embankments and countermeasures (Seepage/leakage)

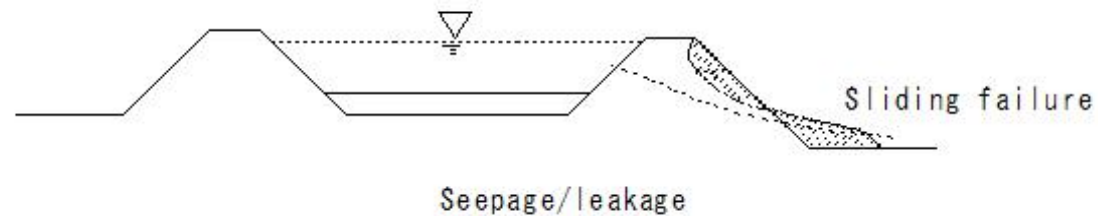
Destruction of embankments and countermeasures

③ Seepage/leakage

- Sliding failure due to water permeability of embankment body soil
- Sliding failure due to permeability of foundation ground

countermeasure

- Water leak prevention
- Water volume - reduce
- Fastly flush out of the embankment body
- Longer penetration slope line
- Water permeability - a little



(R64) Destruction of embankments and countermeasures (Measures for the levee body)

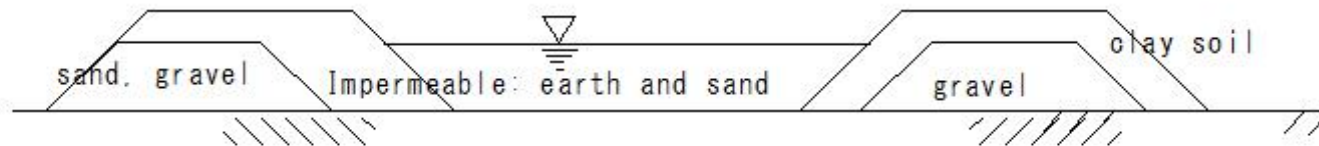
(R64) Destruction of embankments and countermeasures (Measures for the levee body)

Destruction of embankments and countermeasures

Measures for the levee body

① Embankment material

Embankment material - permeability - low soil Use sandy soil with an appropriate mix of sand



(R65) Destruction of embankments and countermeasures (Measures for the levee body)

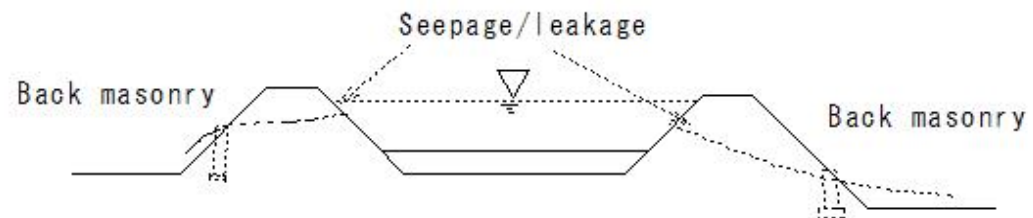
(R65) Destruction of embankments and countermeasures (Measures for the levee body)

Destruction of embankments and countermeasures

Measures for the levee body

② Back masonry method

- stone masonry and dry stone masonry at the back toe of slope
- Lower the infiltration line
- Prevent collapse of back slope due to seepage flow



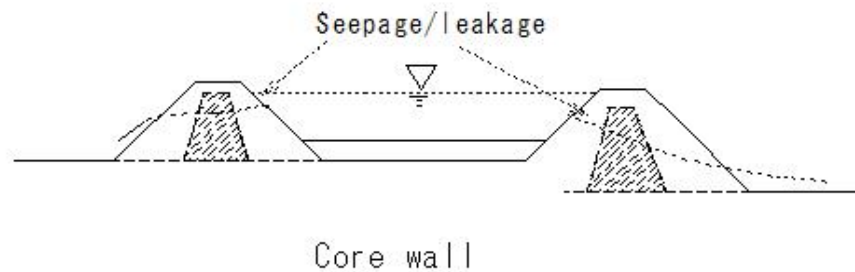
(R66) Destruction of embankments and countermeasures (Measures for the levee body)

(R66) Destruction of embankments and countermeasures (Measures for the levee body)

Destruction of embankments and countermeasures

Measures for the levee body

③ Core wall construction method: A core of clay or other material is placed in the embankment body to stop seepage water.



(R67) Destruction of embankments and countermeasures (Measures for the levee body)

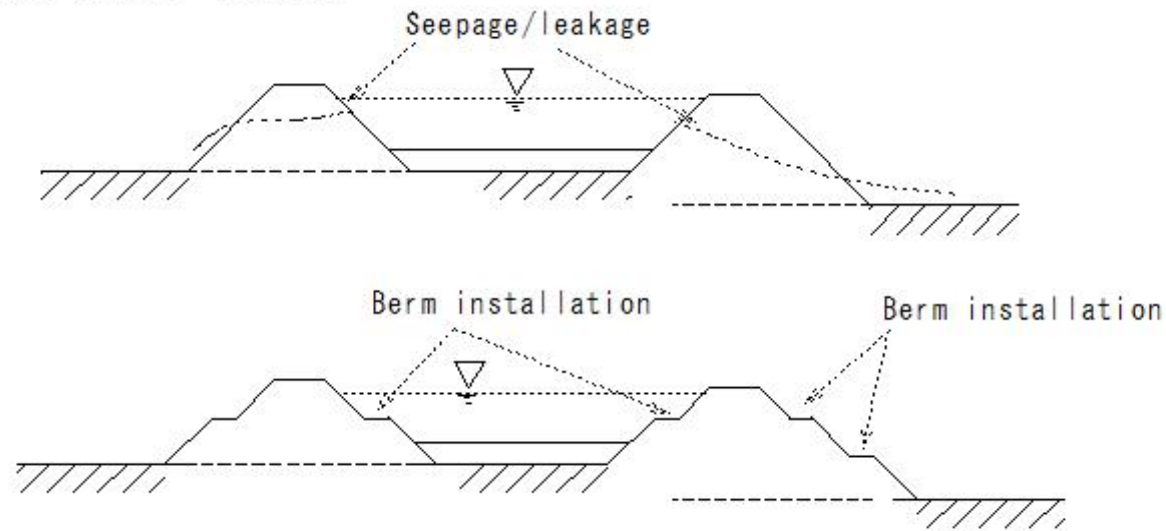
(R67) Destruction of embankments and countermeasures (Measures for the levee body)

Destruction of embankments and countermeasures

Measures for the levee body

④ Berm installation method

- Increase the length of the slope line for infiltrating water.
- Increase resistance to flow
- Lower the infiltration surface
- Improvement of backslope infiltration
- Water leakage amount - reduced



(R68) Destruction of embankments and countermeasures (Measures for the levee body)

(R68) Destruction of embankments and countermeasures (Measures for the levee body)

Destruction of embankments and countermeasures

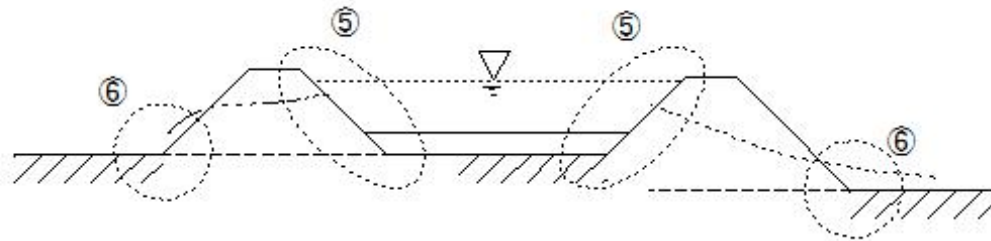
Measures for the levee body

⑤ Surface slope coating method

- Cover the surface of the embankment with clay, concrete, masonry, etc. with low permeability.

⑥ Back slope: placing stones and cobble stone

- Improve drainage by placing stones and cobble stone on the backside.



(R69)Destruction of embankments and countermeasures(Measures for foundation ground)

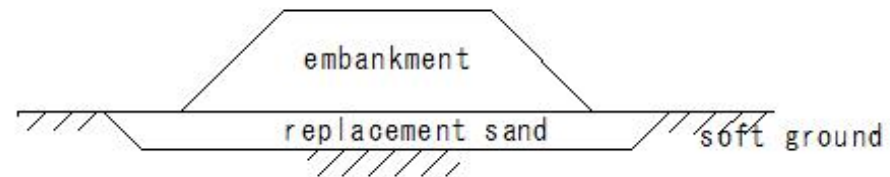
(R69)Destruction of embankments and countermeasures(Measures for foundation ground)

Destruction of embankments and countermeasures

Measures for foundation ground

① Replacement method

- Removal of permeable ground
- Replace with less permeable soil



① Replacement method

(R70)Destruction of embankments and countermeasures(Measures for foundation ground)

(R70)Destruction of embankments and countermeasures(Measures for foundation ground)

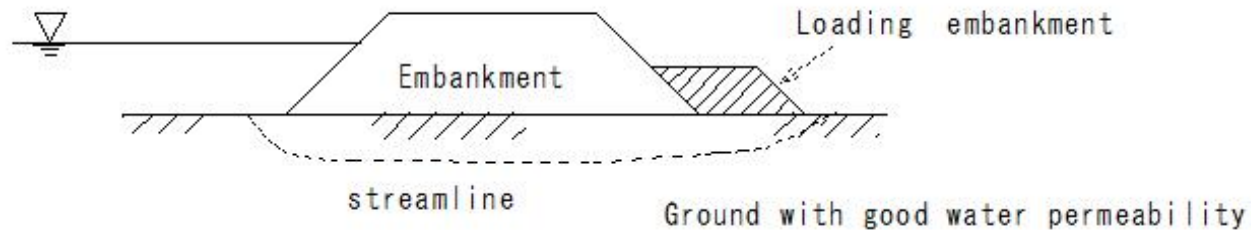
Destruction of embankments and countermeasures

Measures for foundation ground

②Loading method

- Behind the embankment body
- Water permeable material
 - Embankment with good drainage
- Longer penetration slope line
- Water permeability - mitigation

Measures for the levee body



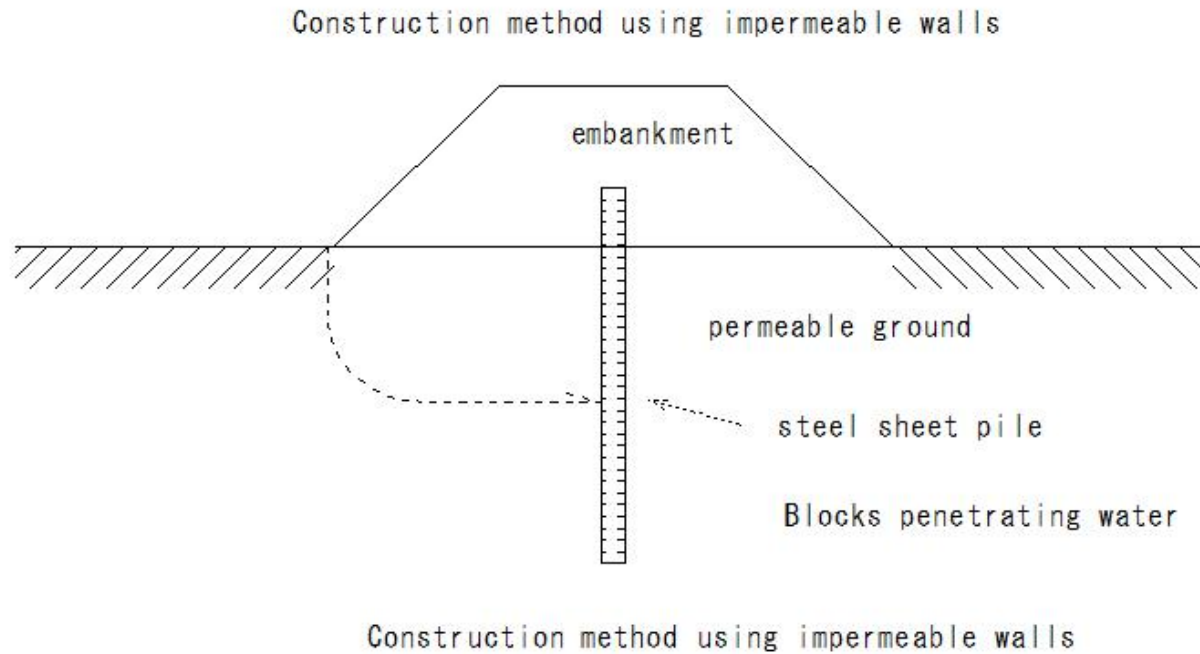
(R71)Destruction of embankments and countermeasures(Measures for foundation ground)

(R71)Destruction of embankments and countermeasures(Measures for foundation ground)

Destruction of embankments and countermeasures

Measures for foundation ground

③Construction method using impermeable walls

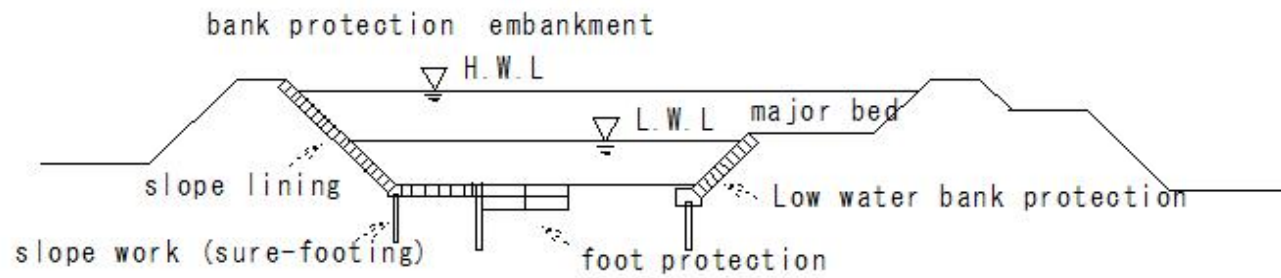


(R72)Types of bank protection

(R72)Types of bank protection

bank protection

Types of bank protection



(R73)Types of bank protection

(R73)Types of bank protection

bank protection

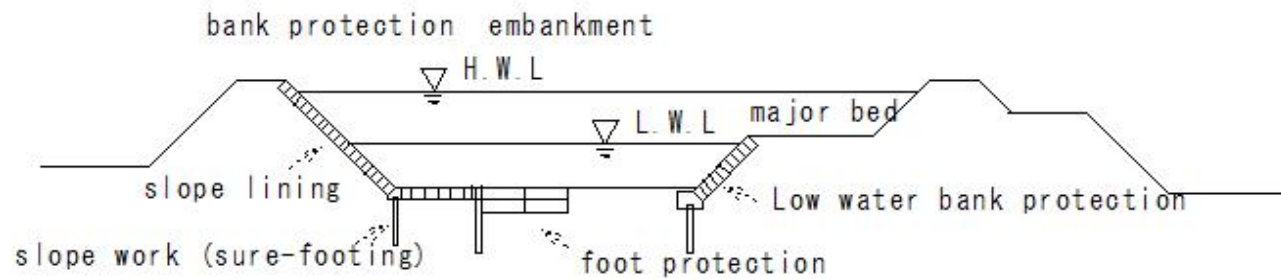
Types of bank protection

① slope lining

① Prevention of scouring of bank protection and embankments. protection of slopes

② Prevention of water penetration into the embankment body

③ Earth retaining work - collapse prevention



(R74)Types of bank protection

(R74)Types of bank protection

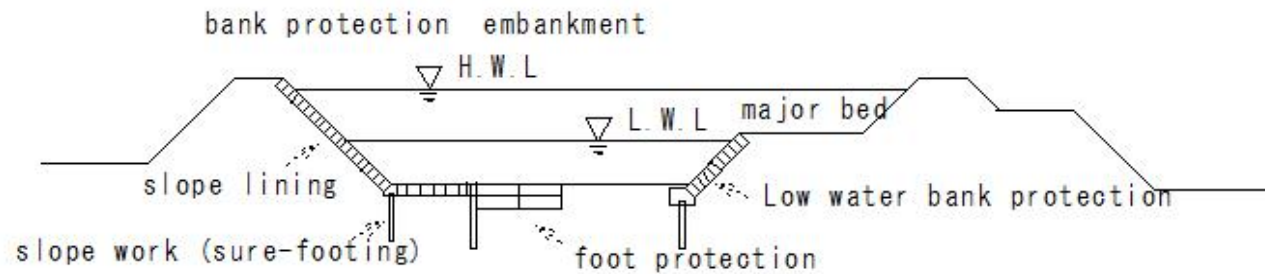
bank protection

Types of bank protection

○ slope work (sure-footing)

① Supports slope covering (lining) works

② Prevention of collapse and slipping of slope covering (lining) works



(R75)Types of bank protection

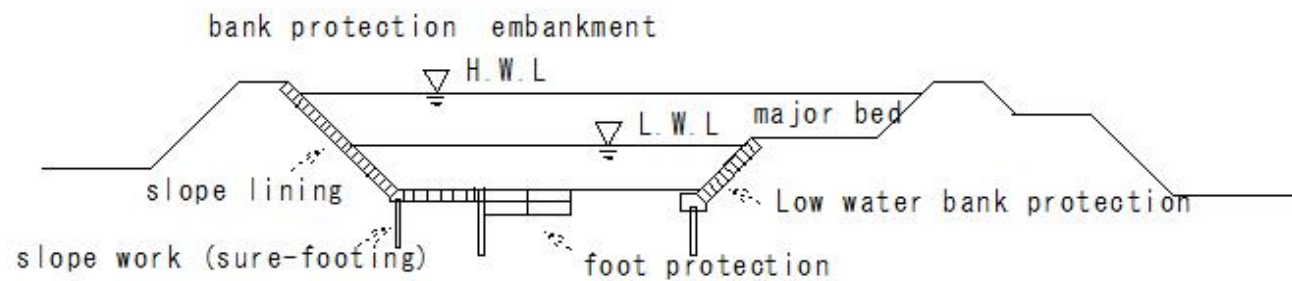
(R75)Types of bank protection

bank protection

Types of bank protection

○ foot protection work

- ① Preventing riverbed scouring
- ② Securing stability of slope work (sure-footing)



(R76) Structure and design of bank protection

(R76) Structure and design of bank protection

Structure and design of bank protection

- Rapid rivers - Collision of water flow - Large erosion

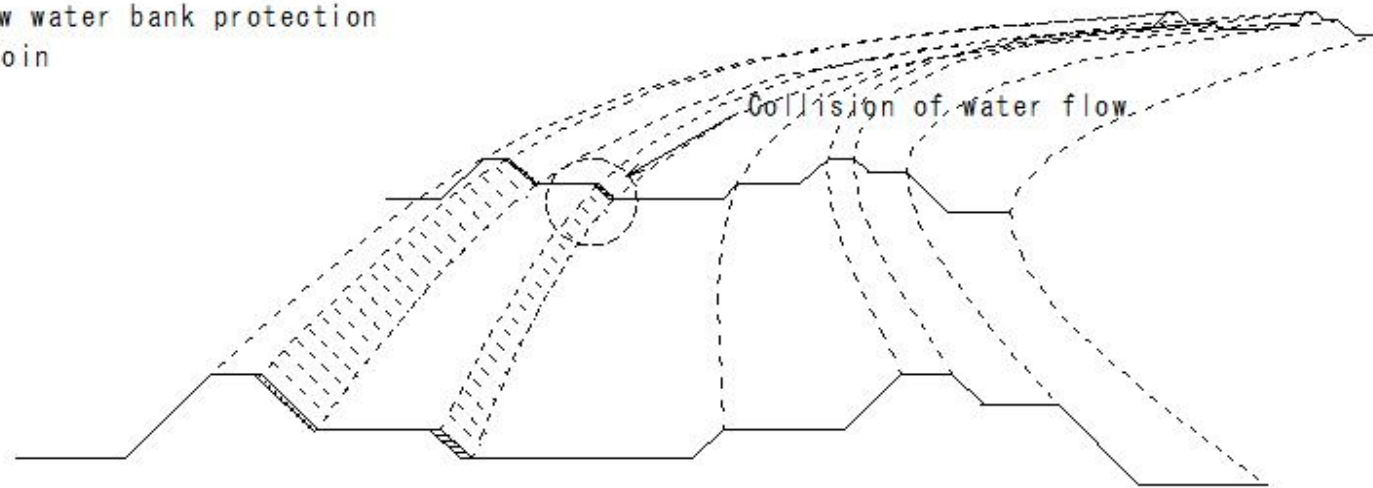
Total length - Embankment protection

- Relaxation river

- water collision part - focus

Low water bank protection

groin



(R77)Structure and design of bank protection

(R77)Structure and design of bank protection

Structure and design of bank protection

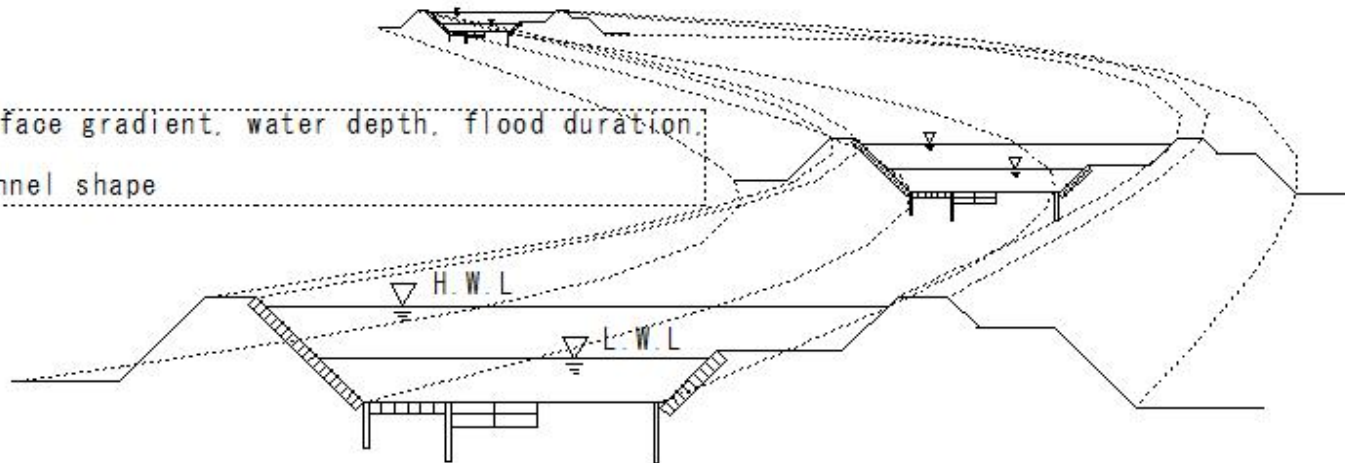
Structural plan of bank protection

- Water surface gradient, water depth, flood duration, river channel shape
- Hydraulic function
- Past experience/achievements: Examining the characteristics of the river -

Designing the bank protection

- ① Make the roughness of the bank protection equivalent to the roughness of the upstream and downstream slopes.
- ② Make the roughness of the bank protection equal to or rougher than the roughness of the river bed.

• Water surface gradient, water depth, flood duration,
river channel shape

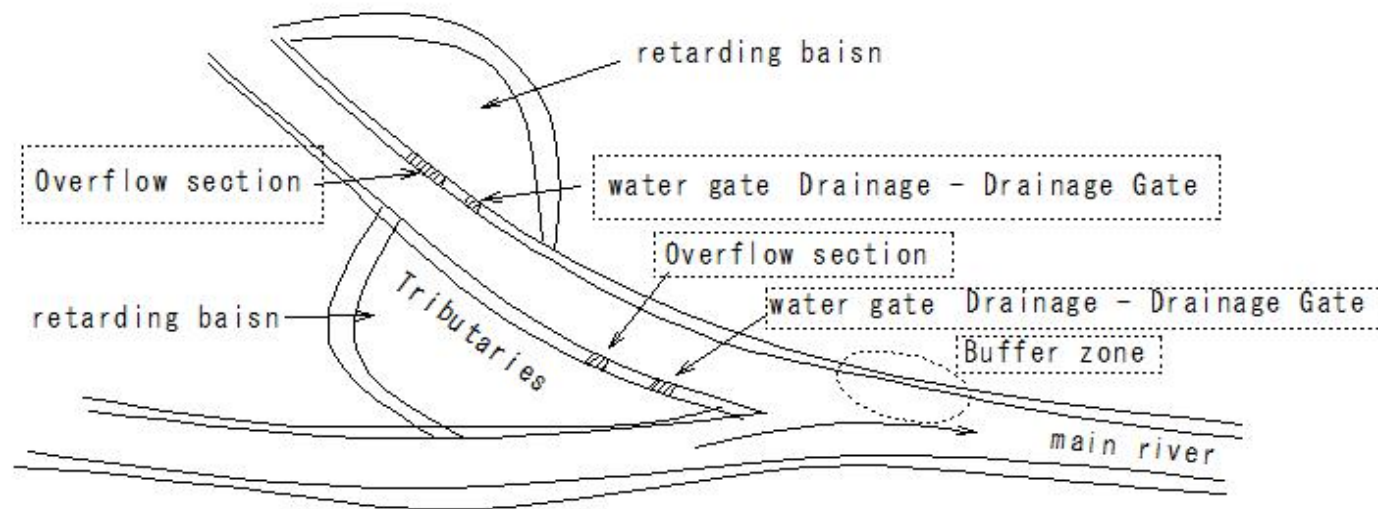


(R78) Structure and design of bank protection

(R78) Structure and design of bank protection

Structure and design of bank protection

- Construction area and extension of bank protection
 - Weirs, sluices, bridges, upstream/downstream of structures - Changes in flow, scouring
- Buffer zone - Establish a bank protection



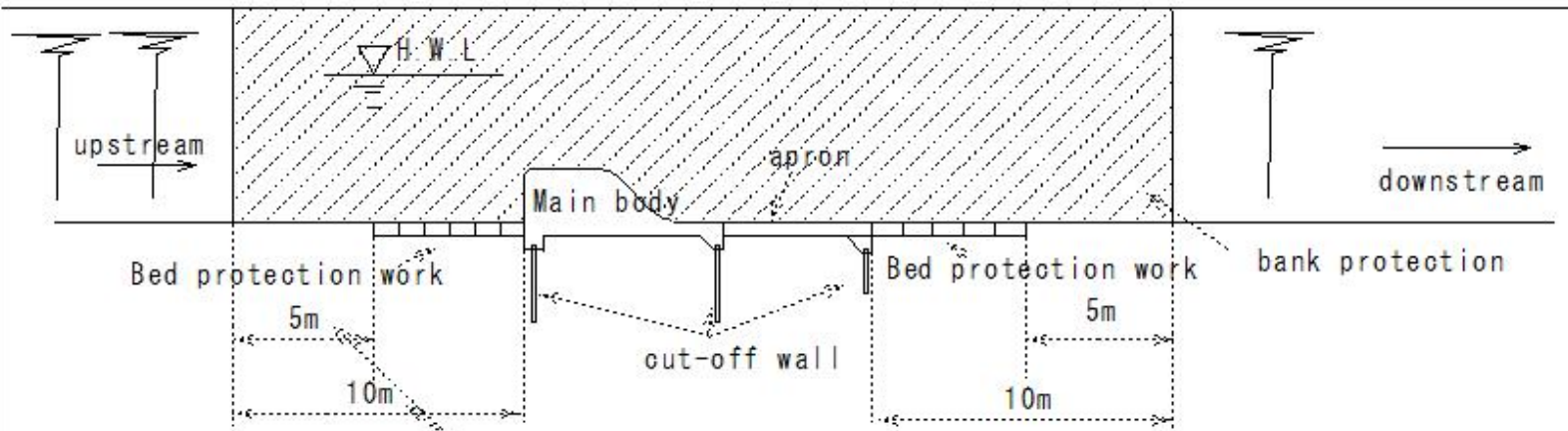
(R79)Structure and design of bank protection

(R79)Structure and design of bank protection

Structure and design of bank protection

- Construction area and extension of bank protection

① case of touching a groundsill or weir



Install a bank protection in the longer section.

① case of touching a floor stop or weir

(R80) Structure and design of bank protection

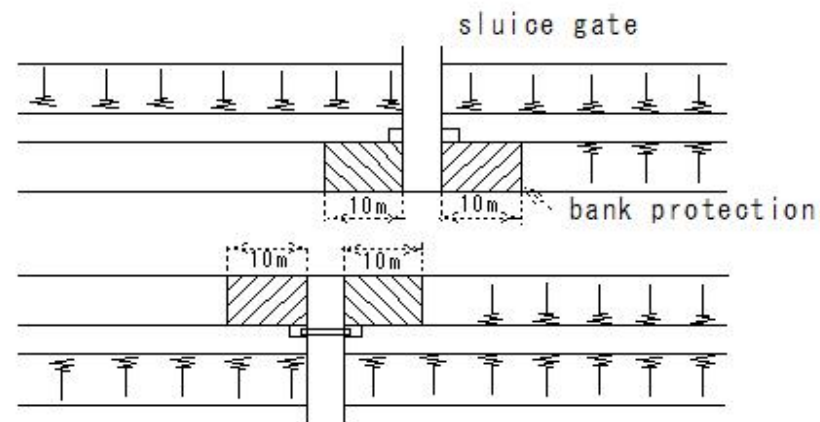
(R80) Structure and design of bank protection

Structure and design of bank protection

- Construction area and extension of bank protection

② Flood gate: case of the sluice gate crosses

Installed in a 10m section on the upstream and downstream sides



② Flood gate: case of the sluice gate crosses

(R81) Structure and design of bank protection

(R81) Structure and design of bank protection

Structure and design of bank protection

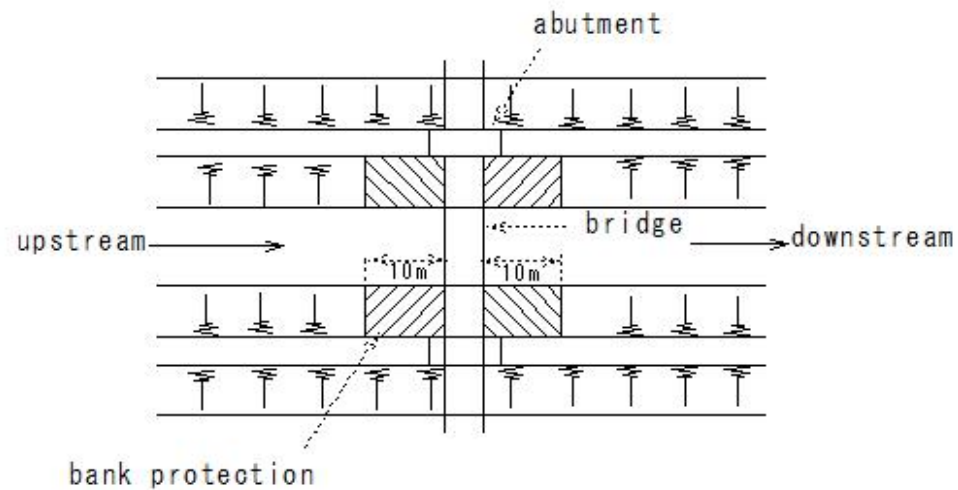
Structure and design of bank protection

• Construction area and extension of bank protection

③ Cases involving the installation of a bridge

case of installing a bridge abutment on a riverbank or embankment

Installed at least 10m upstream and downstream from both ends of the bridge abutment.



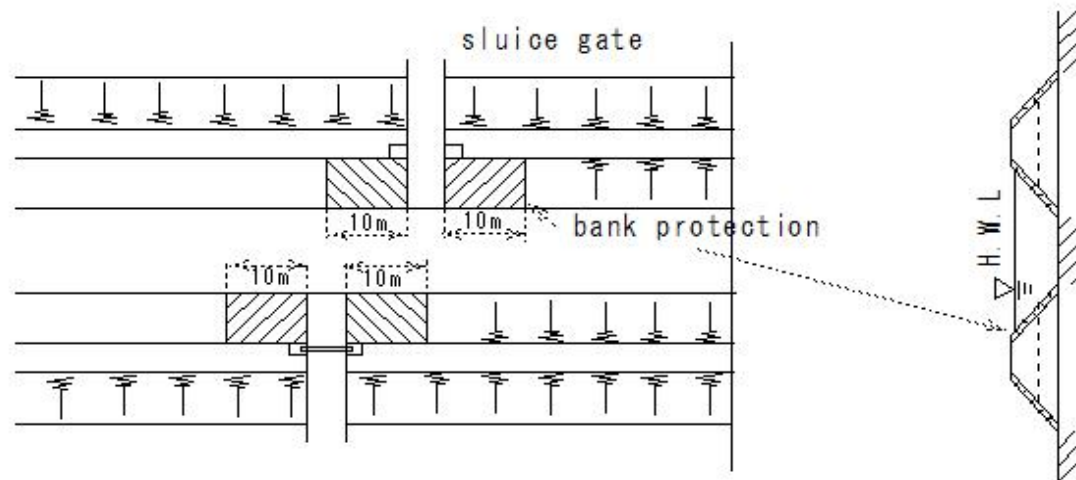
(R82) Structure and design of bank protection

(R82) Structure and design of bank protection

Structure and design of bank protection

- Height of bank protection
- Planned high water level
- Retarding basin: wide river, near the river mouth, areas where waves occur

Rapid river, up to the crown if necessary



(R83) Structure and design of bank protection

(R83) Structure and design of bank protection

Structure and design of bank protection

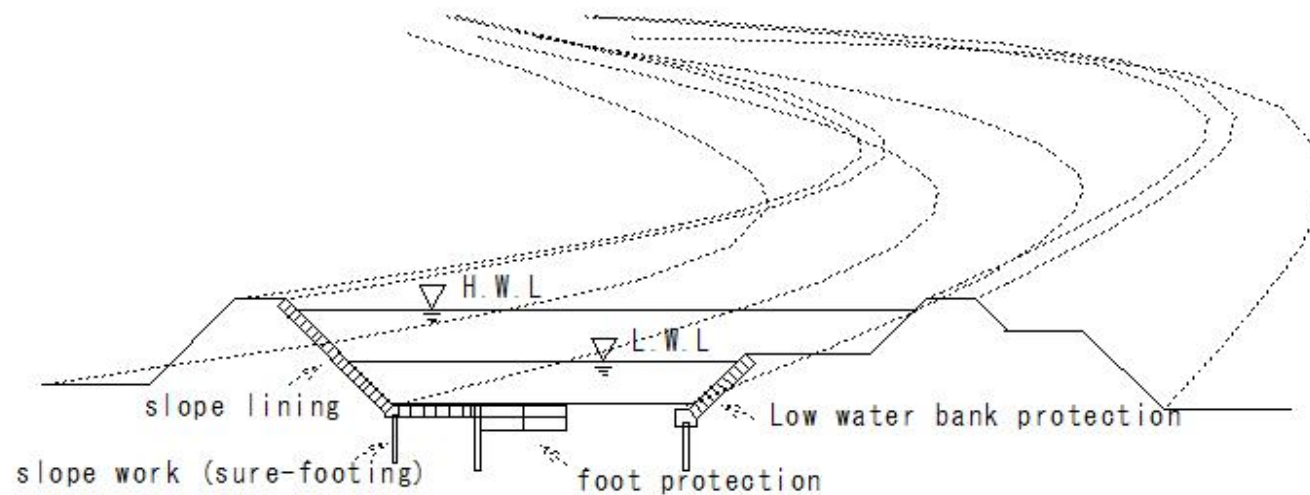
- Penetration of bank protection

Enough penetration depth

withstand scour

Small and medium-sized rivers: approximately 50cm to 1m

Large river - 1m or more



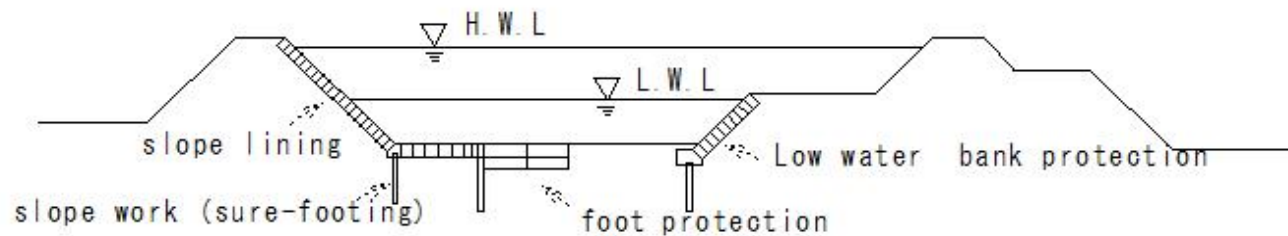
(R84)Structure and design of bank protection

(R84)Structure and design of bank protection

Structure and design of bank protection

- Slope of bank protection and height of lining

Structure of slope lining		Straight height of slope lining (m)	slope (gradient)
Masonry/Concrete block masonry	mortar masonry	3 or more, less than 5	0.5
		less than 3	0.3
	dry masonry	less than 3	1
Stone pitching/Concrete block pitching	mortar masonry		1.5
	dry masonry	less than 3	2
Concrete slope pavement			1.5
wire cylinder masonry work(gabion)		3 or more	2
Connecting concrete pitching		less than 3	1.5



(R85) Structure and design of bank protection

(R85) Structure and design of bank protection

Structure and design of bank protection

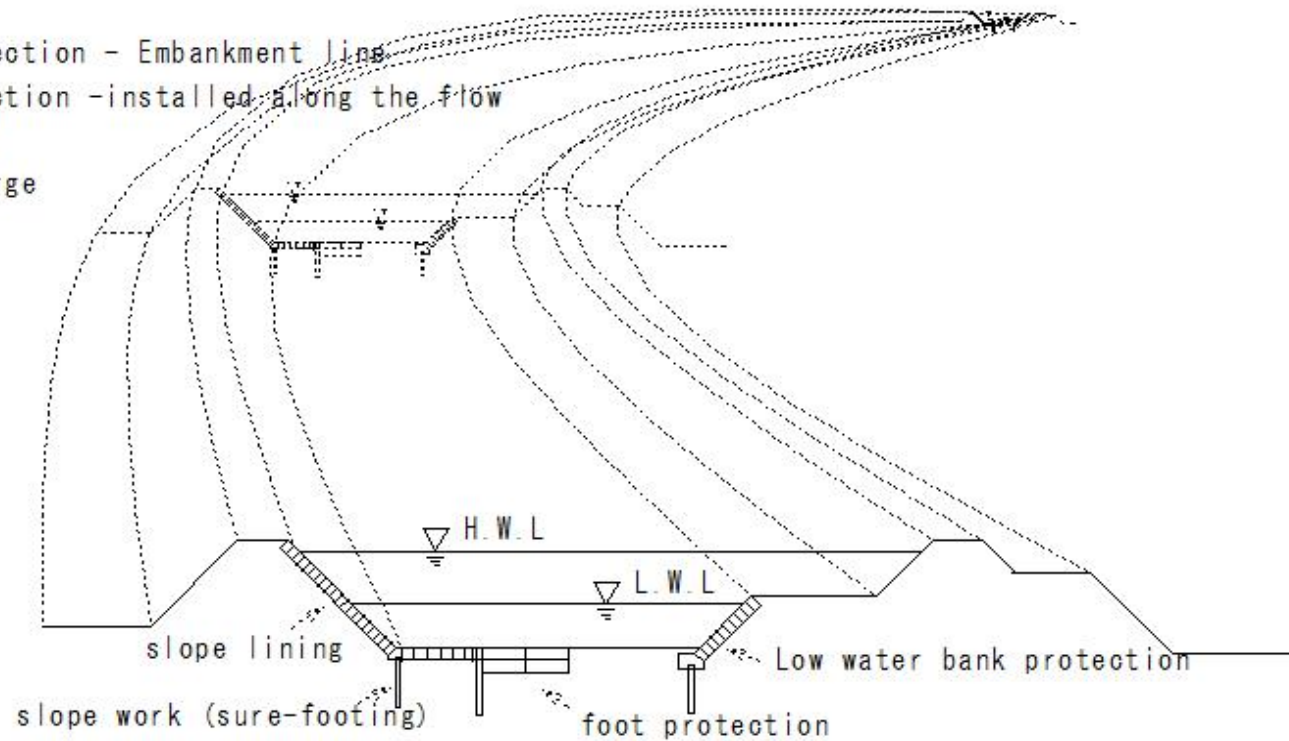
- bank protection line

High water bank protection - Embankment line

Low water bank protection - installed along the flow

Surface - unevenness

Flow resistance - large



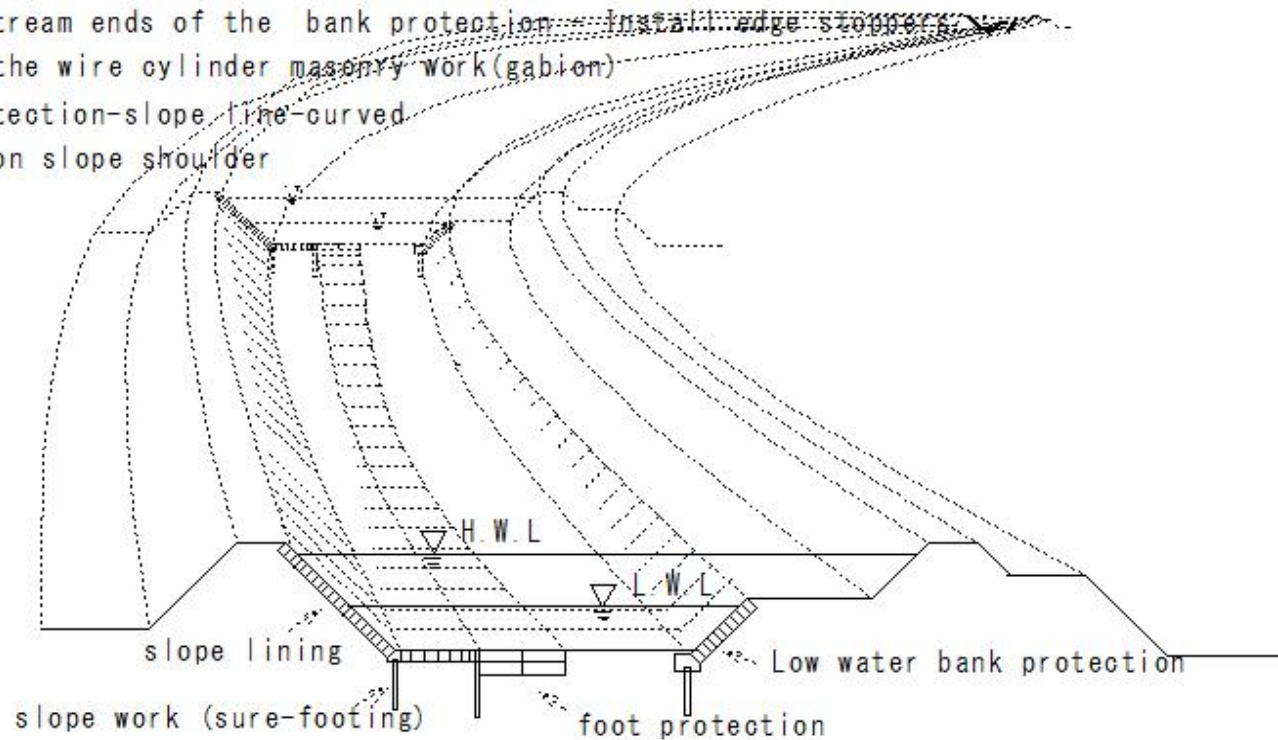
(R86)Structure and design of bank protection

(R86)Structure and design of bank protection

Structure and design of bank protection

• Points to attention

- ① Slope lining: Consider expansion and contraction due to temperature changes
- ② Slope lining and slope work (sure-footing) are insulated.
- ③ Upstream and downstream ends of the bank protection — install edge stoppers.
Get familiar with the wire cylinder masonry work (gabion)
- ④ Low water bank protection—slope line—curved concrete pitching on slope shoulder



(R87)Construction of Slope lining work(willow branch works)

(R87)Construction of Slope lining work(willow branch works)

Construction of Slope lining work

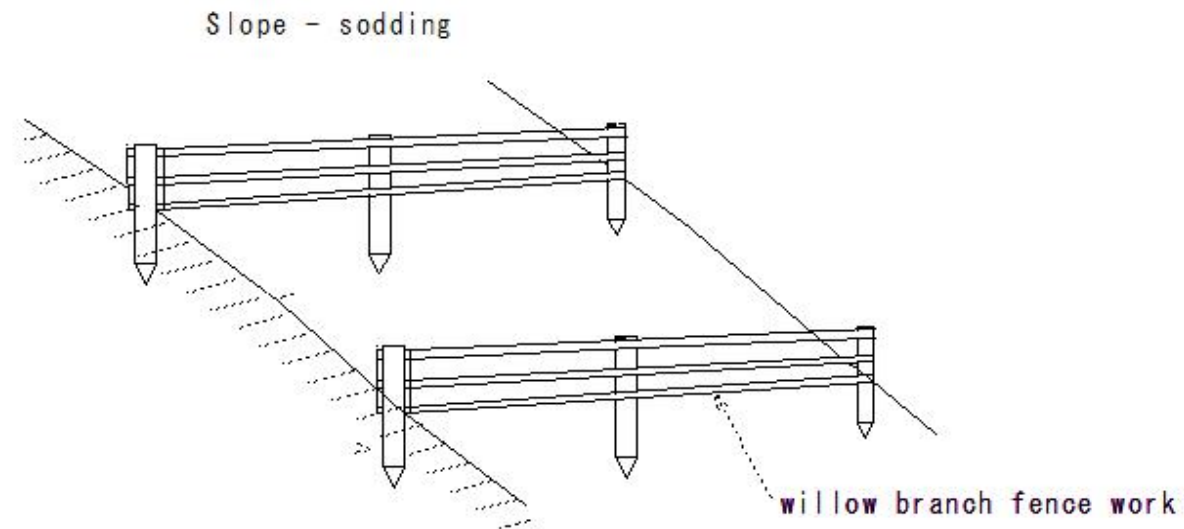
• Ordinary embankment

Slope - sodding

① willow branch works

willow branch fence work

fill with gravel



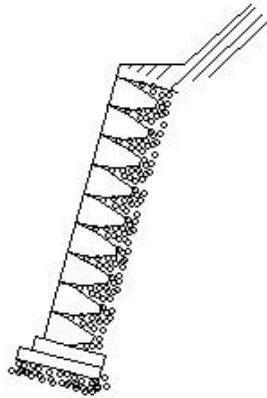
(R88)Construction of Slope lining work(Masonry/stone masonry)

(R88)Construction of Slope lining work(Masonry/stone masonry)

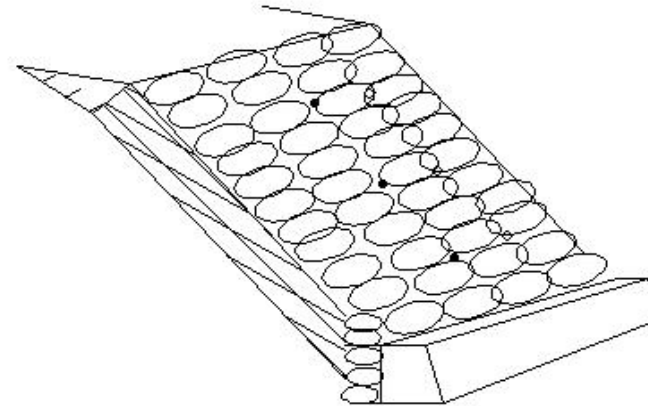
Construction of Slope lining work

②Masonry/stone masonry

- Slope steeper than 10%: Stone masonry
- Slope less than 10%: stone lining
- Mortar/concrete use -stone masonry y/stone pitching
- Do not use mortar or concrete - dry masonry/dry pitching



stone masonry



stone pitching

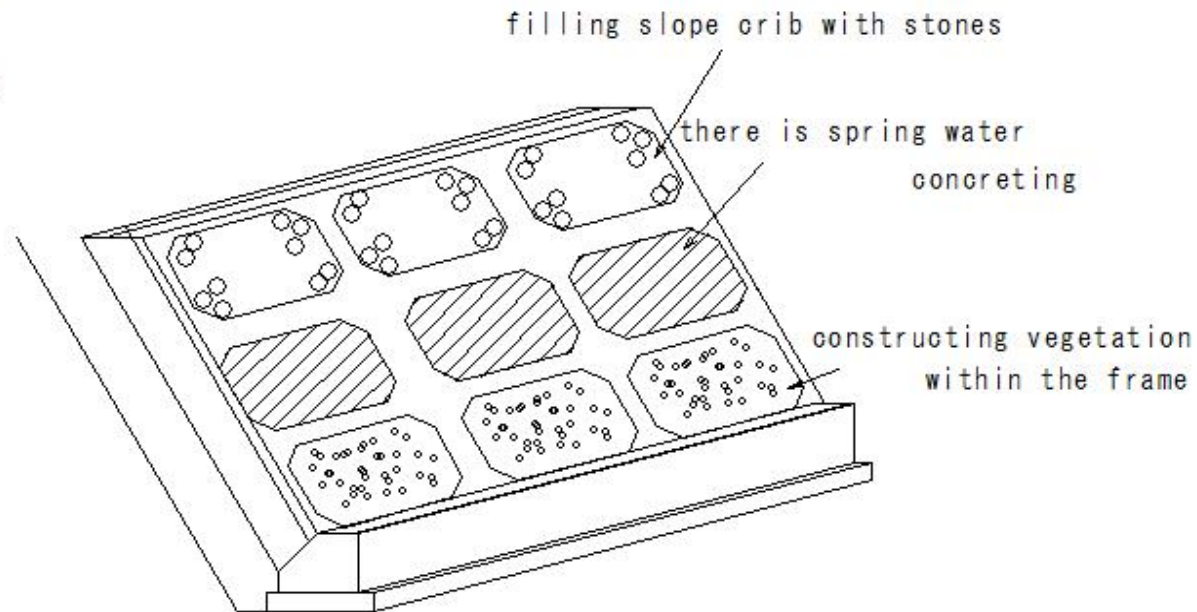
(R89)Construction of Slope lining work(Stone filling slope crib work method)

(R89)Construction of Slope lining work(Stone filling slope crib work method)

Construction of Slope lining work

③ Stone filling slope crib work

- On the slope
- Reinforced concrete material - rectangular frame
- Concrete pouring
- cobble stone
- Slope 1:2 or less



Stone filling slope crib method

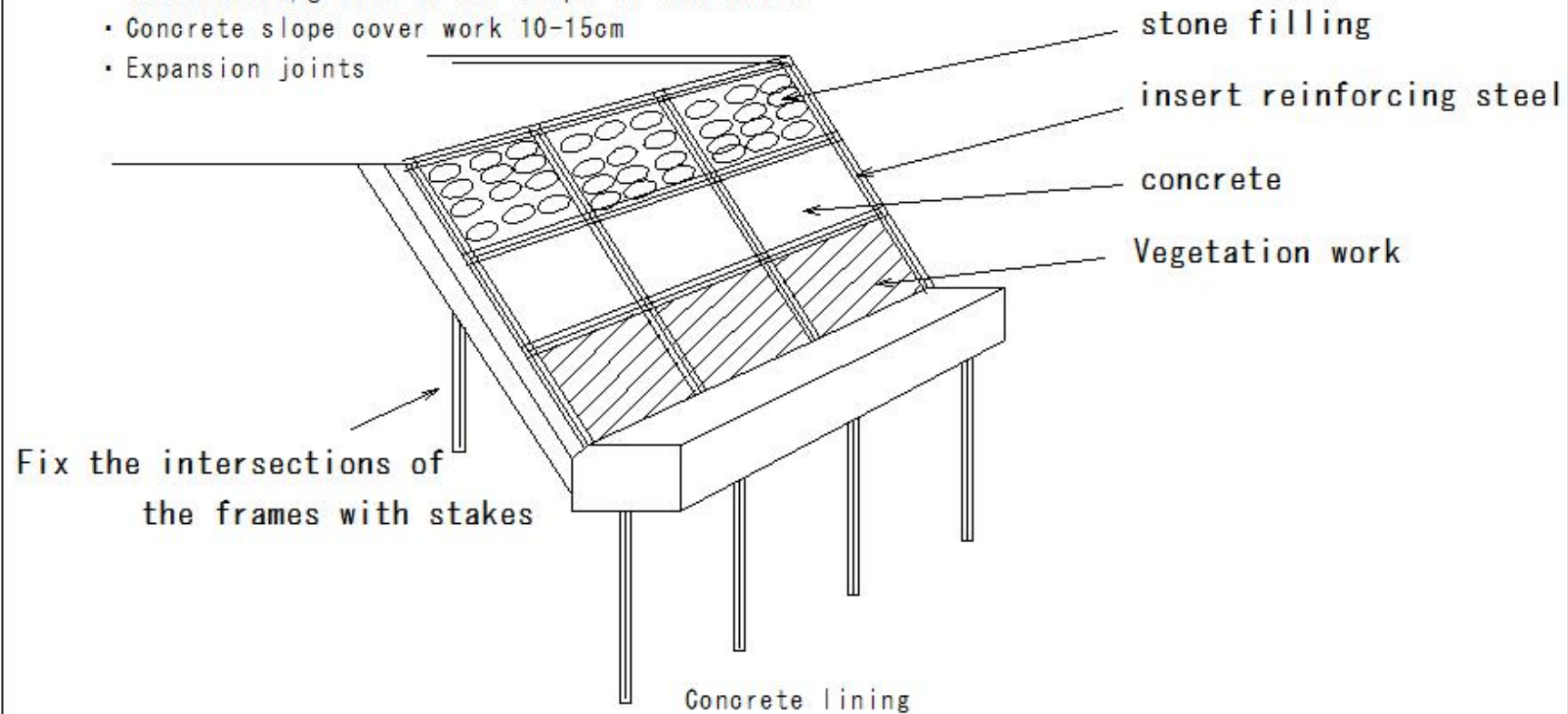
(R90)Construction of Slope lining work(Concrete lining)

(R90)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



(R91)Construction of Slope lining work(Concrete lining)

(R91)Construction of Slope lining work(Concrete lining)

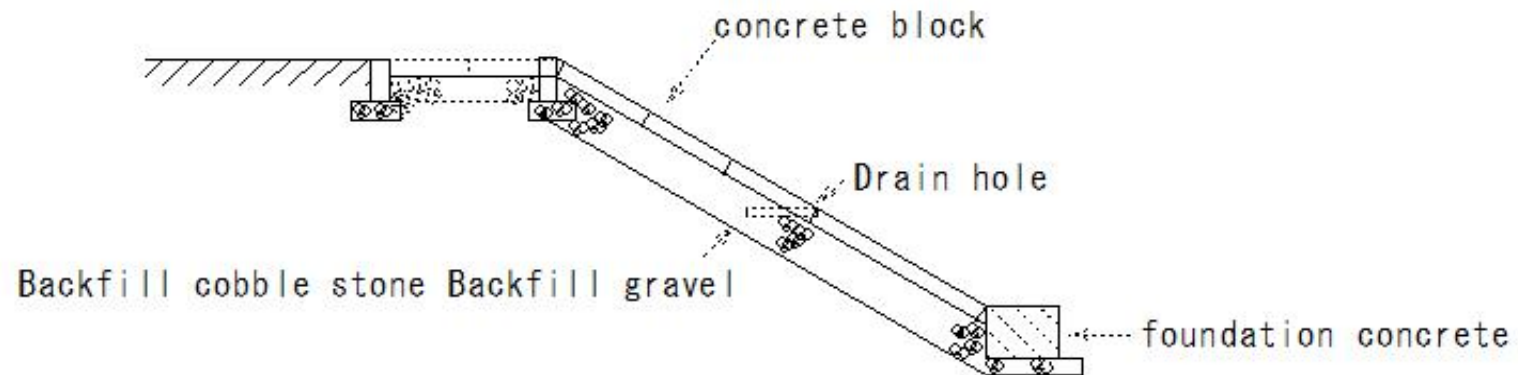
Construction of Slope lining work

⑤Concrete block construction

concrete block pitching

Sediment outflow - Block settlement - Cavity - Small

Easy to repair



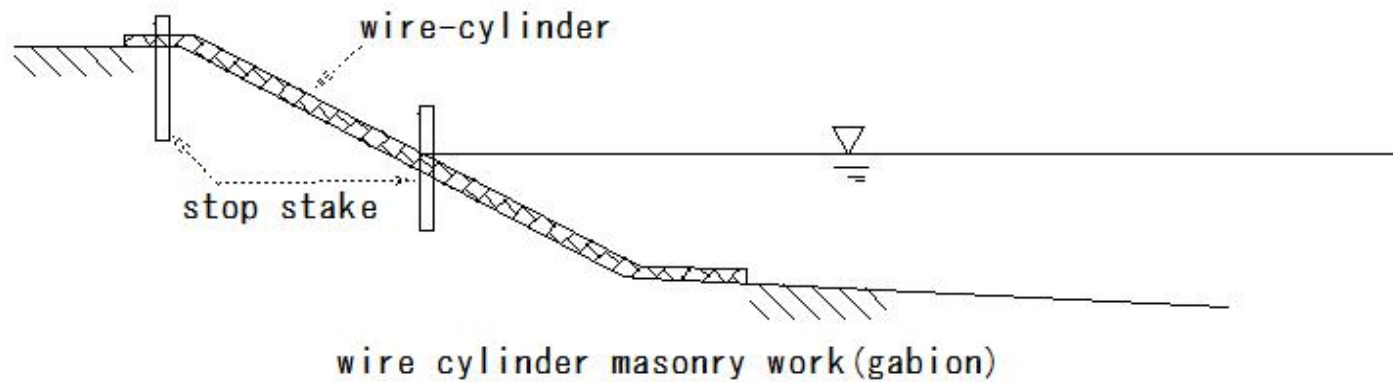
(R92)Construction of Slope lining work(Concrete lining)

(R92)Construction of Slope lining work(Concrete lining)

Construction of Slope lining work

⑥ wire cylinder masonry work(gabion)

- Cylindrical shape
- Diameter 50-90cm Length 10m
- Durability - poor



(R93)Construction of Slope lining work(Concrete lining)

(R93) Construction of Slope lining work(Concrete lining)

Construction of Slope lining work

• Selection

① Overflow section

sodding works

willow branch works

wire cylinder masonry work(gabion)

dry masonry

concrete block pitching

• Points to consider

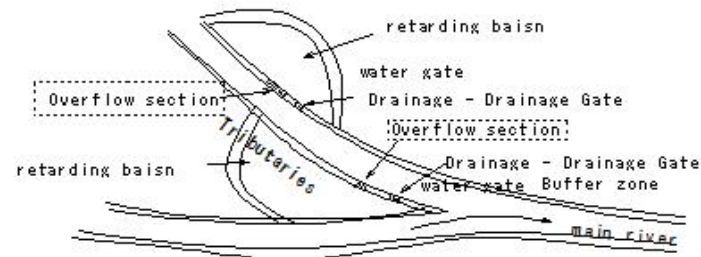
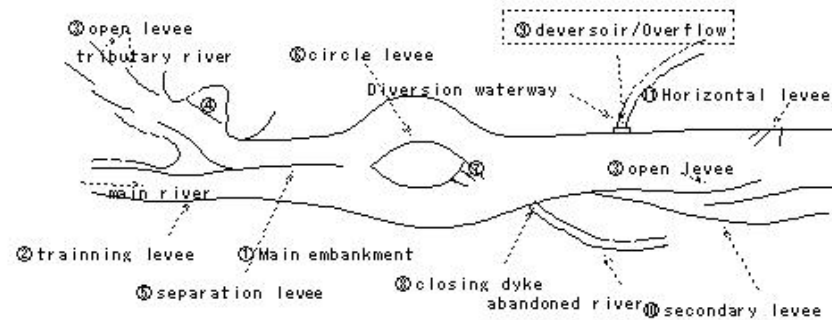
Selection of construction method

• River gradient

• Roughness of riverbed material

• Flow

• Slope lining work



(R94)Construction of Slope lining work

(R94) Construction of Slope lining work

Construction of Slope lining work

- Selection

② Midstream section

wire cylinder masonry work(gabion)

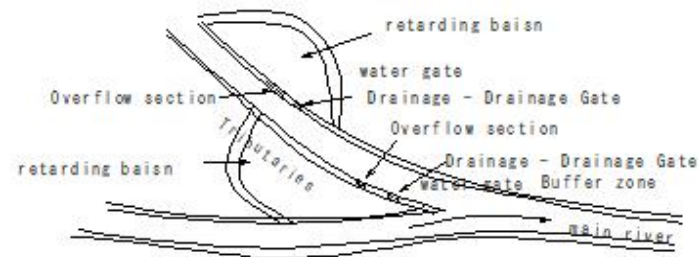
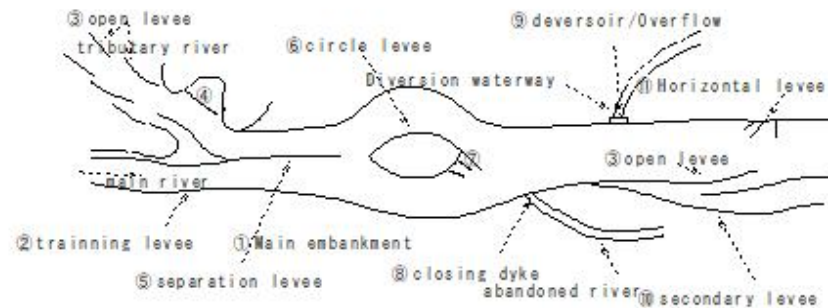
stone masonry

concrete block pitching

Points to consider

Selection of construction method

- River gradient
- Roughness of riverbed material
- Flow
- Slope of Slope lining work



(R95)Construction of Slope lining work

(R95)Construction of Slope lining work

Construction of Slope lining work

- Selection

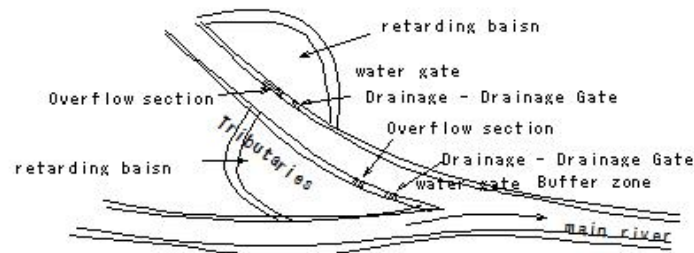
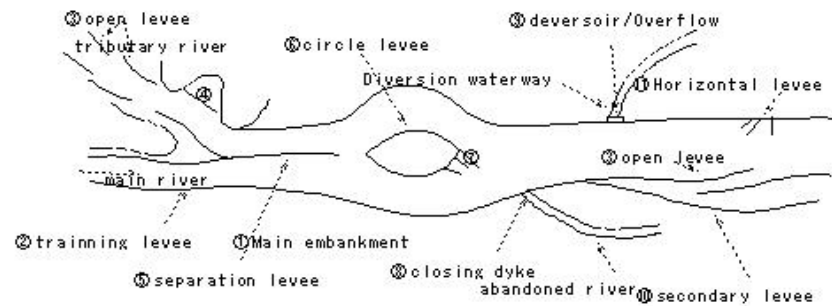
③Rapids section

- Stone masonry work
- Concrete lining

Points to consider

Selection of construction method

- River gradient
- Roughness of riverbed material
- Flow
- gradient of Slope lining

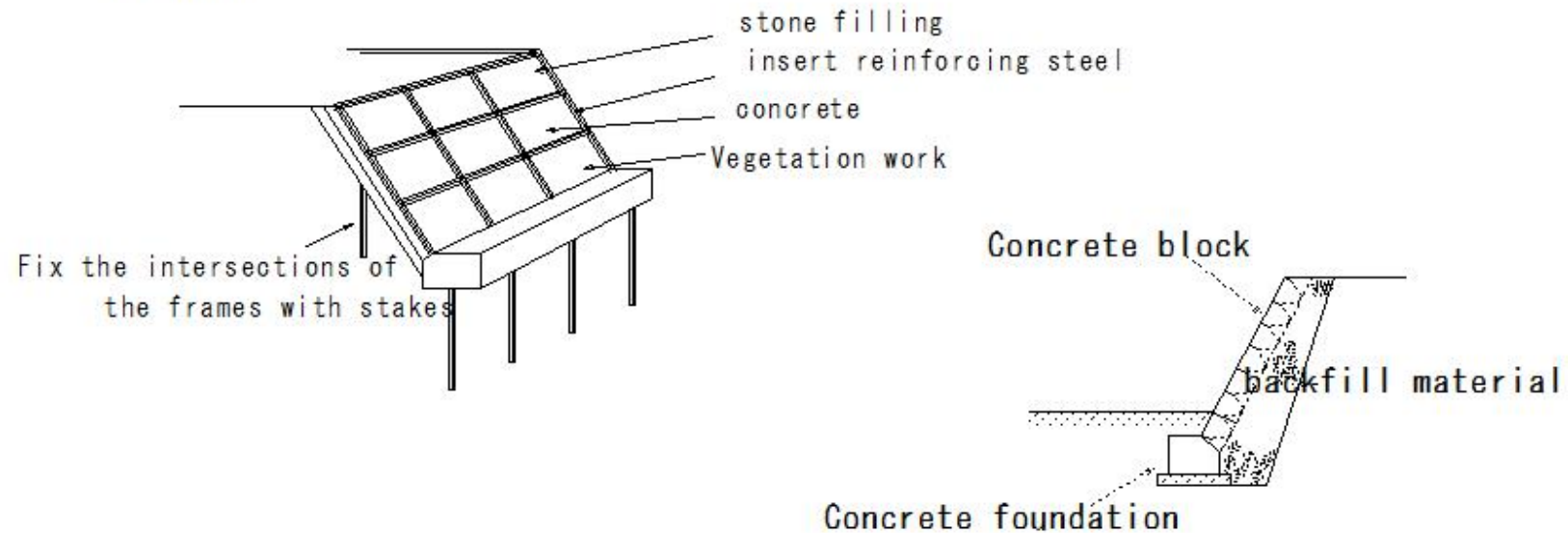


(R96) Foundation work/slope work (sure-footing)

(R96) Foundation work/slope work (sure-footing)

Foundation work/slope work (sure-footing)

- Supports slope work (sure-footing)
- bank protection legs - scouring prevention
- Water depth - Shallow - Foundation work
- Water Depth - Deep Foundation penetration - Difficult - slope work (sure-footing)
- insulation



(R97)Foundation work/slope work (sure-footing)

(R97)Foundation work/slope work (sure-footing)

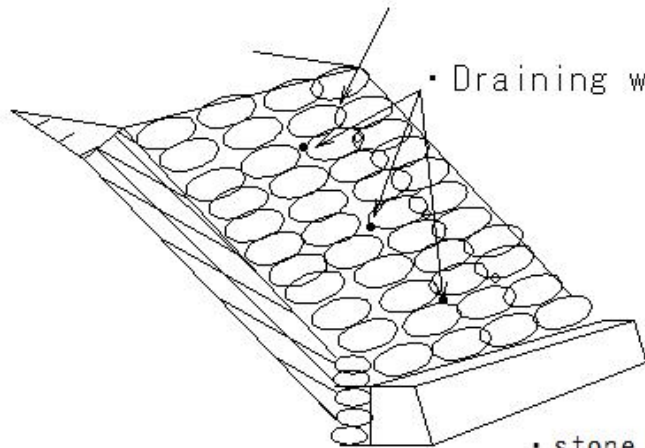
Foundation work/slope work (sure-footing)

①Types of foundation work

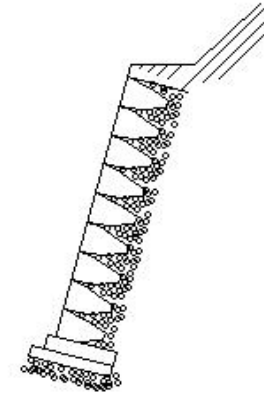
- Concrete foundation
- Concrete block masonry
- Concrete framework
- dry masonry - basics of simple slope lining work
- 1 retaining pile foundation
- ladder base

• Stop with mortar

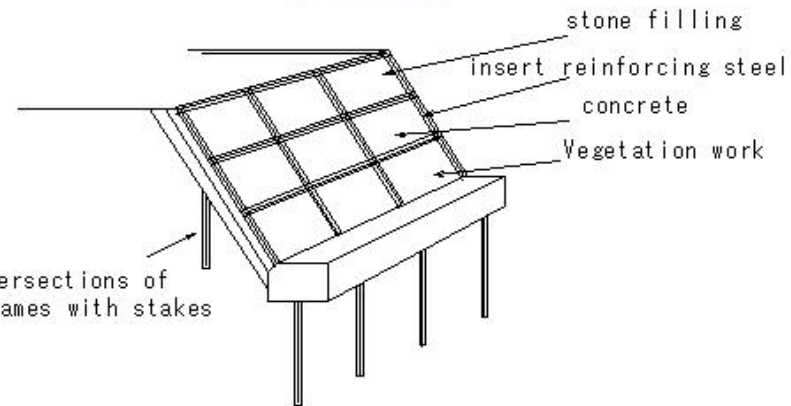
• Draining water



• stone pitching



• stone masonry



Fix the intersections of the frames with stakes

• Concrete framework

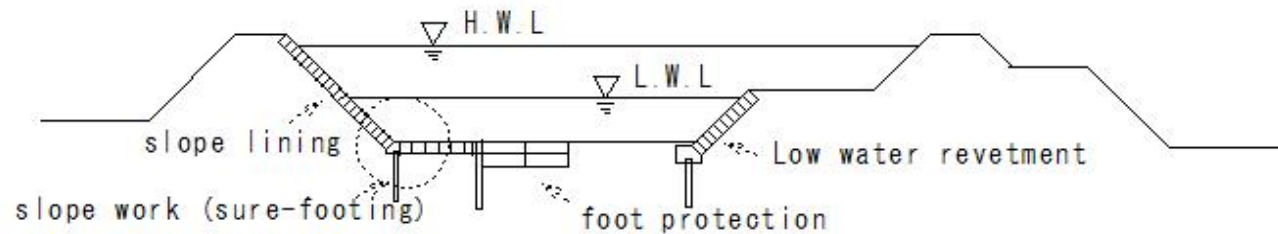
(R98) Foundation work/slope work (sure-footing)

(R98) Foundation work/slope work (sure-footing)

Foundation work/slope work (sure-footing)

② Height of foundation work height

- Planned riverbed - embed approximately (0.5-1.5m) below the riverbed



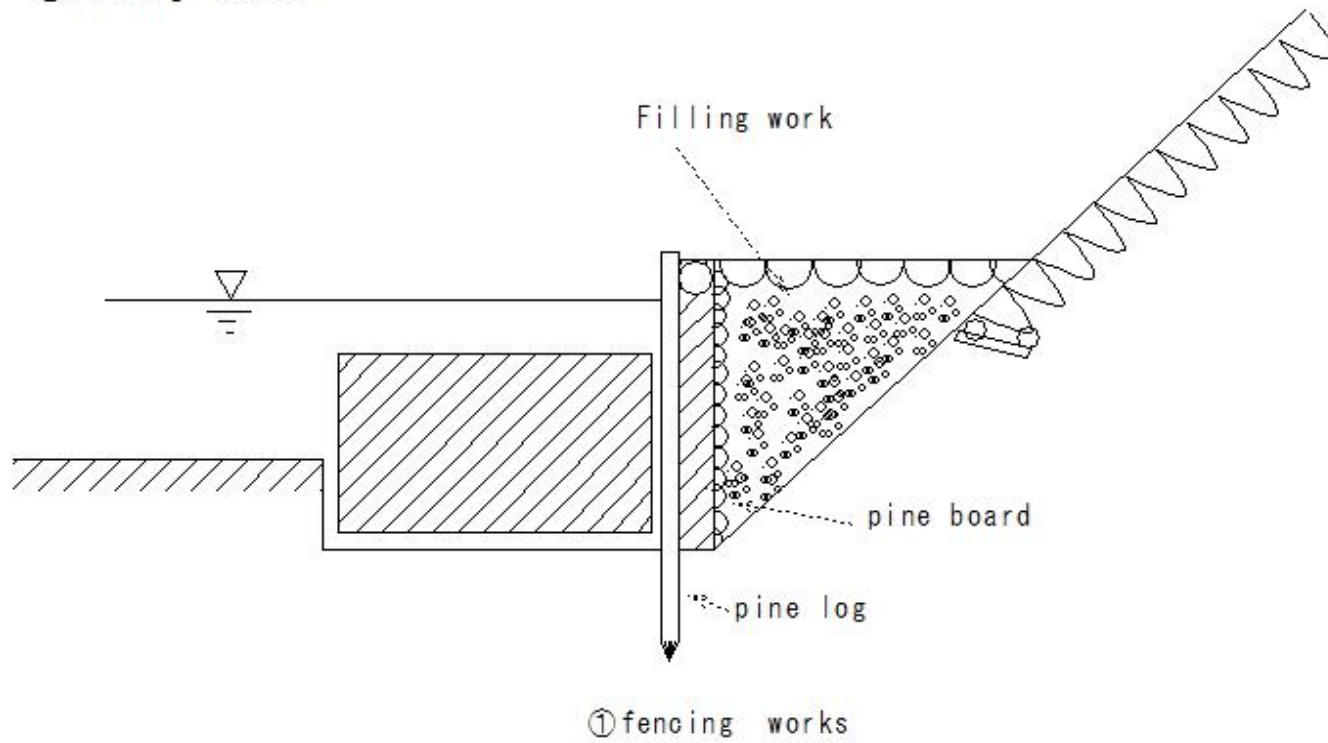
(R99)Foundation work/slope work (sure-footing)

(R99)Foundation work/slope work (sure-footing)

Foundation work/slope work (sure-footing)

③ Types of slope work (sure-footing)

① fencing works



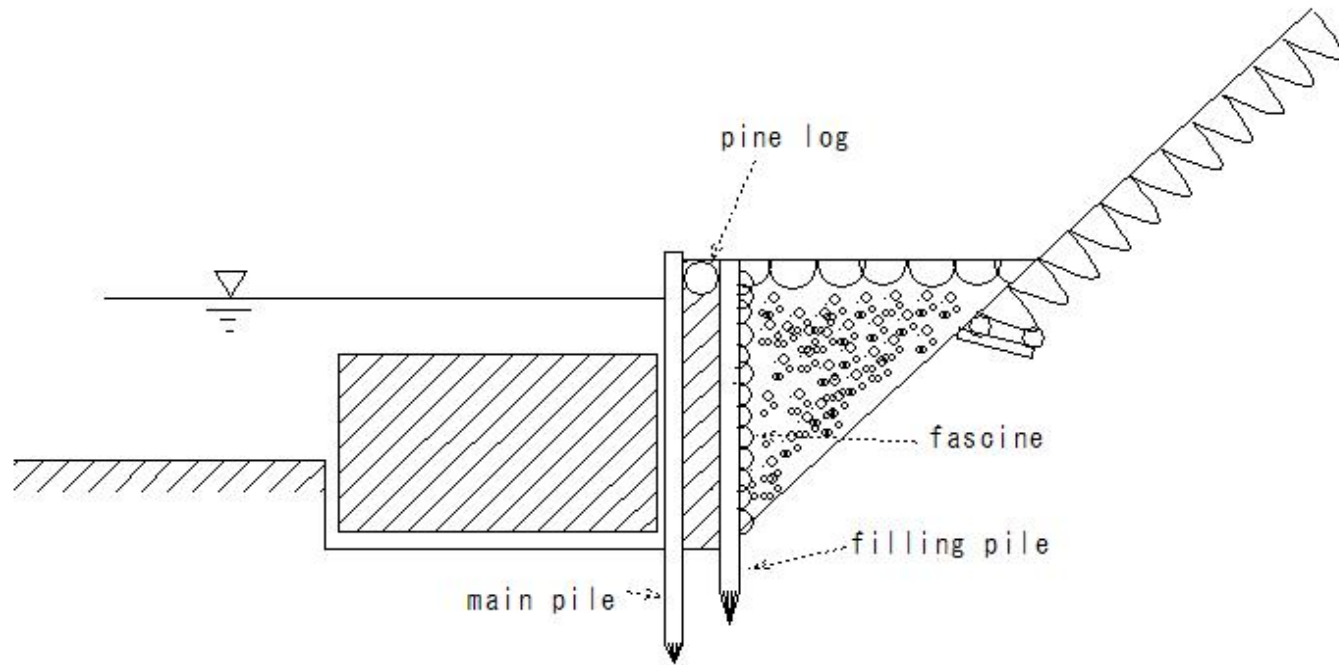
(R100)Foundation work/slope work (sure-footing)

(R100)Foundation work/slope work (sure-footing)

Foundation work/slope work (sure-footing)

③Types of slope work (sure-footing)

②Piling work



②Piling work

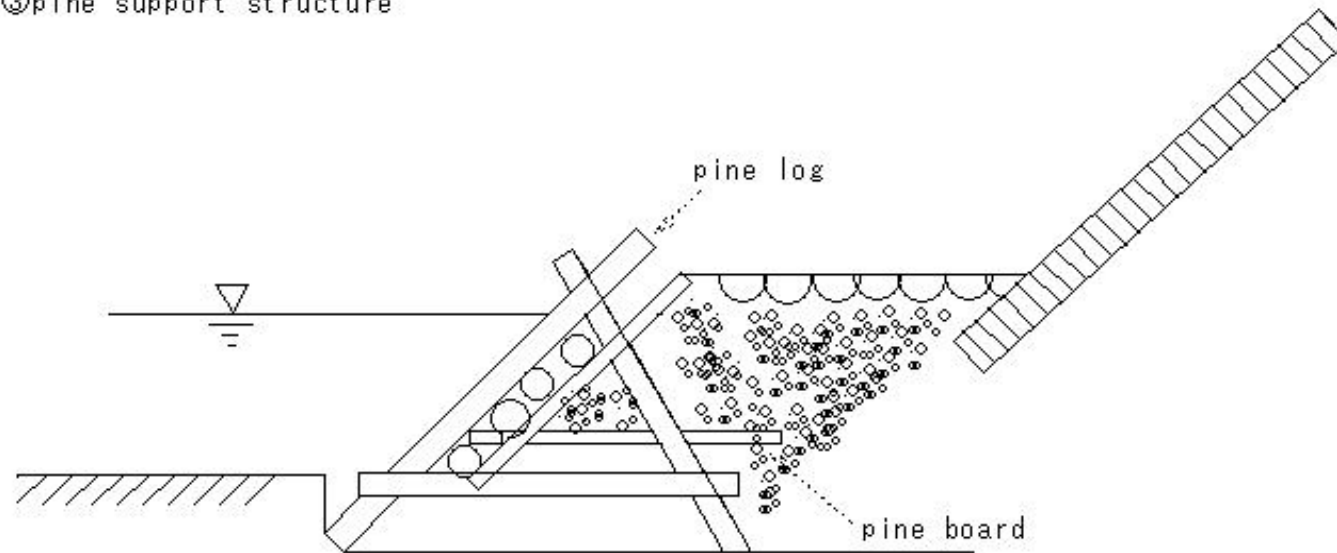
(R101)Foundation work/slope work (sure-footing)

(R101)Foundation work/slope work (sure-footing)

Foundation work/slope work (sure-footing)

③Types of slope work (sure-footing)

③pine support structure



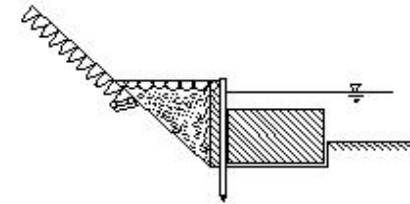
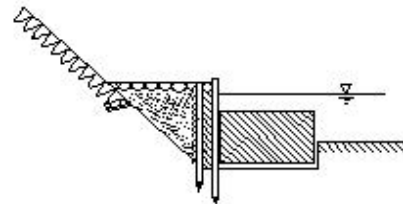
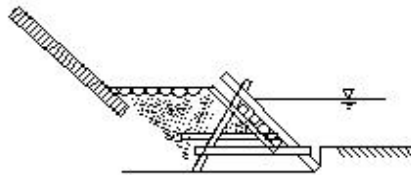
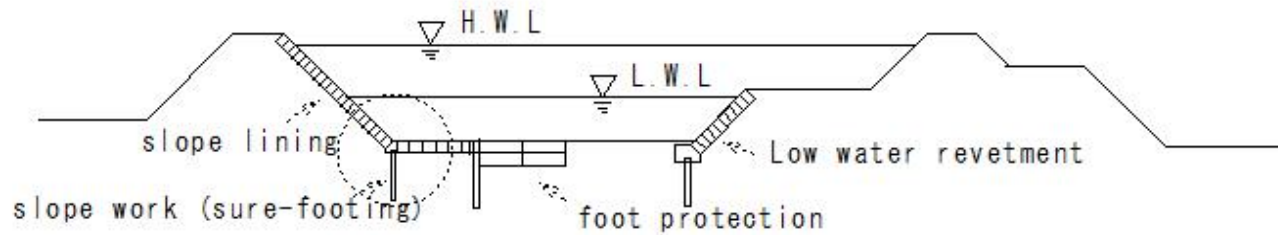
③pine support structure

(R102)Foundation work/slope work (sure-footing)

(R102)Foundation work/slope work (sure-footing)

Foundation work/slope work (sure-footing)

- ④ Height of slope work (sure-footing)
Below average low water level
penetration - the deeper the better

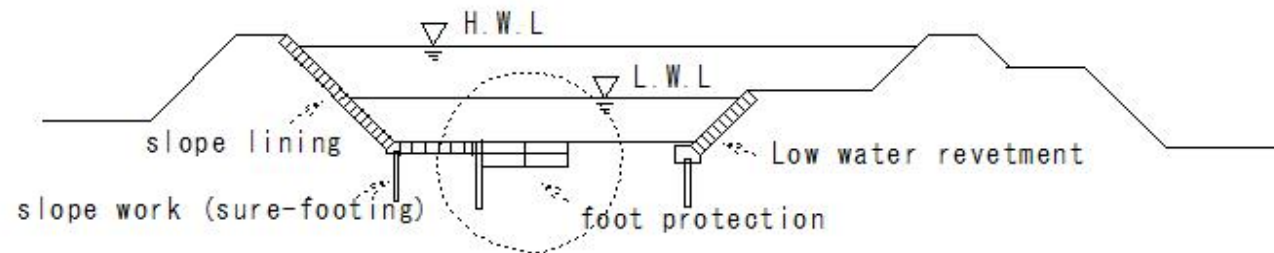


(R103) Foundation work/slope work (foot protection)

(R103) Foundation work/slope work (foot protection)

foot protection

- Foundation work: Located in front of slope work (sure-footing)
- Prevention of scouring of slope work (sure-footing)
- Places where scouring is likely to occur
- Used in combination with groin
- slope work (sure-footing) (foundation work)
- Constructed on the front to prevent riverbed scouring
- Protects the slope lining work

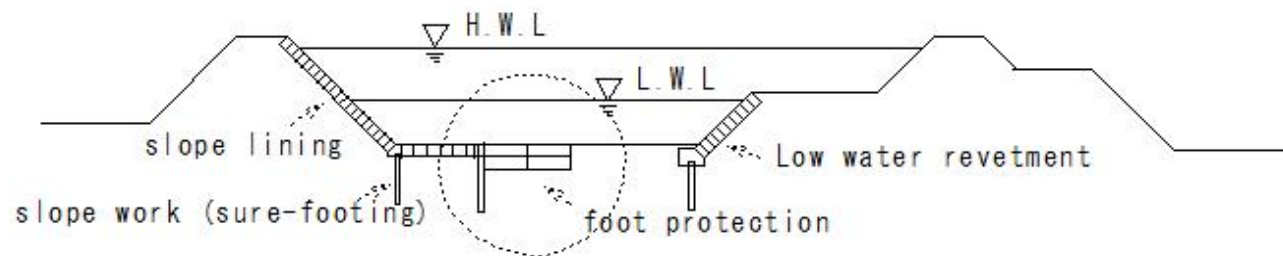


(R104) Foundation work/slope work (foot protection)

(R104) Foundation work/slope work (foot protection)

foot protection work

- ① To withstand sweeping force
 - ② Adaptable to river bed changes
 - ③ Easy construction
 - ④ Durability - great
- Set the foot protection work low.
 - water collision parts? deep installation



(R105) Foundation work/slope work (foot protection)

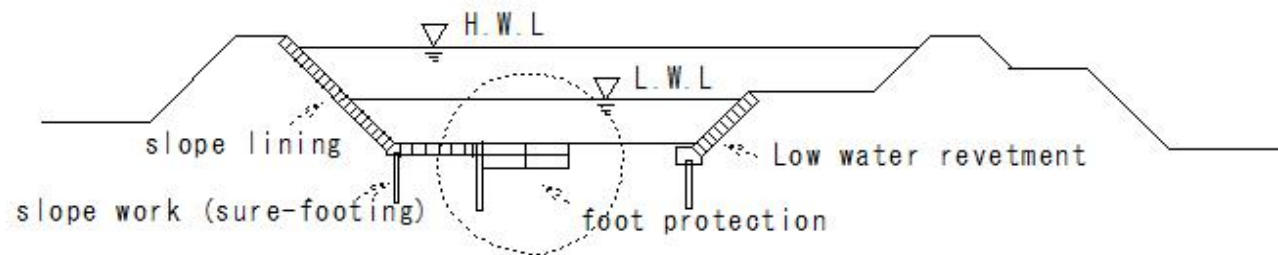
(R105) Foundation work/slope work (foot protection)

foot protection work

① Structure

① Height, width, thickness

- Height of the top of foot protection work: Below the planned river bed height
- Considering past experience and achievements

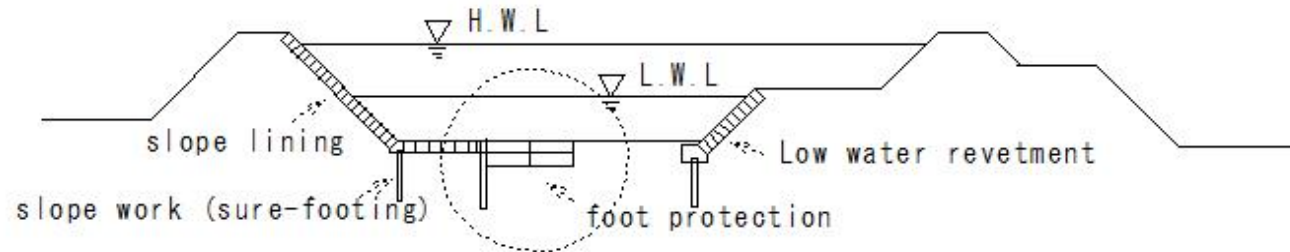


(R106) Foundation work/slope work (foot protection)

(R106) Foundation work/slope work (foot protection)

foot protection work

- ① Structure
- ② Adapt to changes in the river channel
- ③ Rigid structure



(R107)Foundation work/slope work (foot protection)

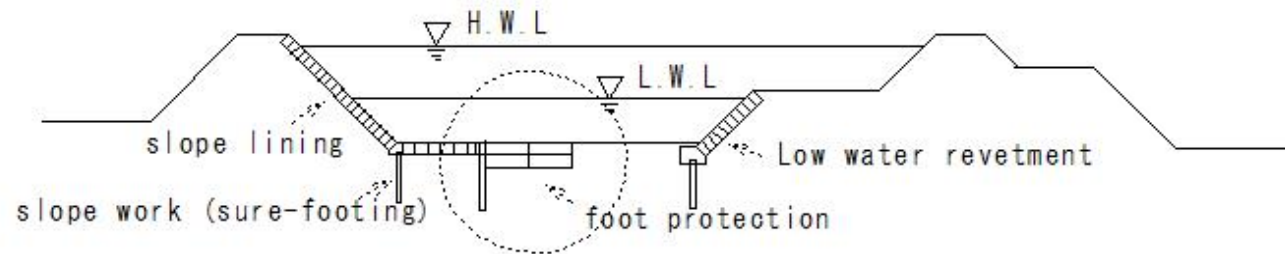
(R107)Foundation work/slope work (foot protection)

foot protection work

① Structure

② Roughness

- Destruction of slope work (foot protection) - scouring of foundation
- scouring - to reduce
- foot protection hardening - gives roughness
- Reducing current force and flow rate during floods



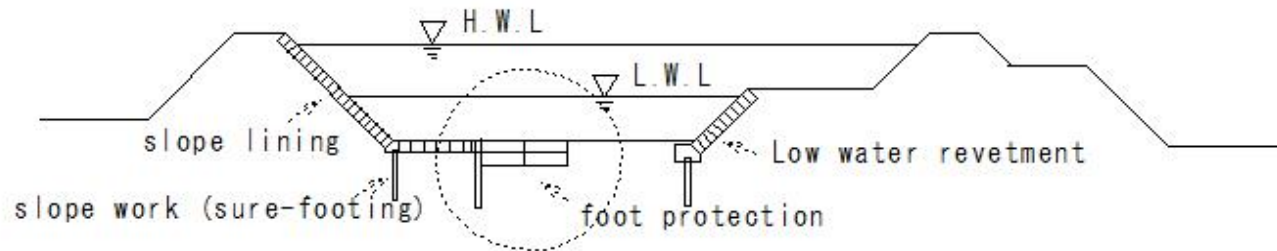
(R108) Foundation work/slope work (foot protection)

(R108) Foundation work/slope work (foot protection)

foot protection work

③ Weight

- Supports water leaks
- Appropriate weight is required



(R109) Foundation work/slope work (foot protection)

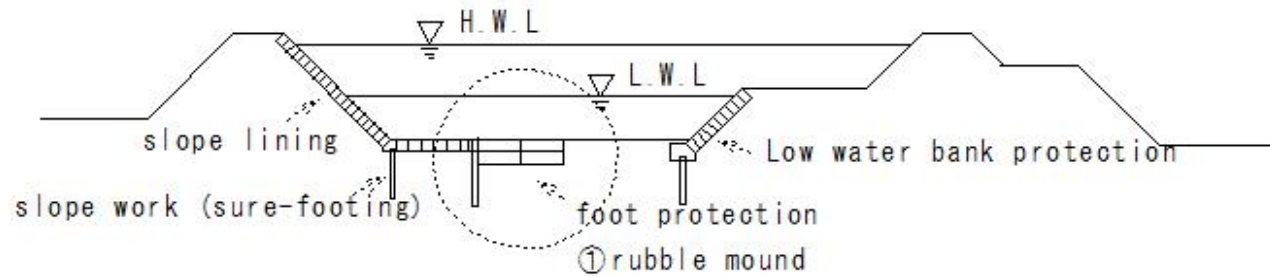
(R109) Foundation work/slope work (foot protection)

foot protection work

type

① rubble mound

- Using rubble mound and concrete blocks at the end of the bank protection



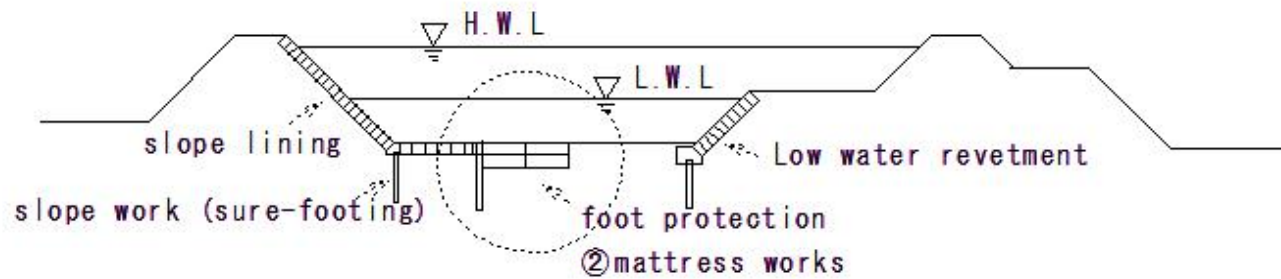
(R110) Foundation work/slope work (foot protection)

(R110) Foundation work/slope work (foot protection)

foot protection work

type

- ② mattress works
- fascine mattress
- wood mattress
- concrete mattress



(R111)Foundation work/slope work (foot protection)

(R111)Foundation work/slope work (foot protection)

foot protection work

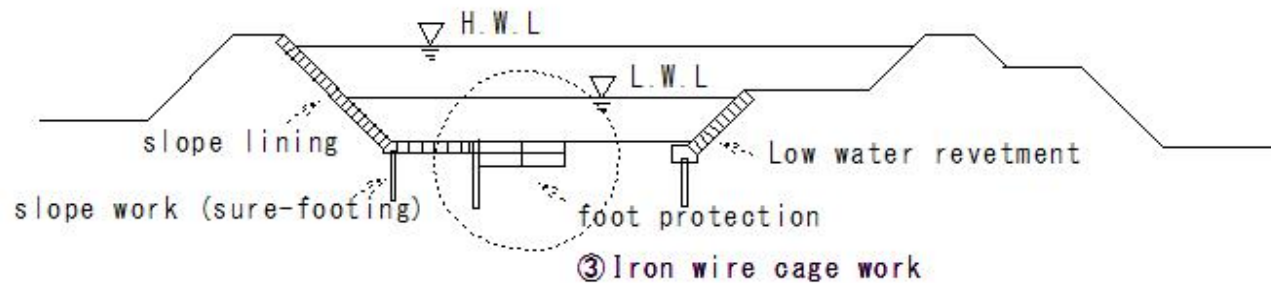
type

③ Iron wire cage work

• Pack stones in a wire basket

For emergency use

Durability - poor



(R112)Foundation work/slope work (foot protection)

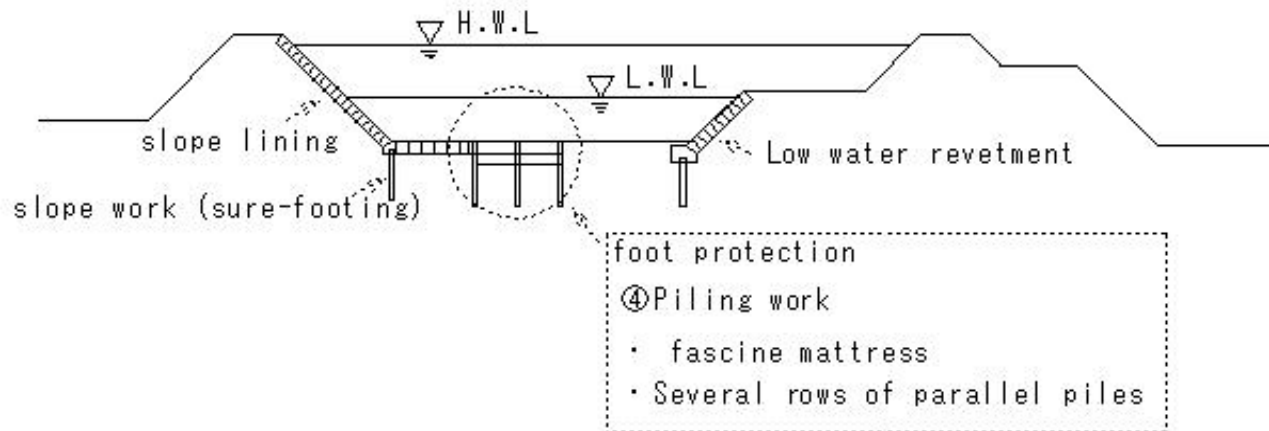
(R112)Foundation work/slope work (foot protection)

foot protection work

type

④Piling work

- Used for anchorage parts
- fascine mattress
- Several rows of parallel piles
- flowing regulations
- Riverbank - erosion prevention



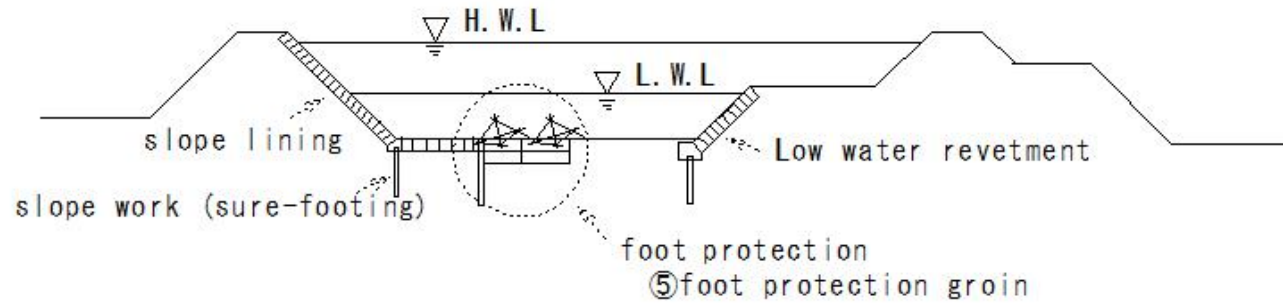
(R113)Foundation work/slope work (foot protection)

(R113)Foundation work/slope work (foot protection)

foot protection

type

⑤ foot protection groin



groin

(R114)Foundation work/slope work (foot protection)

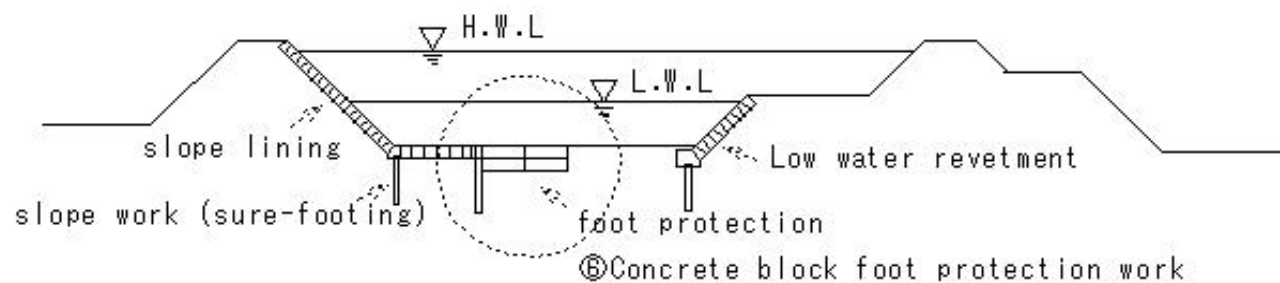
(R114)Foundation work/slope work (foot protection)

foot protection

type

㊦ Concrete block foot protection work

- Combination of blocks
- Appropriate familiarity

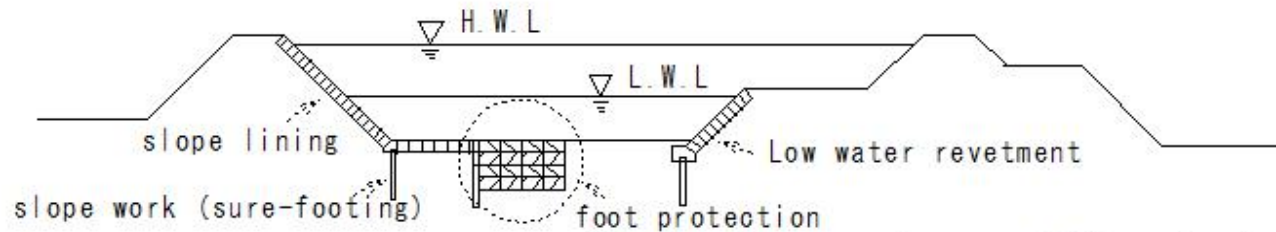


(R115)Foundation work/slope work (foot protection)

(R115)Foundation work/slope work (foot protection)

foot protection

① Wood mattress works—case of the water is deep



① Wood mattress works—case of the water is deep

- overlap width: 1/2 of the width of the lower bed
- pile up: 3-4 tiers

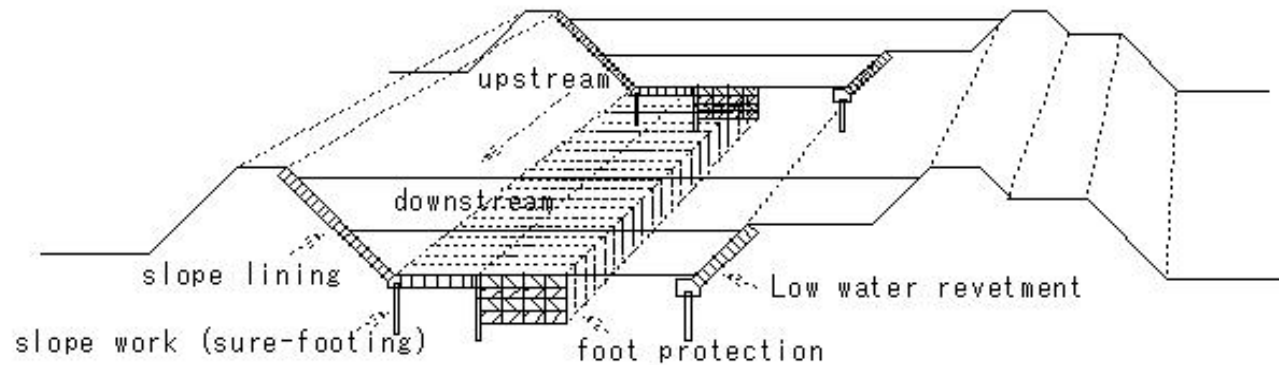
(R116)Foundation work/slope work (foot protection)

(R116)Foundation work/slope work (foot protection)

foot protection

②Construction of foot protection work

- Proceed with construction from upstream to downstream



②Construction of foot protection work

- Proceed with construction from upstream to downstream

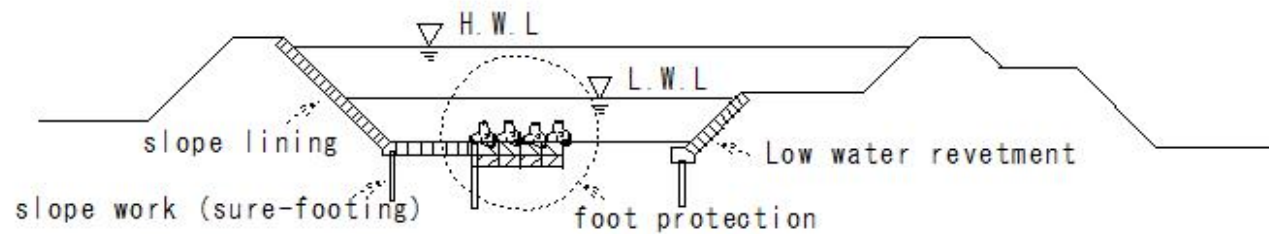
(R117)Foundation work/slope work (foot protection)

(R117)Foundation work/slope work (foot protection)

foot protection

③ Deformed concrete block block

- Porosity of random pile foot protection work 50-60%



③ Deformed concrete block block

- Porosity of random pile foot protection work 50-60%

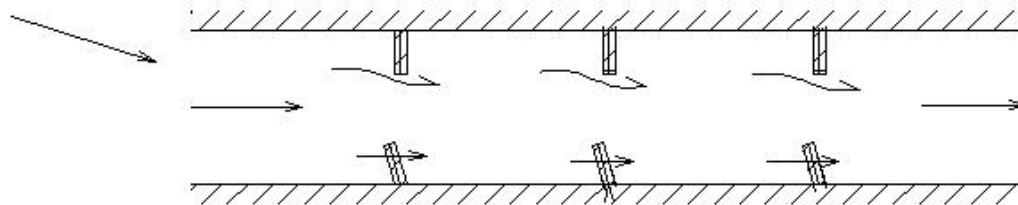
(R118)groin

(R118) groin

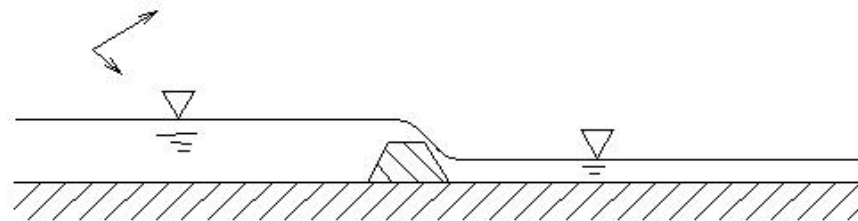
groin

- ① Bank protection: Suppression of flow velocity in front of riverbank
- ② Prevention of scouring
- ③ Water flow, separate the flow from the heart
- ④ Fixing of regular waterway Direction
- ⑤ Considering the impact on the opposite shore, upstream and downstream
- ⑥ groin - reduce current force
- ⑦ groin - water flow control
- ⑧ Protrude from the riverbank at an angle.

non overflow groin



Overflow water control



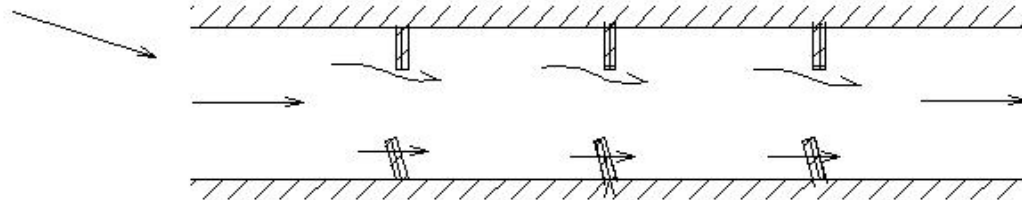
(R119)groin

(R119) groin

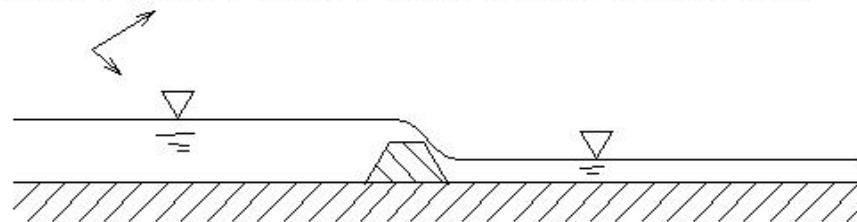
Purpose of groin

- ① Change the direction of the flowing water
- ② Flow velocity - relaxation
 - Sedimentation - Stability of embankments and riverbanks
- ③ Maintaining the width and depth of low water channels
- ④ Concentrate running water and make water intake convenient

non overflow groin



Overflow water control



(R120)groin

(R120) groin

groin

type of groin

• Classification by structure

○ Permeable groin

• Flow velocity decrease

• High flow permeability structure

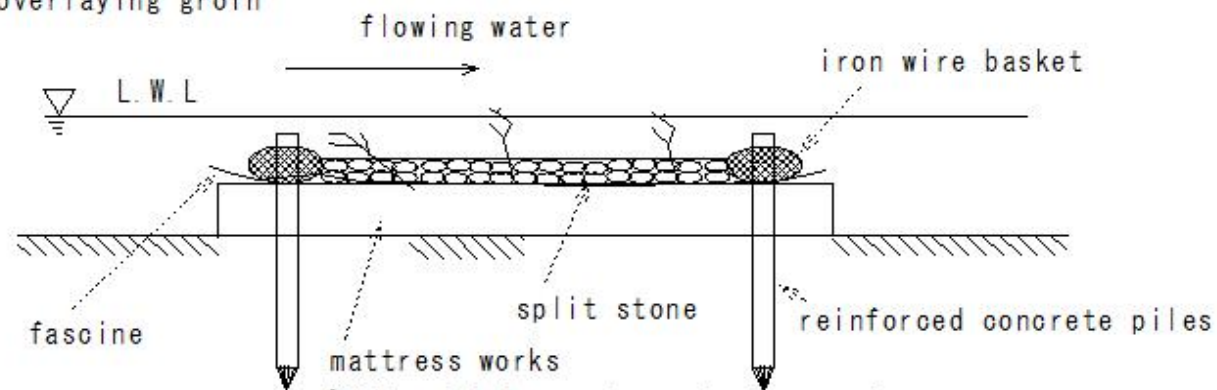
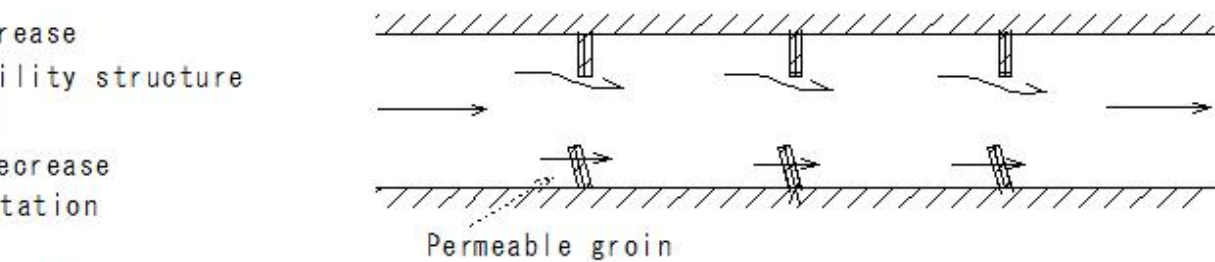
• Easy maintenance

• Flow velocity - decrease

• Effective sedimentation

① Pile driving and overlaying groin

flowing water



(R121)groin

(R121) groin

groin

type of groin

- Classification by structure

- Permeable groin

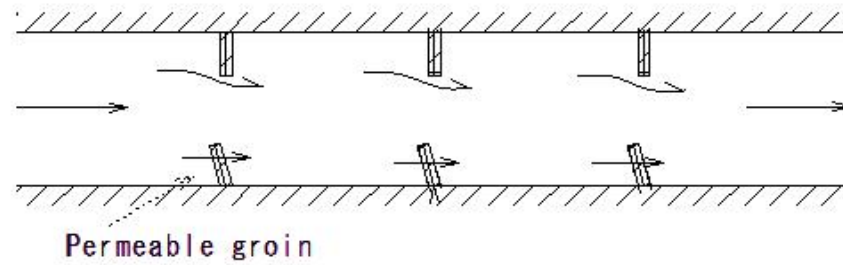
- Flow velocity decrease

- High flow permeability structure

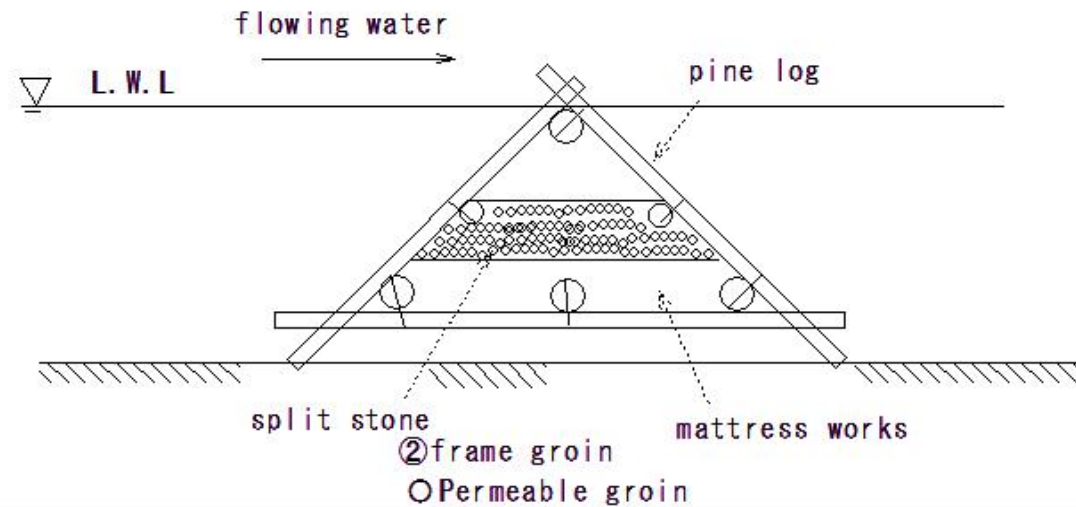
- Easy maintenance

- Flow velocity - decrease

- Effective sedimentation



② frame groin



(R122)groin

(R122) groin

groin

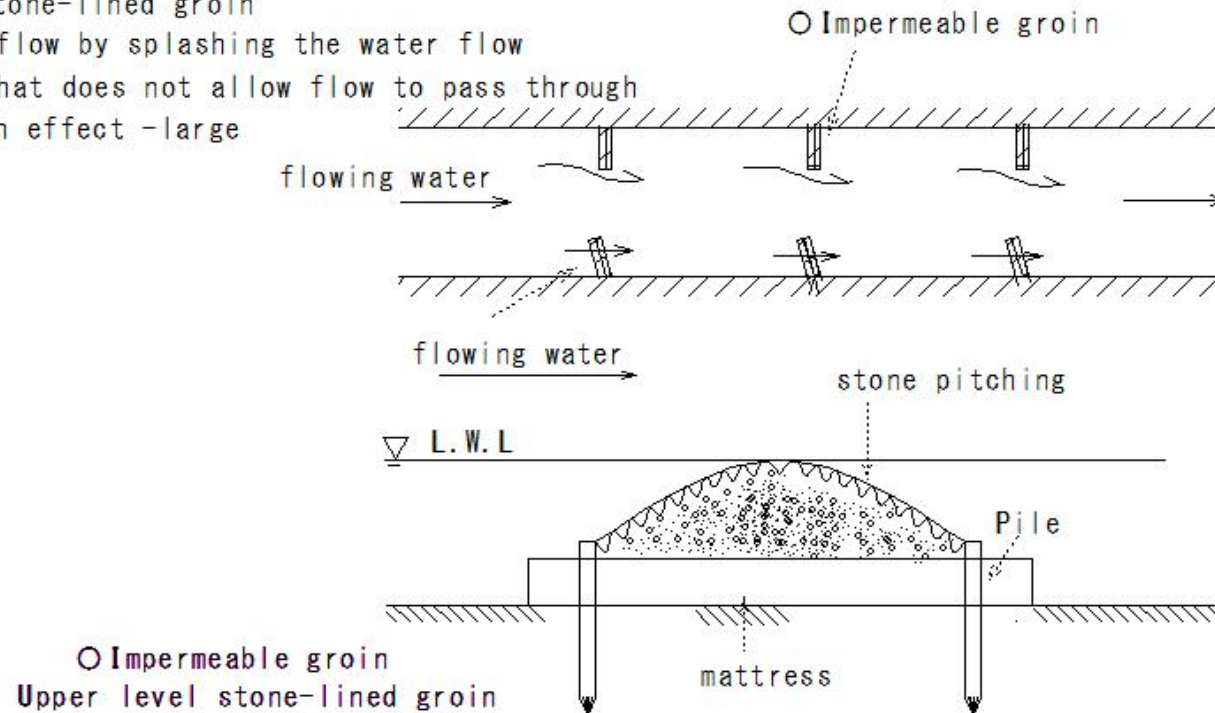
type of groin

- Classification by structure

○ Impermeable groin

Upper level stone-lined groin

- Change the flow by splashing the water flow
- Structure that does not allow flow to pass through
- Water splash effect - large



(R123)groin

(R123) groin

Type of groin

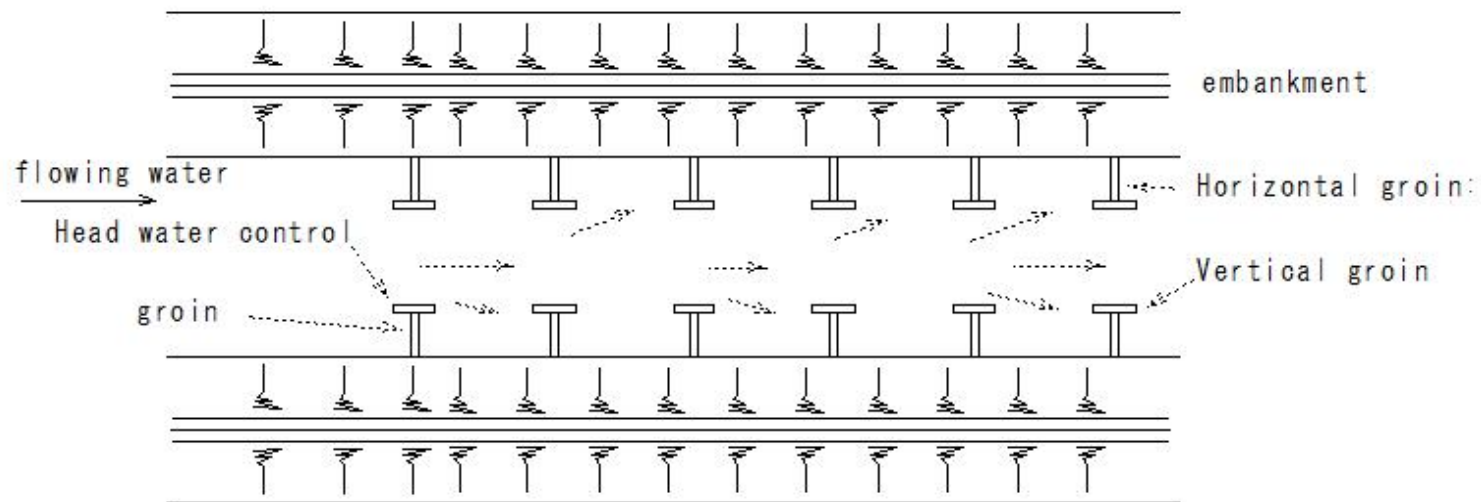
- Classification by flow direction

Horizontal groin: The direction in which the water pipe is perpendicular to the water flow.

Vertical groin: parallel to the water flow

Head water control: water control tip protection

Horizontal groin



Vertical/horizontal groin

(R124)groin

(R124) groin

groin

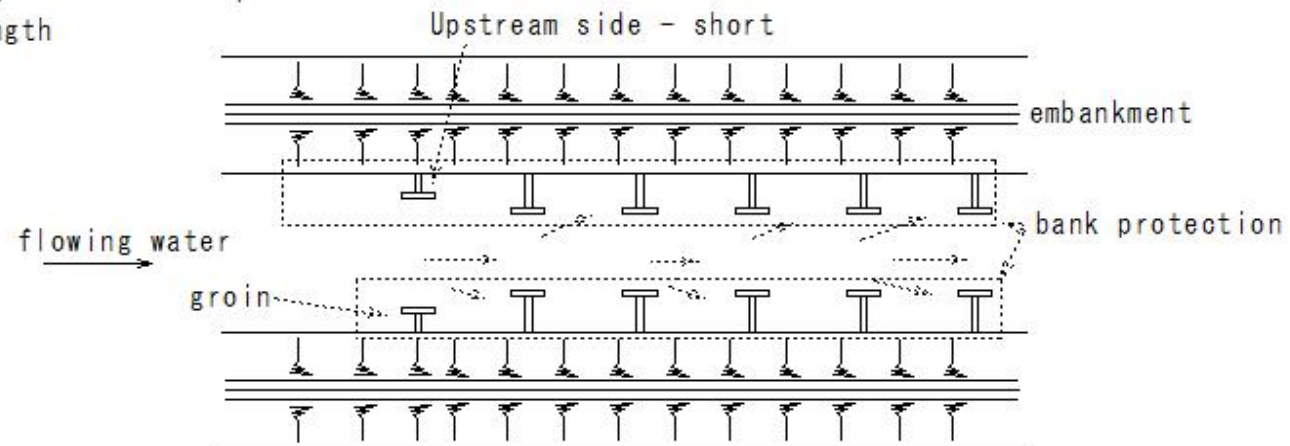
Structure and plan of groin

groin plan

- Check of plane, vertical and transverse shape, flow rate, water level, riverbed material, and riverbed fluctuations

① Length of groin

- Upstream side - short
- Reduce water force
- Equipped with groin and bank protection
- Appropriate length



(R125)groin

(R125) groin

groin

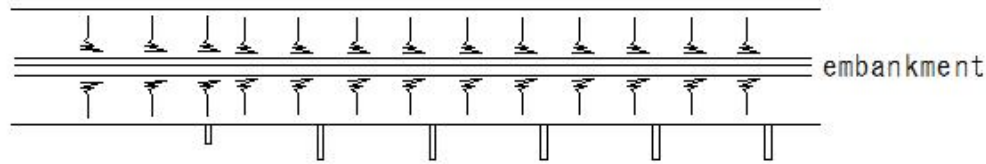
Structure and plan of groin

groin plan

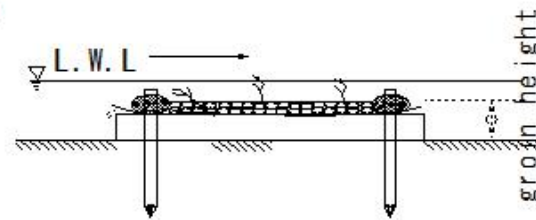
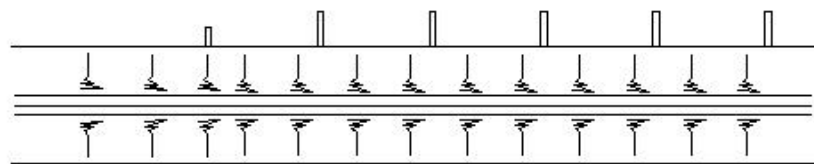
②groin height

Prevention of scouring around the height of permeable groin

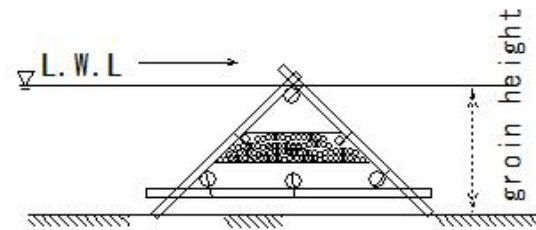
make low



flowing water



permeable groin



permeable groin

(R126)groin

(R126) groin

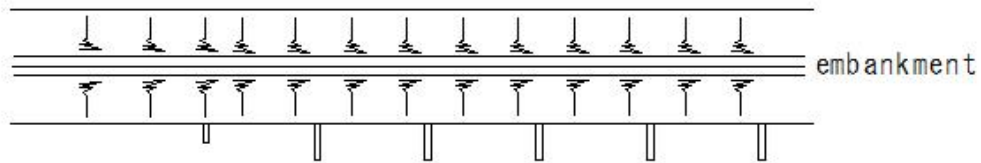
groin

Structure and plan of groin

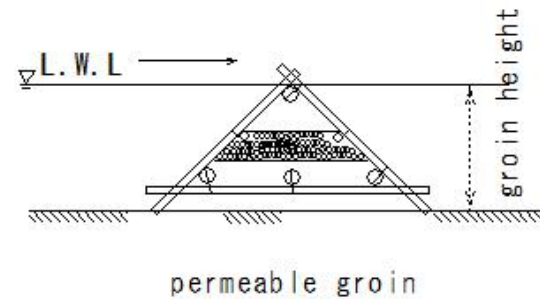
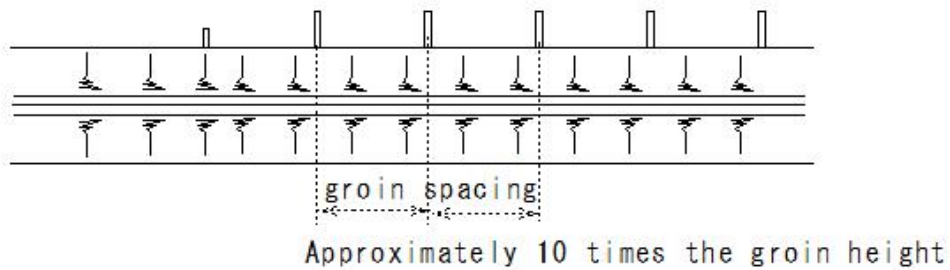
groin plan

③ groin spacing

Approximately 10 times the groin height



flowing water
→



(R127)groin

(R127) groin

groin

Structure and plan of groin

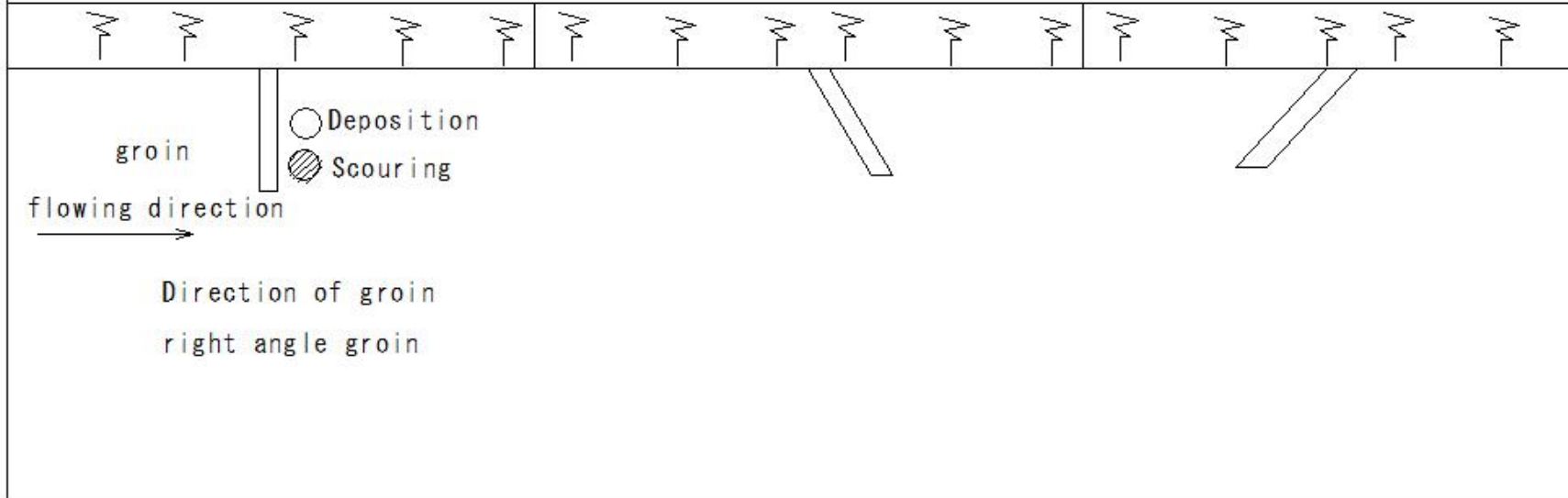
groin plan

④ Direction

Direction of groin

○ Upward groin - pedestal - deposition

right angle groin



(R128)groin

(R128) groin

groin

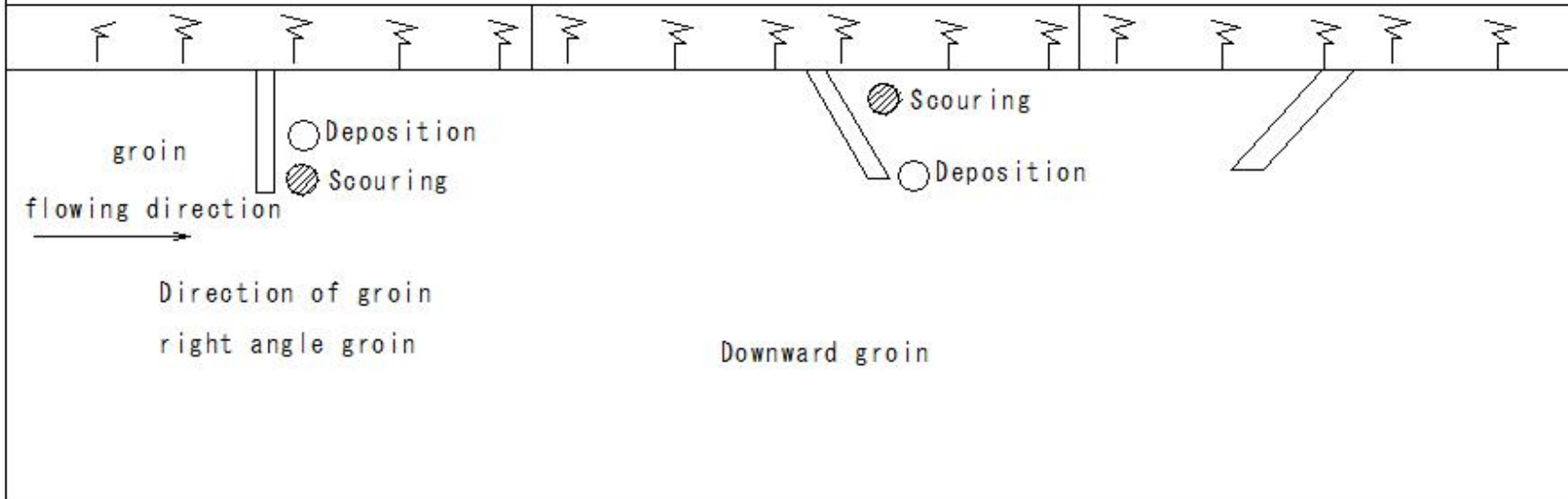
Structure and plan of groin

groin plan

④ Direction

Direction of groin

○ Downward groin - pedestal - scour - better to avoid



(R129)groin

(R129) groin

groin

Structure and plan of groin

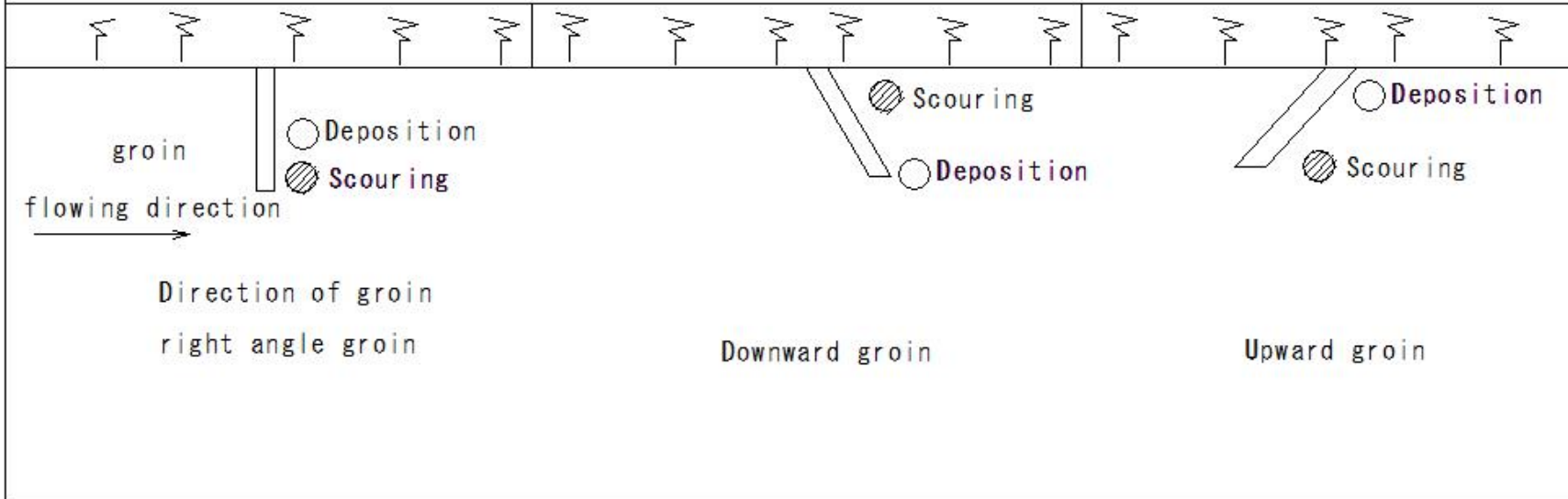
groin plan

④ Direction

Direction of groin

○ Upward groin - pedestal - deposition

Upward and perpendicular to the flow direction -general



(R130)groin

(R130) groin

groin

groin construction method

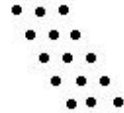
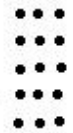
①Pile groin

2 or more rows of stakes

slow flowing river



Pile groin



→
flowing direction

①Pile groin

(R131)groin

(R131) groin

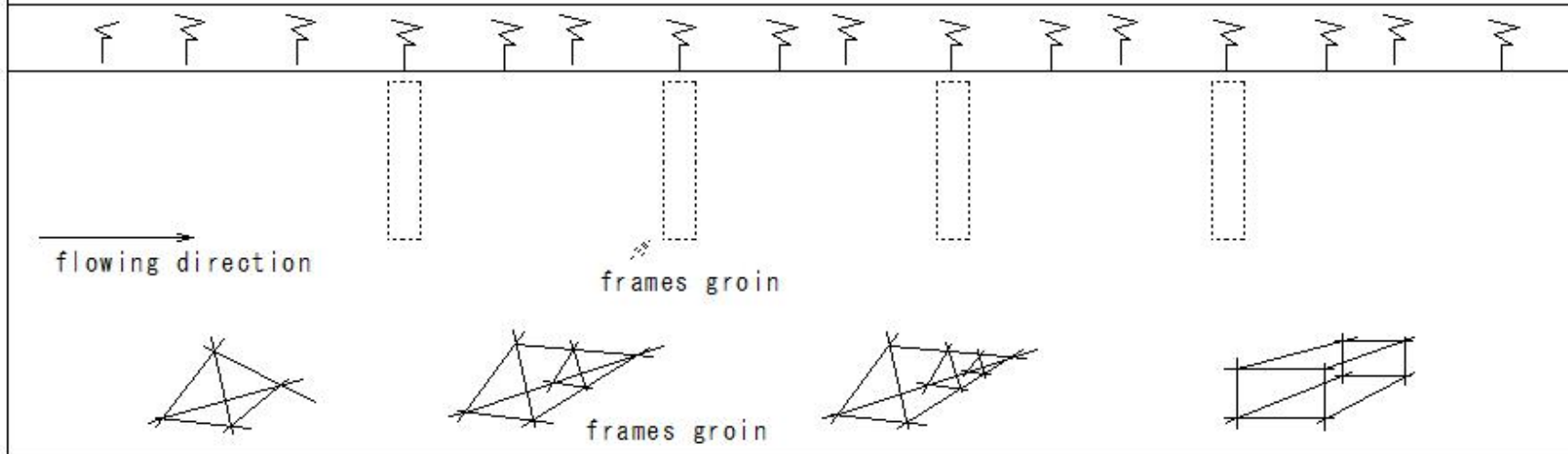
groin

groin construction method

② frames groin

Assemble parts into a triangular shape

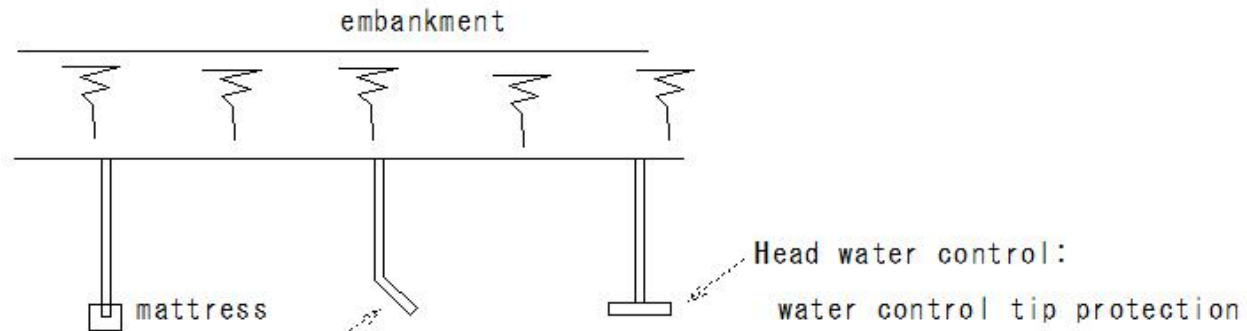
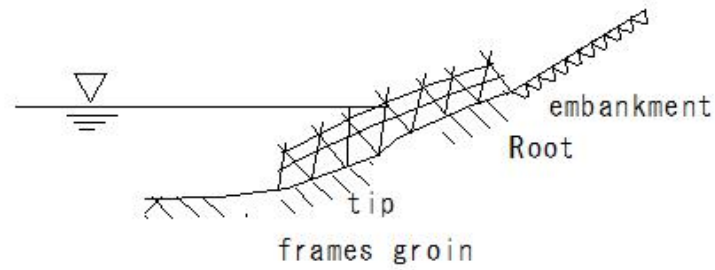
- wire cylinder masonry work(gabion) boulder -sunk
- Frame - Build a frame with logs, etc
- Midstream area where piles cannot be driven
- River with a lots of boulders



(R132)groin

(R132) groin

groin
groin construction method
groin protection



• Settled mattress for root hardening Tip downwards

groin protection

(R133) groundsill

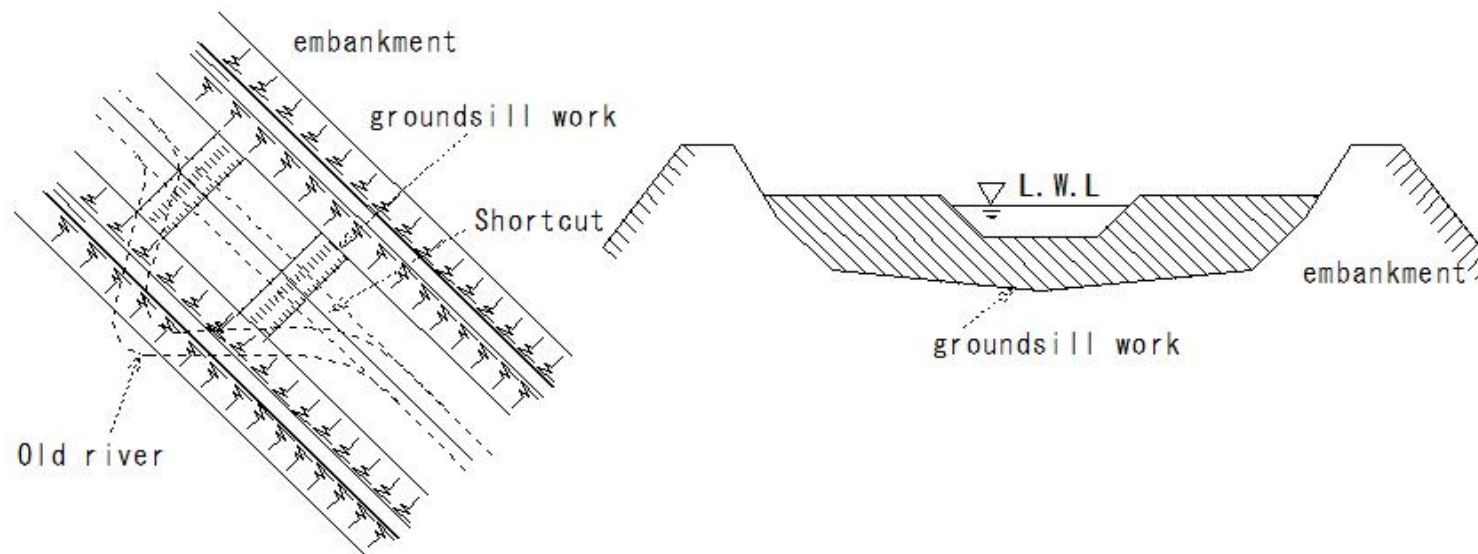
groundsill

- River bed Stability of high water channel (major bed)
- Cross the river
- Adjustment of water depth

① Maintenance of high water channel (major bed)

② Prevention of riverbed decline

Prevention of riverbed scour



(R134) groundsill

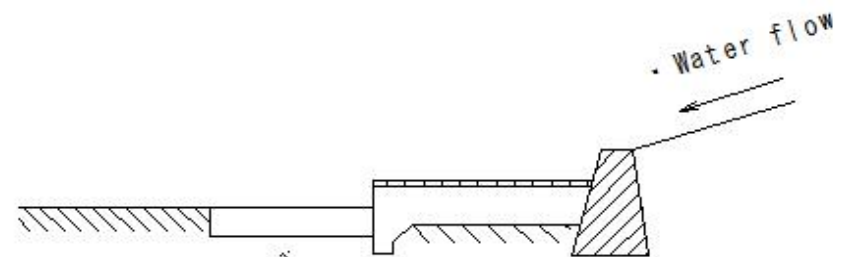
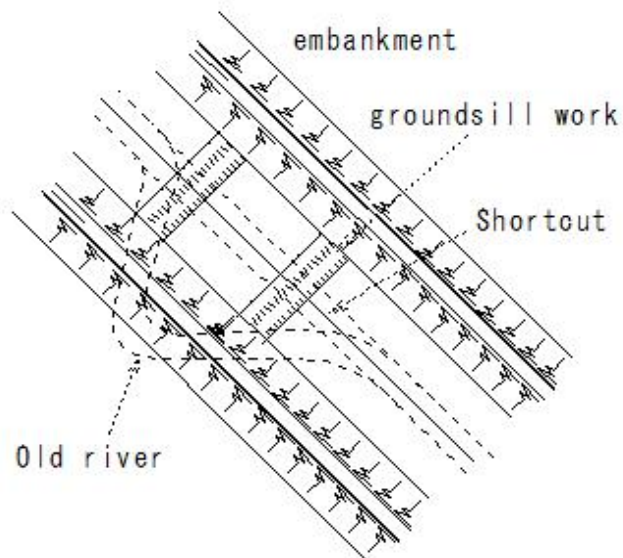
(R134) groundsill

groundsill

ground sill consolidation works

③ Reducing steep slopes

- Rapid rivers - Collision of water flow - Large erosion
- groundsill in the form of stairs
- Gradient-relaxation
- River bed - stable



• Wood mattress

groundsill for reducing steep slopes

(R135) groundsill

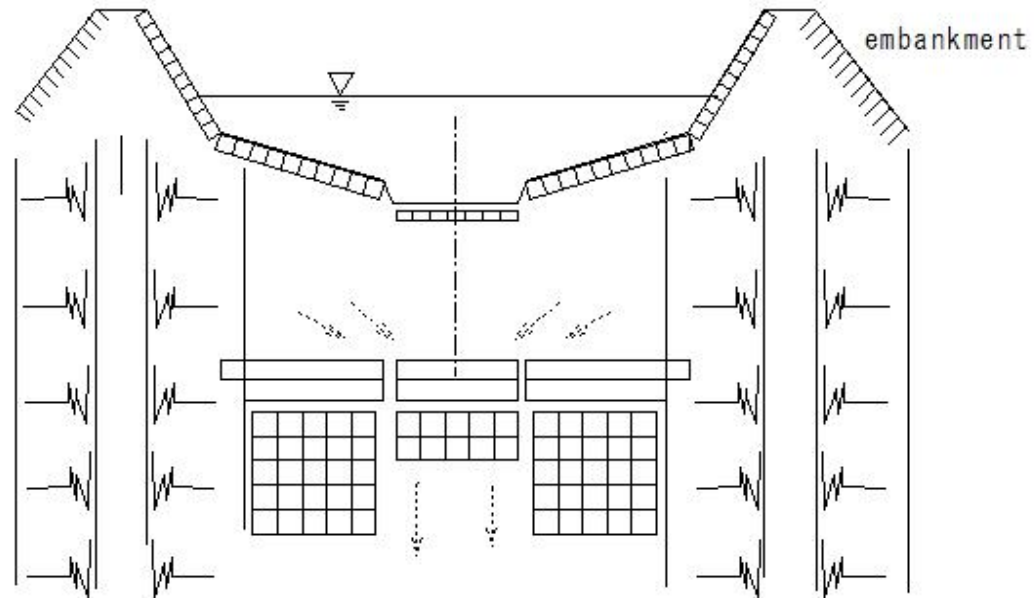
(R135) groundsill

groundsill

ground sill consolidation works

④ Turbulence prevention

- Prevention of river turbulence
- Lead the flow path to the center of the river
- Fixing flow center
- Changing direction



groundsill of turbulence prevention

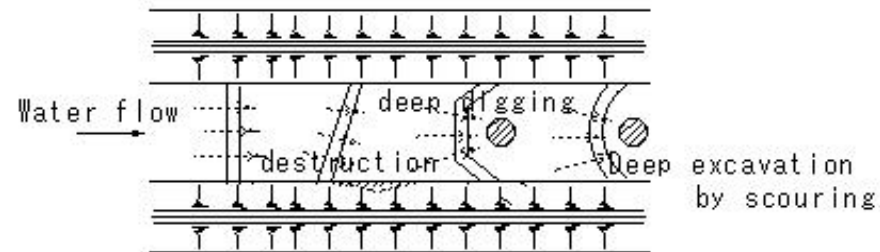
(R136)groundsill

(R136)groundsill

groundsill

ground sill consolidation works structure

- head-fall-drop work
- No drop-riverbed girdle
- Diversion channel - Channel length
 - Short - Steep slope
- Easy to be Scouring
- Install a groundsill
- Repair work on rapid rivers
- Provided in a continuous staircase shape



good defective defective defective

Planar shape of groundsill and direction of flow

①Shape and direction

- Direction of groundsill -important
- take the wrong direction, the downstream revetment will be destroyed.
- The planar shape of the groundsill should be a straight line.

Planar shape of groundsill and direction of flow

(R137) groundsill

(R137) groundsill

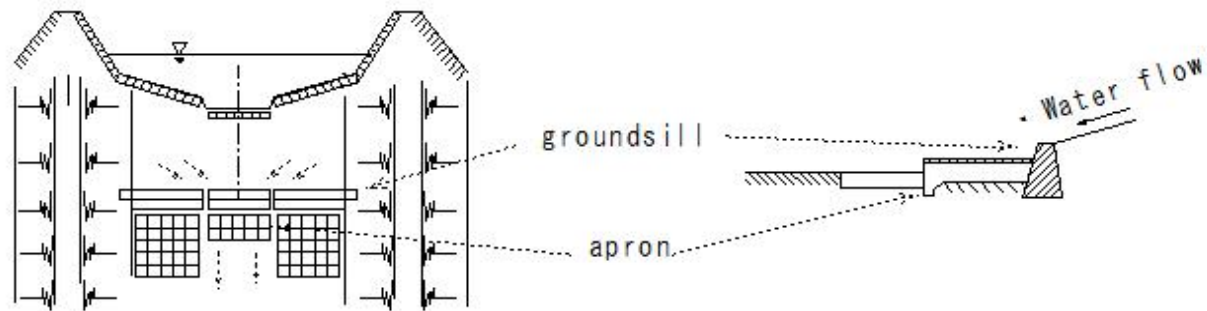
groundsill

ground sill consolidation works

structure

② Height

- crown height should match the planned river bed height.
- The drop in the riverbed due to the groundsill is within 2m.
- Both ends of the main body are fully inserted into the embankment and major bed.
- If necessary, install a apron downstream.



(R138) groundsill

(R138) groundsill

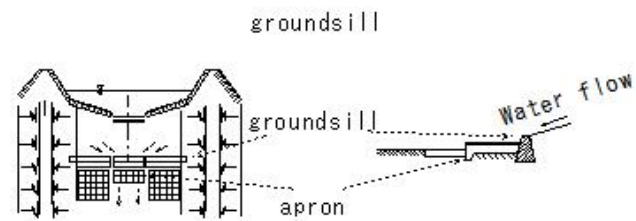
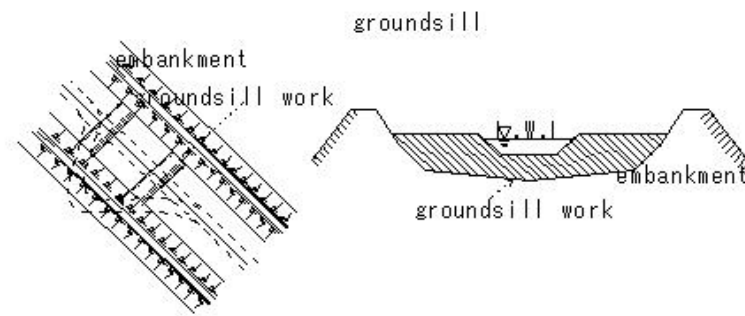
groundsill

ground sill consolidation works

structure

③ foundation

- foundation that are familiar to the river bed
- foundation that are familiar to the river bed



(R139) groundsill

(R139) groundsill

groundsill

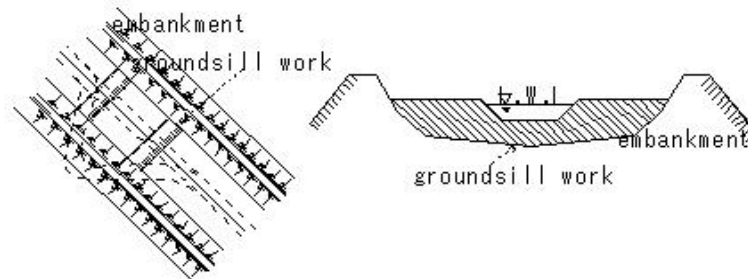
ground sill consolidation works

structure

④ Main body

- Safe against falling and slipping
- Both ends of the main body are fully inserted into the embankment

and high water channel (major bed)
groundsill



groundsill



(R140)apron/bed protection work

(R140) apron/bed protection work

apron/bed protection work

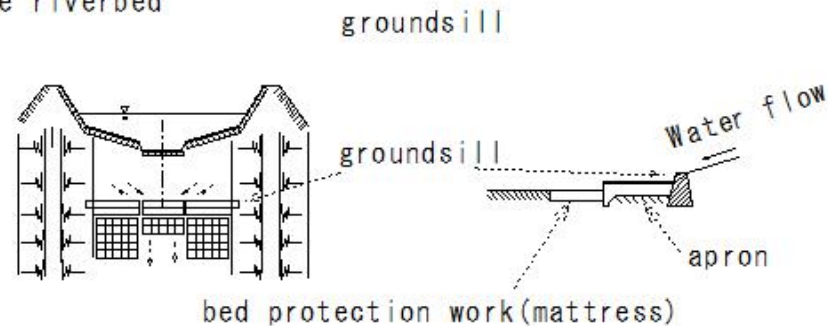
- Cause of damage to groundsill
- Sucking out the earth and sand from the bottom of the groundsill
- Downstream scouring

countermeasure

- Make sure the length of the apron is sufficient.
- Longer infiltration water flow
- Establish a impermeable wall using sheet piles, etc. upstream and downstream of the apron

Bed protection work

- Reduce the flow
- fascine mattress , wood mattress, concrete mattress, concrete block, etc.
- Improve the familiarity with the riverbed

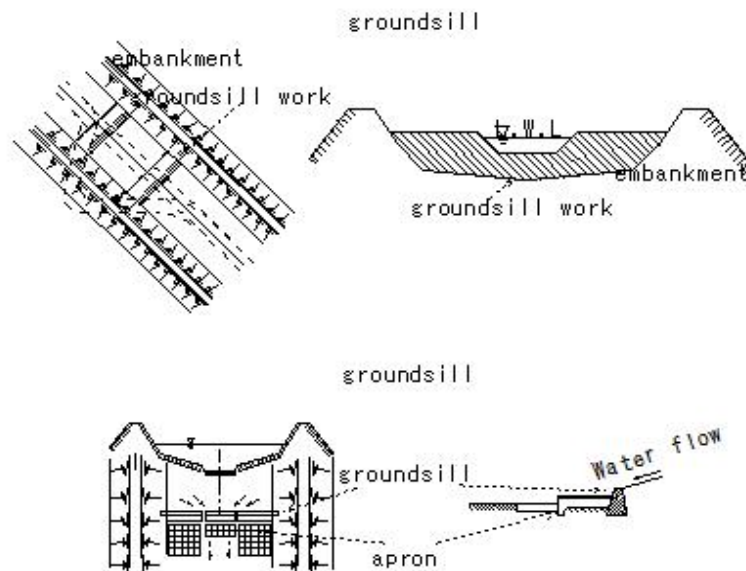


(R141)Construction of groundsill

(R141)Construction of groundsill

Construction of groundsill

- Construction while changing the river flow
- Construction costs - high
- Difficult to maintain and repair
- Perform sufficient planning and investigation before construction
- Pay attention to harmony with nature

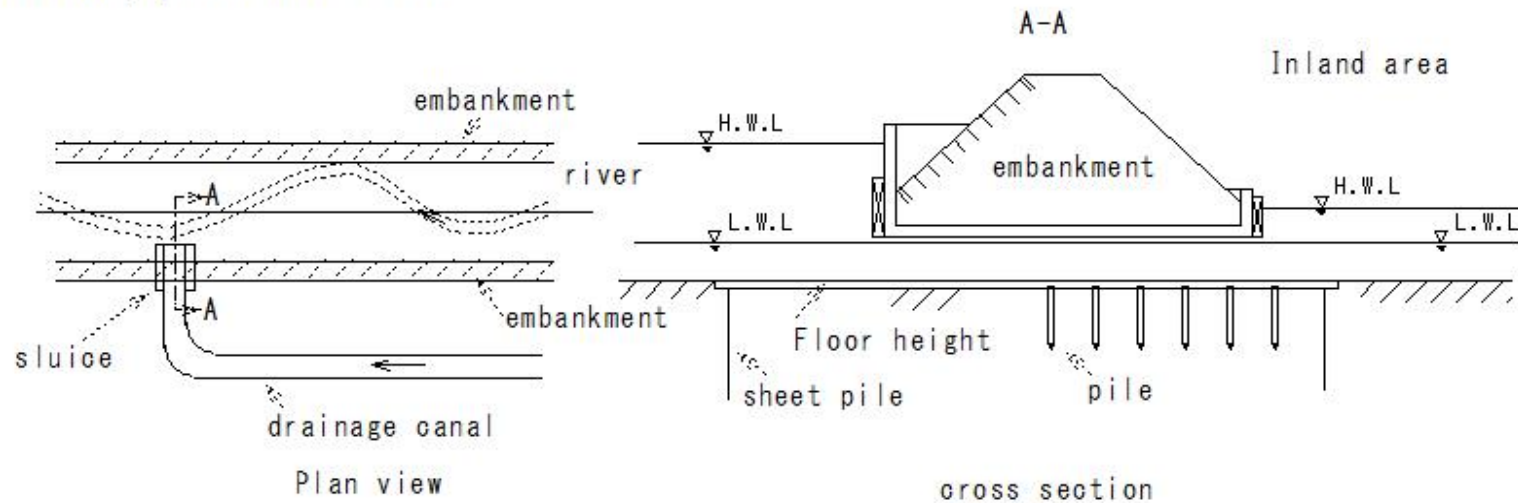


(R142)sluice-slucice pipe-slucice gate- weir

(R142)sluice-slucice pipe-slucice gate- weir

sluice-slucice pipe-slucice gate- weir

- canal drainage water intake Crossing the embankment for water intake
- Establish a culvert under the embankment
- Take in using water
- Drainage if river water is low
- During floods, close the door to protect against flooding.
- large water flow cross section - Sluice
- sluice pipe for small items



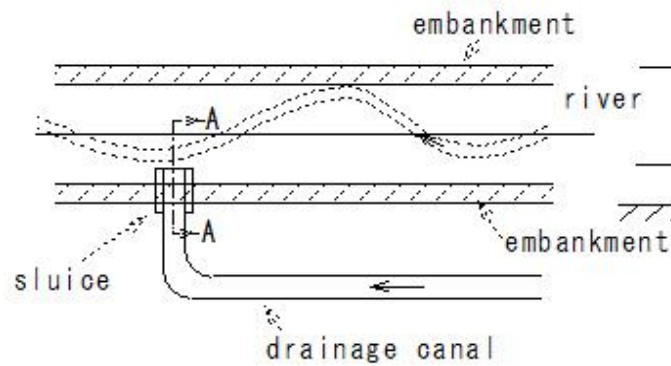
sluice-slucice pipe

(R143)sluice-sluiice pipe-sluiice gate- weir

(R143)sluice-sluiice pipe-sluiice gate- weir

Structure of sluice-sluiice pipe

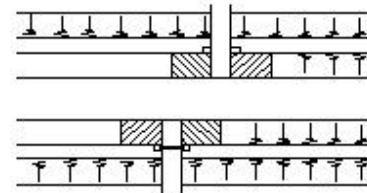
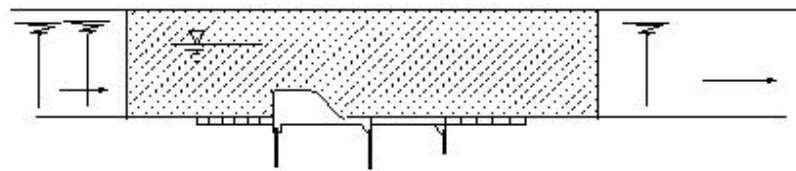
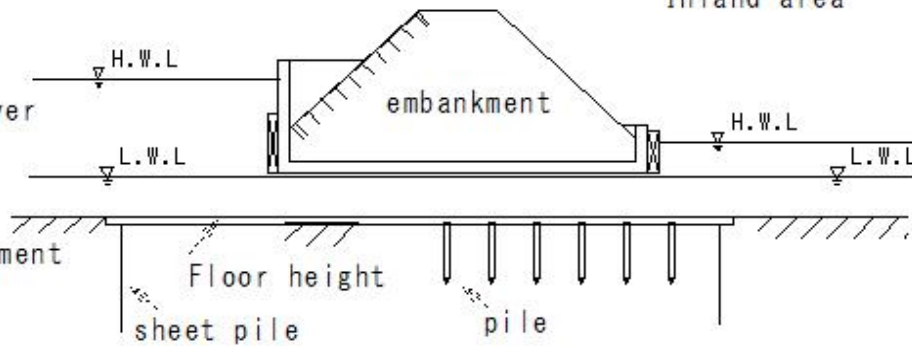
Plan view



cross section

A-A

Inland area



weir

sluice pipe-sluiice

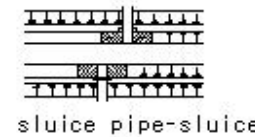
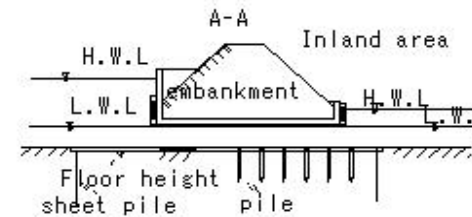
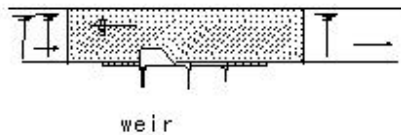
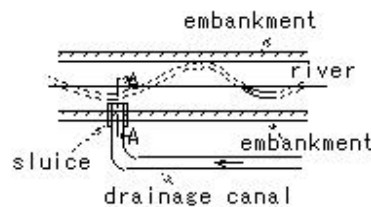
(R144)sluice-sluice pipe-sluice gate- weir

(R144)sluice-sluice pipe-sluice gate- weir

Structure of sluice-sluice pipe

- case of installing a sluice
- case of excavating an existing embankment
- Avoid the flood season
- constructing during the flood season
- Height of temporary cofferdam The strength is equal to or higher than the existing embankment
- Large river - double steel pile structure

sluice-sluice pipe- weir



sluice-sluice-sluice pipe- weir

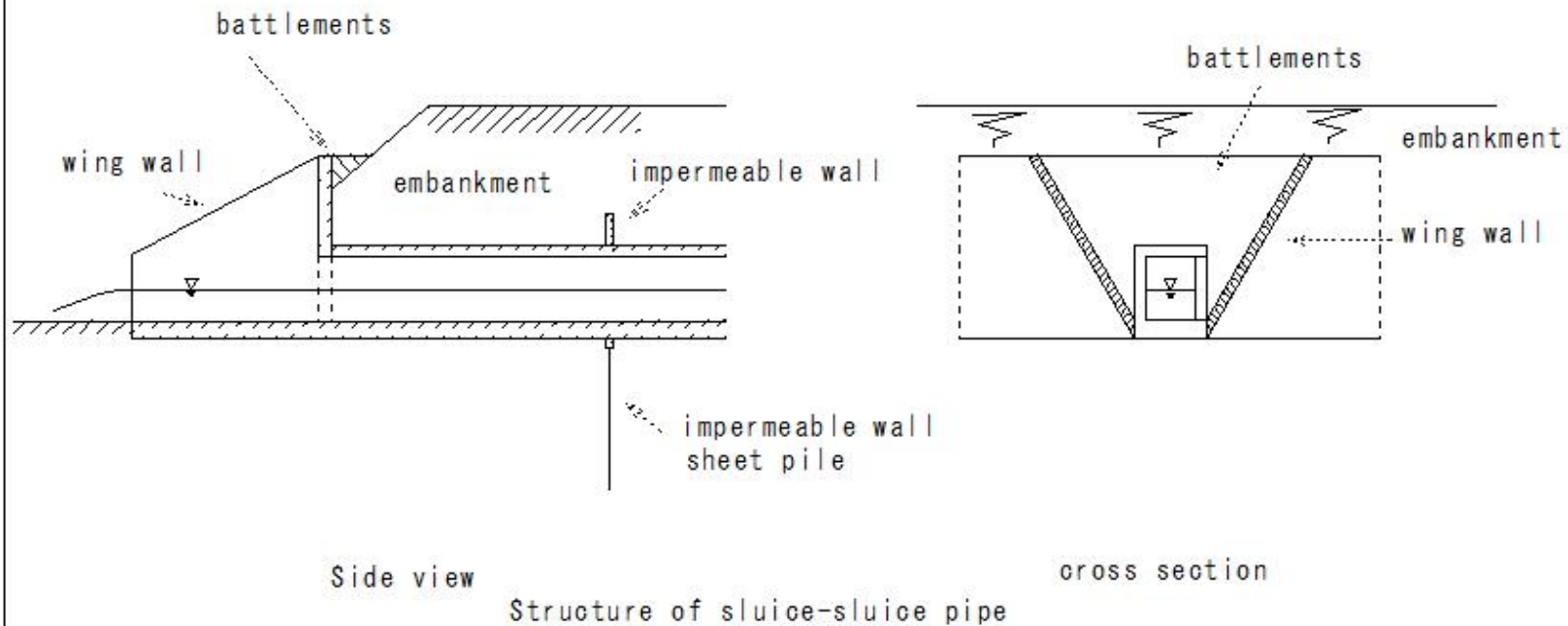
(R145)sluice-slucice pipe-slucice gate- weir

(R145)sluice-slucice pipe-slucice gate- weir

Structure of sluice-slucice pipe

- Reinforced concrete
- Hume pipe - wrapped around the outside with concrete
- Both ends of the main body are cut into the embankment.

Structures that protrude from the river surface should not be constructed.

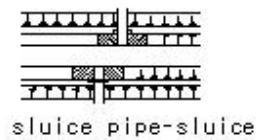
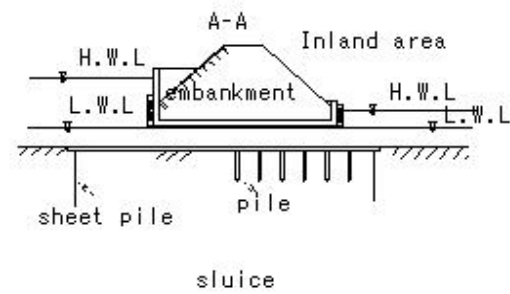
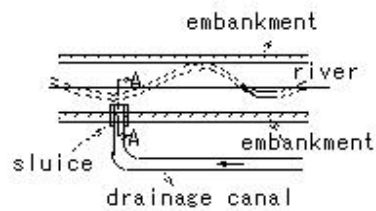


(R146)sluice-sluice pipe-sluice gate- weir

(R146) sluice-sluice pipe-sluice gate- weir

Structure of sluice-sluice pipe

- Avoid unstable river
- Installation location - Weak point - Cause of destruction
- As much as possible - integration
- Reduce installation locations



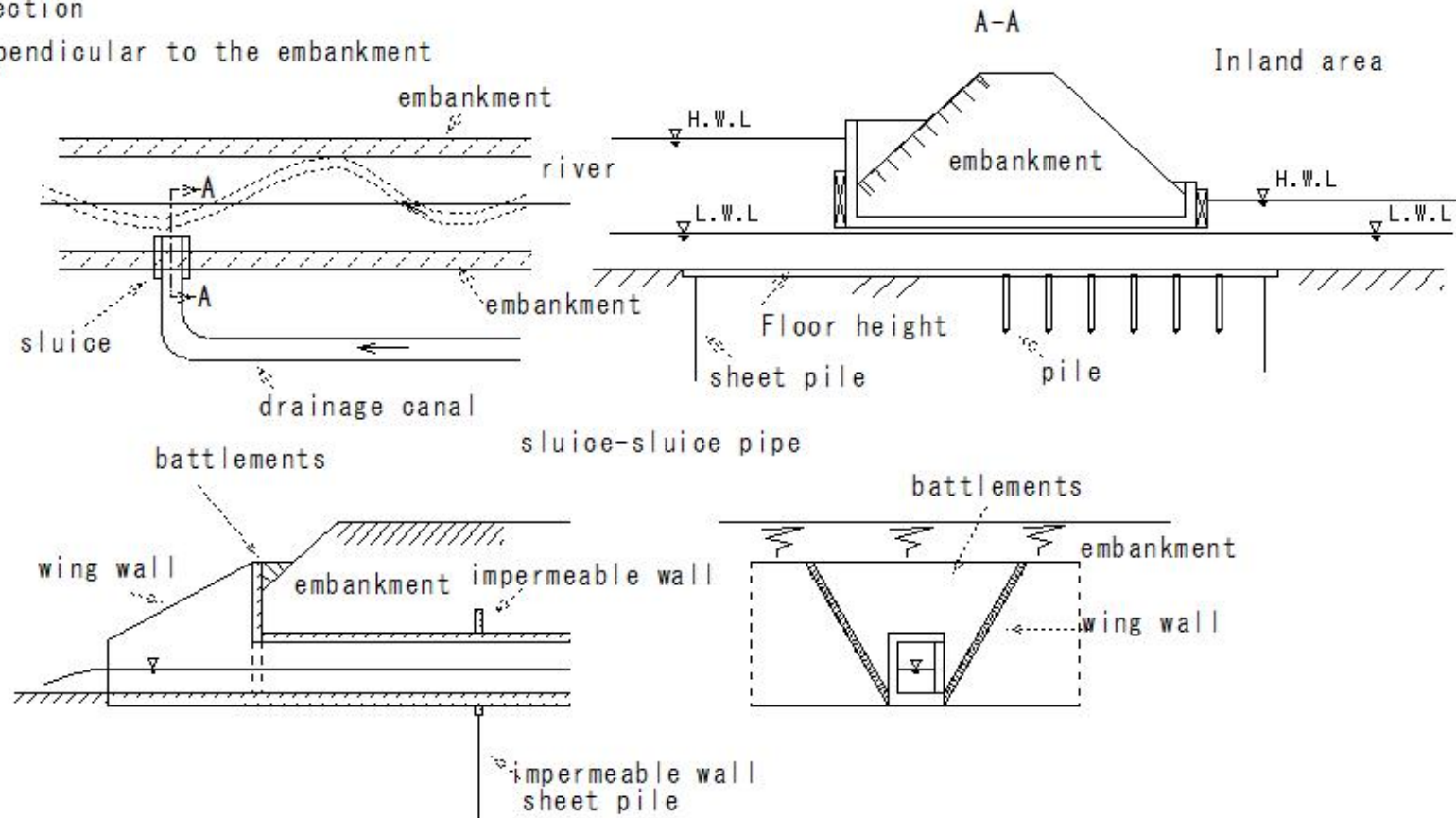
(R147)sluice-sluice pipe-sluice gate- weir

(R147)sluice-sluice pipe-sluice gate- weir

Structure of sluice-sluice pipe

② Direction

- Perpendicular to the embankment



(R148)sluice-slucice pipe-slucice gate- weir

(R148)sluice-slucice pipe-slucice gate- weir

Structure of sluice-slucice pipe

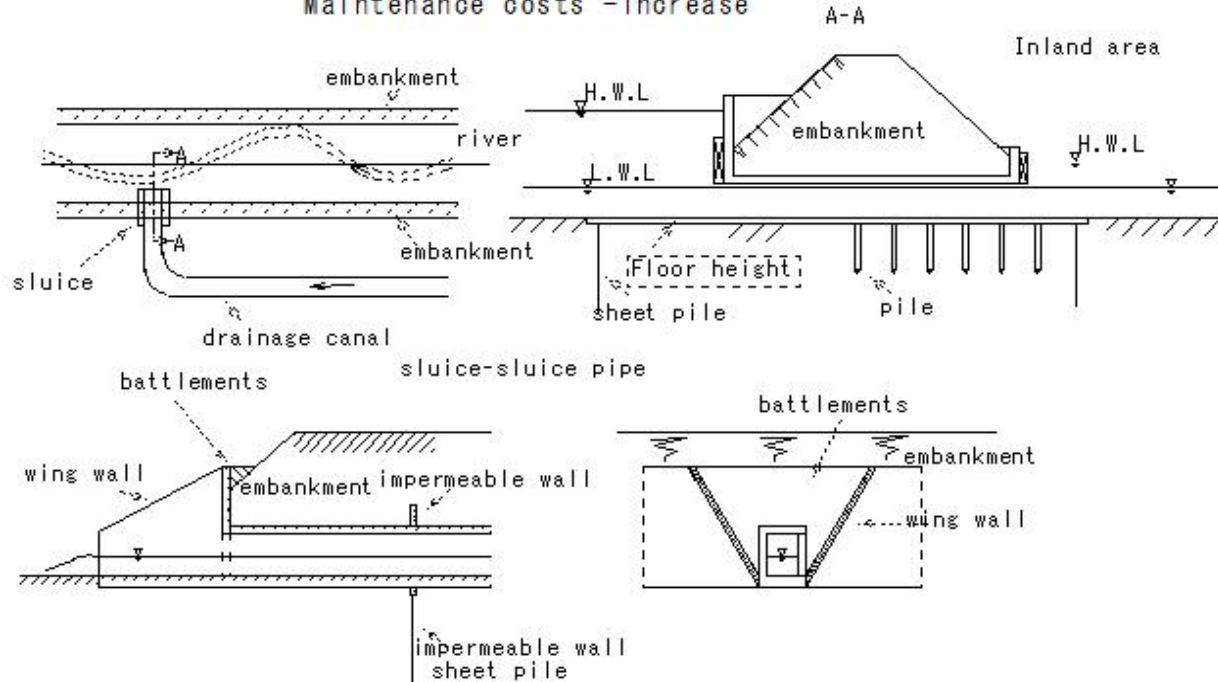
③ Floor height

- past record
- Water intake purpose

• Adjustment of water intake amount

① Sluice height - low case - sedimentation - effective cross section - decrease

② Sluice height - If high - Drainage/water intake capacity - Decrease
Maintenance costs - increase



(R149)sluice-sluice pipe-sluice gate- weir

(R149)sluice-sluice pipe-sluice gate- weir

Structure of sluice-sluice pipe

④Determine the cross section

- For water use
 - within the range that does not be excessive
- During drought
 - Planned water intake amount - Secured cross section - Minimum diameter - 60cm or more
- Drainage purpose
 - Rainfall in catchment area
 - Water flow status of main river and tributaries
 - Planned drainage volume - determination
- Flow velocity in the drainage sluice - Plan to avoid any increase or decrease

• Flow velocity in the drainage sluice

	Design flow rate
For rivers in flat areas	1-2m/s
For small cross sections	3.5m/s
For prevention of sedimentation	2.5m/s

(R150)sluice-slucice pipe-slucice gate- weir

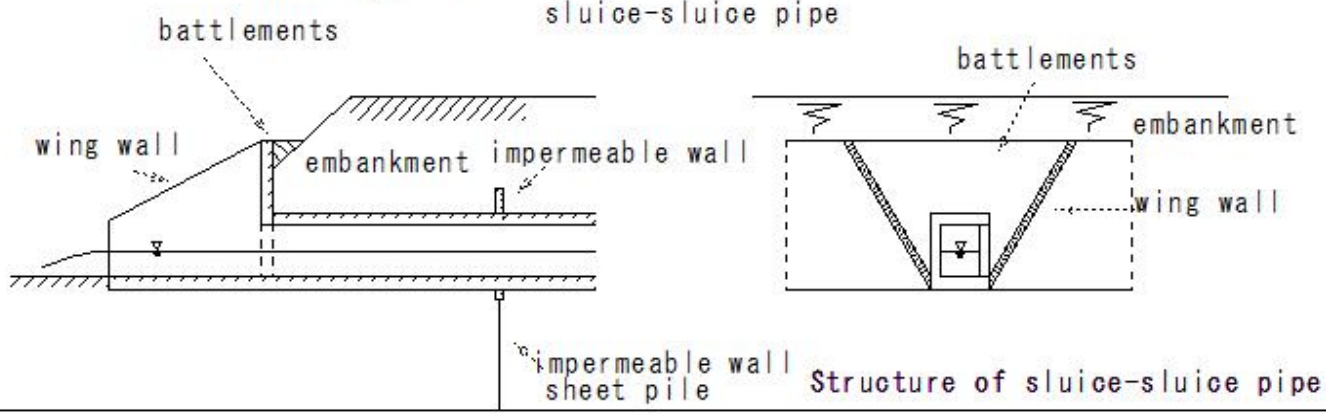
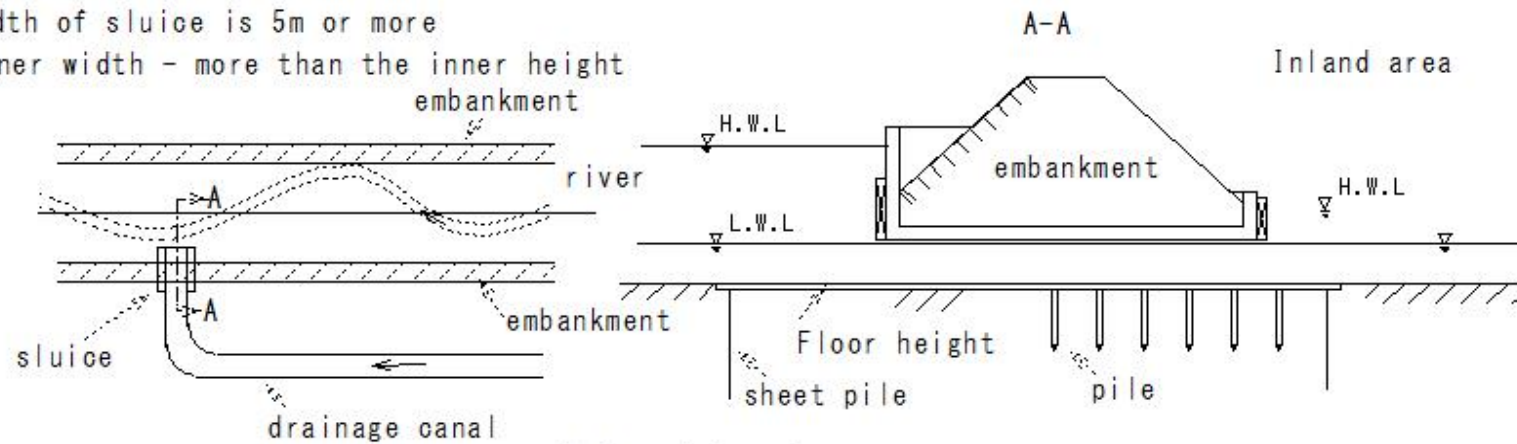
(R150)sluice-slucice pipe-slucice gate- weir

Structure of sluice-slucice pipe

⑤ Span length of 2 or more sluice

• Width of sluice is 5m or more

Inner width - more than the inner height



Structure of sluice-slucice pipe

(R151)sluice-sluice pipe-sluice gate- weir

(R151)sluice-sluice pipe-sluice gate- weir

Structure of sluice-sluice pipe

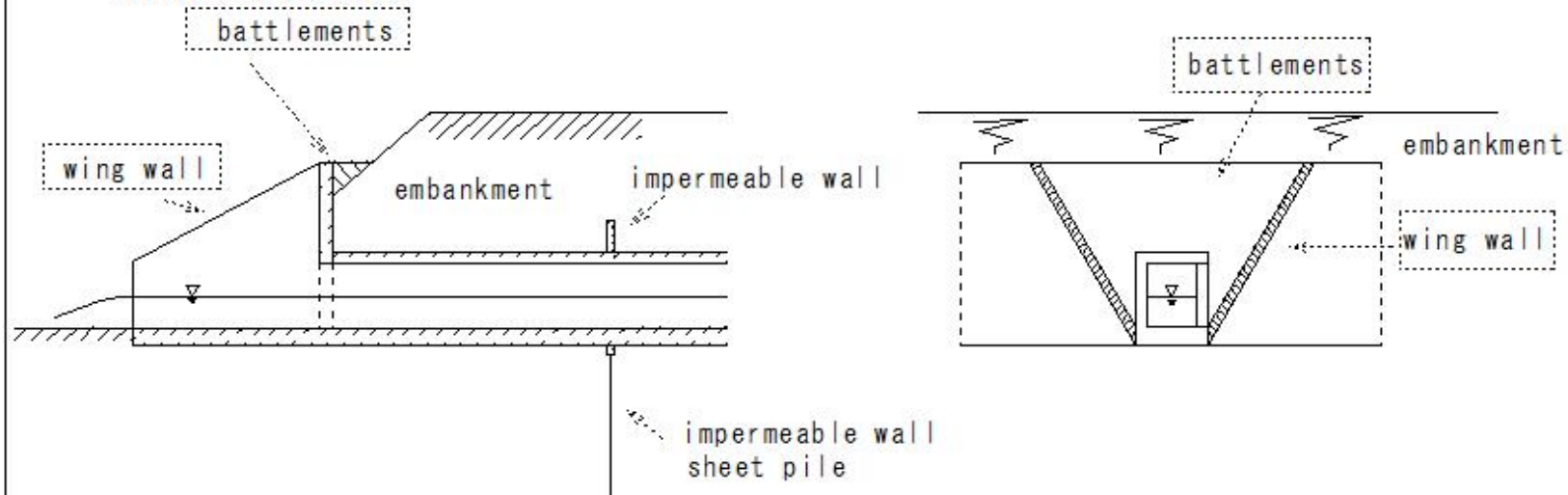
⑥ Battlements, wing walls

- sluice-sluice pipe- Install Battlements

Considering topographical conditions

Integrated with the main body

reinforced concrete



Side view

cross section

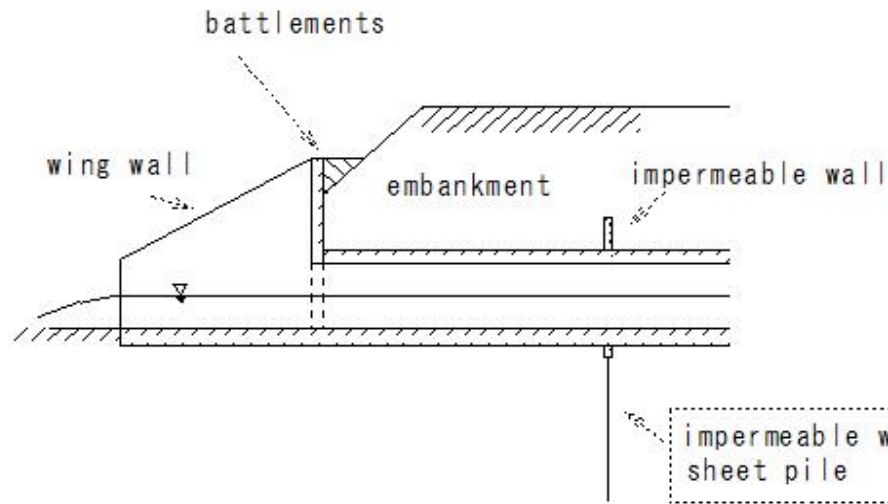
Structure of sluice-sluice pipe

(R152)sluice-slucice pipe-slucice gate- weir

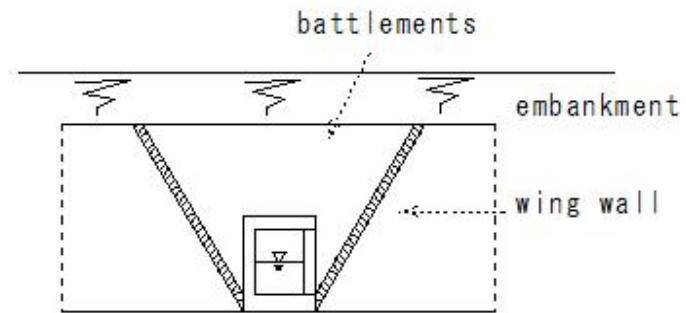
(R152)sluice-slucice pipe-slucice gate- weir

Structure of sluice-slucice pipe

- ⑦ impermeable wall
 - Use of sheet piles
 - Considering topographical conditions



Side view



cross section

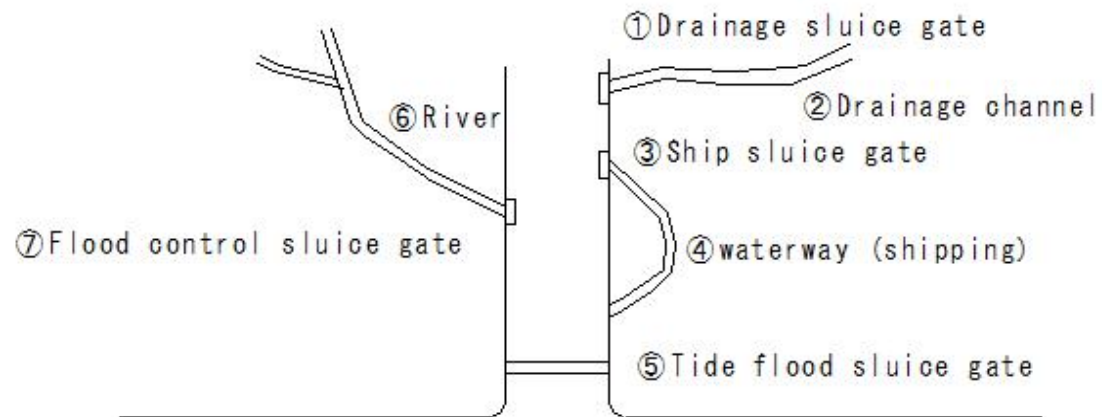
Structure of sluice-slucice pipe

(R153)sluice-sluice pipe-sluice gate- weir

(R153)sluice-sluice pipe-sluice gate- weir

sluice gate by purpose

- Cross the embankment
- sluice gate - upper part - open
- sluice-sluice pipe - culvert that crosses the embankment
- During high water, it does not interfere with running water



sluice gate by purpose

(R154)weir

(R154)weir

weir

Irrigation, water supply, water intake for power generation

Shipping flow rate adjustment

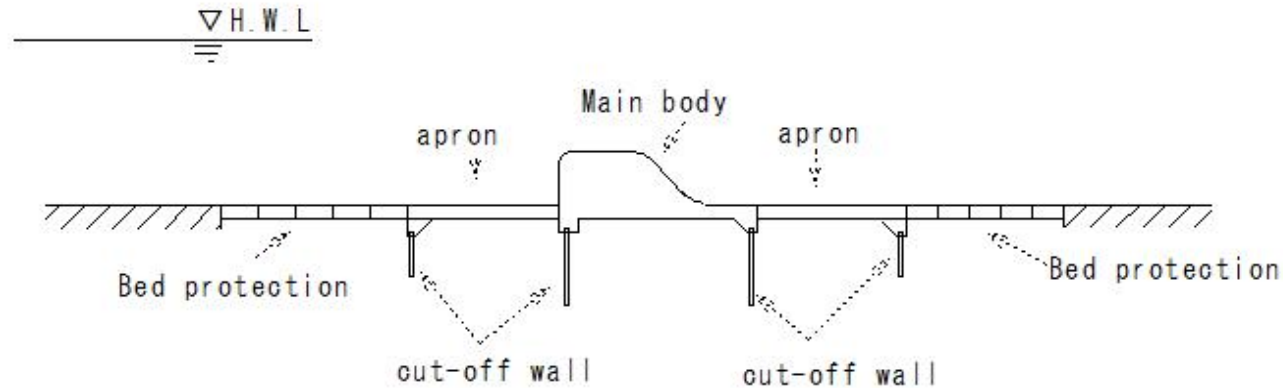
- Cross the river
- pump up river water

Type: Installation purpose

- Water intake weir
- Dividing weir

Type: By structure

- Fixed weir
- Movable weir



Fixed weir composition

(R155)weir

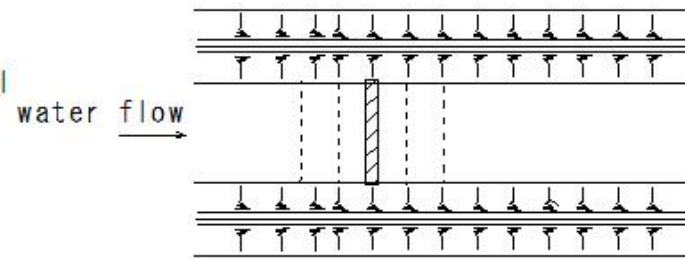
(R155) weir

weir

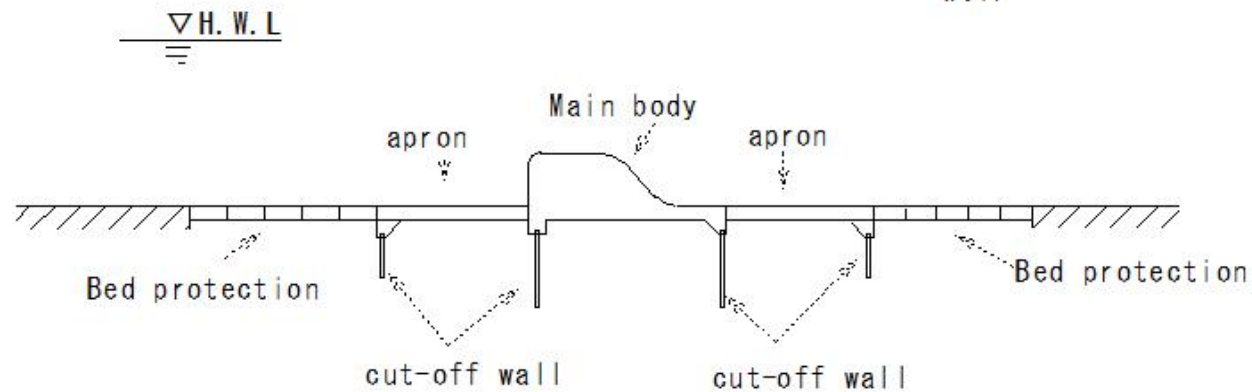
structure of weir

① Installation position

- Curved part of the river
- Avoid narrow sections of the river channel



weir



Fixed weir composition

(R156)weir

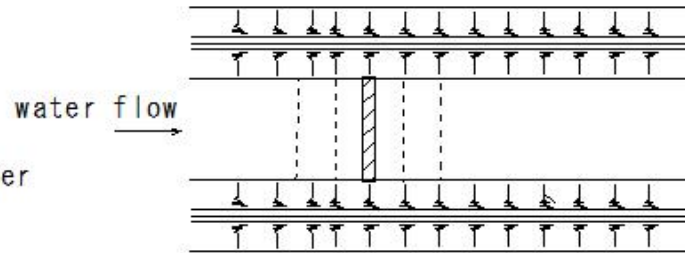
(R156) weir

weir

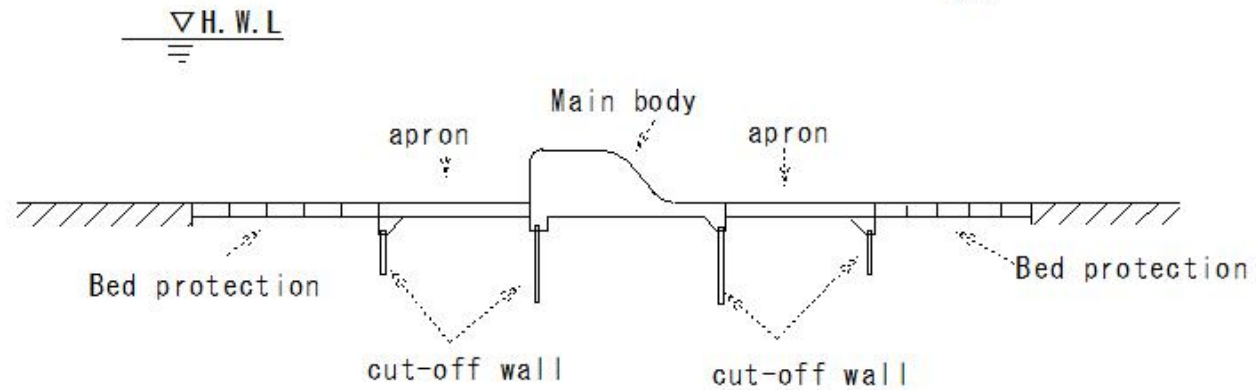
structure of weir

② Shape direction

- Plane shape: straight line
- Right angle to the direction of flowing water



weir



Fixed weir composition

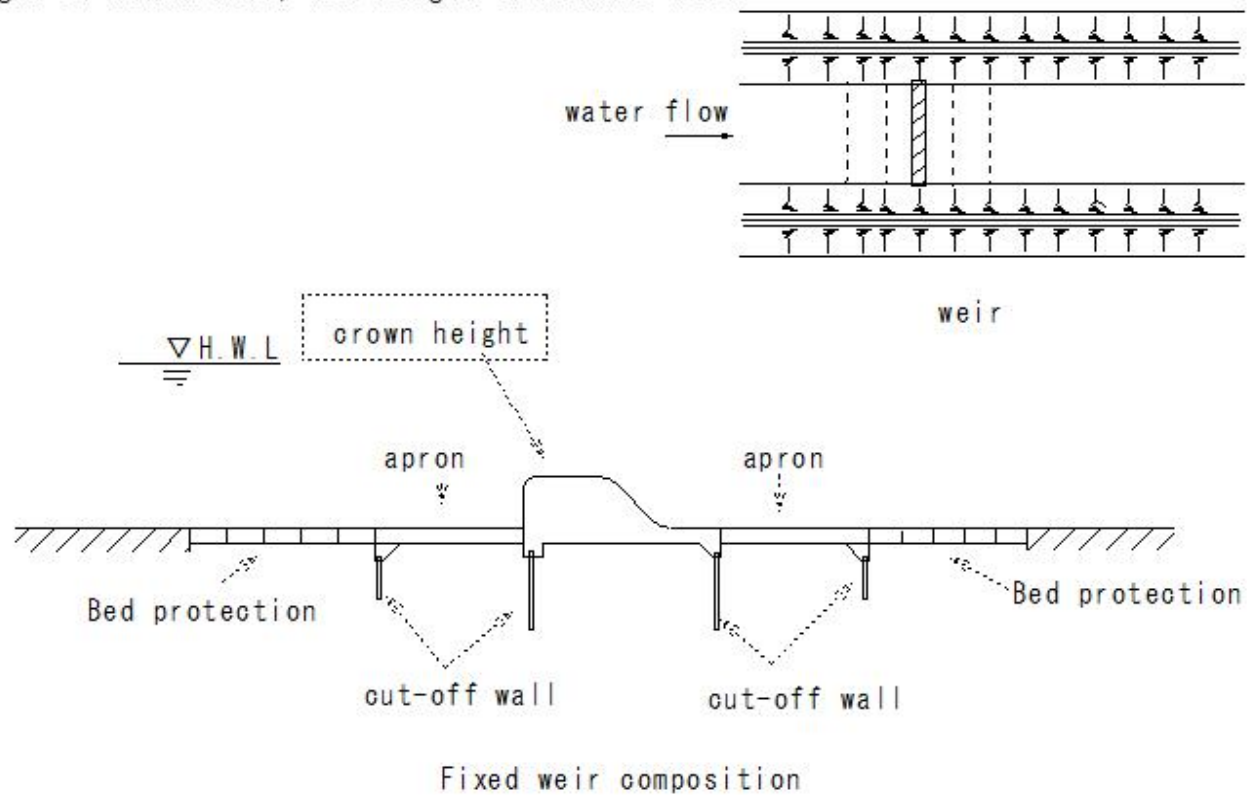
(R157)weir

(R157) weir

weir

structure of weir

③ crown height of fixed weir, bed height of movable weir



(R158)weir

(R158) weir

weir

structure of weir

④ Span length

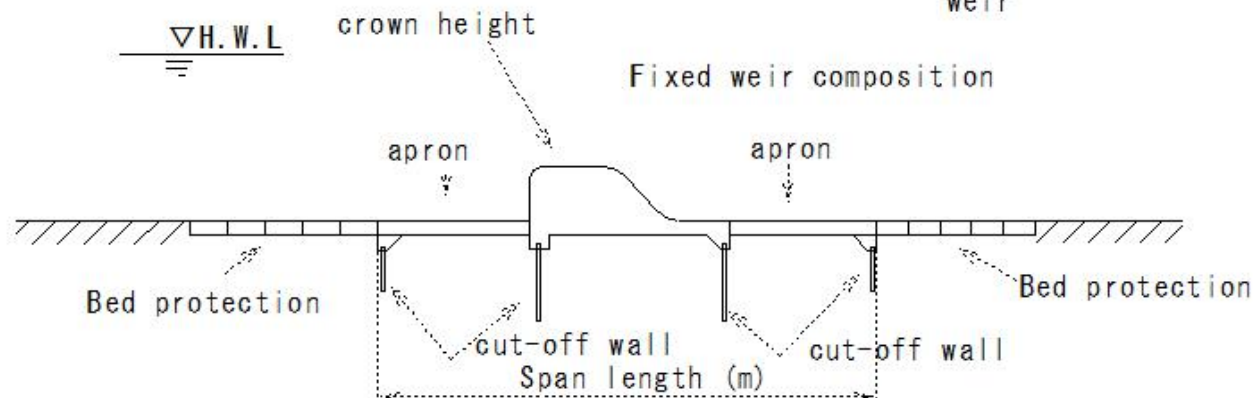
- Make the span length as long and large as possible

estimated high water discharge m^3/s

estimated high water discharge and span length (m)

estimated high water discharge (m^3/s)	Span length (m)
less than 500	15
500-2000	20
2000-4000	30
Over 4000 Stream center - span	40
others	30

weir



(R159)weir

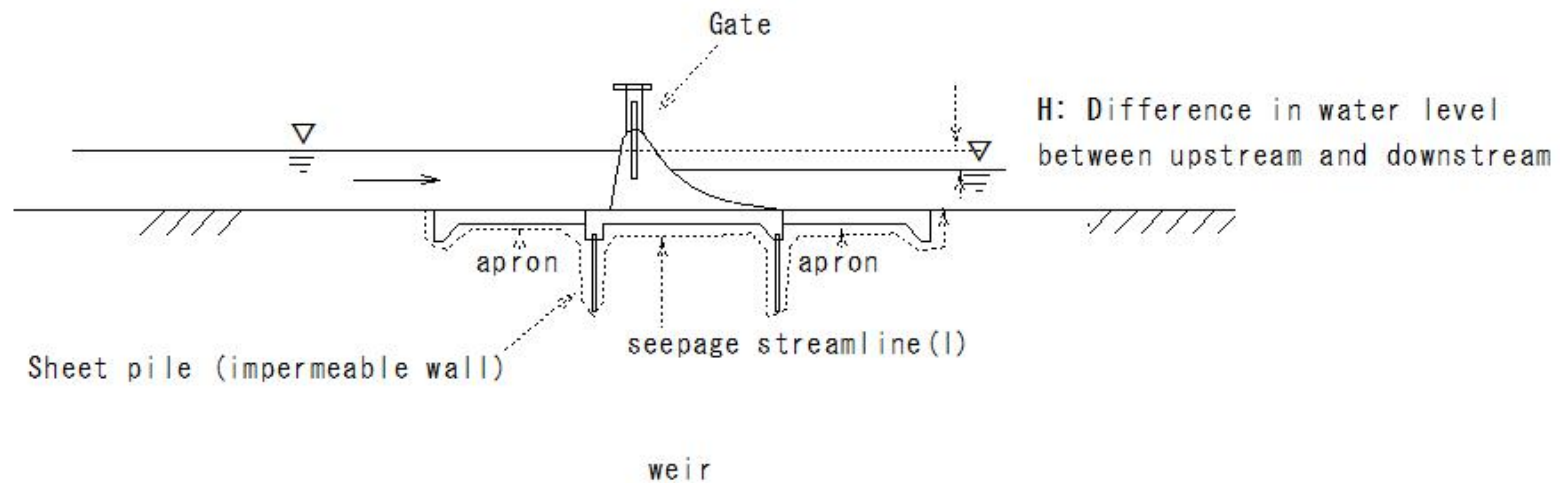
(R159) weir

weir

structure of weir

⑤ foundation

- Above the gravel layer
- Damage to the weir due to water level difference between upstream and downstream of the weir
- take seepage streamline-long length
- Reduce water permeability



(R160)weir

weir

(R160) weir

structure of weir

⑤ foundation

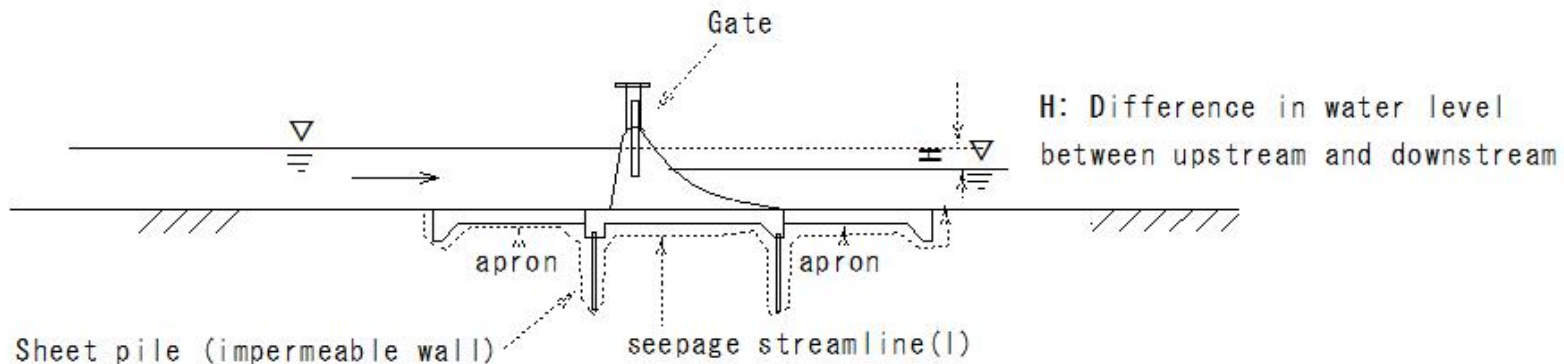
- Naturally deposited gravel layer
- It is safe if it is above the l/H table
- No danger from scour under the foundation

Less than or equal to table value

- Longer the upstream and downstream apron
- Lengthen the sheet pile (impermeable wall)-shielding sheet piles
- Get close to the limit value

Limit value of l/H

① Fine sand	② Fine sand	③ Coarse sand	④ Gravel mixed with sand	⑤ Boulders mixed with sand and gravel
18	15	12	9-5	4



(R161)weir

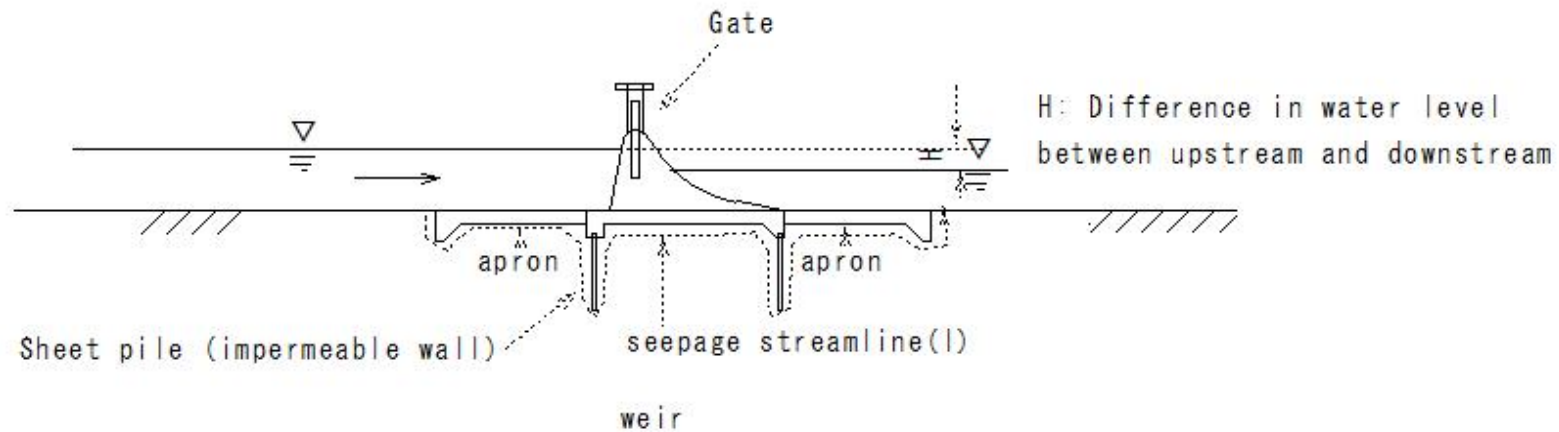
(R161)weir

weir

structure of weir

⑥ apron

- Weakens the energy of water
- ① Gradually widen the river downstream of the apron to weaken the water flow
- ② Add a vertical slope to the apron part
- ③ Longer apron will reduce scouring.
- ④ Install barriers, barriers, etc. downstream of the apron



(R162)weir

(R162)weir

weir

structure of weir

Construction of weir

- Weir: Difficult to repair after completion as it is located in a washed-out area

Points to check

① Most of the construction work will be completed, including part of the entire width.

- Construction will be carried out during the non-flood season.
- Add margin to maximum flow rate based on past data

Determine the scale of the temporary drainage channel

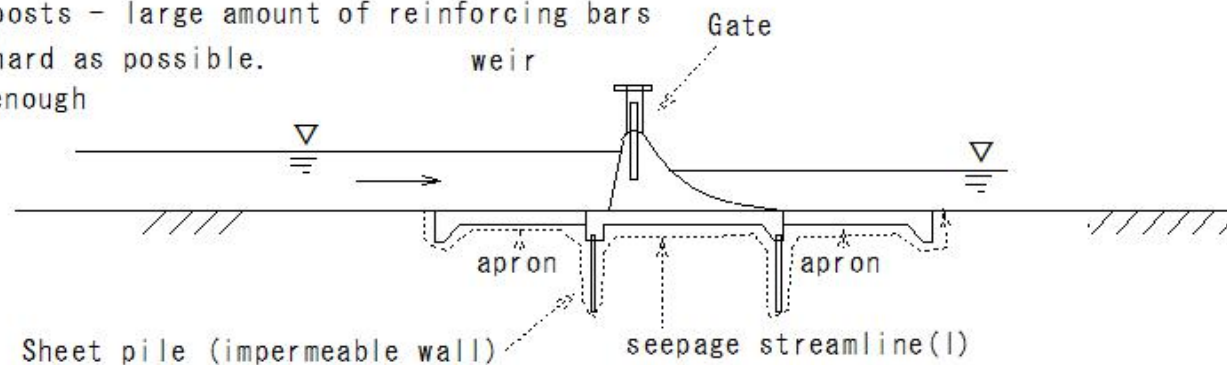
② Complete the work as soon as possible after temporary cofferdam is completed.

③ Excavation and transportation as it is carried out in a narrow area

Selection of pile driver: Determine work order in advance

④ Weir pillars/gateposts - large amount of reinforcing bars

- Make concrete as hard as possible.
- Use the vibrator enough



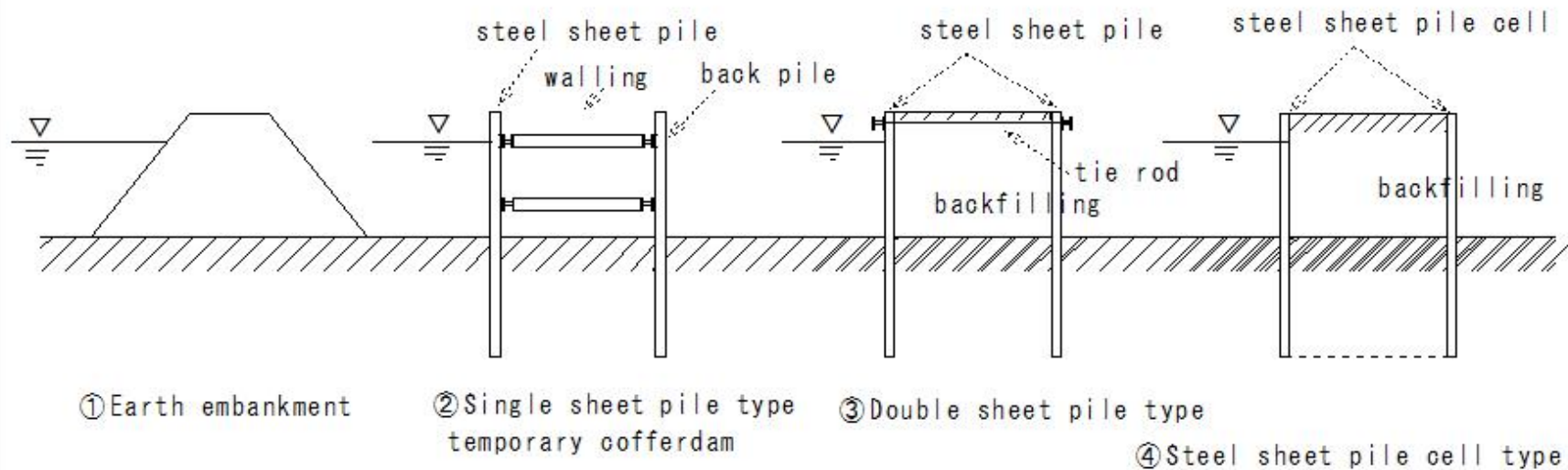
(R163)temporary cofferdam

(R163)temporary cofferdam

temporary cofferdam

structure

- Substitute for embankment
- Height and crown width should be the same as the embankment.
- Foundation work required
- Same height and strength as existing levees upstream and downstream
- Water-stopping properties need to be considered
- Check the construction order



(R164)temporary cofferdam

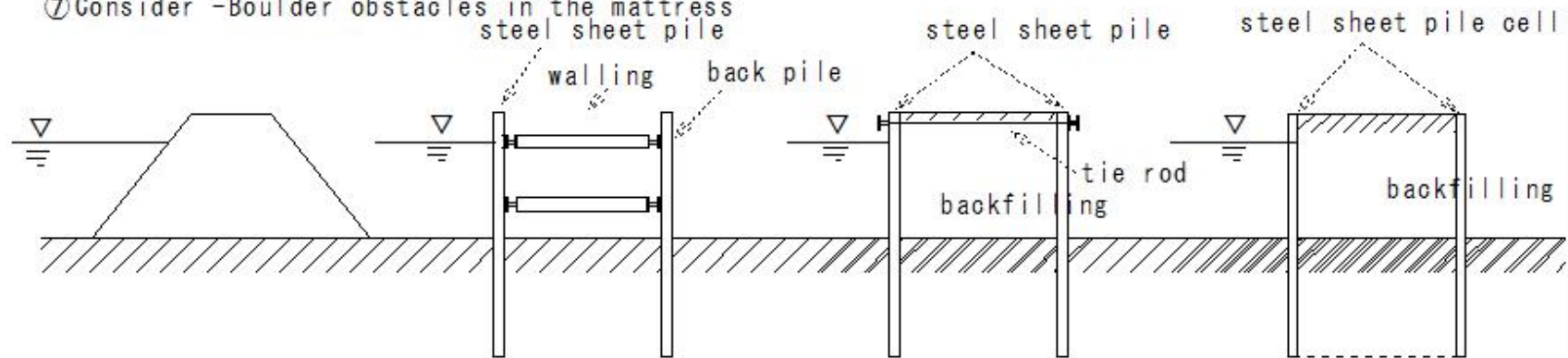
(R164)temporary cofferdam

temporary cofferdam

structure

check points in planning

- ① Built to counter the flow velocity
- ② The penetration area is washed away by the flow.
- ③ Because the center of flow moves, there is an effect of surrounding scour.
- ④ As the river width becomes narrower, the allowable flow rate during floods will decrease.
- ⑤ Avoid temporary cofferdam construction during flood season
- ⑥ The highest water level in the past 10 years is considered the allowable high water level.
- ⑦ Consider -Boulder obstacles in the mattress



① Earth embankment

② Single sheet pile type
temporary cofferdam

③ Double sheet pile type

④ Steel sheet pile cell type

(R165)temporary cofferdam

(R165) temporary cofferdam

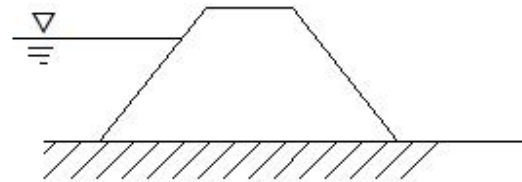
temporary cofferdam

structure

Types/Characteristics

① Earth embankment

- ① Advantageous when the water depth is shallow
- ② Large site is required considering the water depth
- ③ Water stop works are generally required.
- ④ Construction is simple with few types of work
- ⑤ Embankment materials may be washed away by currents or waves.
- ⑥ Requires protection against slope currents and waves
- ⑦ The top of the embankment body can be used as a construction road



① Earth embankment

(R166)temporary cofferdam

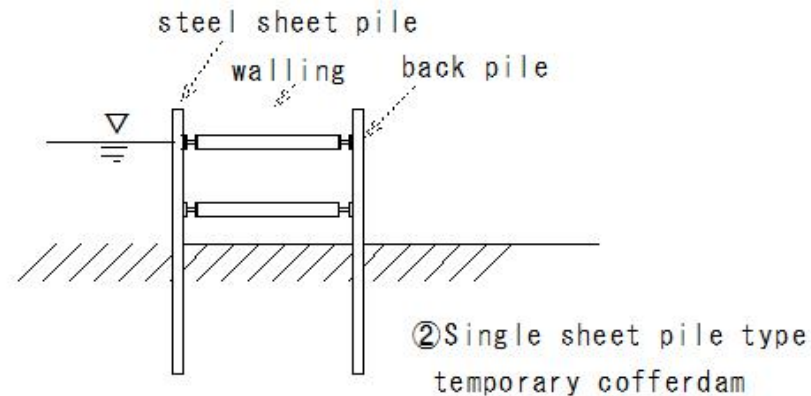
(R166) temporary cofferdam

temporary cofferdam
structure

Types/Characteristics

② Single sheet pile type temporary cofferdam

- ① Used case of the excavation cross section is relatively small, such as on bridge piers.
- ② Good for small spaces
- ③ Stop water with sheet piles
- ④ Can be done with simple construction
- ⑤ Stability during construction is a problem
- ⑥ Weak against uneven pressure due to waves and currents
- ⑦ Due to the presence of strut, the workability of this construction is poor.



(R167)temporary cofferdam

(R167)temporary cofferdam

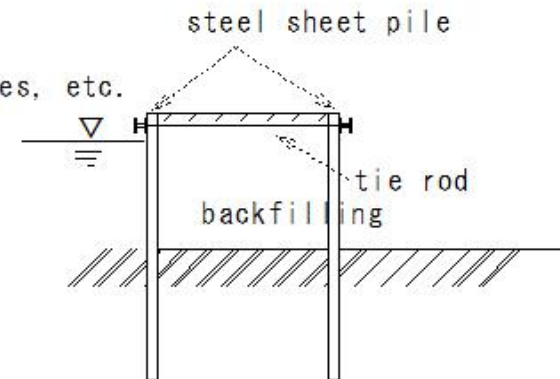
temporary cofferdam

structure

Types/Characteristics

③Double sheet pile type

- ①The water is deep and is used for large-scale construction.
- ②Considering the depth of the water, you can get as much area as possible on a small site.
- ③Generally, sheet piles are used to stop water, but because they are filled with soil, the water-stopping effect is superior to single sheet pile type
- ④Can be done with simple construction
- ⑤Safety as a standalone product is not good
 - flowing water during construction
 - leakage of filled soil due to waves
 - There are problems with the independence of the sheet piles, etc.
- ⑥Good stability after completion
- ⑦It is advantageous if this construction is used as a temporary deadline.
- ⑧The top of the embankment body can be used as a construction road



③Double sheet pile type

(R168)temporary cofferdam

(R168)temporary cofferdam

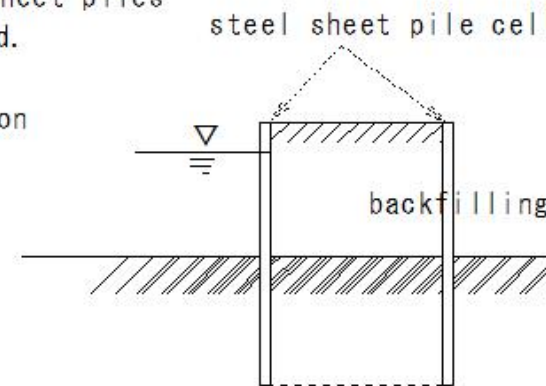
temporary cofferdam

structure

Types/Characteristics

④Steel sheet pile cell type temporary cofferdam

- ①The water is deep and is used for large-scale construction.
- ②Considering the depth of the water, you can get as much area as possible on a small site.
- ③There is little water leakage from the joints of sheet piles.
- ④a lot of seepage water
- ⑤Limited to driving F-type sheet piles into the used sheet piles
- ⑥Construction is simple with few types of work required.
- ⑦Good stability as a single unit
 - Less affected by waves and currents during construction
- ⑧Good stability after completion



④Steel sheet pile cell type

(R169)temporary cofferdam

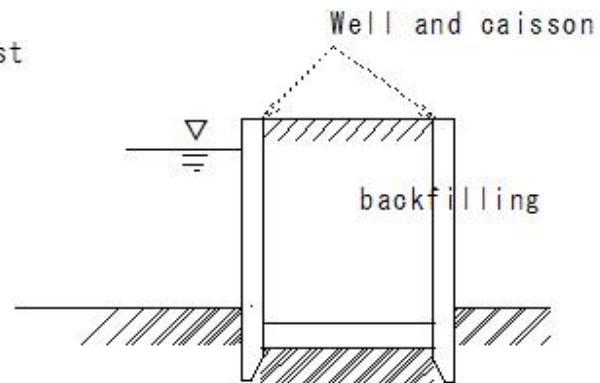
(R169)temporary cofferdam

temporary cofferdam
structure

Types/Characteristics

⑤ Well and caisson type temporary cofferdam

- ① The water is deep and is used for large-scale construction.
- ② For water-stopping properties, install a water-stopping structure.
- ③ Many types of work
 - Drilling, reinforcing bars, formwork, concrete
- ④ Good stability during construction
- ⑤ The stability after completion is the best
- ⑥ Difficult to remove during erection



⑤ Well and caisson type temporary cofferdam

(R170)temporary cofferdam

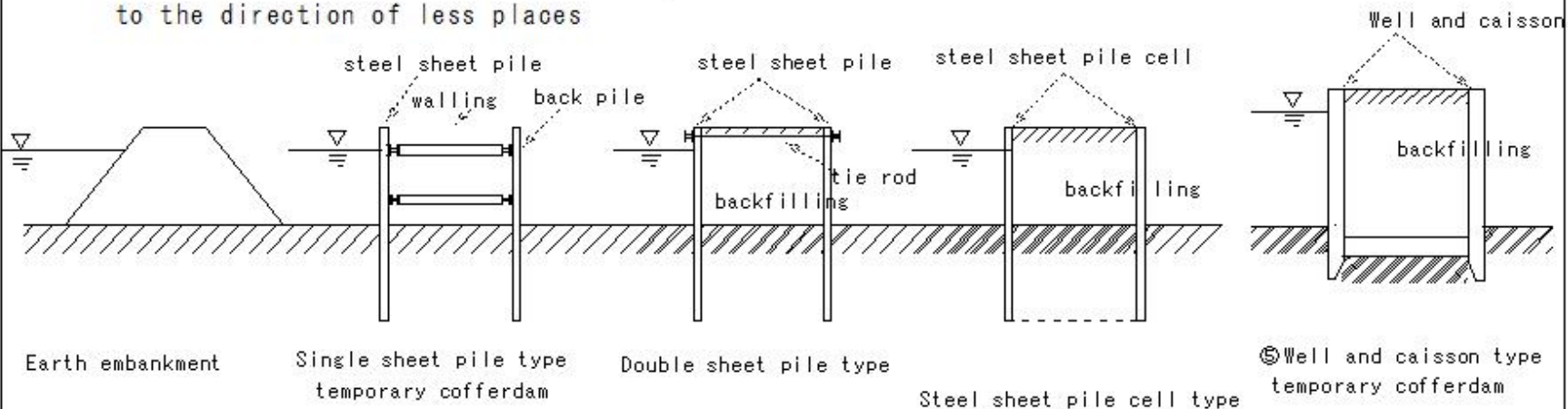
temporary cofferdam

structure

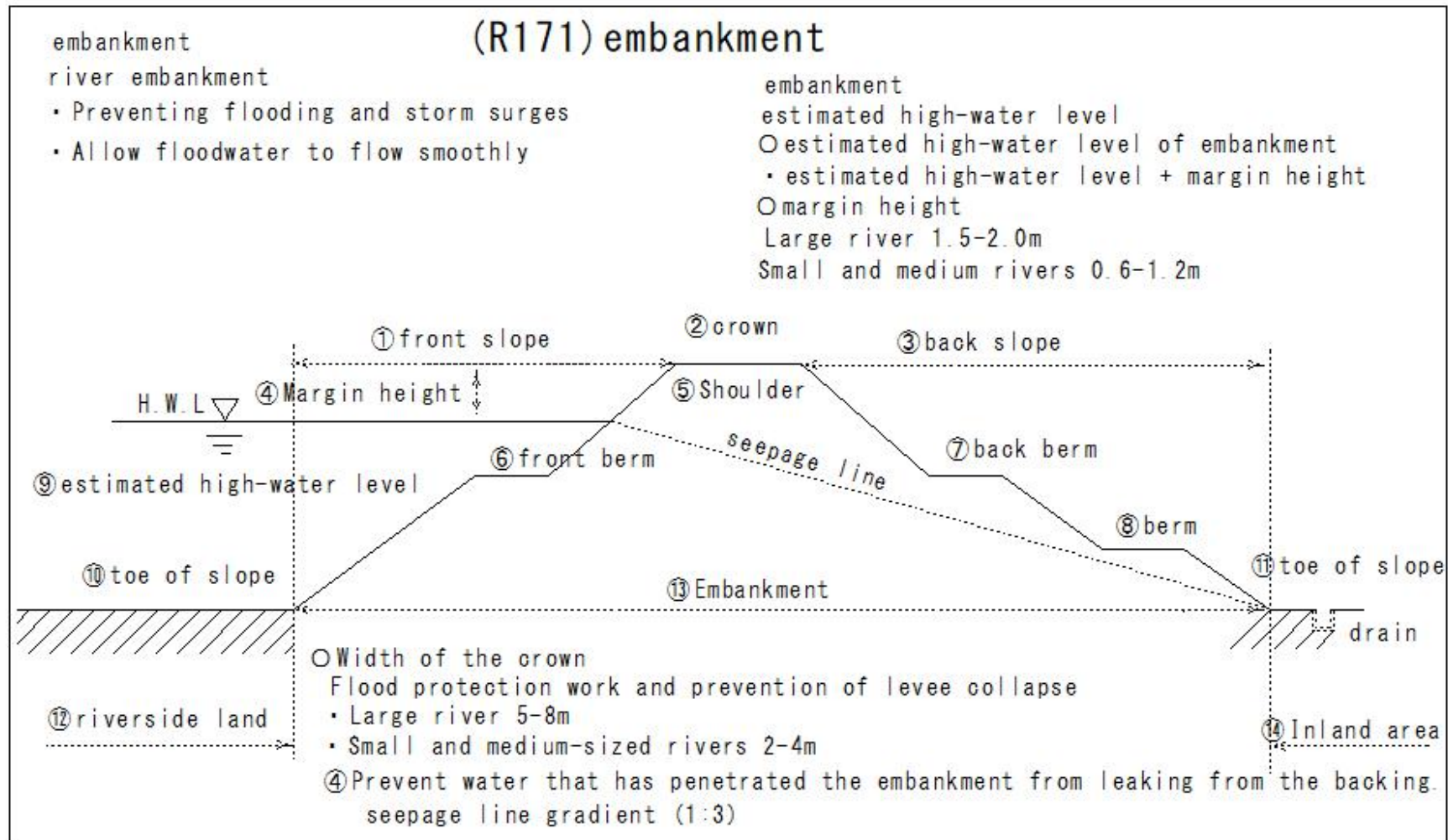
Points to note case of constructing temporary cofferdam

- ① If there are many boulders on the riverbed, it is difficult to drive steel sheet piles.
In this case, the earth embankment style is better.
- ② Single-layer steel sheet pile is a simple locking method.
 - case of storm high tide, tsunamis, etc. are expected at the river mouth.
 - need a strong temporary cofferdam
- ③ For the subsequent construction, earth and sand are poured into the wooden frame.
Function as a cofferdam as a gravity retaining wall
- ④ Direction of driving the sheet pile
 - From areas where there is a lot of expected scour
 - to the direction of less places

(R170) temporary cofferdam



(R171)embankment



(R172)embankment

(R172) embankment

embankment

embankment materials

① Low water permeability

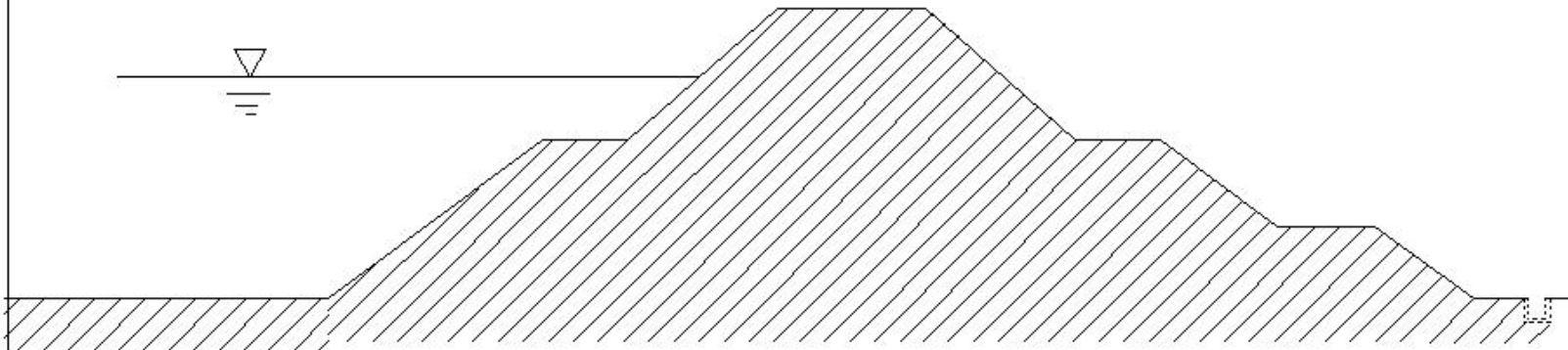
- Good workability for excavation, transportation, compaction, etc.

② Does not contain organic matter such as plants

③ Wetting and drying expansion and shrinkage are small

④ Does not cause slope slippage case of saturated with water

⑤ Even if the water content ratio increases, the internal friction angle does not decrease.



(R173)embankment

(R173) embankment

embankment

Construction of embankment

①Consolidation settlement of foundation ground

- Compaction of levee body sediment
- Consideration of traffic on the embankment body, etc.
- Excess of 10-50cm

②Embankment body has strength

- Embankment body soil with low permeability
- Sufficient compaction

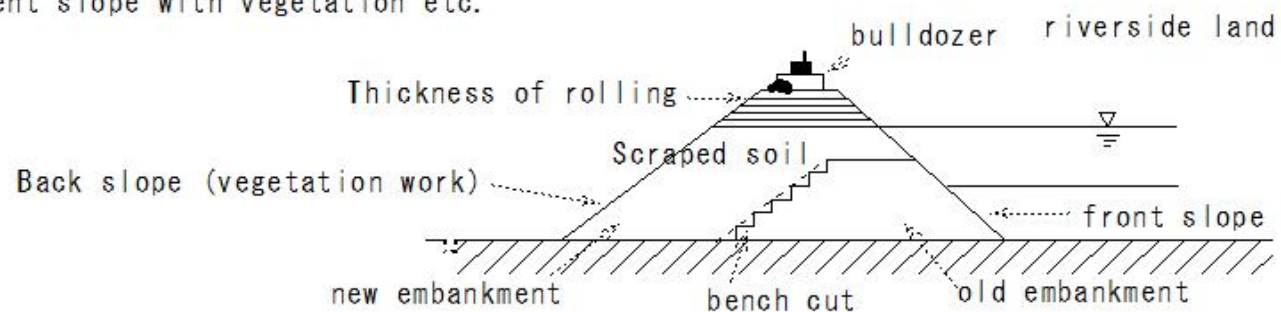
③case of expanding the old embankment

Cut the slope into steps to prevent slipping.

④Spread out the embankment soil in a layer of about 20-40cm

- Compaction with bulldozer road roller

⑤Protect the embankment slope with vegetation etc.



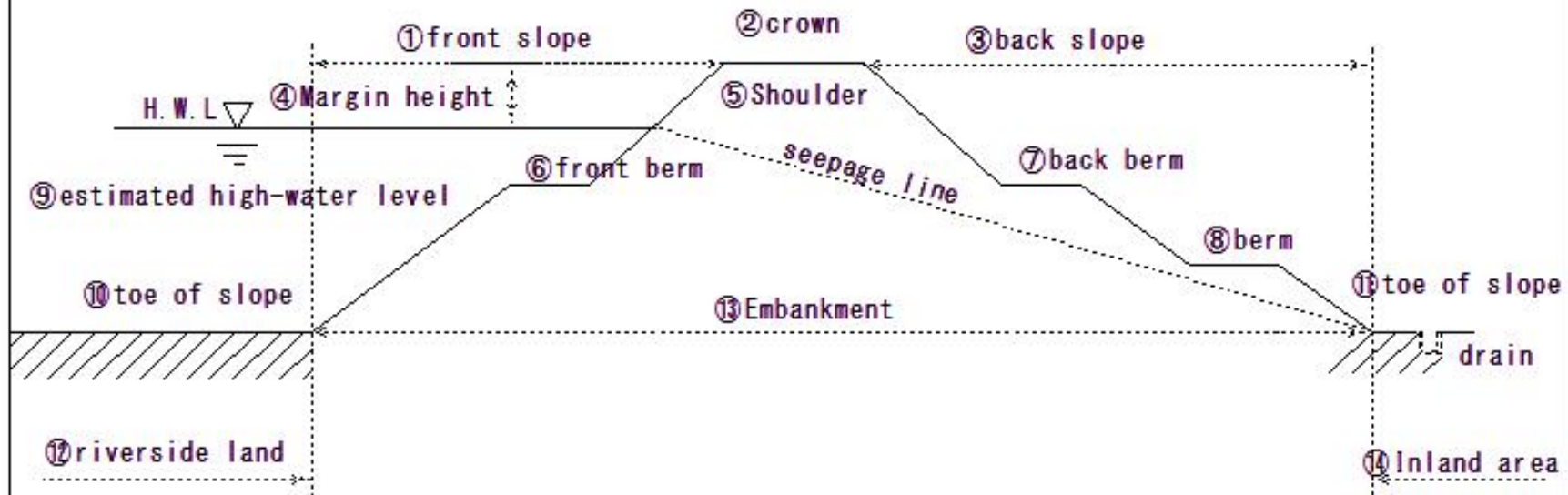
(R174)embankment

(R174)embankment

embankment

Measures against water leakage from embankments

- ①Expansion of embankment cross section
levee widening
- ②slope covering works(slope lining work)
Installation of cut-off walls
Cover the top slope with concrete, etc.
- ③Set up berm etc. to prevent the seepage line from coming out.



(R175) Structures protect riverbanks and embankments

(R175) Structures protect riverbanks and embankments

Structures protect riverbanks and embankments

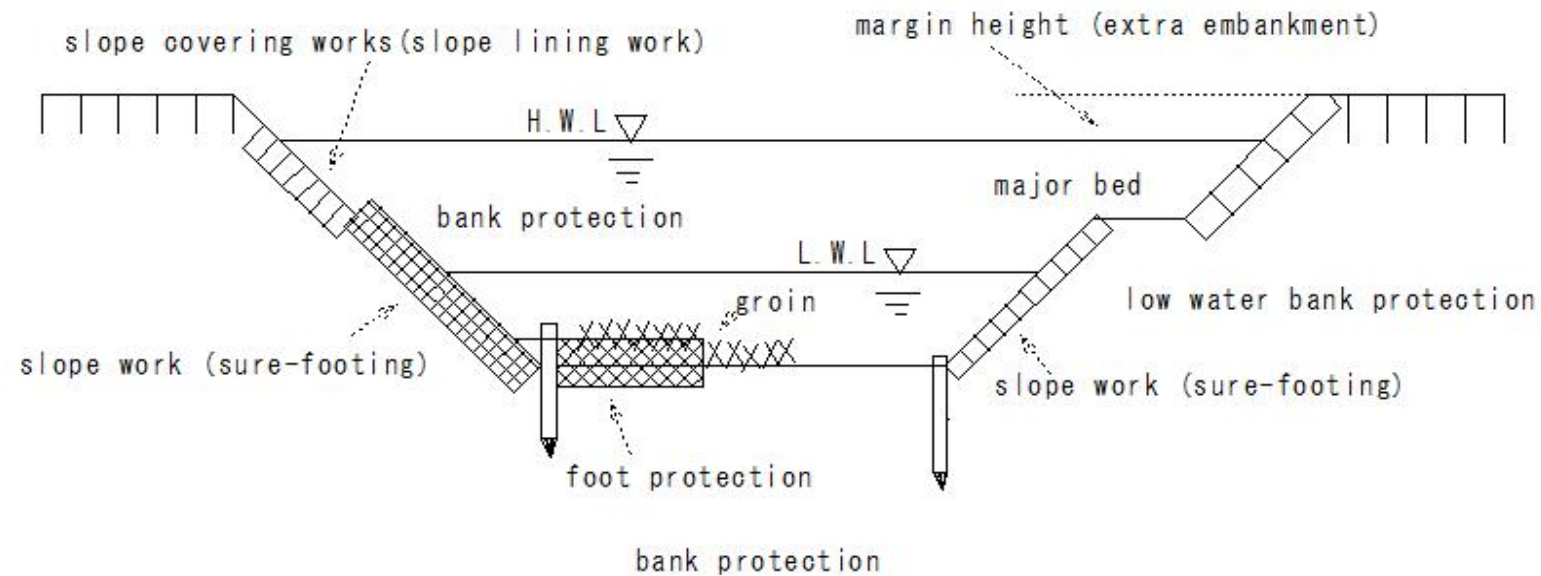
revetment

① Protect rivers and embankments against erosion caused by river flowing water

② bank protection: Constructed on the slope of the embankment

Low water bank protection: maintain low water channel

③ river bank protection: slope covering works, slope work (sure-footing), foot protection work



(R176) Structures protect riverbanks and embankments

(R176) Structures protect riverbanks and embankments

Structures protect riverbanks and embankments

slope lining work (slope covering works)

- torrent area - sodding installation
- Rapid section

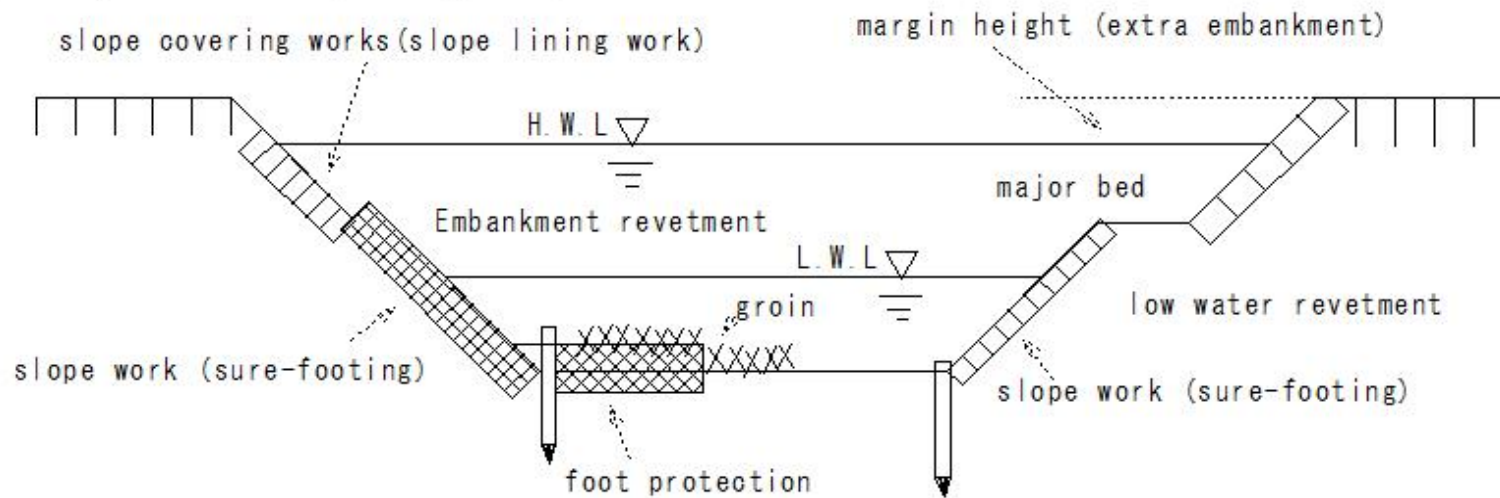
① Stone masonry

② Masonry work

③ Concrete pitching

④ Concrete block pitching

⑤ wire cylinder masonry work (gabion)



(R177) Structures protect riverbanks and embankments

(R177) Structures protect riverbanks and embankments

Structures protect riverbanks and embankments

slope work (sure-footing)

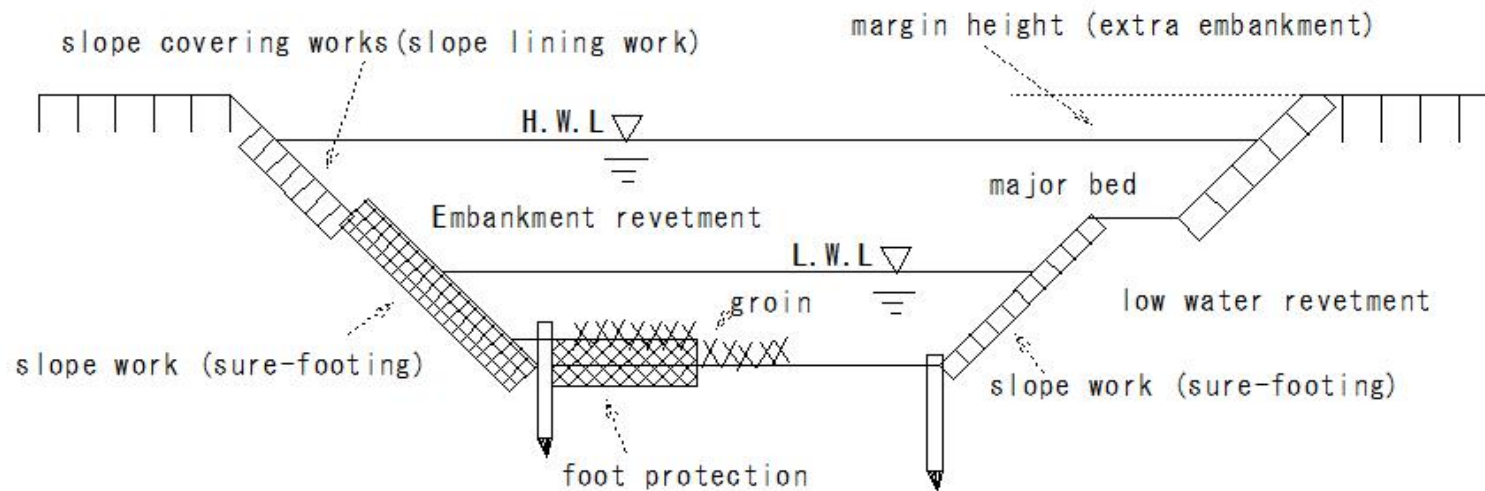
foot protection

• Construction method to prevent the tip of the river bank from being scoured

① rubble mound

② various concrete block pitching

③ mattress



(R178) Structures protect riverbanks and embankments

(R178) Structures protect riverbanks and embankments

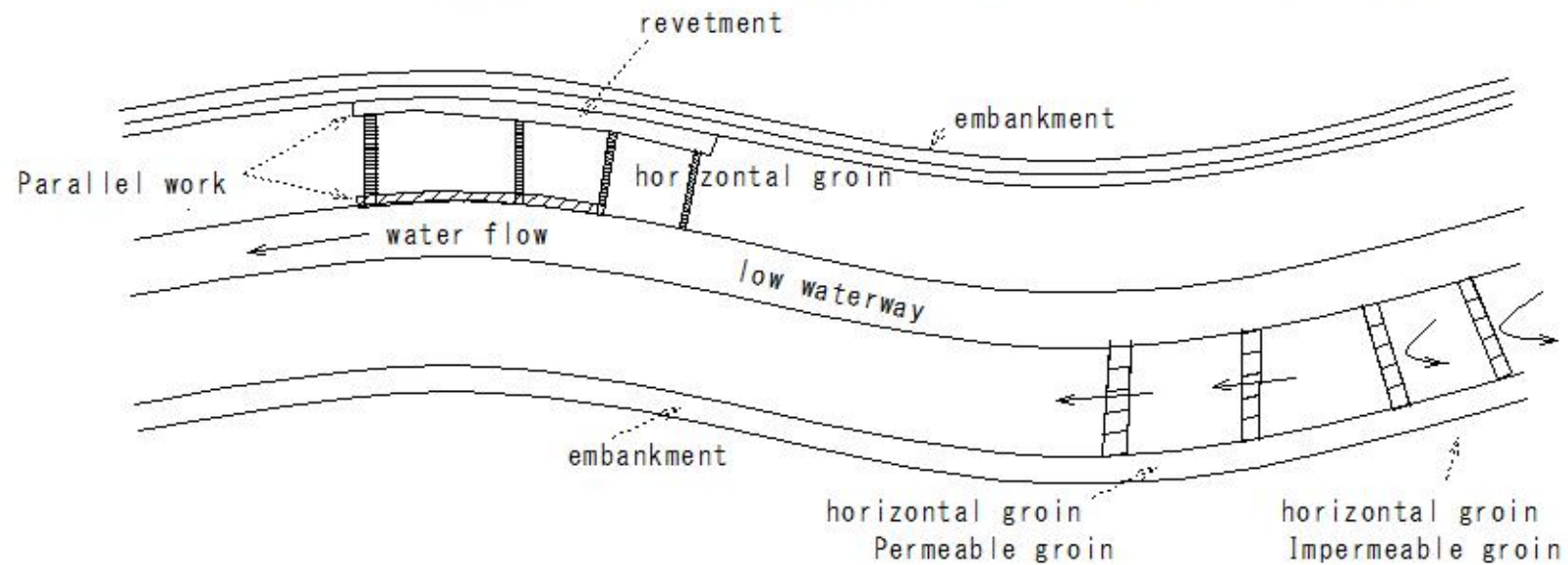
groin

① Weaken the flow

- Regulating the direction of water flow
- Permeation groin : weakens the flow force
- Impermeable groin: Blocking the flow in the groin

groin : parallel groin

○ The direction of horizontal groin is perpendicular to the water flow.



(R179) Structures protect riverbanks and embankments

(R179) Structures protect riverbanks and embankments

Structures protect riverbanks and embankments

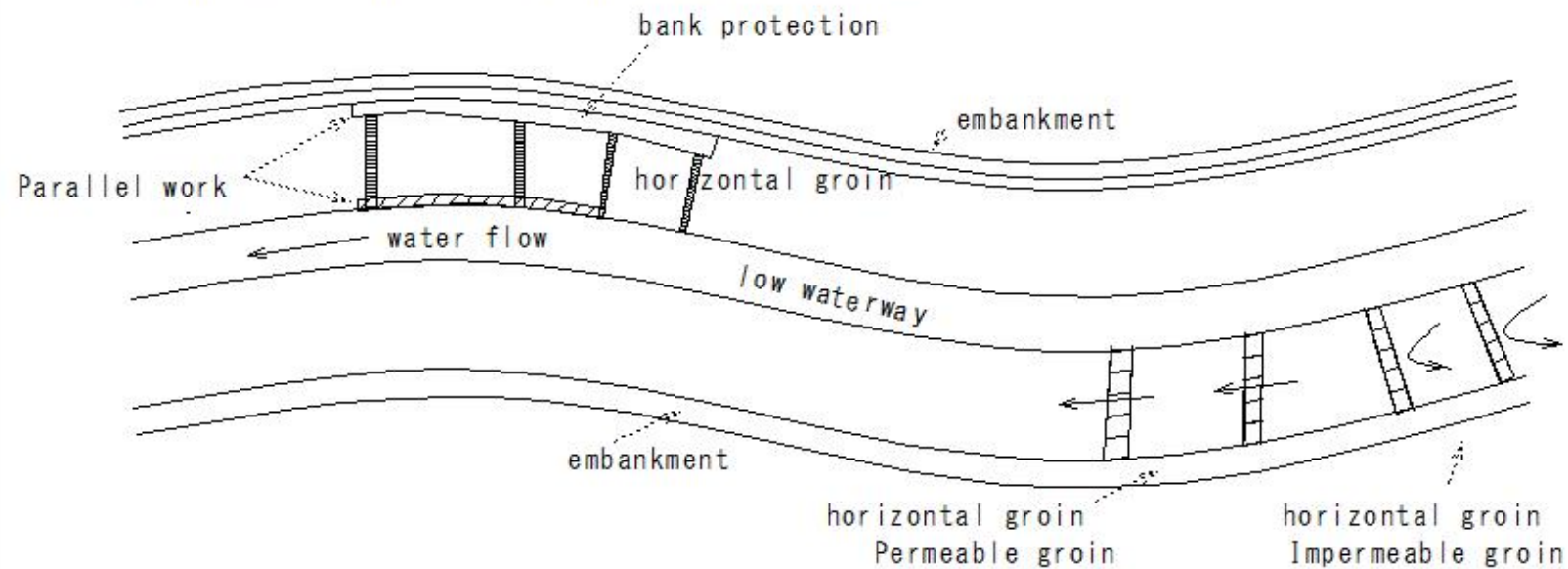
Effect of groin

- ① Direct the water flow toward the center of the river.
 - Make it in a certain direction

Regular waterway Fixed the width of the low waterway and maintained the water depth

- ③ Weaken the flow force and settle the earth and sand

Prevention of scouring of riverbanks and embankment legs

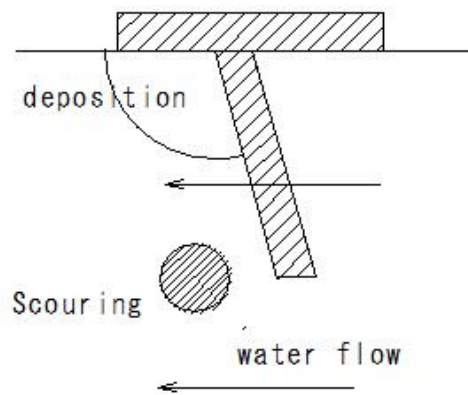


(R180) Structures protect riverbanks and embankments

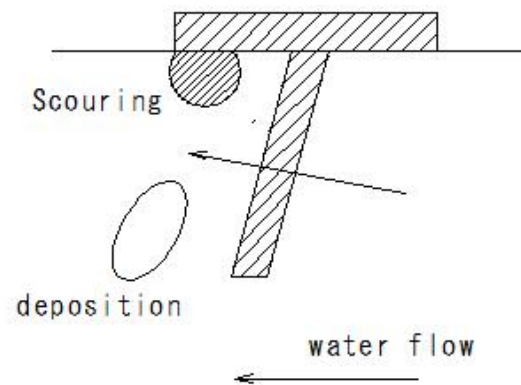
(R180) Structures protect riverbanks and embankments

Structures protect riverbanks and embankments

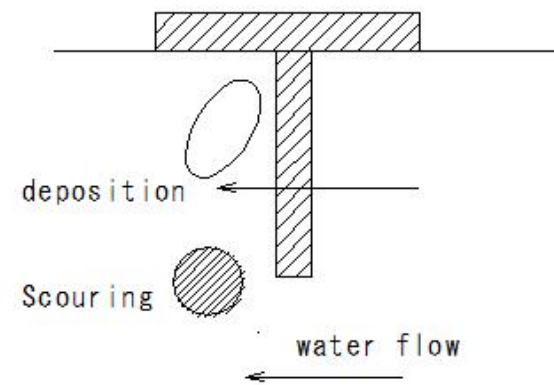
Direction of water control



① Upward groin



② Downward groin



③ Right angle groin

(R181)River

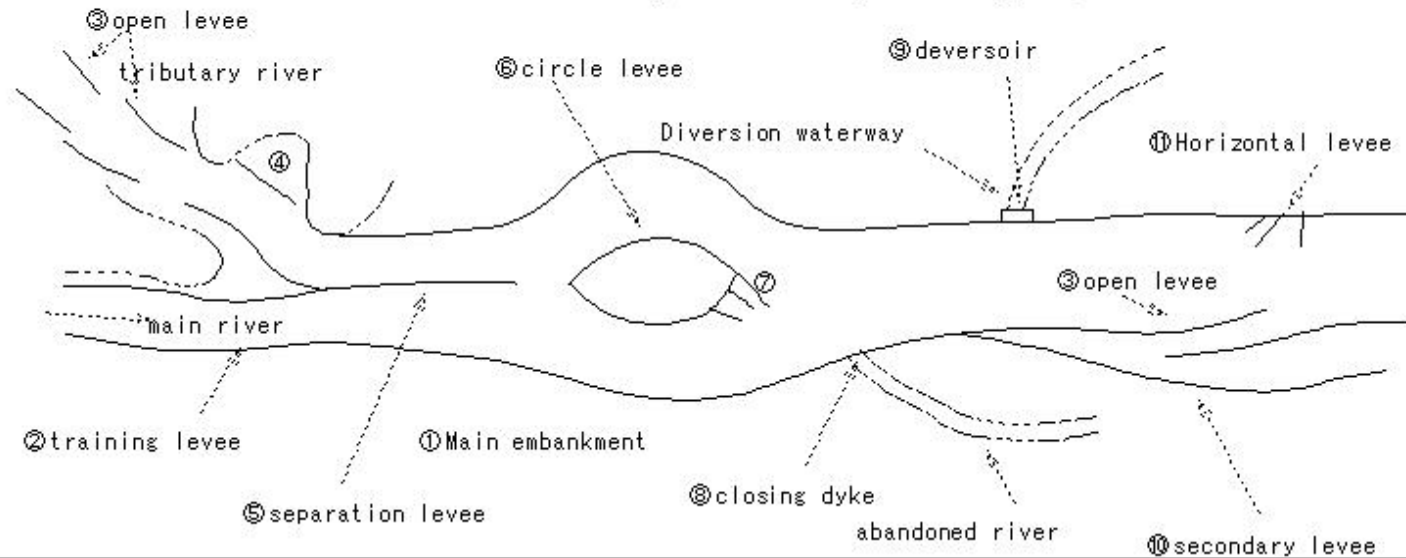
(R181)River

River functions

- ① Flood control, water utilization, environmental conservation
- ② Flood control- hydrology survey- survey river condition survey
- ③ River planning
- ④ River construction

- embankments construction
- bank protection work
- river channel repair work
- new river excavation work

- Flood control work
- River structures
- Embankment, bank protection, groin, ground sill, sluice gate, weir



(R182)River

(R182) River

River classification

Water system: Main river, tributary rivers, branch rivers, lakes and marshes

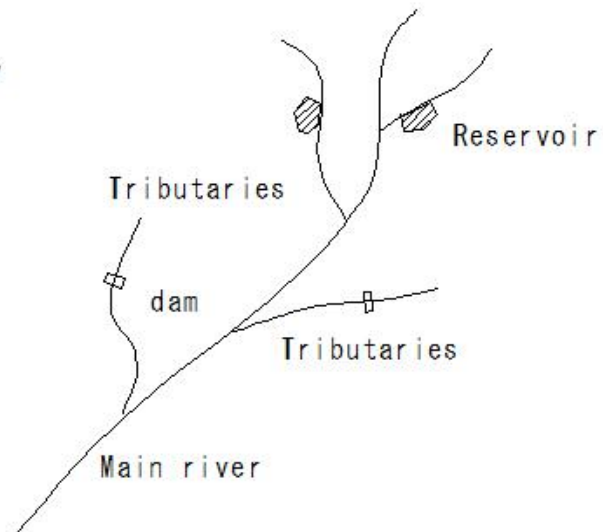
• Tributaries and main river

dam

tributary river

Reservoir use

Main river, tributary river water flow



Main river, tributary river water flow

(R183)River

(R183) River

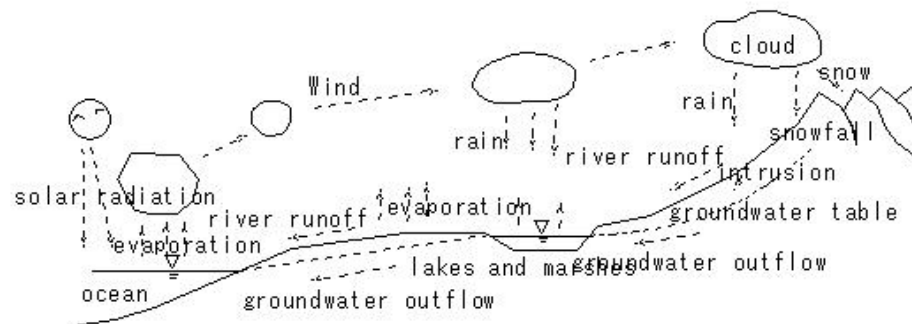
Hydrological survey and river survey

water on earth

Hydrological survey: evaporation-precipitation-runoff-evaporation sluice phenomenon

River condition survey: Investigating-changes in river basin morphology and shape

River improvement plan



(R184)River

(R184) River

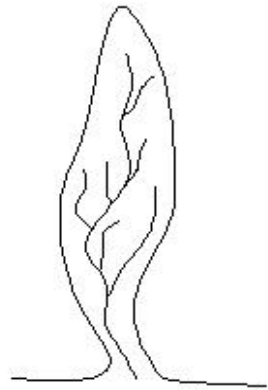
Comprehensive river plan

River functions

Flood control, water utilization, environmental conservation

- Flood protection plan
- Environmental conservation plan
- Water usage plan
- River channel river structure planning

River improvement plan materials



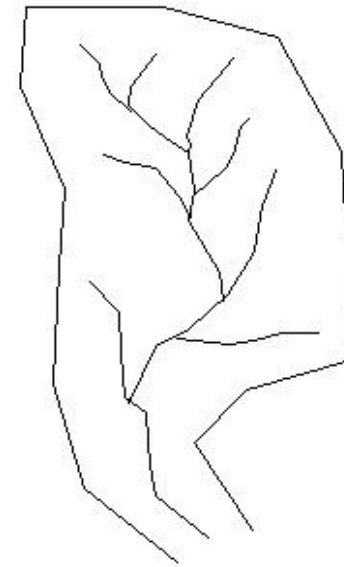
pinnate basin



parallel basin

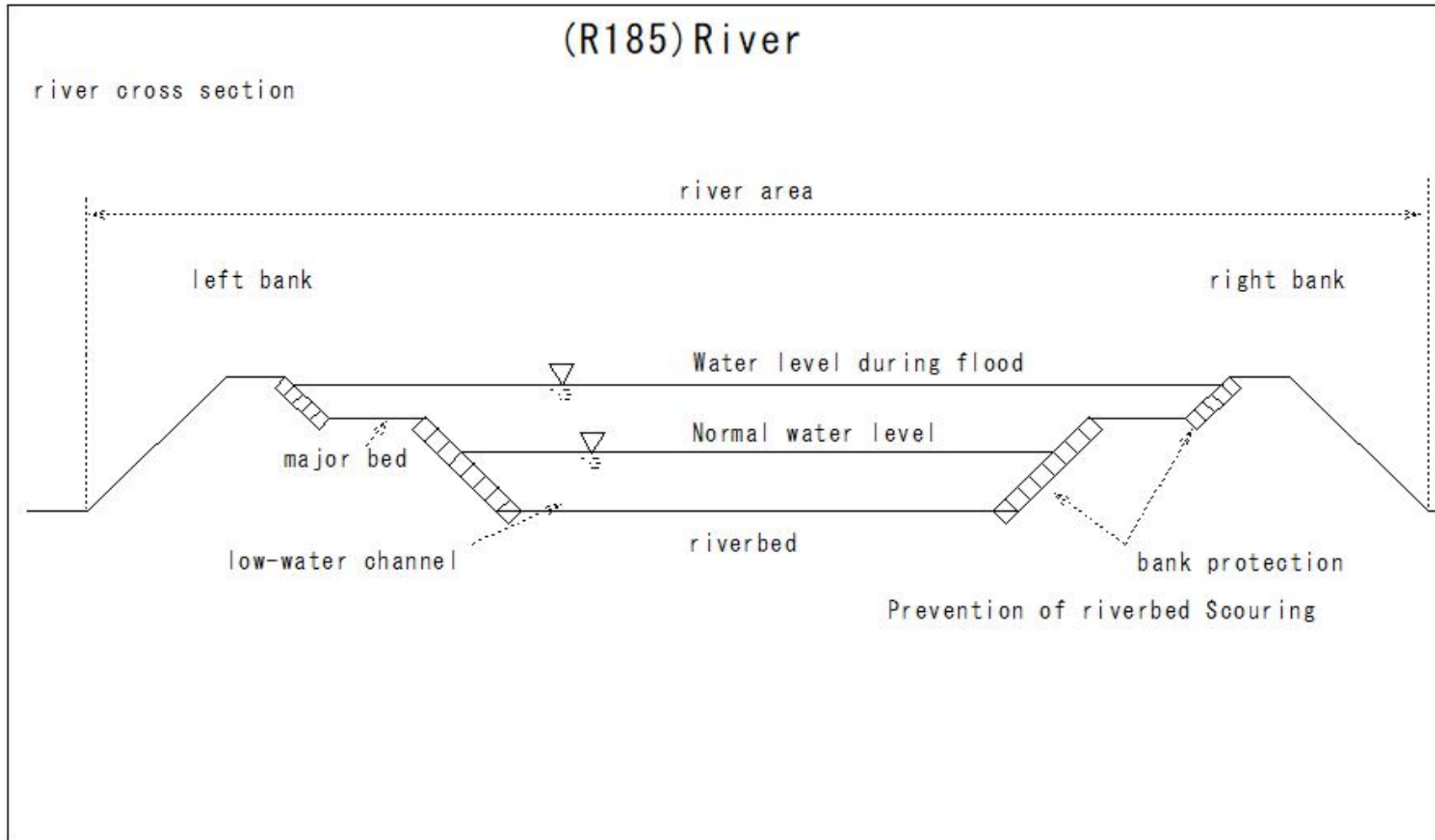


radial basin



composite basin

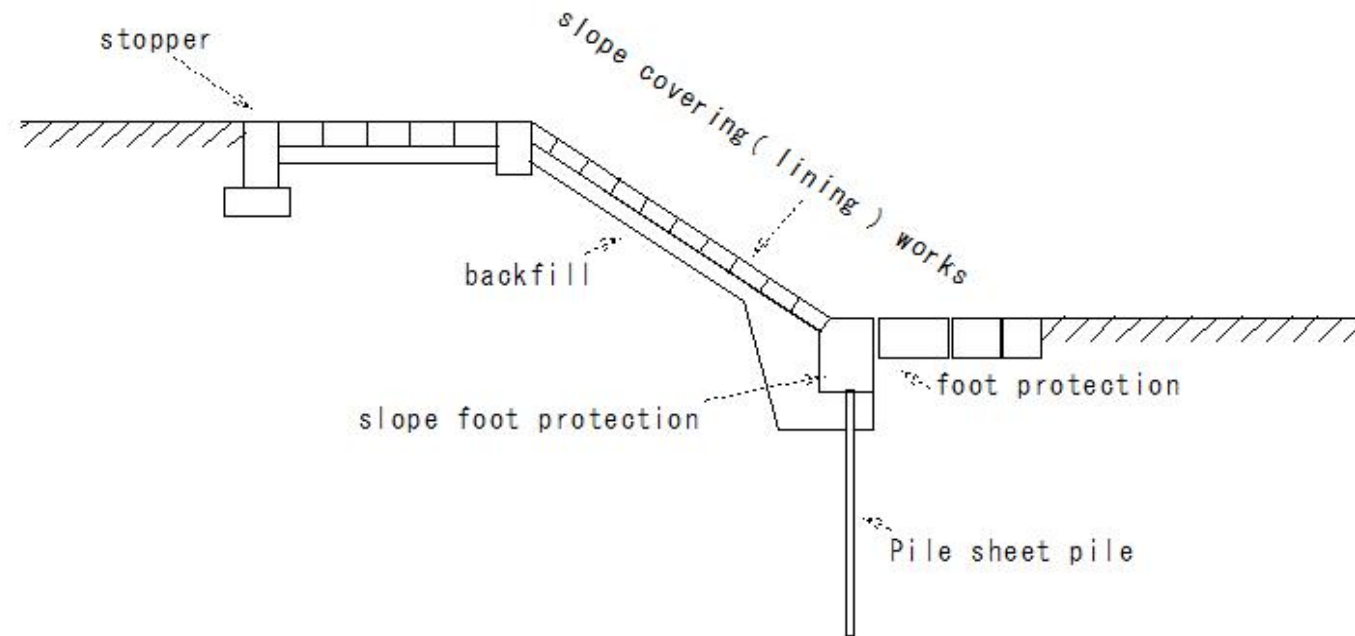
(R185)River



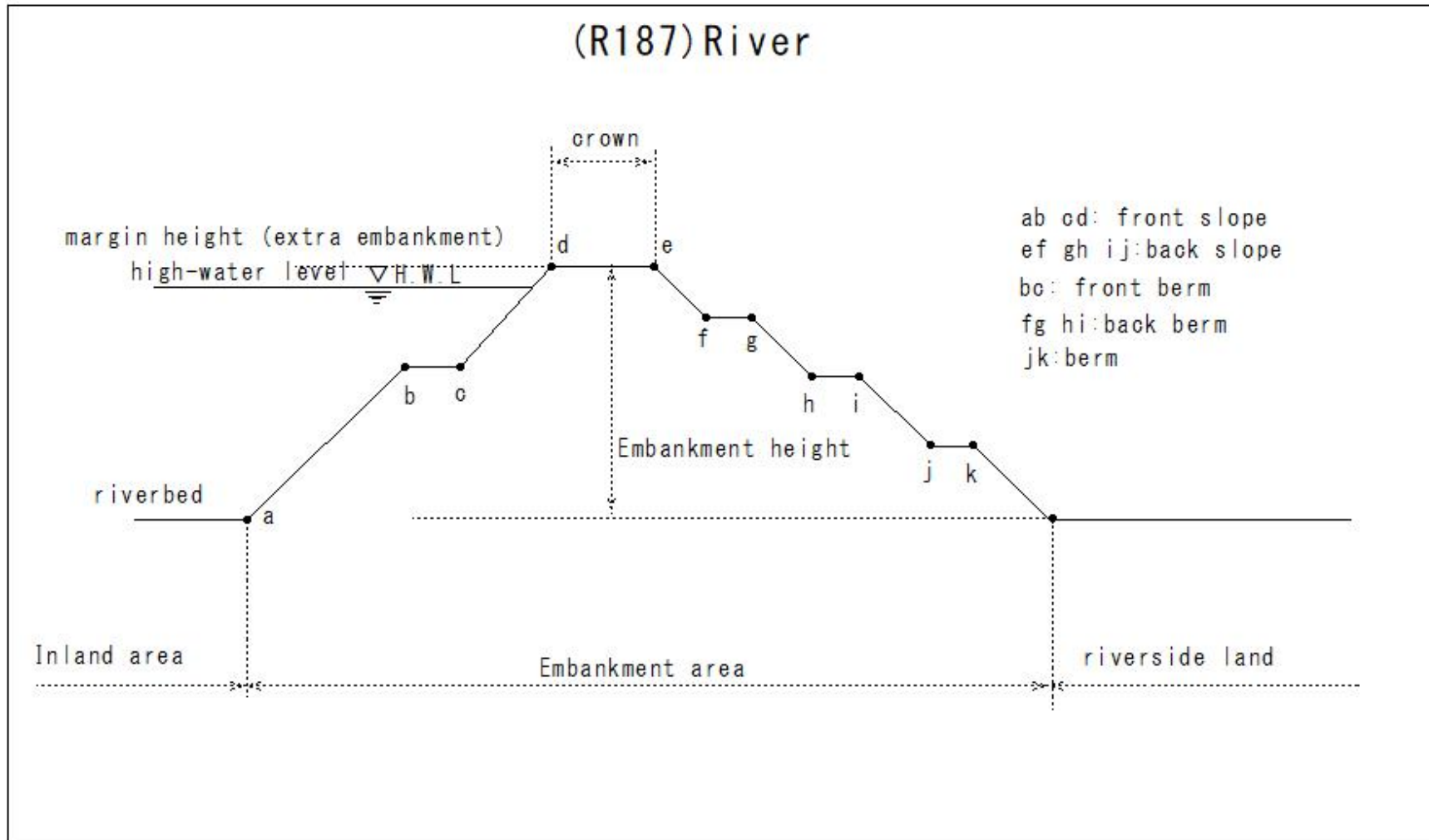
(R186)River

(R186) River

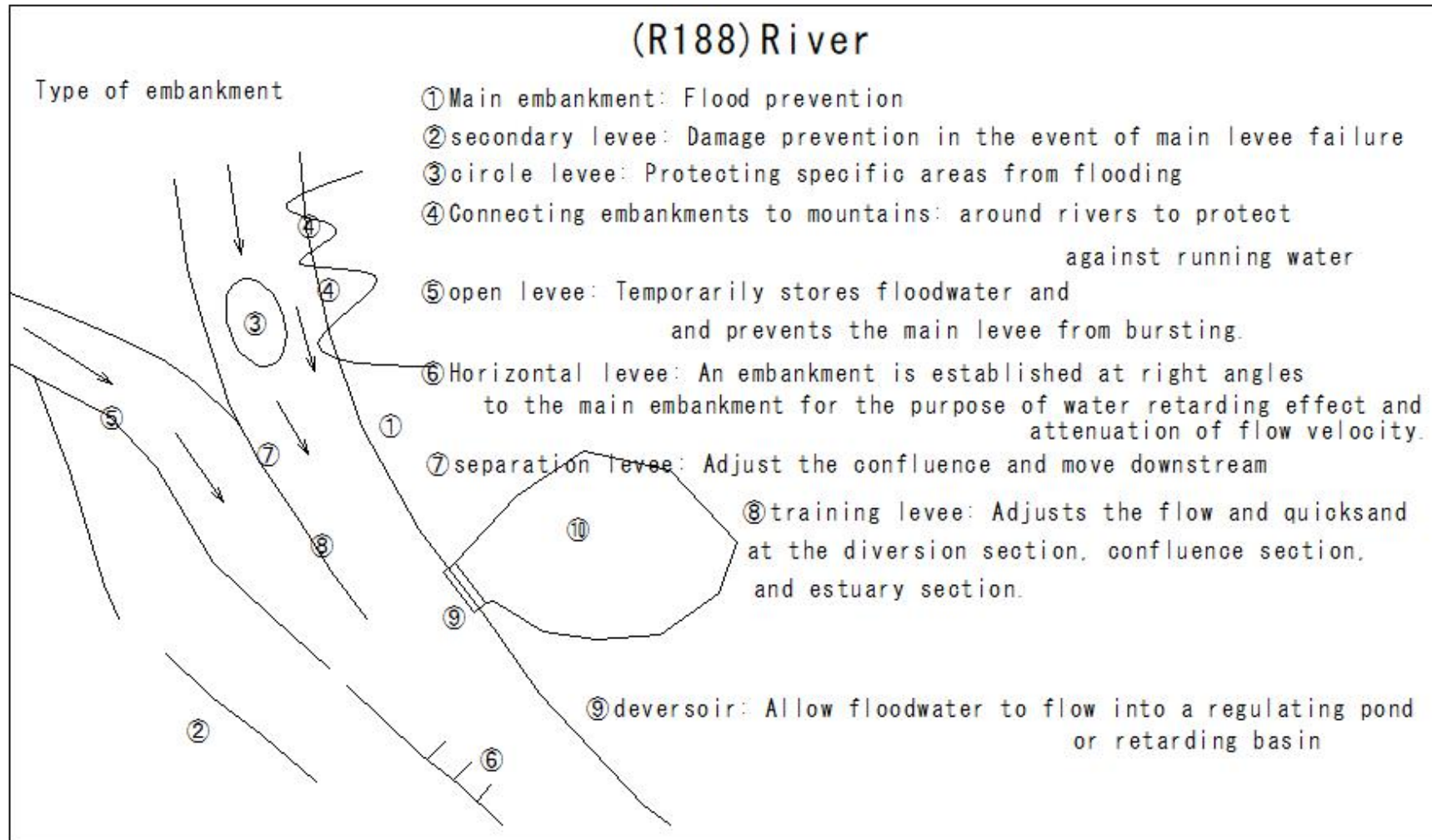
Names of each part of the bank protection



(R187)River



(R188)River



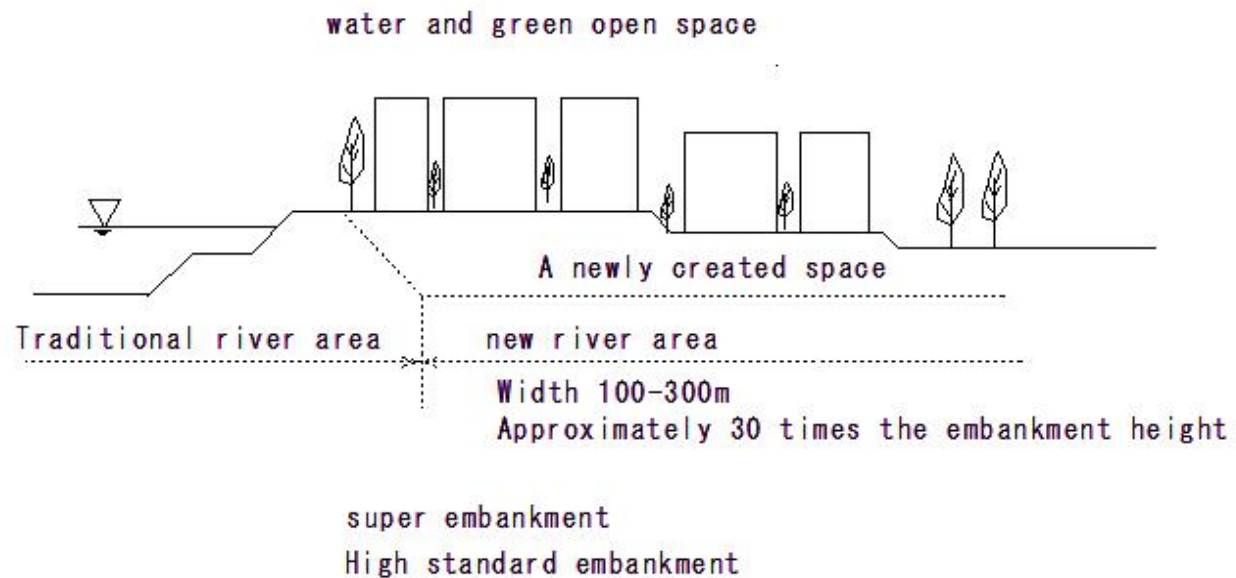
(R189)River

(R189) River

Type of embankment

super embankment

- Excessive floods in large cities -prevention of destructive damage
- Ensuring safety during floods
- Secure a good river space blessed with water and greenery
- Better relationship between people and nature

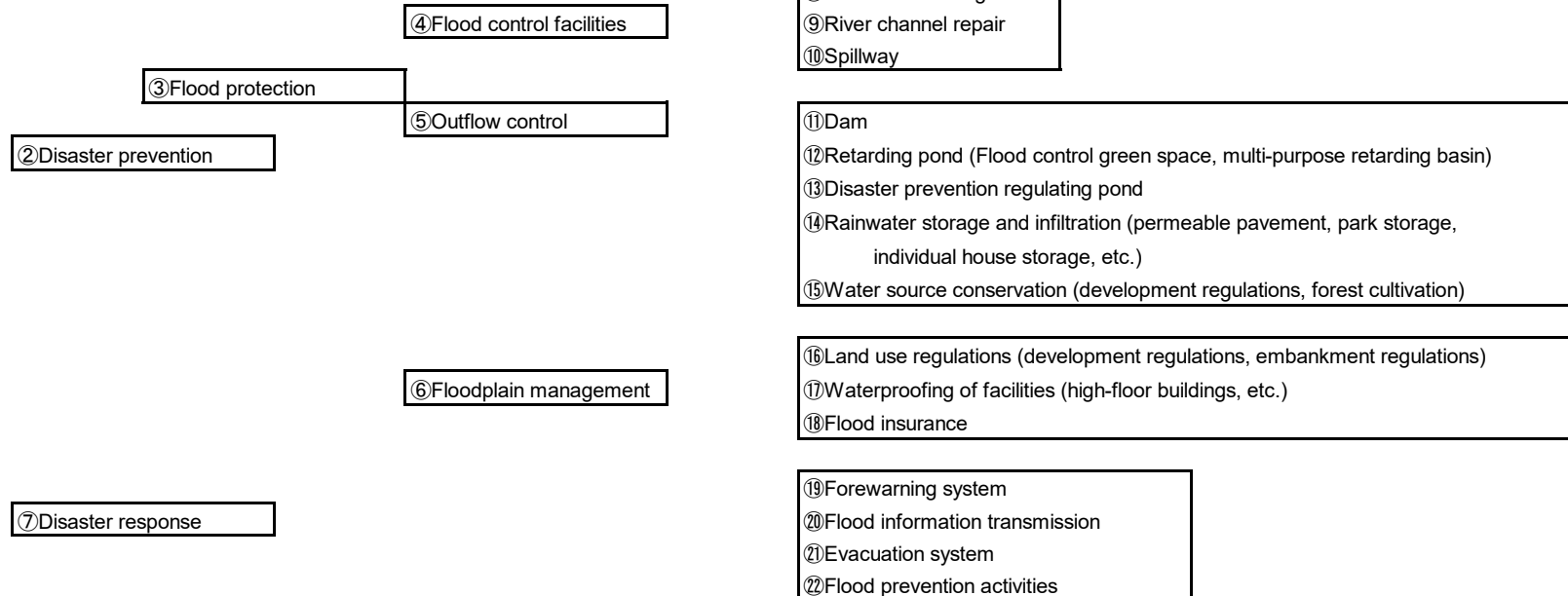


(R190)River

(R190)River

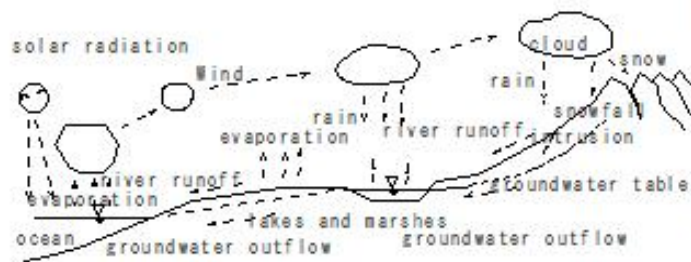
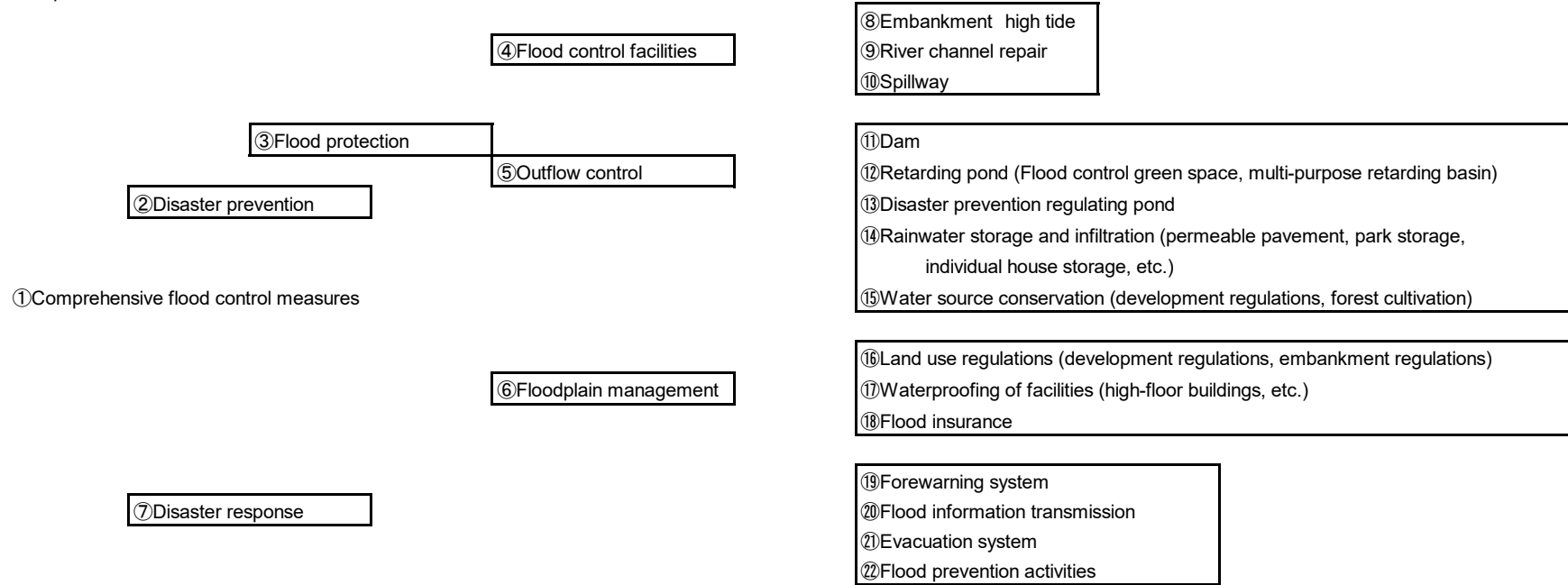
Comprehensive flood control measures

①Comprehensive flood control measures



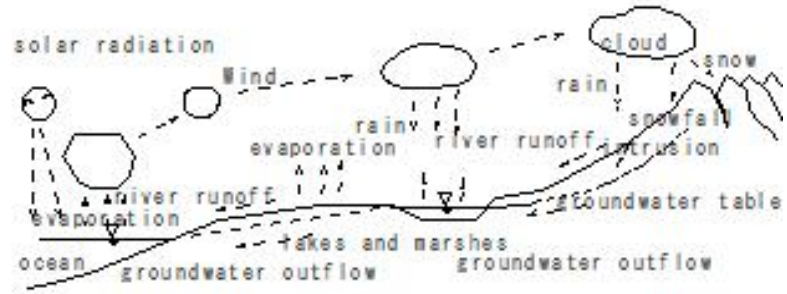
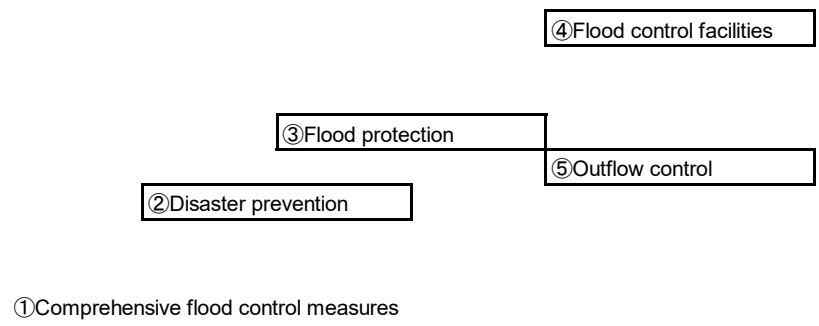
(R191)River

Comprehensive flood control measures

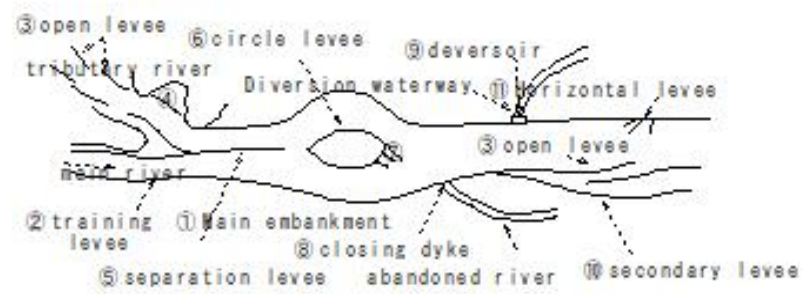
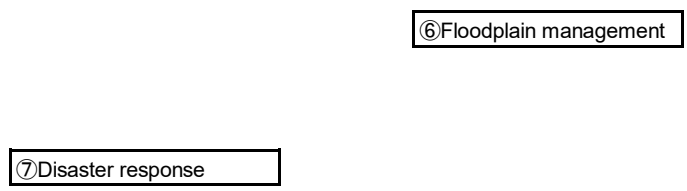


(R192)River

Comprehensive flood control measures



① Comprehensive flood control measures

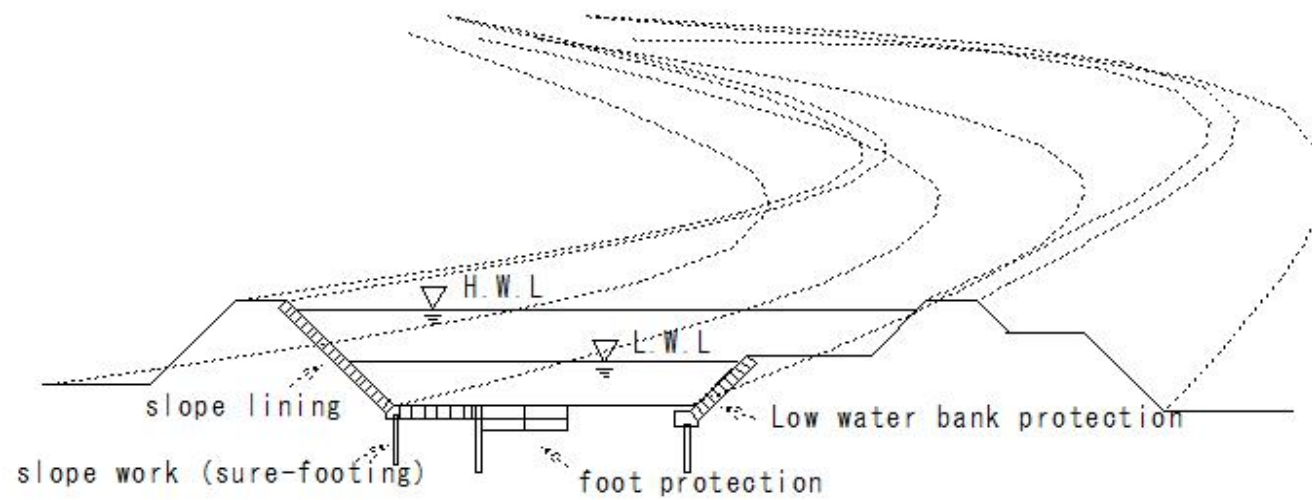


(R193)River structures

(R193)River structures

Type of embankment

- River structures
- ① bank protection
 - Erosion prevention due to flooding of embankments and riverbanks
 - Slope protection

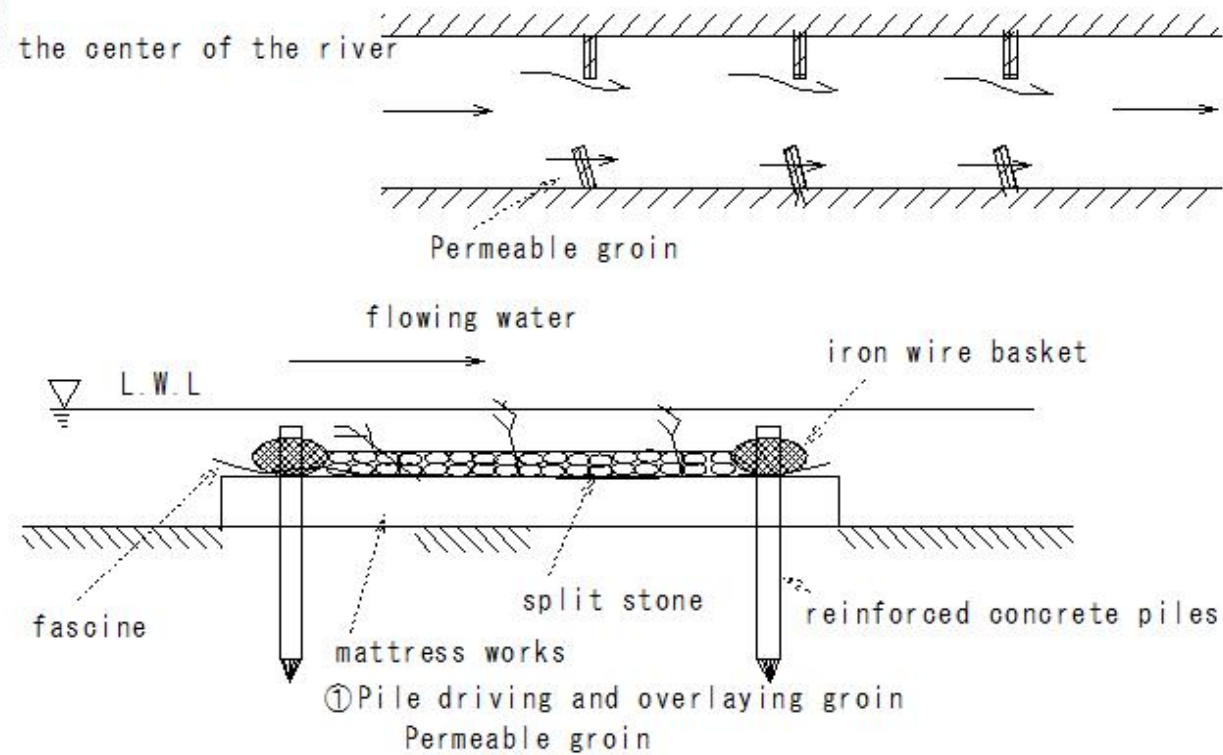


(R194)River structures

(R194)River structures

Type of embankment

- River structures
- ② groin
- Flowing water control
- groin protrude toward the center of the river

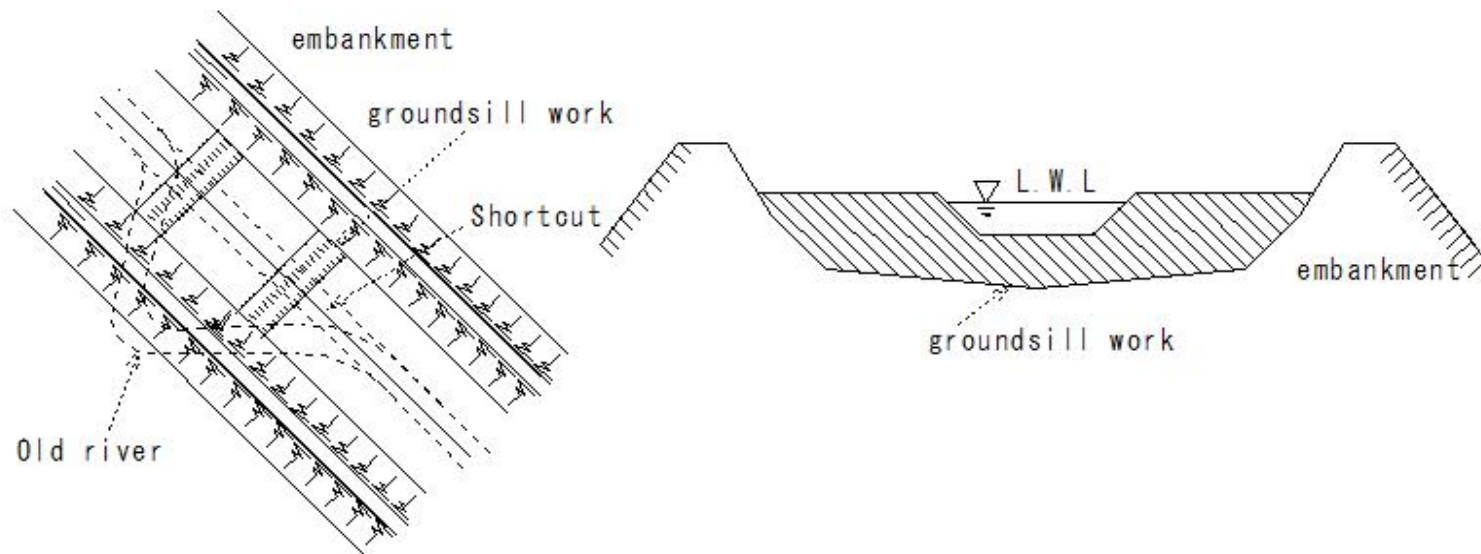


(R195)River structures

(R195)River structures

Type of embankment

- River structures
- ③ Ground sill consolidation works
- River bed decline
- River crossing
- Maintenance of major bed
- Prevention of riverbed decline



(R196)River structures

(R196)River structures

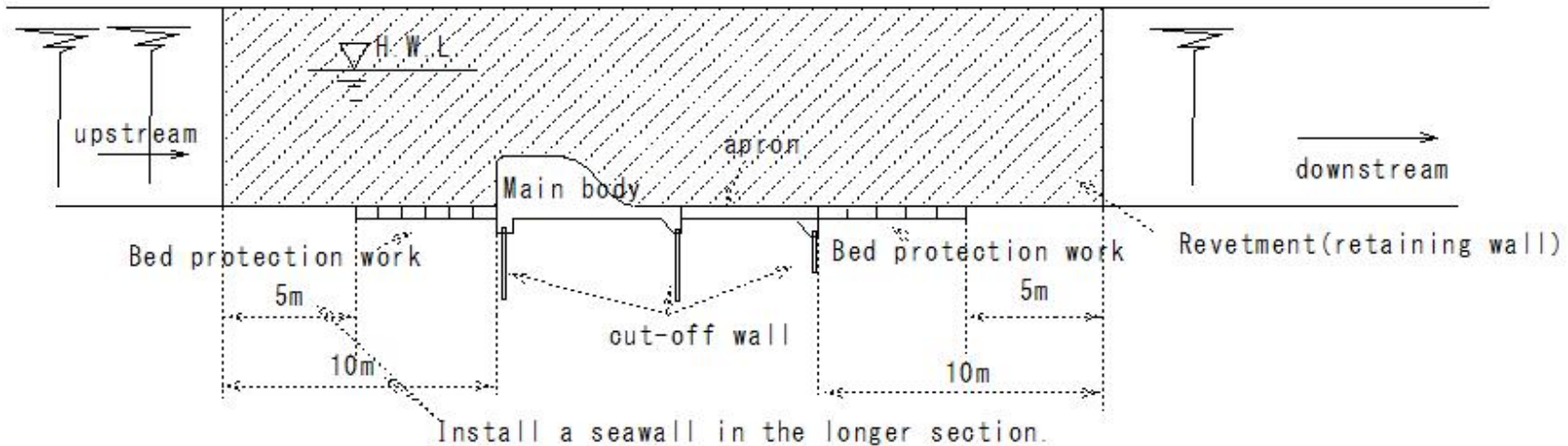
Type of embankment

- River structures

④ Weir

- Prevention of seawater intrusion (salt damage prevention) in estuary areas
- River flow distribution
- Installed at the water intake

Classified into river channel weirs and fixed weirs depending on structure.



① case of touching a floor stop or weir

(R197)Multi-natural river creation

(R197)Multi-natural river creation

Type of embankment

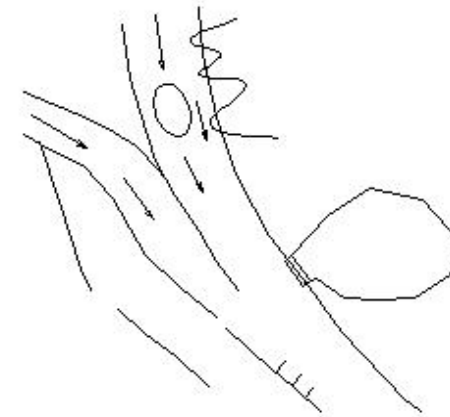
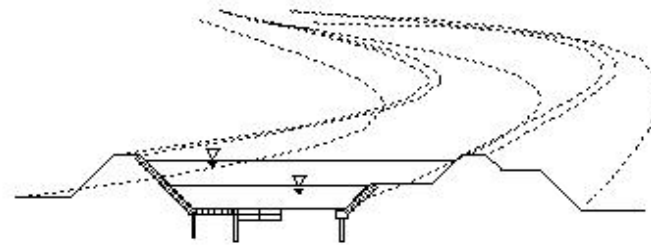
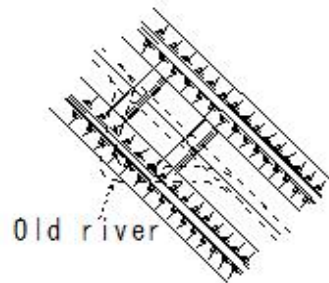
Multi-natural river creation

- Consideration of a good growing environment for living things (biotope)
- Conserve and create natural landscapes

① Embankment

- Normal shape structure material - innovation
- Making use of existing rivers

Adoption of normal lines with bends and bulges



(R198)Multi-natural river creation

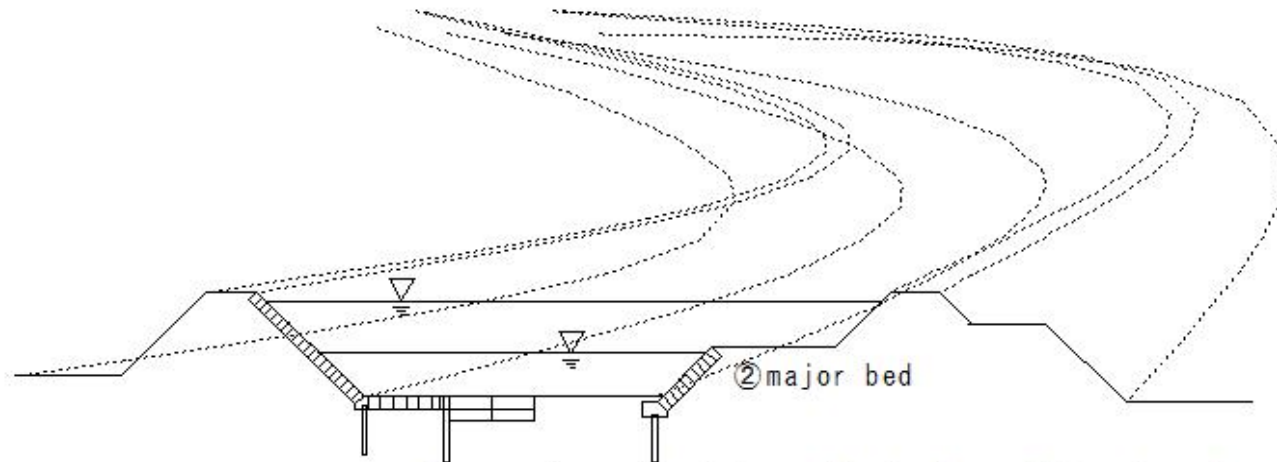
(R198)Multi-natural river creation

Type of embankment

Multi-natural river creation

- Consideration of a good growing environment for living things (biotope)
- Conserve and create natural landscapes

②major bed



- Planar shape, devising methods for cutting down trees, etc.
- Use of trees and plants

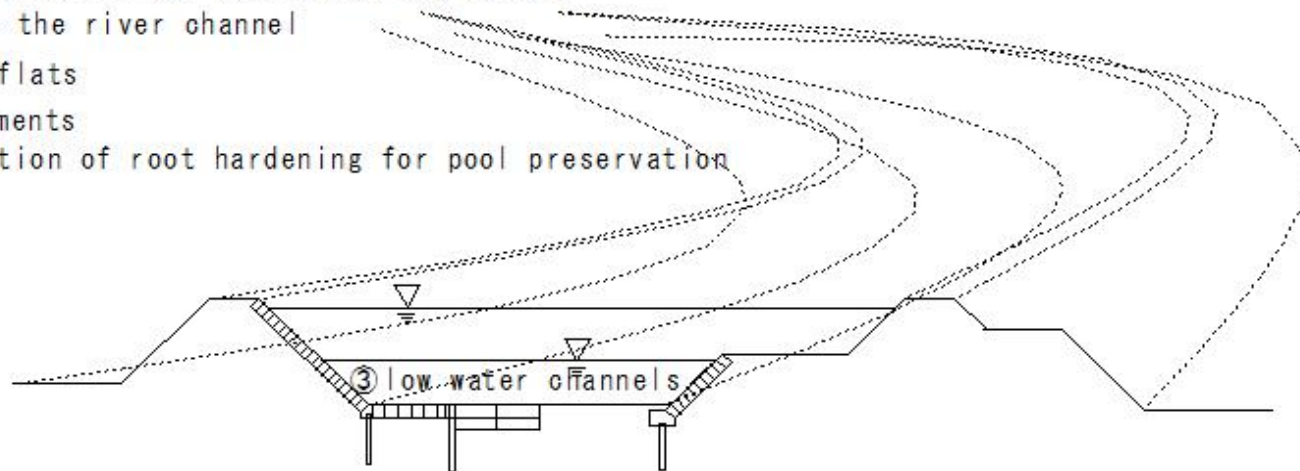
(R199) Multi-natural river creation

(R199) Multi-natural river creation

Type of embankment

Multi-natural river creation

- Consideration of a good growing environment for living things (biotope)
- Conserve and create natural landscapes
- ③ Maintaining the width and depth of low water channels
 - Consideration of fish feeding areas, resting areas, evacuation areas, etc.
 - Adoption of low channel normal with bends and bulges
 - Original stones in the river channel
- Creation of tidal flats
- Vegetation improvements
- Improving the location of root hardening for pool preservation



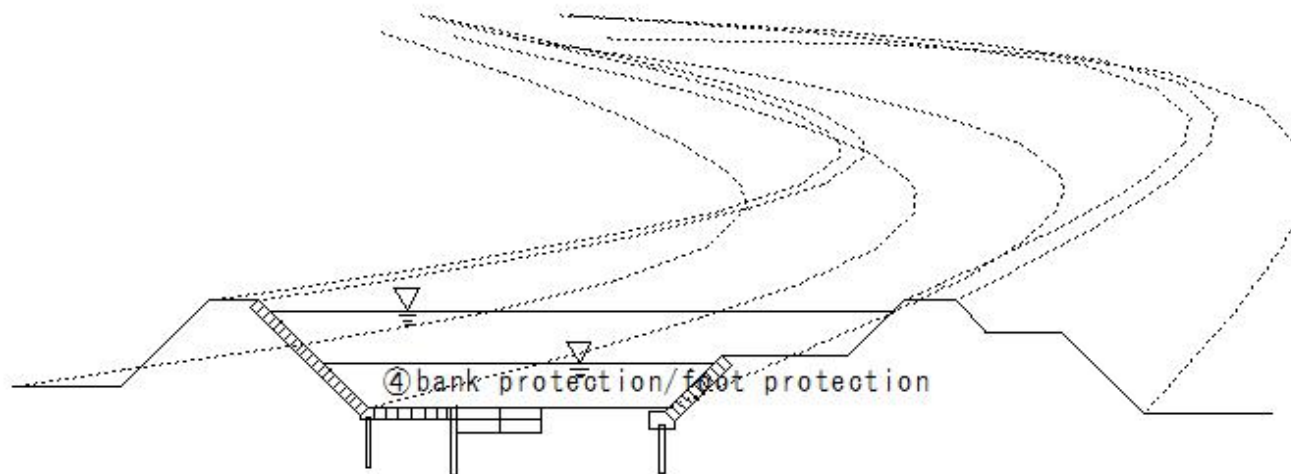
(R200)Multi-natural river creation

(R200)Multi-natural river creation

Type of embankment

Multi-natural river creation

- Consideration of a good growing environment for living(biotope)
- Conserve and create natural landscapes
- ④ bank protection/foot protection
 - Improved structure, materials, etc.
 - Adoption of riverbank protection using a combination of vegetation, trees, and stones
 - Using materials with a void structure for baskets and stones



(R201)Multi-natural river creation

(R201)Multi-natural river creation

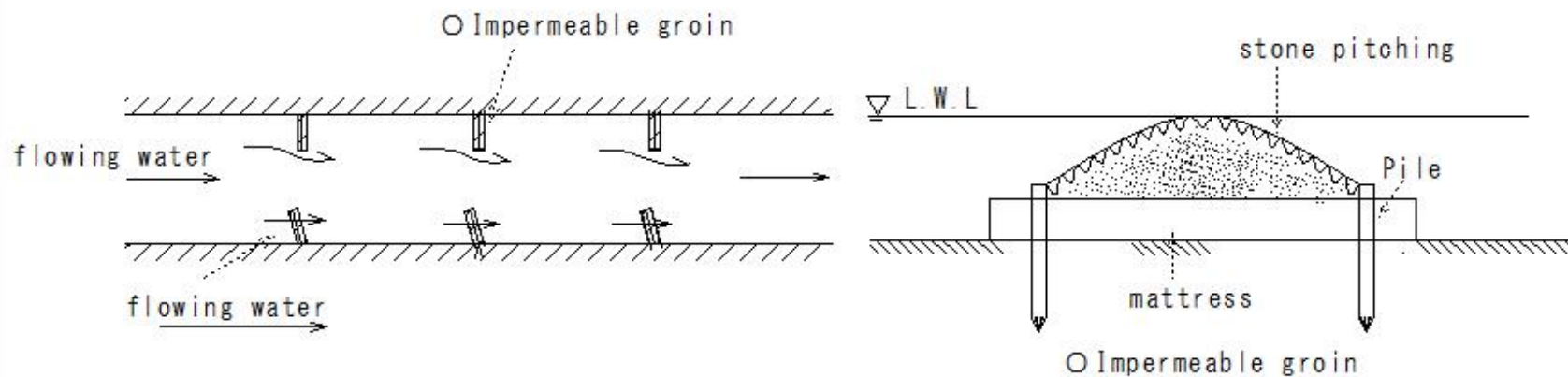
Type of embankment

Multi-natural river creation

- Consideration of a good growing environment for living (biotope)
- Conserve and create natural landscapes

⑤ groin

- Improved structure, material, length, gap, etc.
- Use of materials with various pore structures such as megaliths
- Adoption of short groin that also serve as foot protection



(R202)Multi-natural river creation

(R202)Multi-natural river creation

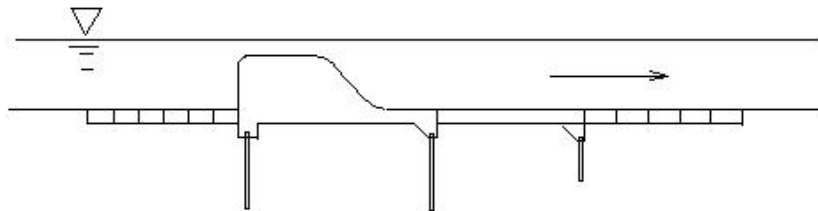
Type of embankment

Multi-natural river creation

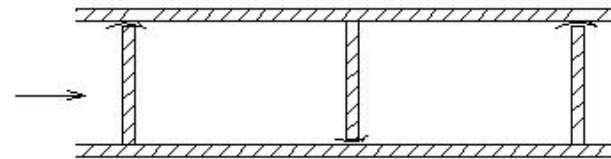
- Consideration of a good growing environment for living (biotope)
- Conserve and create natural landscapes

⑥Weir/head-fall-drop

- Consideration of securing fishladder
- Installation of depressions for fish migration routes
- Multi-head-fall-drop
- Slope head-fall-drop construction (adopting fishladder on all steps)



Weir



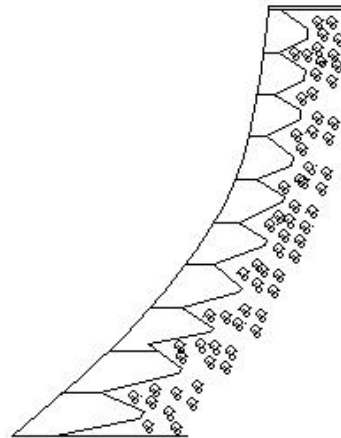
fishladder

(R203)Masonry work

(R203)Masonry work

Masonry work

- A type of lining method
- Protection of steep slope of 1:1 or more
- Empty masonry, dry masonry, stone masonry
- Make the backfill sufficiently thick to prevent soil and sand from flowing out.

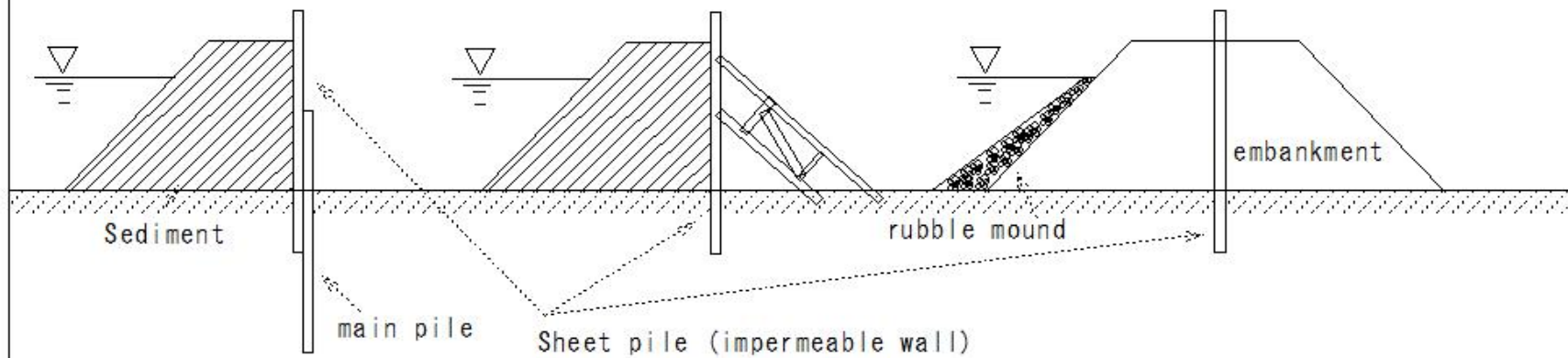


(R204) Temporary cofferdam

(R204) Temporary cofferdam

Temporary cofferdam

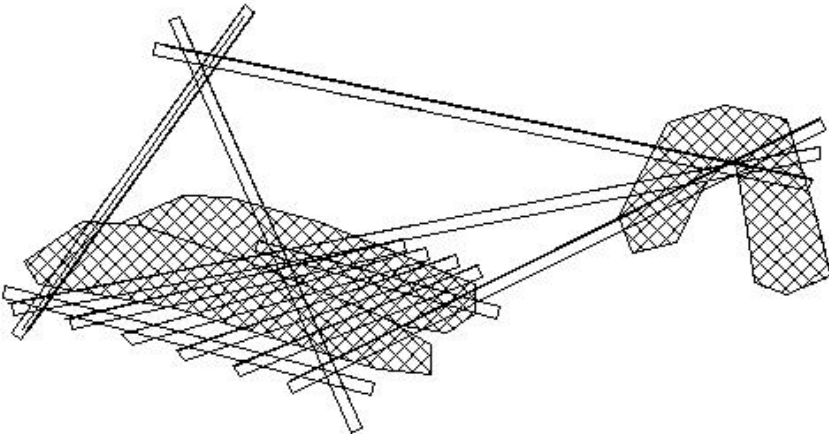
- Single steel sheet pile
- Embankment/Dam: Preventing water leakage and earth and sand outflow
- strut type using freestanding type and beam type



(R205)Groin

(R205) Groin

frame groin
wire cylinder masonry work(gabion)
Rapid river

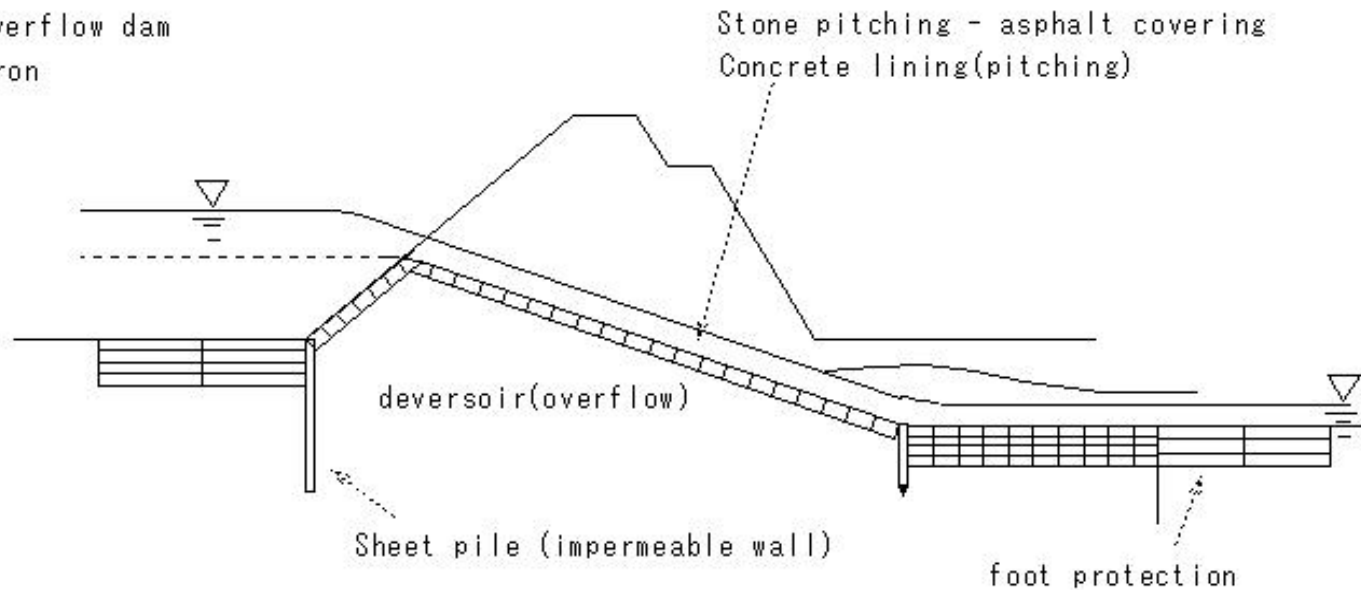


(R206)deversoir(overflow)

(R206)deversoir (overflow)

deversoir(overflow)

- During floods, river water level - above a crown height
- Part of the river water - discharged from the river
- Part of the embankment - low
- Overflowing into reservoirs etc.
- Flood peak flow reduction
- Structure of overflow dam
- Slope-crown-apron



(R207)levee widening

(R207) levee widening

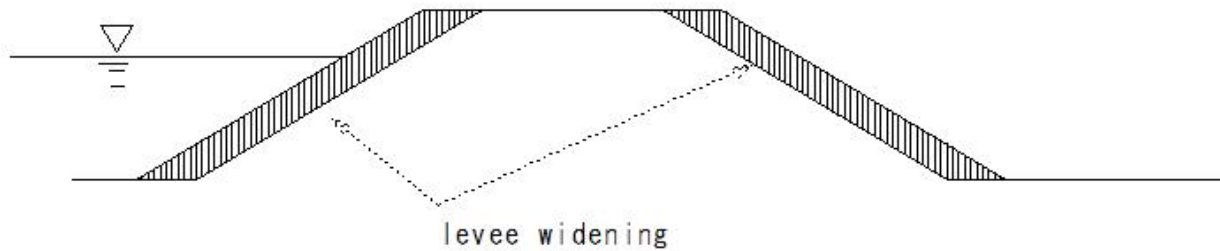
levee widening

Existing embankment water leakage point

River surface - reduce seepage water

Increase penetration distance

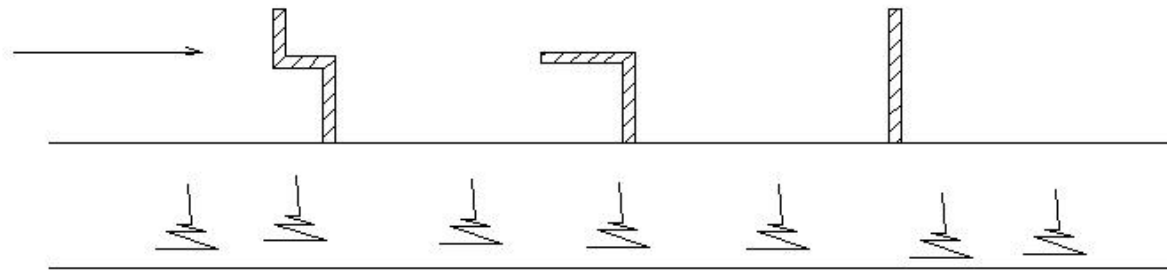
Expand cross-sectional area



(R208)groin

(R208) groin

groin
weaken the current



(R209)embankment(open levee)

(R209) embankment (open levee)

embankment

- open levee

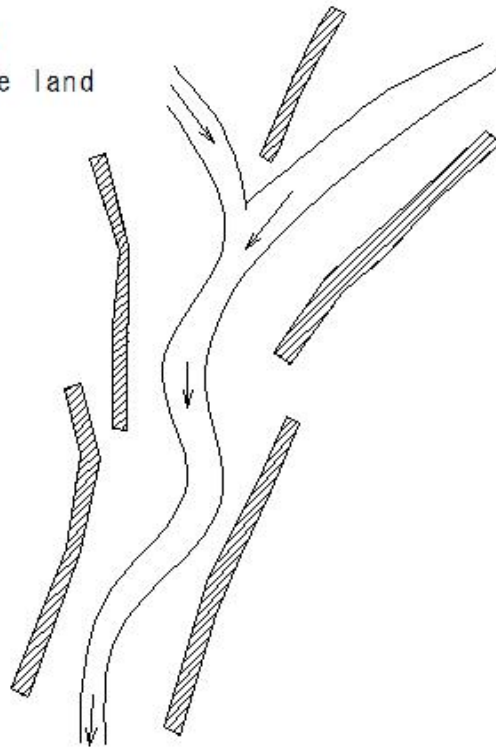
Rapid river, up to the top if necessary

During a flood, running water floods the land

lower maximum flow rate

Reduce damage to farmland

Effect of precipitating new soil



(R210)river

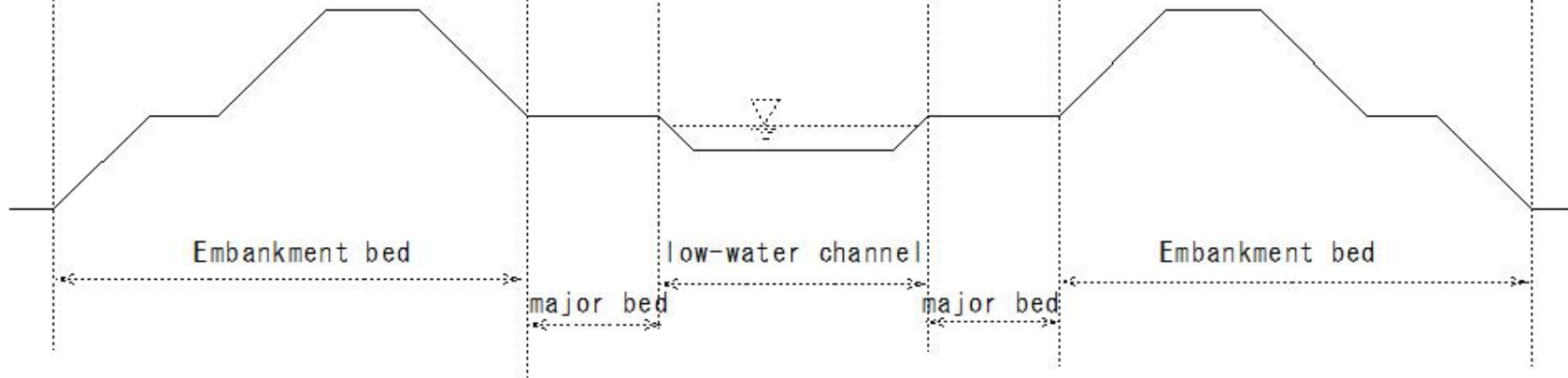
(R210) river

• River area

Inland area

riverside land

Inland area



(R211)River embankment

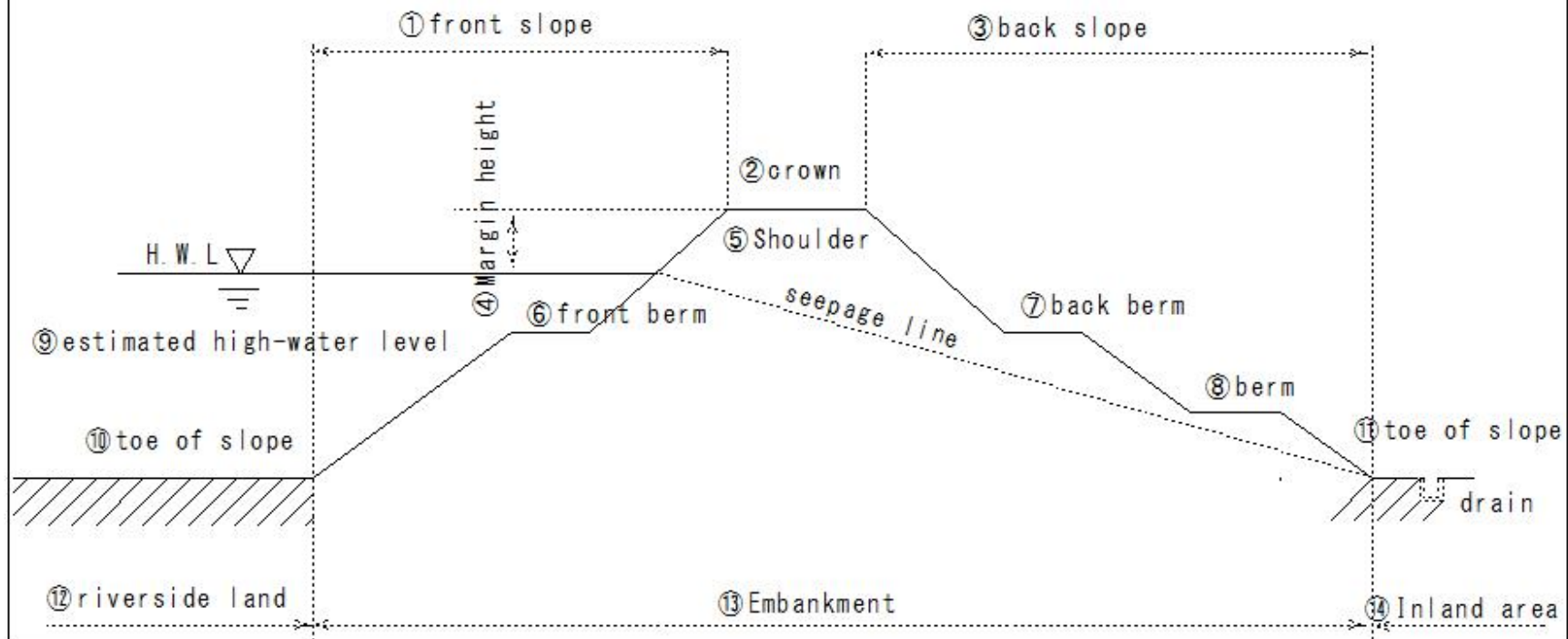
(R211)River embankment

River embankment

Preventing flooding during floods

Check points during construction

① Construct the embankment wide and the slope gentle.



(R212)River embankment

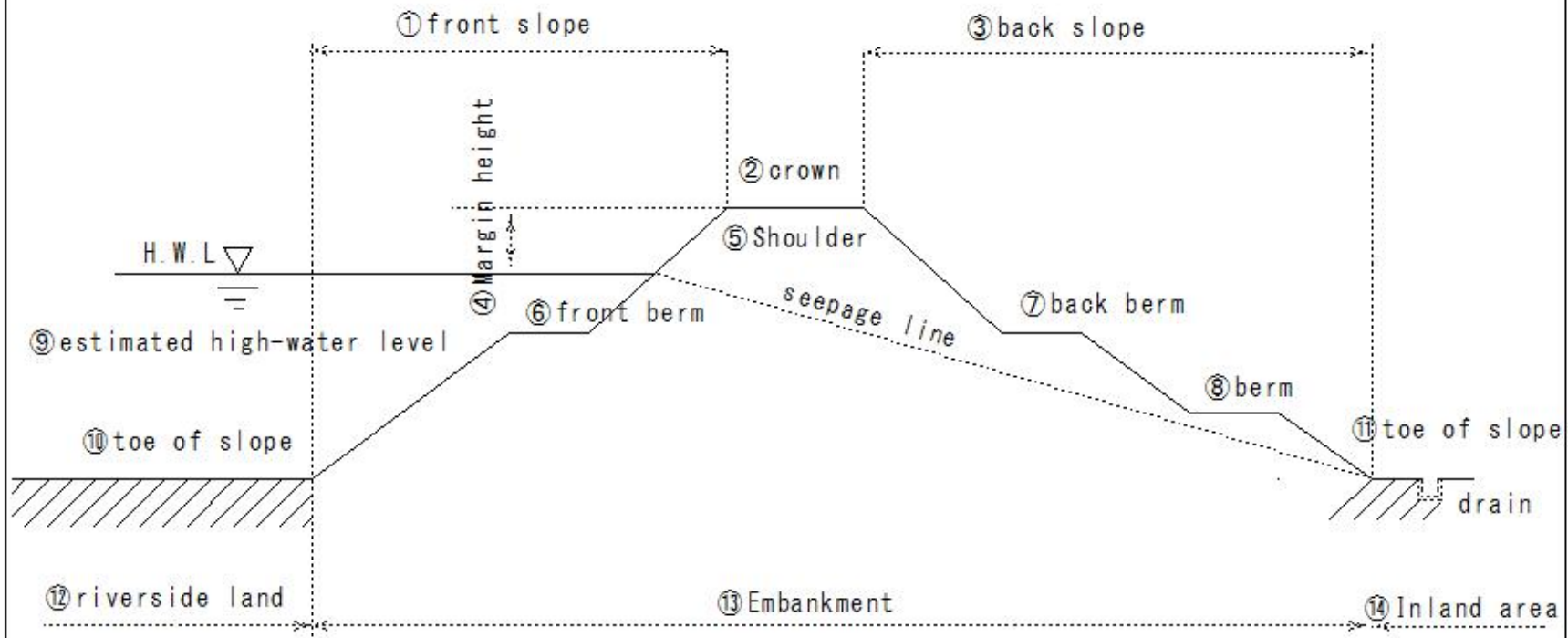
(R212)River embankment

River embankment

Preventing flooding during floods

Check points during construction

② Embankment body with the necessary height and cross section for the estimated high-water level



(R213)River embankment

(R213)River embankment

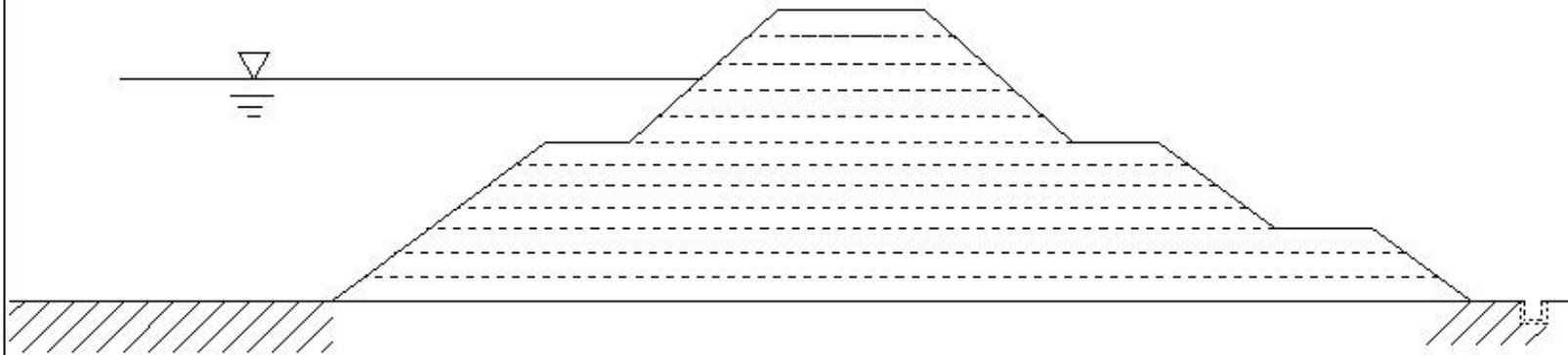
River embankment

Preventing flooding during floods

Check points during construction

③ Spreading the embankment

compaction with appropriate layer thickness



(R214)River embankment

(R214)River embankment

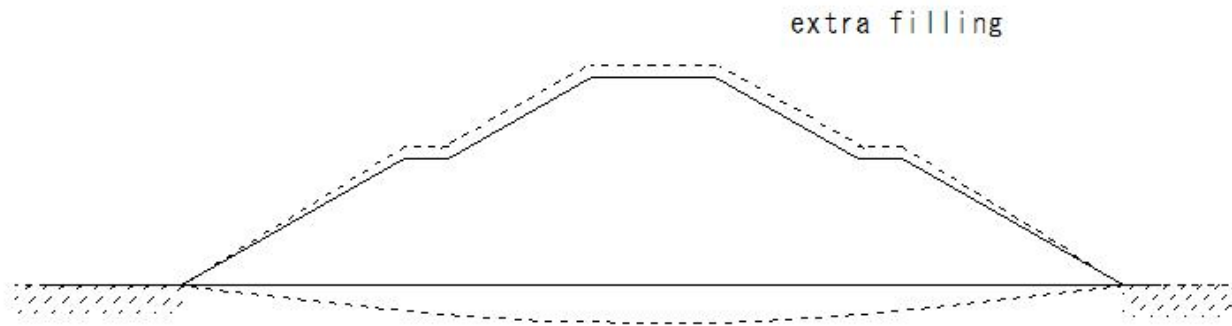
River embankment

Preventing flooding during floods

Check points during construction

④margin height (extra embankment)

The crown of the embankment, the slope and berm are also carried out.



(R215)River embankment

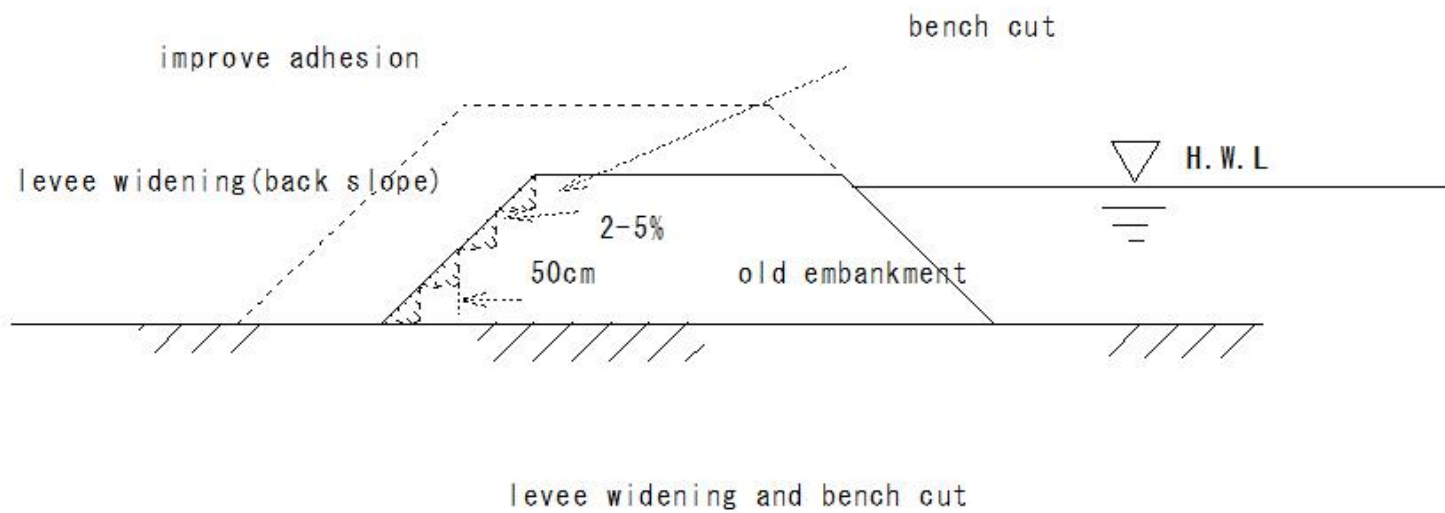
(R215)River embankment

River embankment

Preventing flooding during floods

Check points during construction

⑤Expansion of the embankment -levee widening



(R216)River embankment

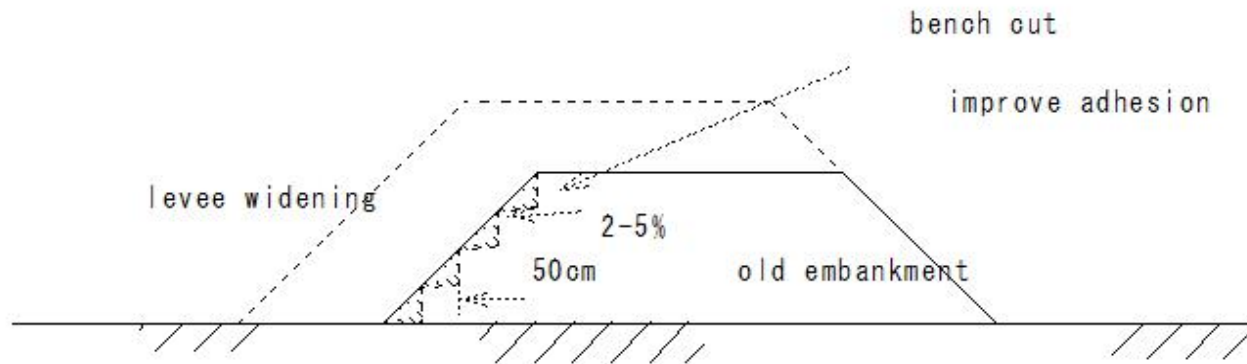
(R216)River embankment

River embankment

Preventing flooding during floods

Check points during construction

- ⑥ In the case of levee widening
Do not disturb the soil by bench out



levee widening and bench out

(R217)River embankment

(R217)River embankment

River embankment

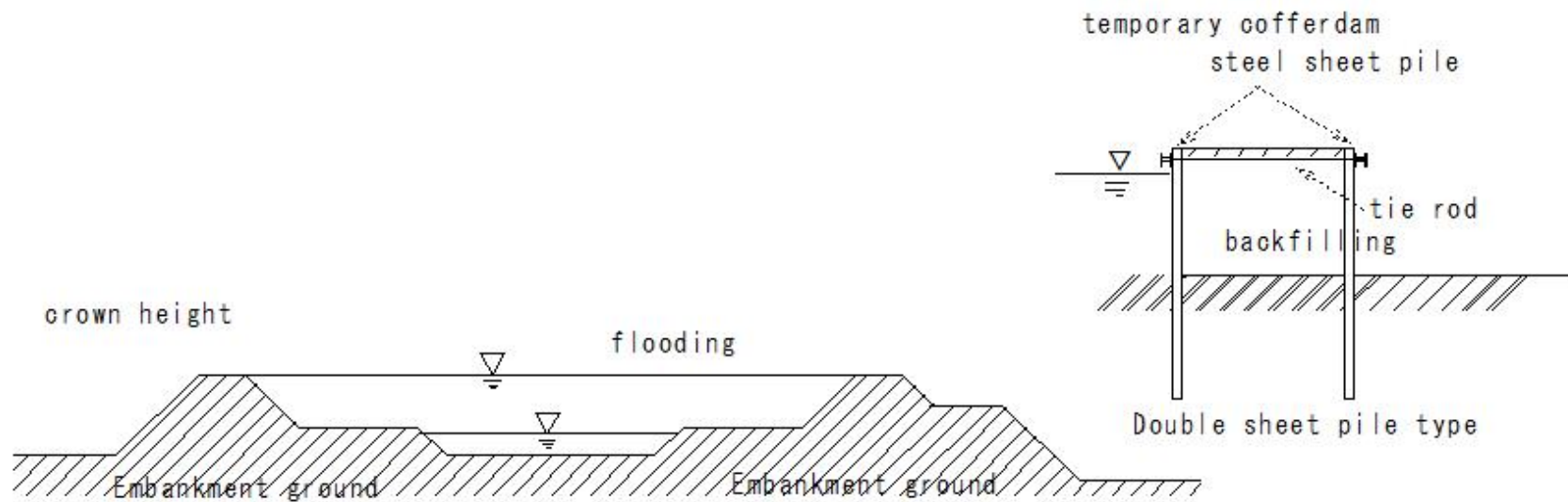
Preventing flooding during floods

Check points during construction

⑦flooding season: case of excavating the existing embankment

temporary cofferdam is double steel sheet pile structure

Construction at the crown height - less than the existing embankment height



(R218)River embankment

(R218)River embankment

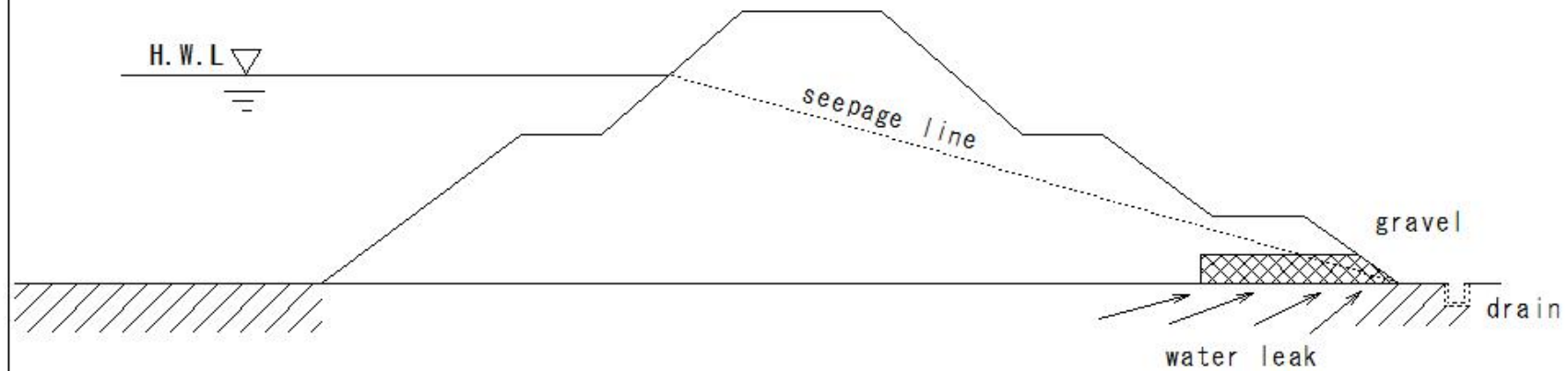
River embankment

Preventing flooding during floods

Check points during construction

⑧water leak at the foundation ground where the new embankment will be constructed

Reinforce the ground with gravel



(R219)River embankment

(R219)River embankment

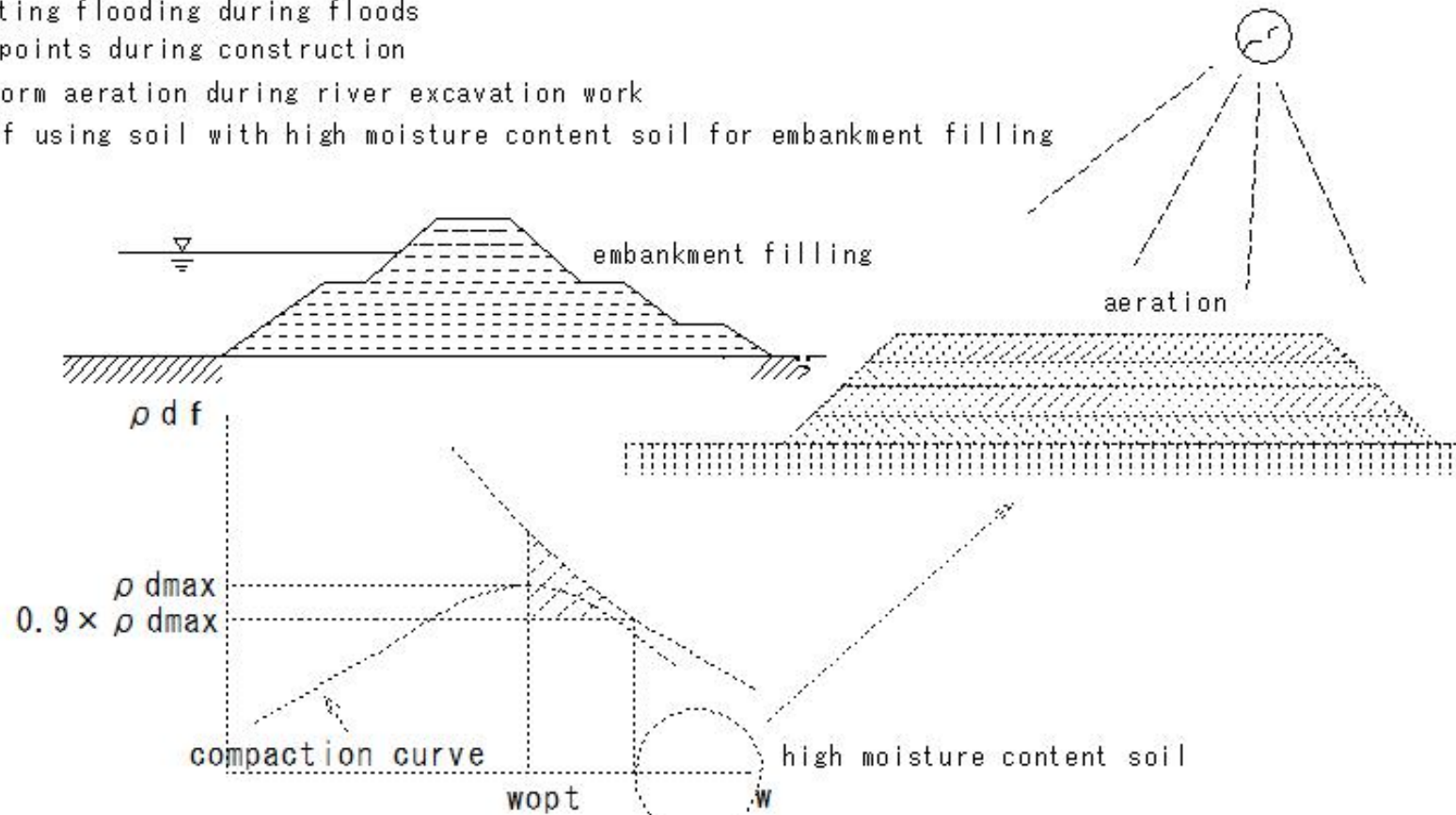
River embankment

Preventing flooding during floods

Check points during construction

⑨ Perform aeration during river excavation work

case of using soil with high moisture content soil for embankment filling



(R220)River earthworks

(R220)River earthworks

River earthworks

river construction

excavation

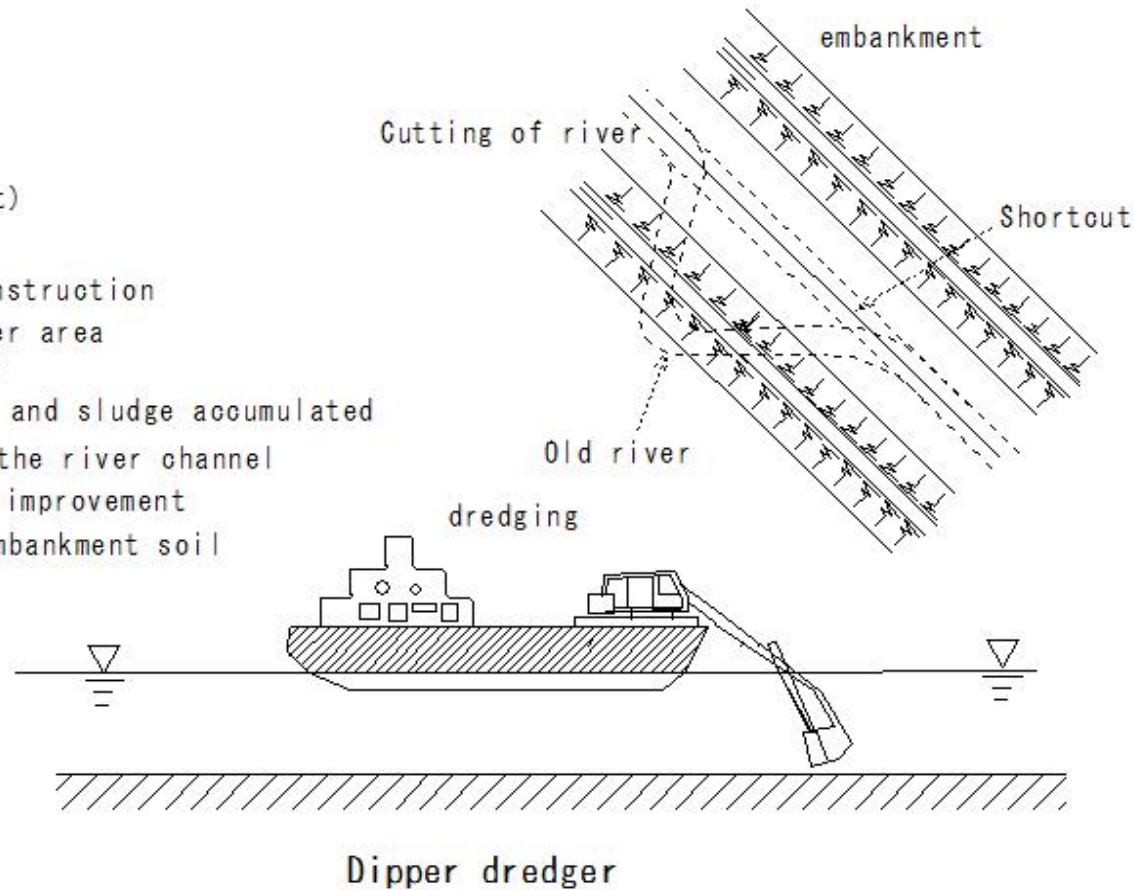
dredging

filling(Embankment)

earthworks

Purpose of river construction

- ① Increase in river area
- ② Cutting of river
- ③ Removal of soil and sludge accumulated
in the river channel
- ④ Water quality - improvement
- ⑤ Collection of embankment soil



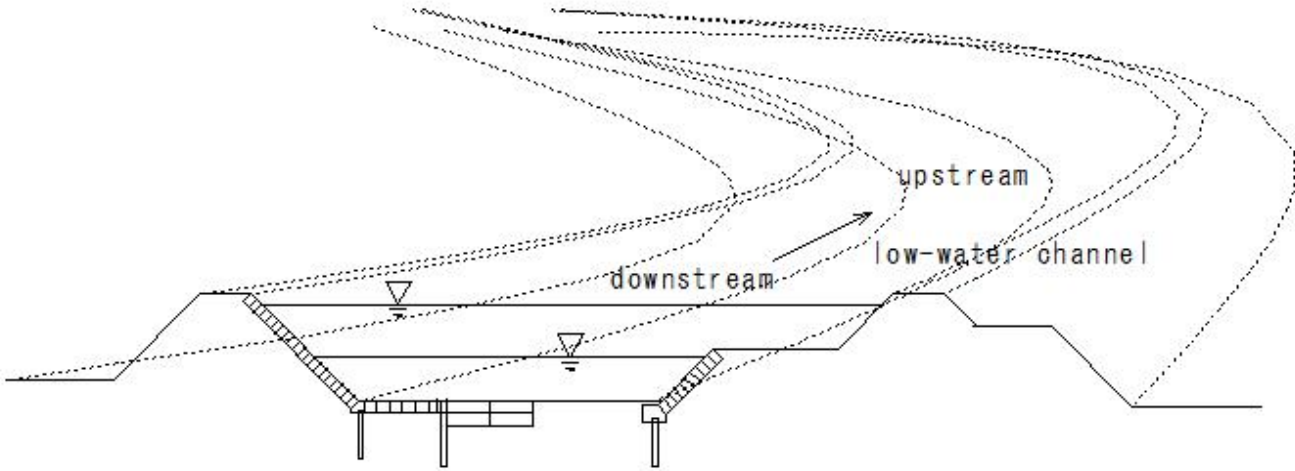
(R221)River earthworks

(R221)River earthworks

River earthworks

Check points

- ① Excavation of low water channels -carried out from downstream to upstream.



(R222)River earthworks

(R222)River earthworks

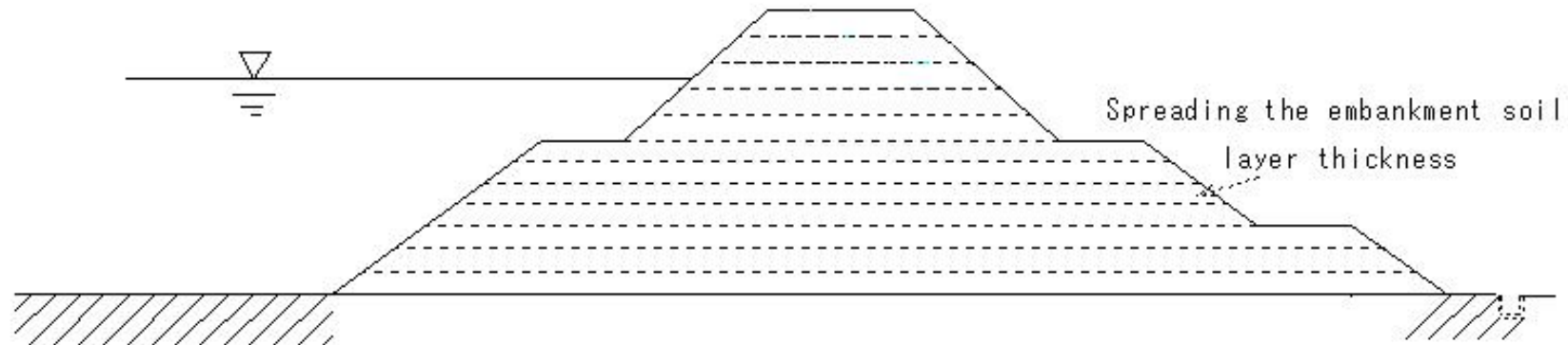
River earthworks

Check points

② Spreading the embankment soil

even compaction

Appropriate layer thickness



(R223)River earthworks

(R223)River earthworks

River earthworks

Check points

③ Embankment

Load capacity -Water resistance

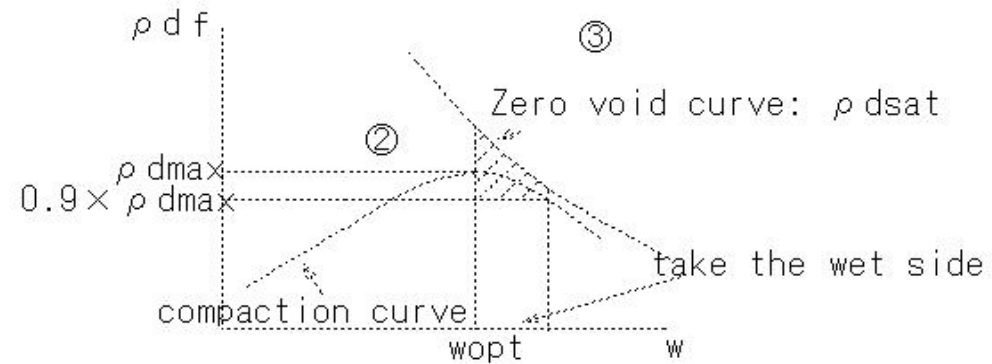
uniform embankment

① Rock masses and cobblestones:

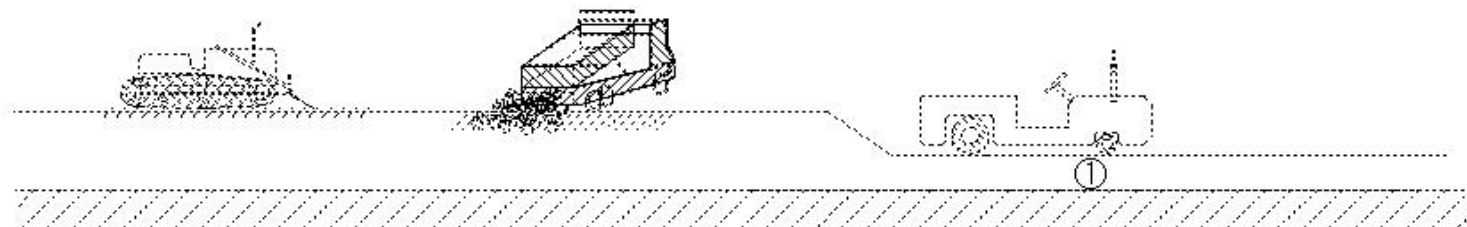
Standards for construction methods

② Criteria for dry density

③ Criteria for saturation



• Compaction degree $C_d = ((\rho_{df} / \rho_{dmax}) * 100(\%))$



(R224)River earthworks

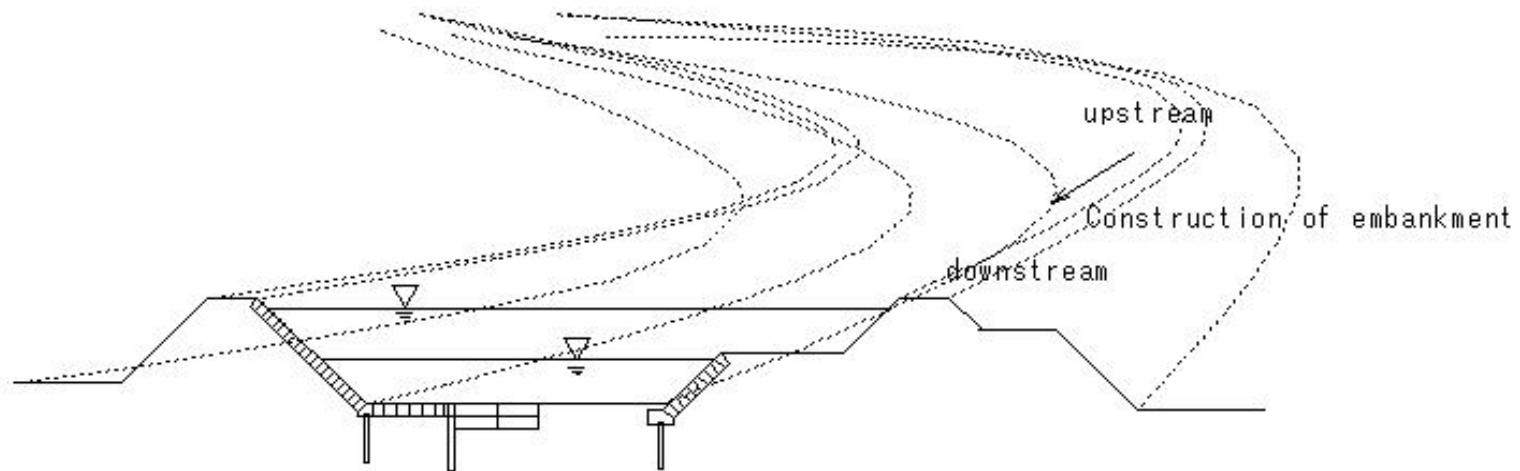
(R224)River earthworks

River earthworks

Check points

④ Construction of embankment

Constructed an even height from upstream to downstream



(R225)River earthworks

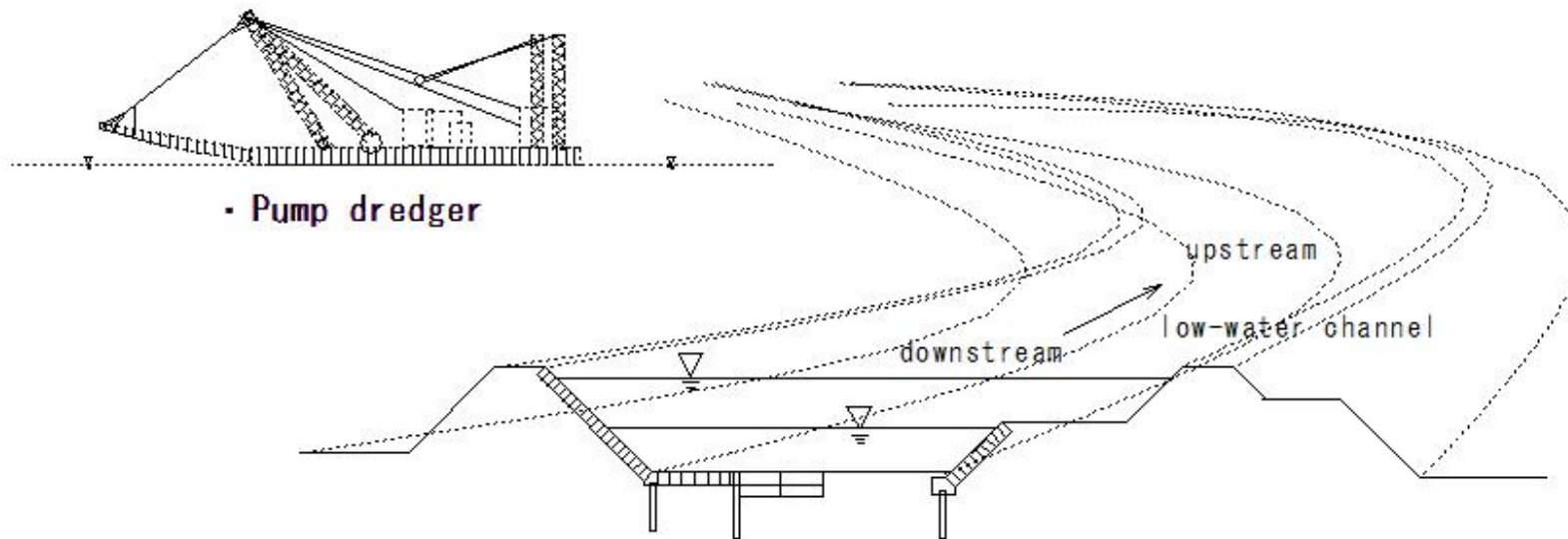
(R225)River earthworks

River earthworks

Check points

⑤ Dredging of low water channels for sand extraction

Construction from downstream to upstream



(R226)River earthworks

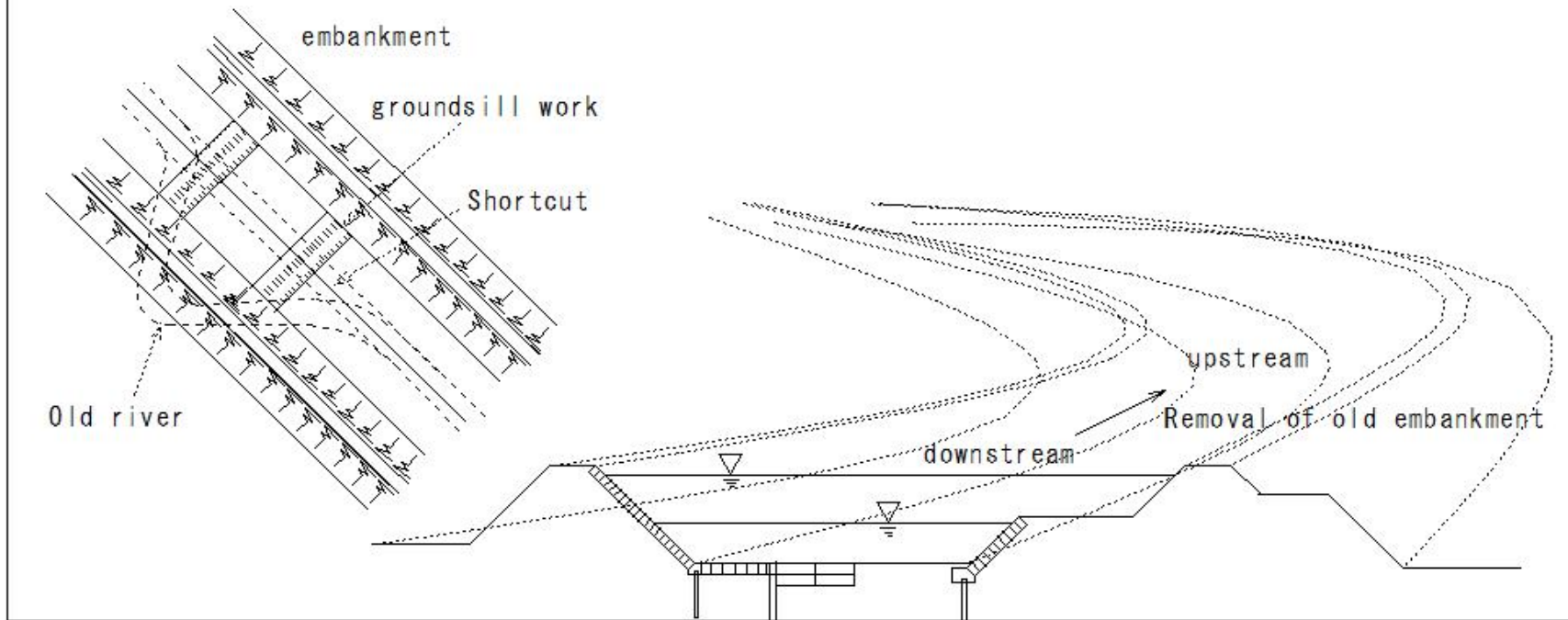
(R226)River earthworks

River earthworks

Check points

⑥ Removal of old embankment

Construction from downstream to upstream



(R227)groin

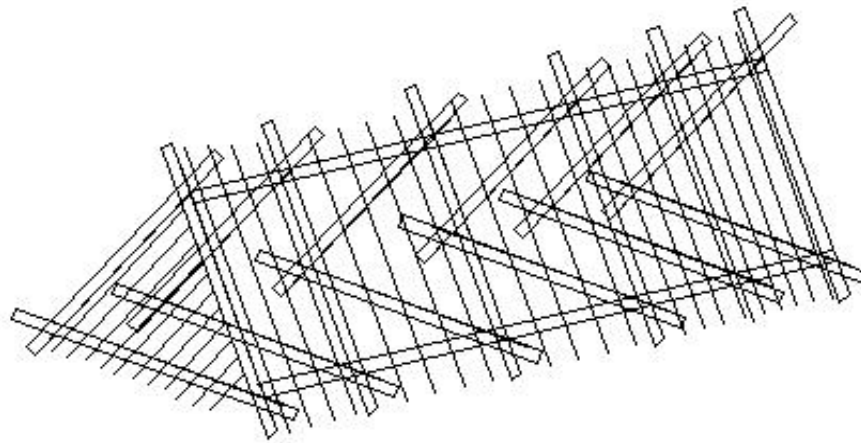
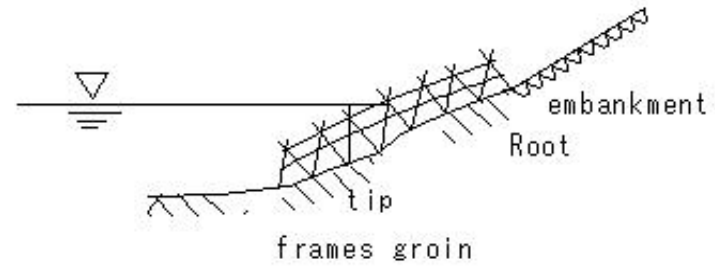
(R227)groin

groin

spill prevention

Height: 1-1.5m

Bottom width: 1.5-2m

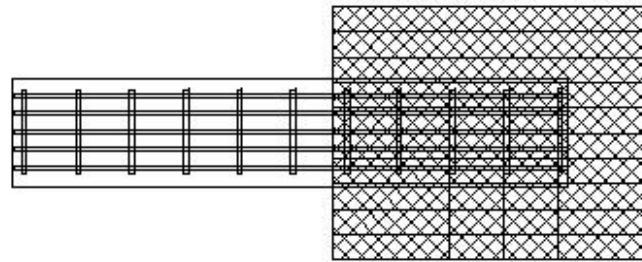


groin

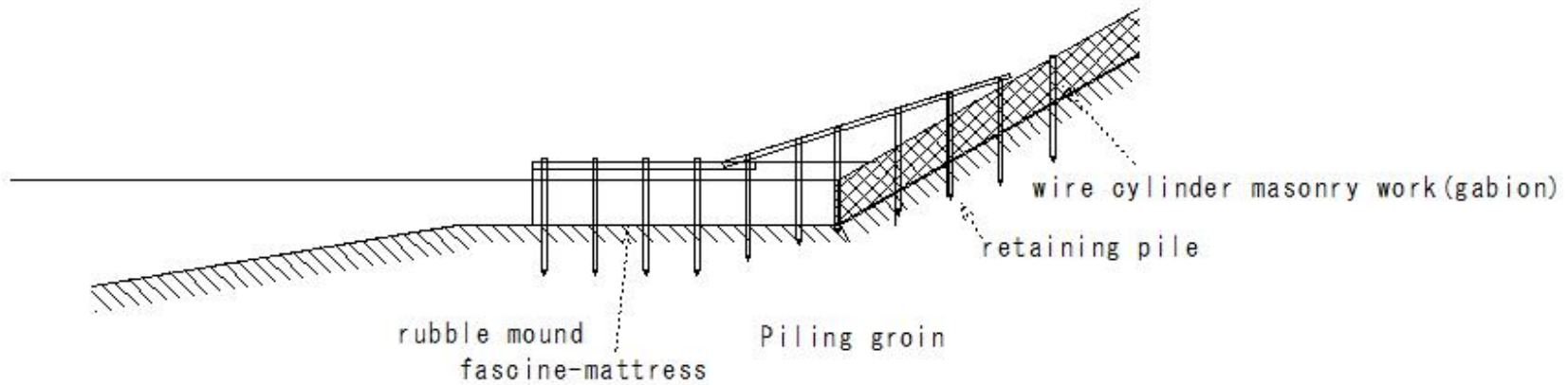
(R228)groin

(R228) groin

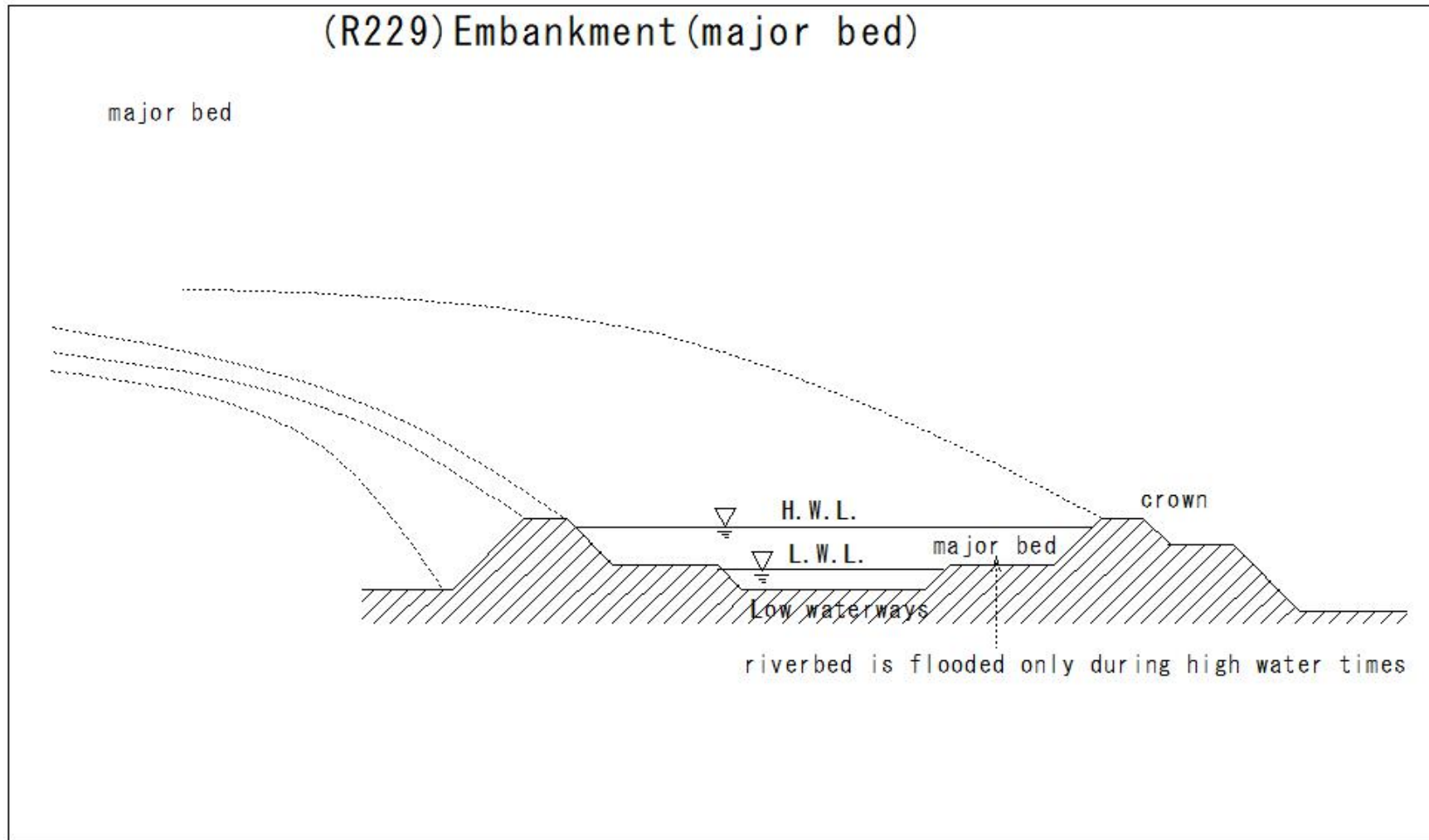
groin



rapids section

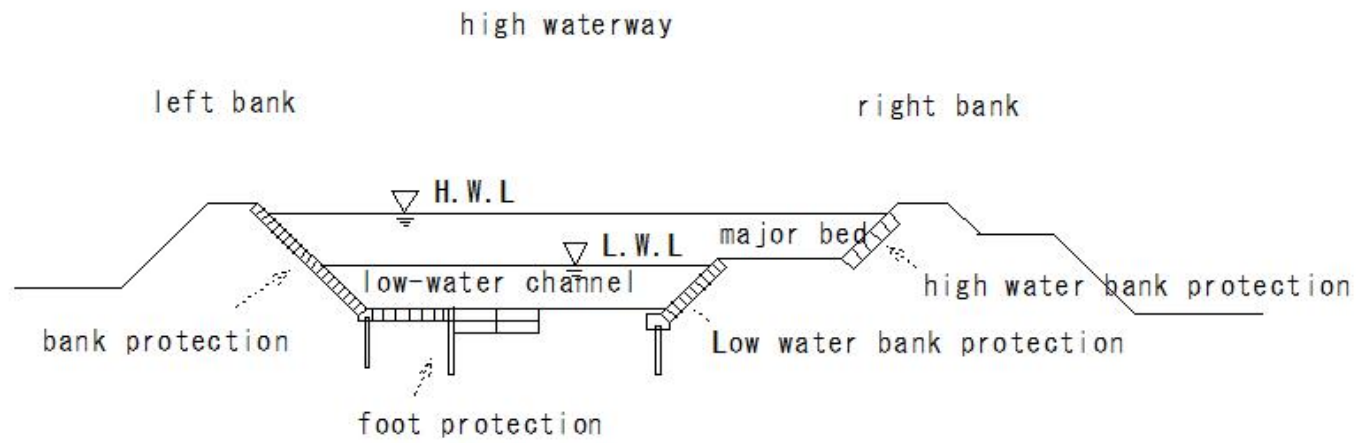


(R229) Embankment (major bed)



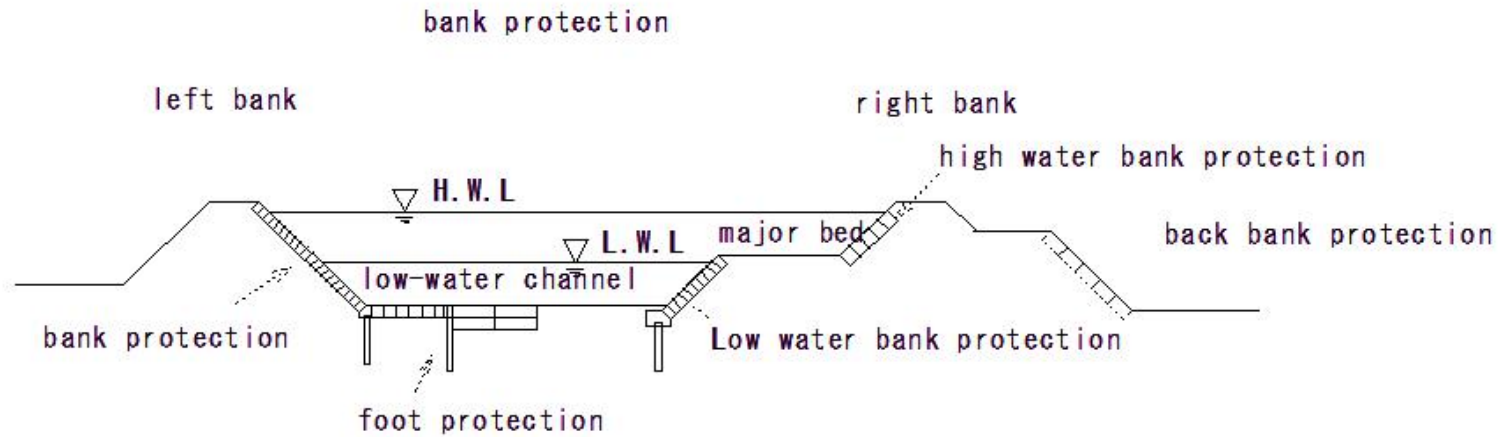
(R230) Embankment (high waterway)

(R230) Embankment (high waterway)



(R231) Embankment (bank protection)

(R231) Embankment (bank protection)



bank protection

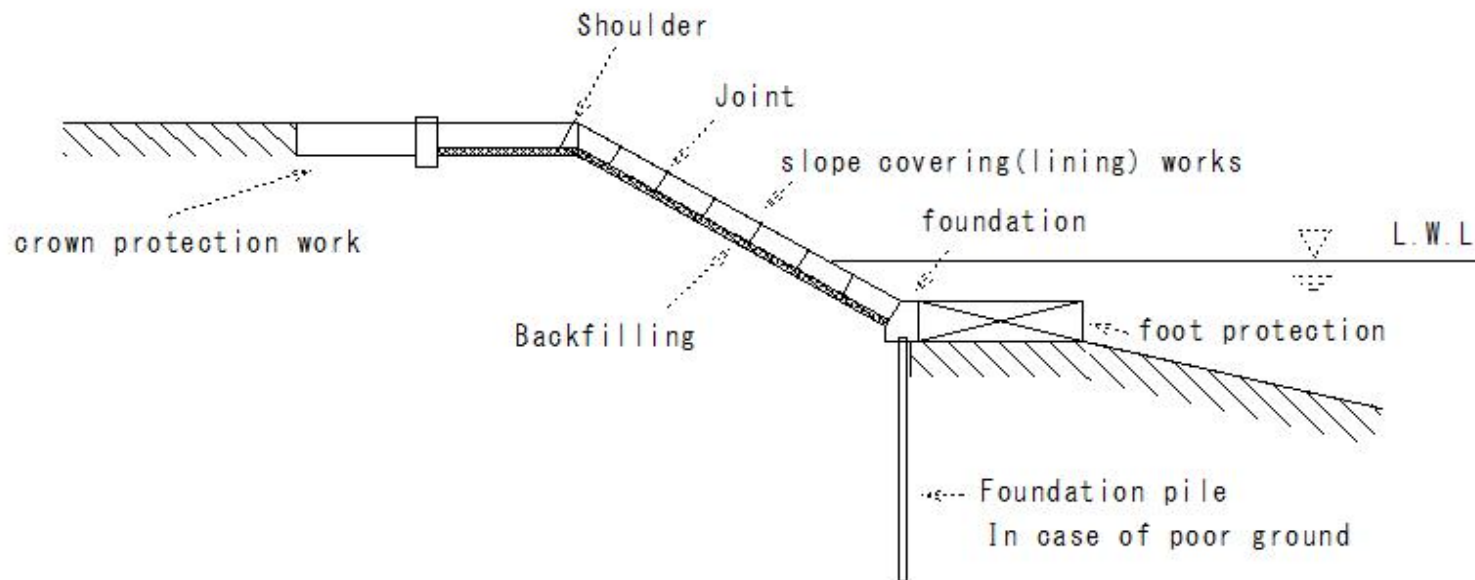
Direct protection of embankments and riverbanks

Prevention of scouring

(R232) Embankment (bank protection)

(R232) Embankment (bank protection)

Embankment (bank protection)

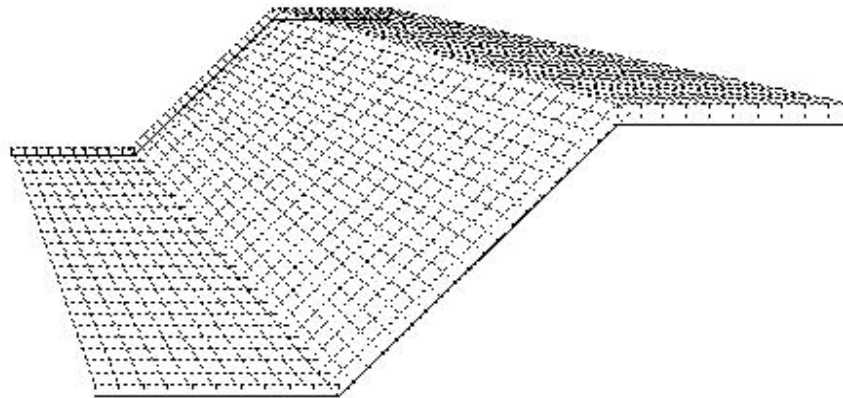


(R233)bank protection slope covering(lining) works

(R233)bank protection slope covering(lining) works

slope covering(lining) works

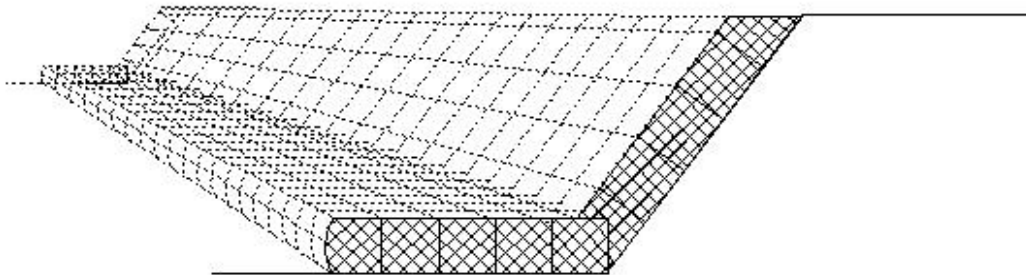
① sodding works



(R234)bank protection slope covering(lining) works

(R234)bank protection slope covering(lining) works

②wire cylinder masonry work(gabion)

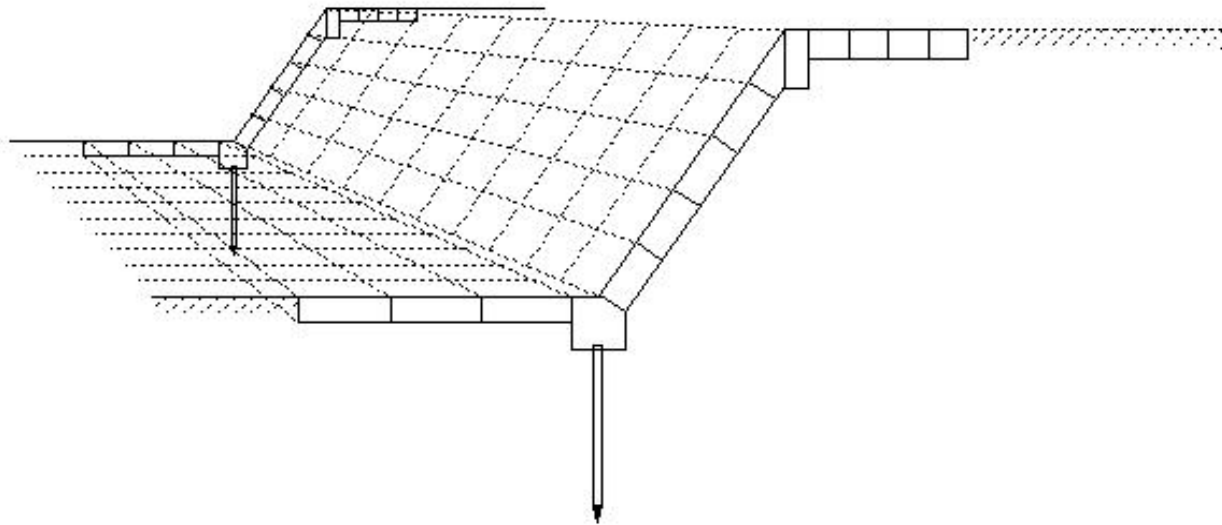


(R235)bank protection slope covering(lining) works

(R235)bank protection slope covering(lining) works

slope covering(lining) works

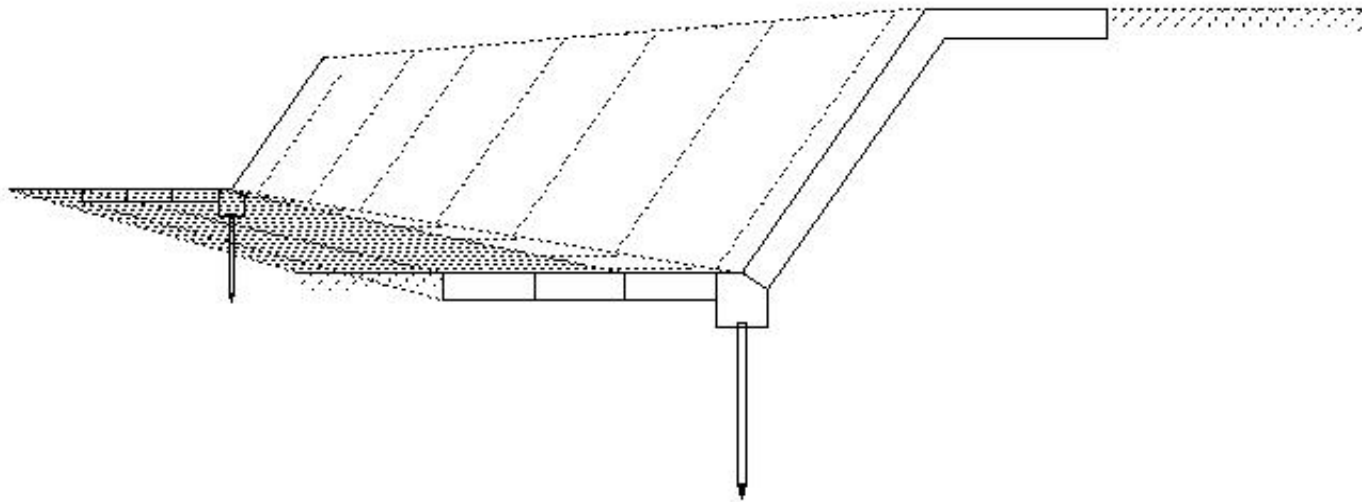
③ Concrete block pitching



(R236)bank protection slope covering(lining) works

(R236)bank protection slope covering(lining) works

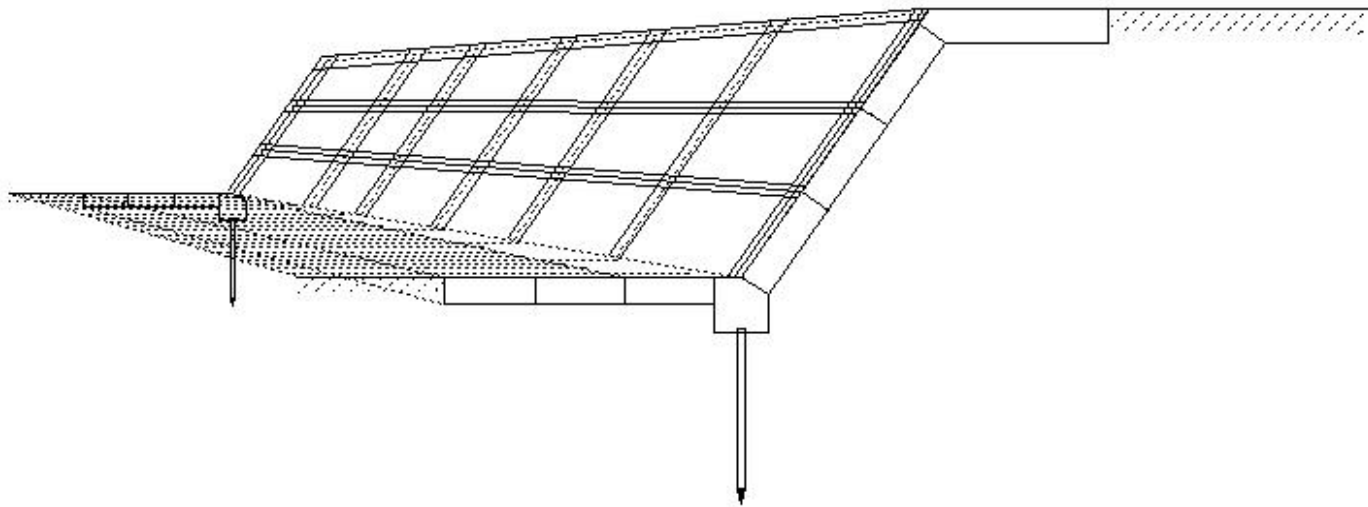
slope covering(lining) works



(R237)bank protection slope covering(lining) works

(R237)bank protection slope covering(lining) works

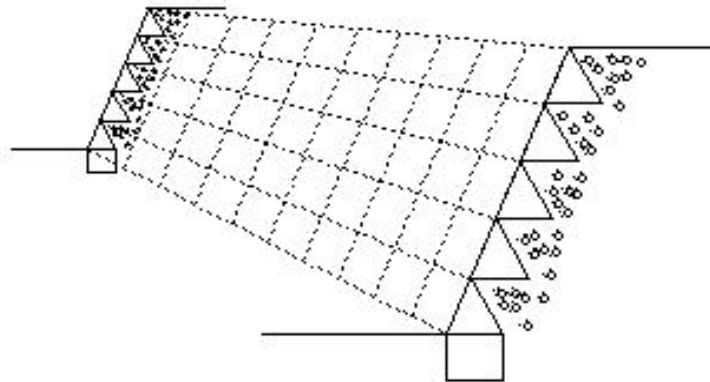
⑤ Concrete slope crib work



(R238)bank protection slope covering(lining) works

(R238)bank protection slope covering(lining) works

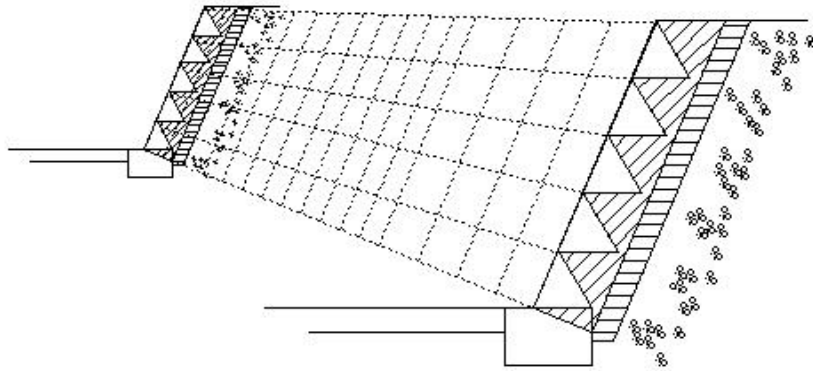
⑥ dry masonry



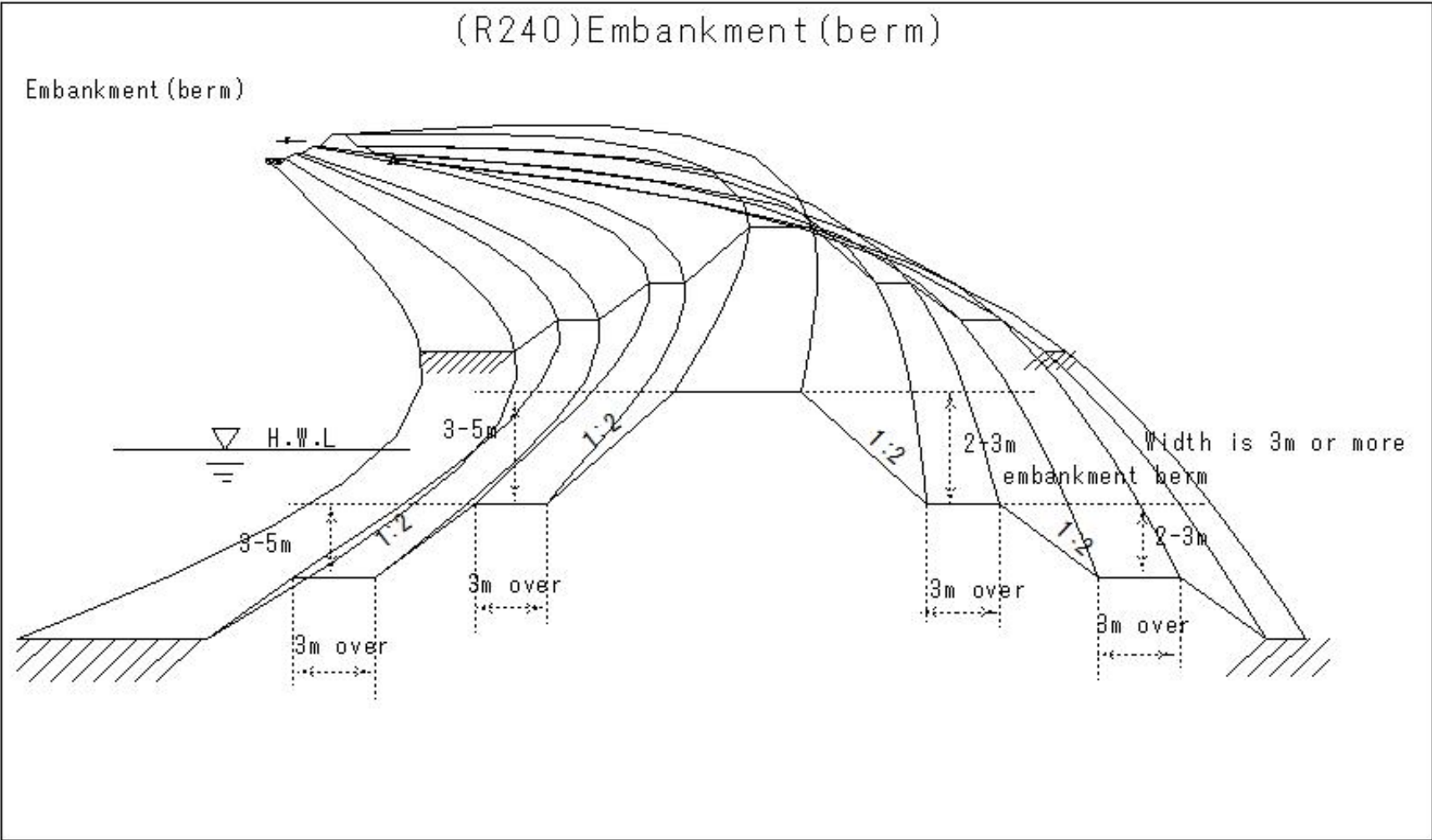
(R239)bank protection slope covering(lining) works

(R239)bank protection slope covering(lining) works

⑦mortar masonry



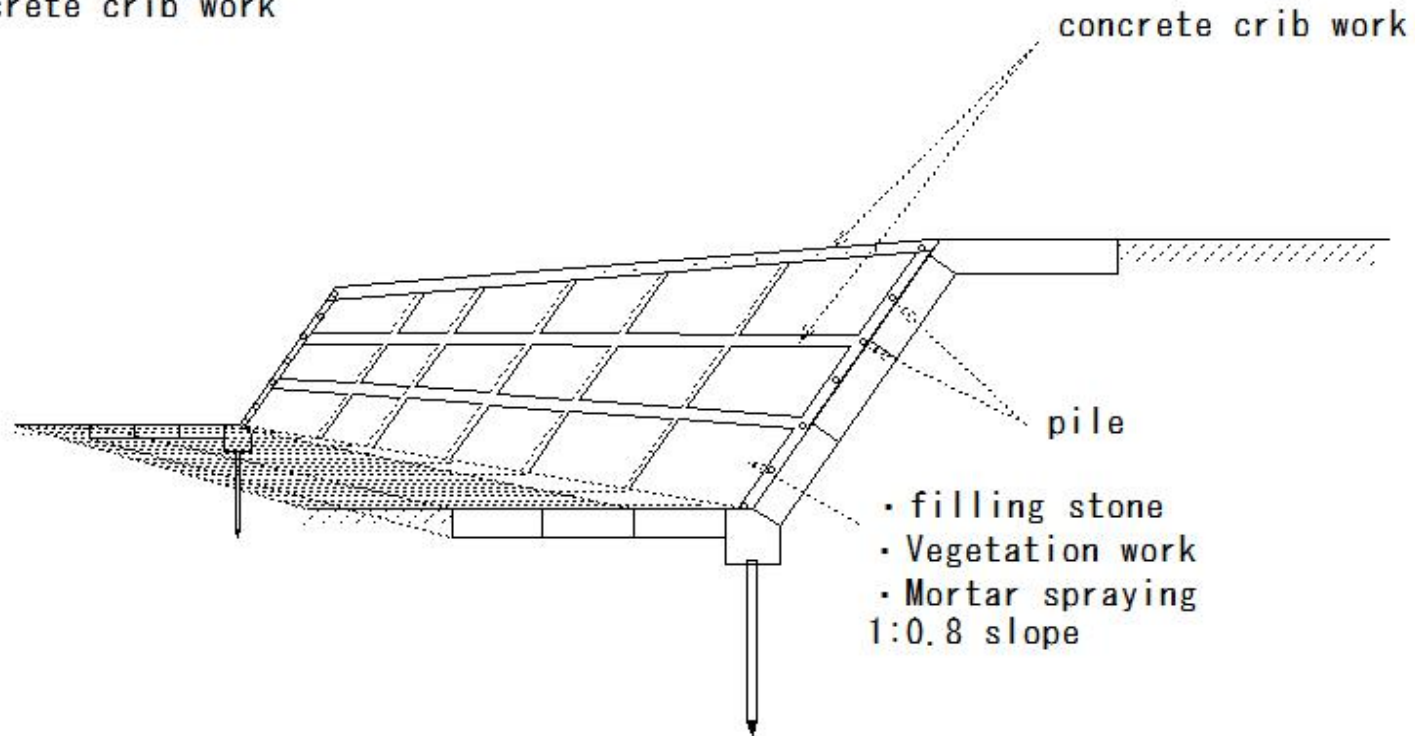
(R240)Embankment(berm)



(R241)bank protection(concrete crib work)

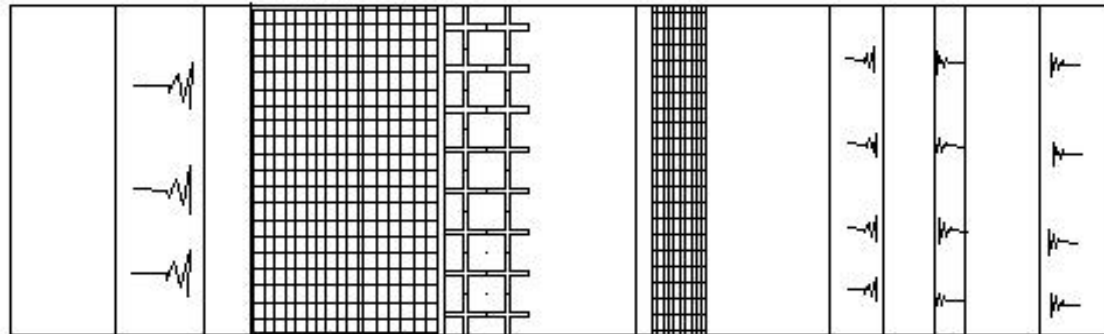
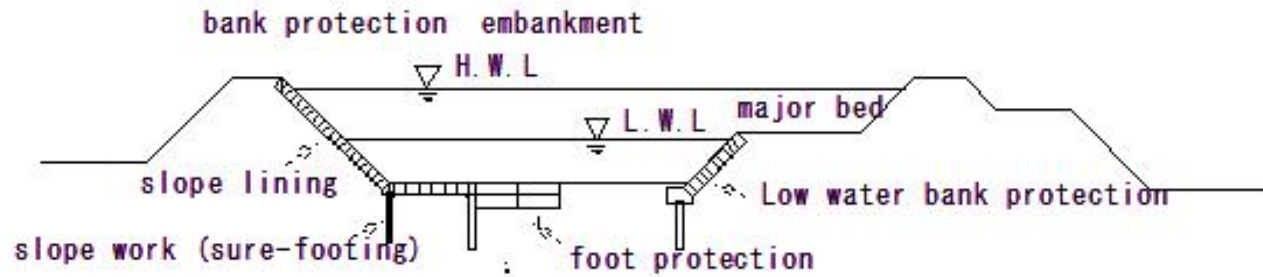
(R241)bank protection(concrete crib work)

concrete crib work
type of bank protection
• Concrete crib work



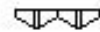
(R242)bank protection(concrete block)

(R242)bank protection(concrete block)



type of root protection work

- Prevention of scouring
- Block - connected by reinforcing bars
- Installed on the riverbed



• Block type

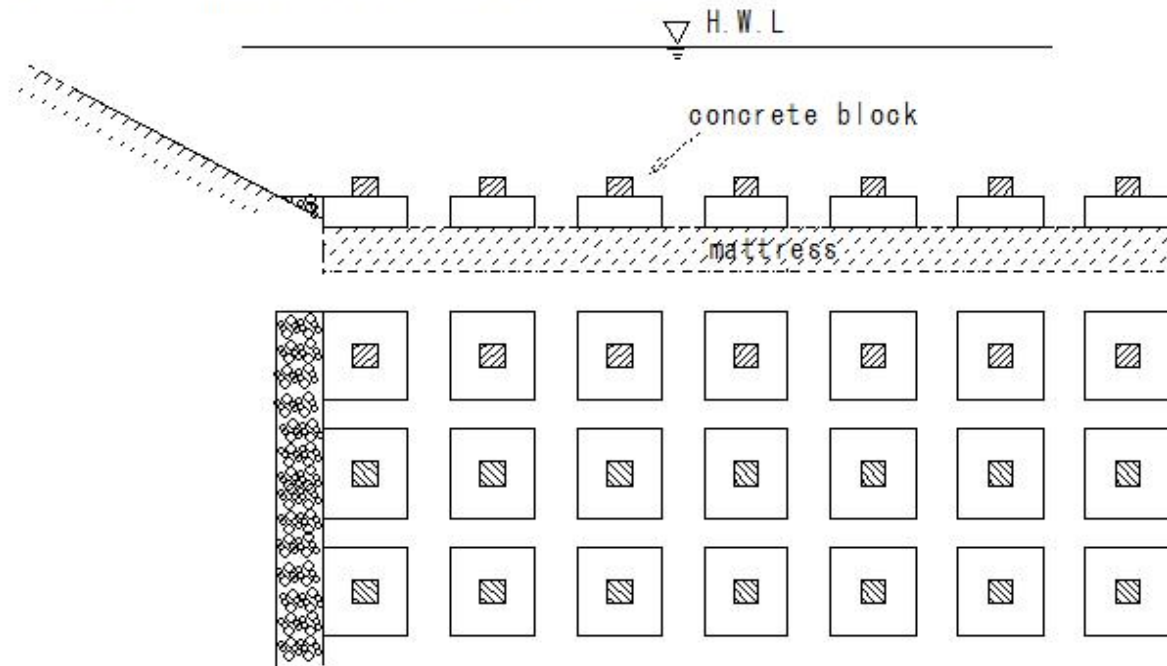
- ① Cross block
- ② Y-shaped block
- ③ H-type block
- ④ Hexapod block

(R243)groin (concrete block groin)

(R243)groin (concrete block groin)

concrete block groin

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



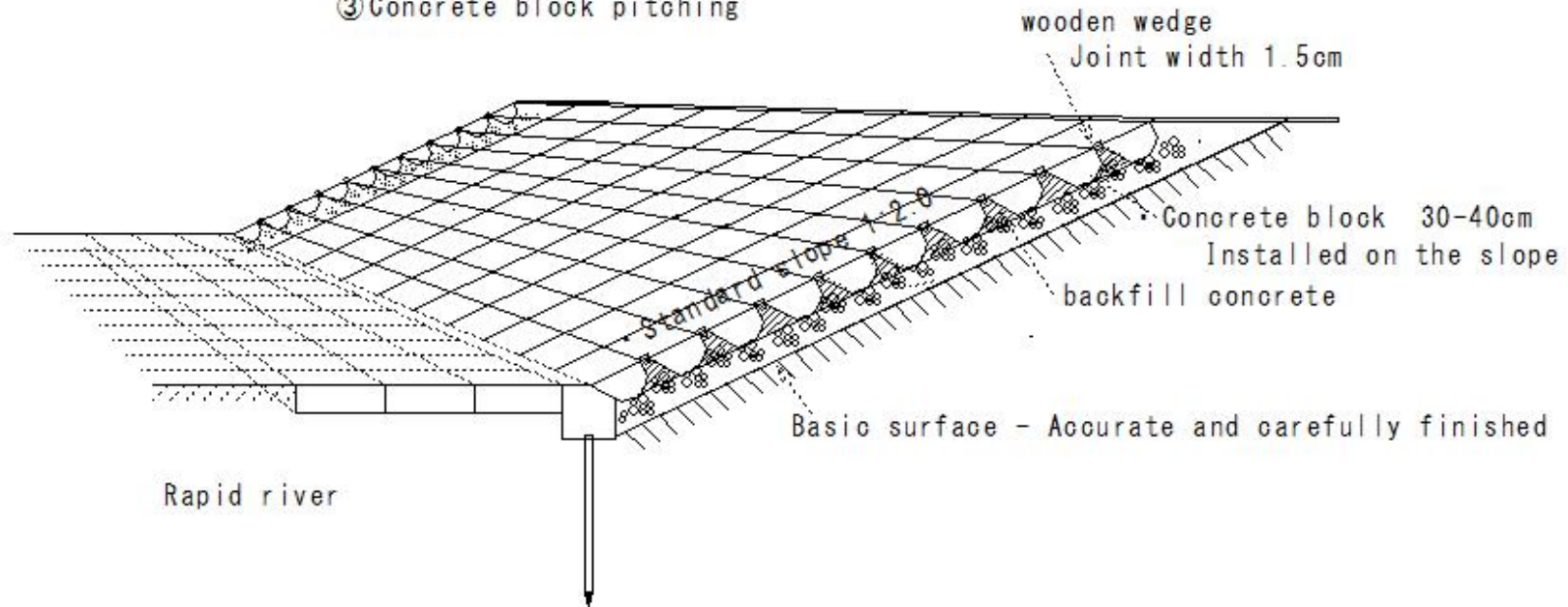
(R244) bank protection (concrete block pitching)

(R244) bank protection (concrete block pitching)

Concrete block pitching

- type of bank protection (slope lining / slope covering)

③ Concrete block pitching

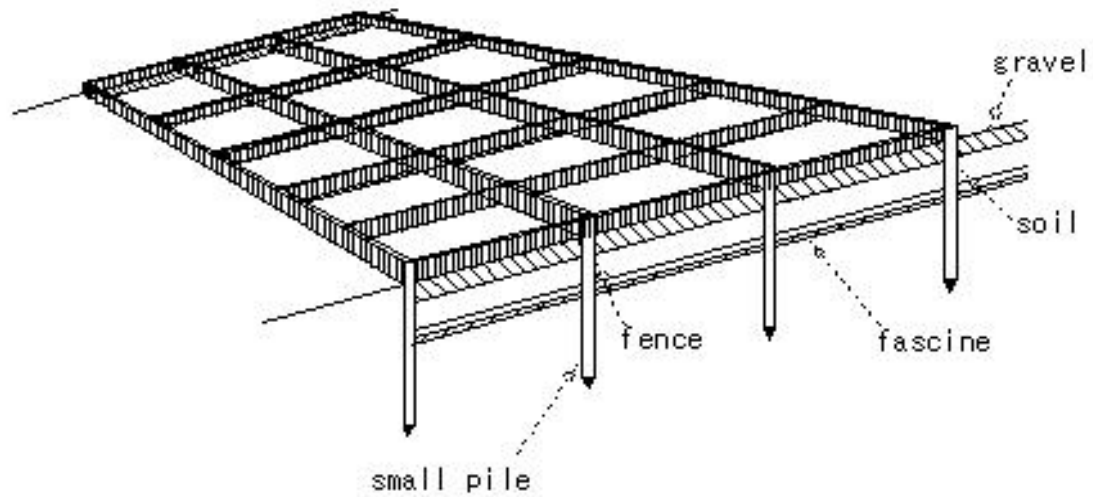


(R245)slope covering(lining) works (fence work)

(R245)slope covering(lining) works (fence work)

slope covering(lining) works

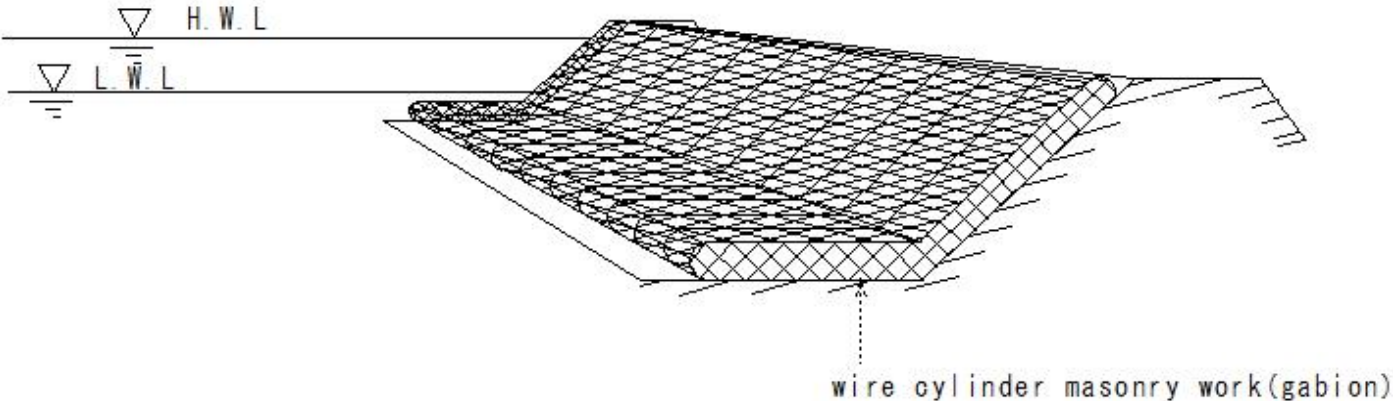
type of bank protection covering work/bank protection



(R246)slope covering(lining) works (wire cylinder masonry work(gabion))

(R246)slope covering(lining) works (wire cylinder masonry work(gabion))

slope covering(lining) works

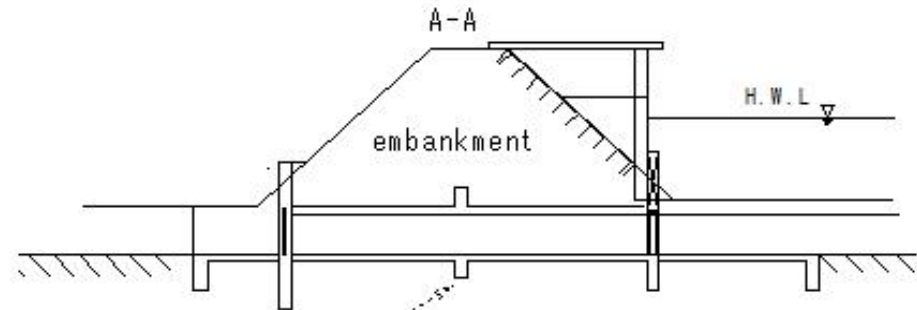


(R247)sluice (impermeable wall)

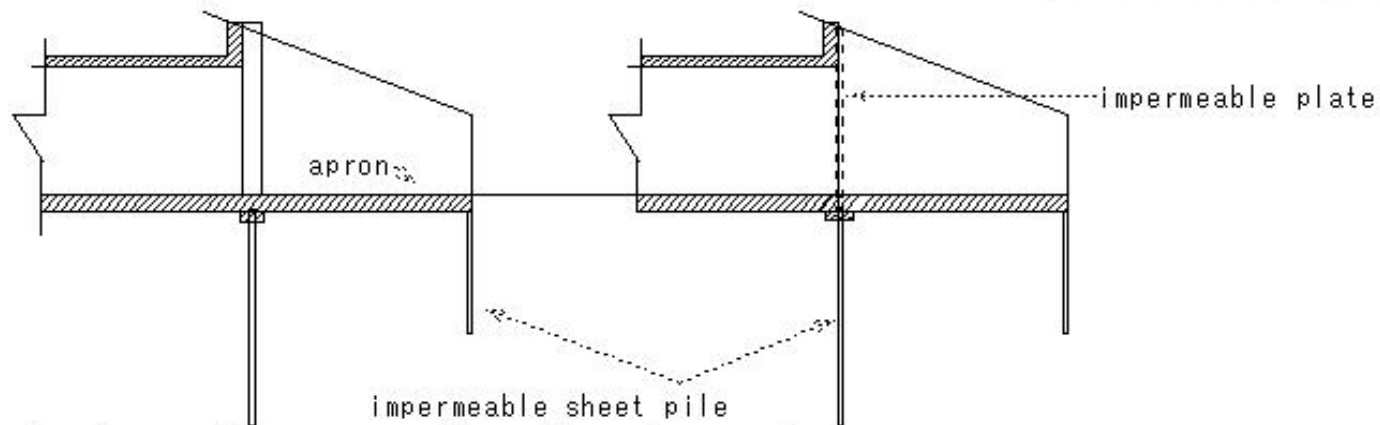
(R247)sluice (impermeable wall)

impermeable wall

- sluice crosses the embankment
- Water leak prevention
- Length of seepage channel - longer
- reduces water leakage



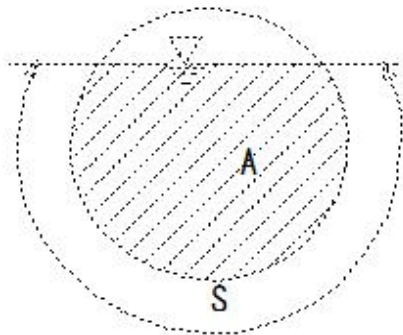
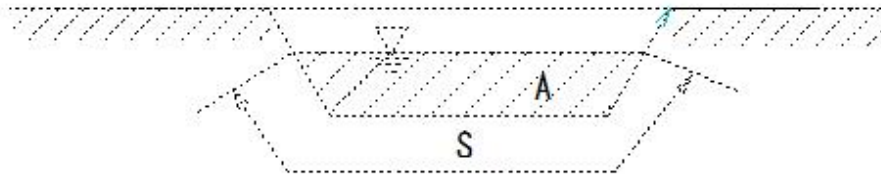
Reinforced concrete impermeable wall
impermeable wall-gravel foundation



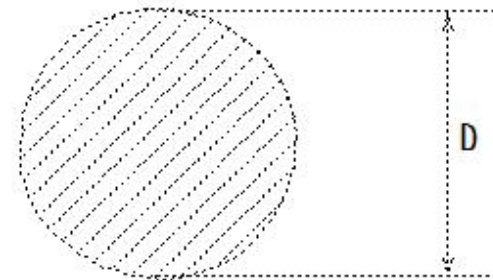
Example of installing impermeable wall at the tip of the apron

(R248)wetted perimeter

(R248) 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

$$R=A/S$$

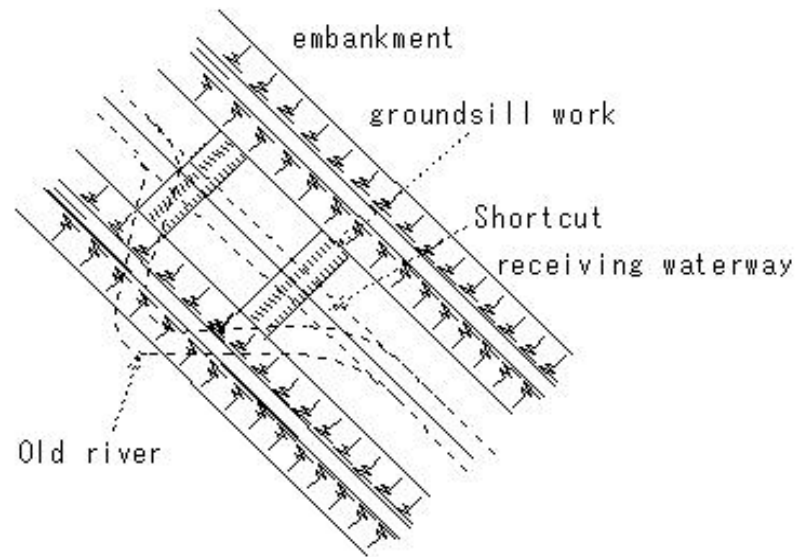
Wetted perimeter: S

(R249)receiving waterway

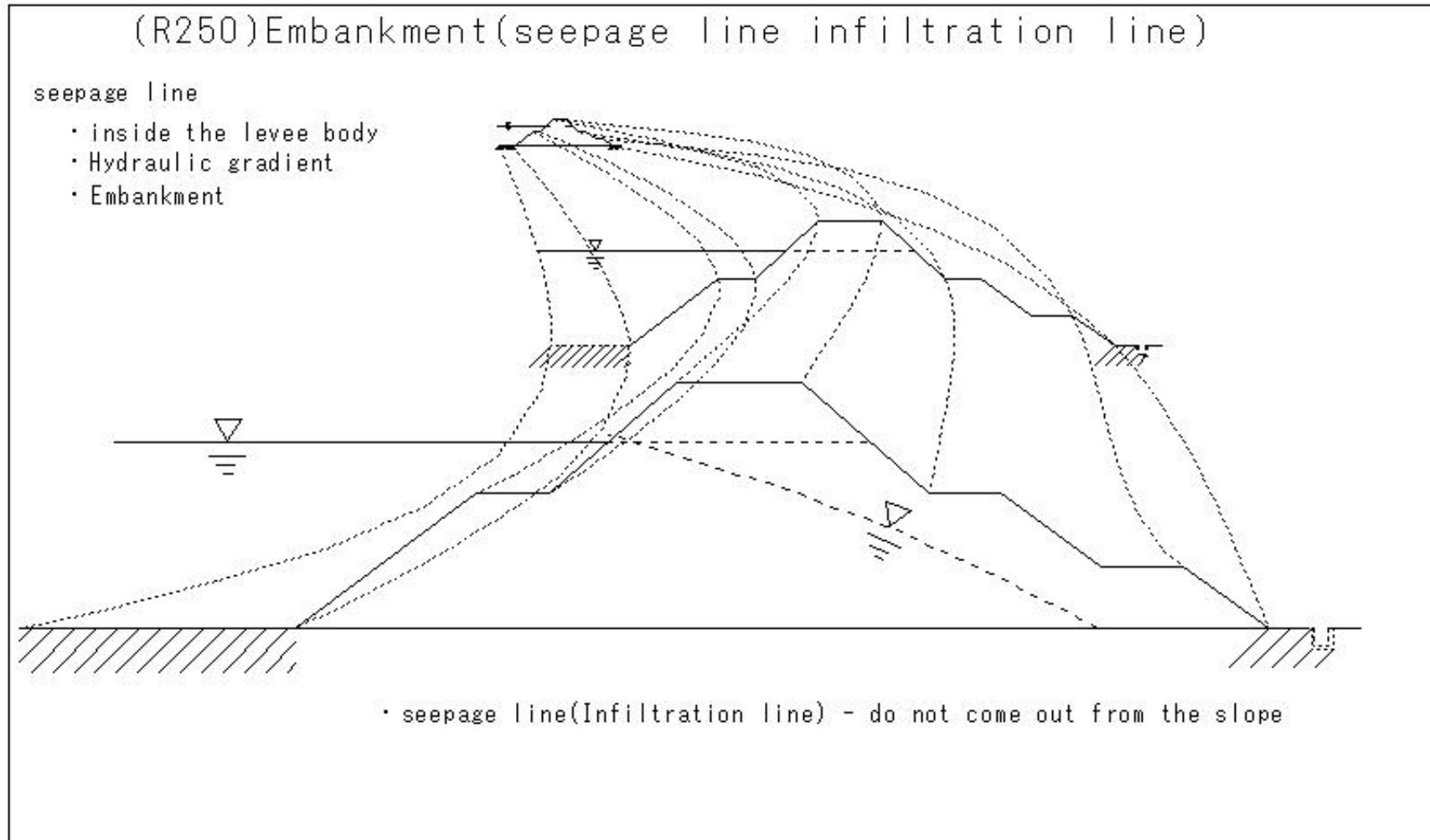
(R249)receiving waterway

receiving waterway

- Many bends in the river channel
- Waterway shortening
- Slope - steep
- receiving waterway - cut and cover
- Local slope change
- Upstream side - riverbed - scouring
- Shortcuts
- embankment
- ground sill consolidation works
- Old river

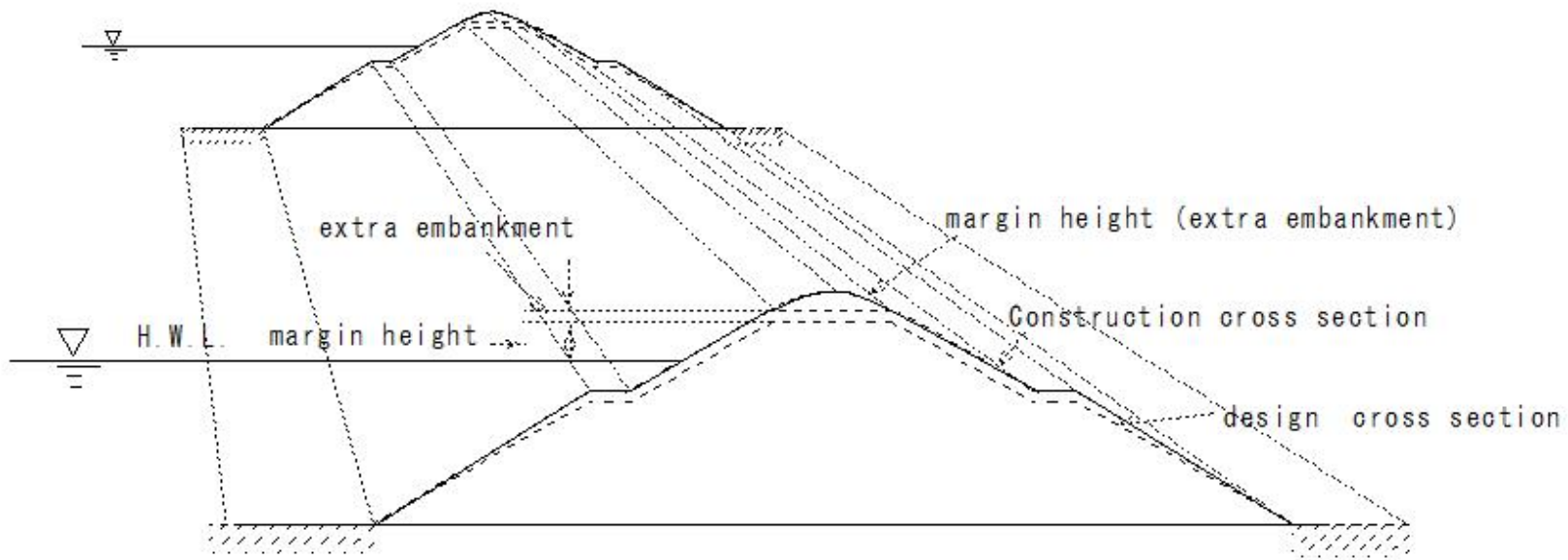


(R250)Embankment(seepage line infiltration line)



(R251)Embankment(seepage line infiltration line)

(R251) Embankment (Construction cross section)

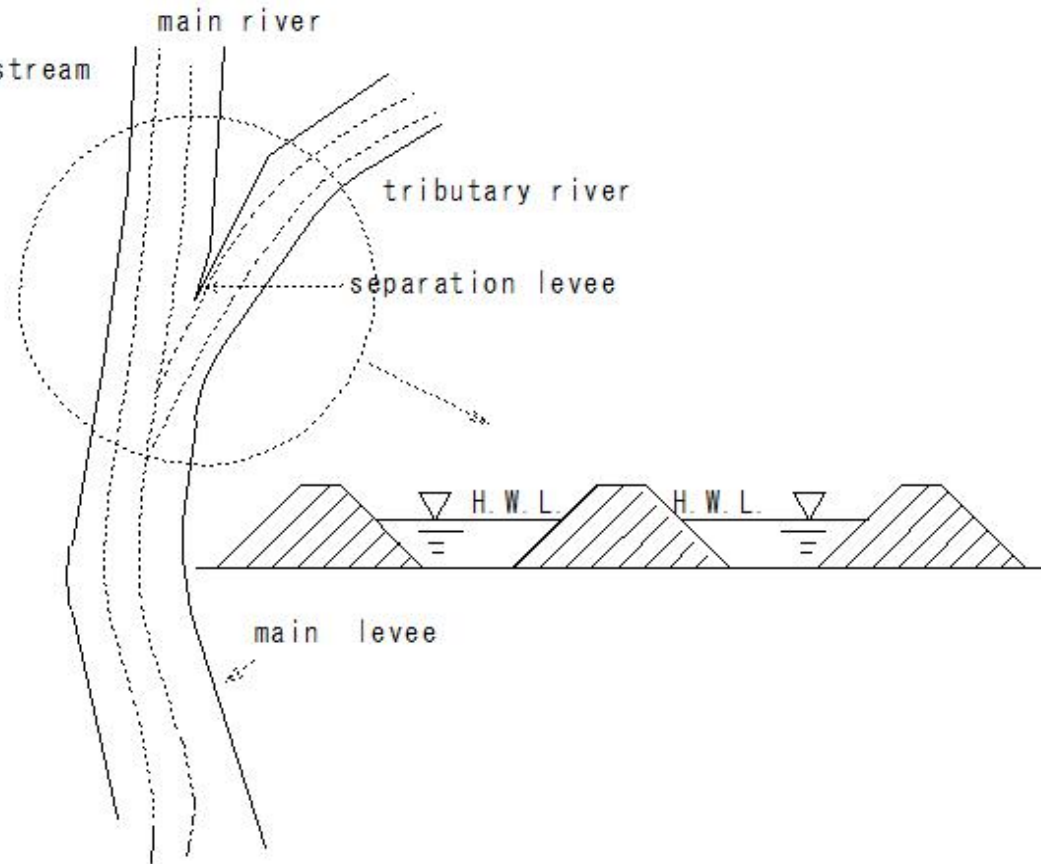


(R252) Embankment (separation levee)

(R252) Embankment (separation levee)

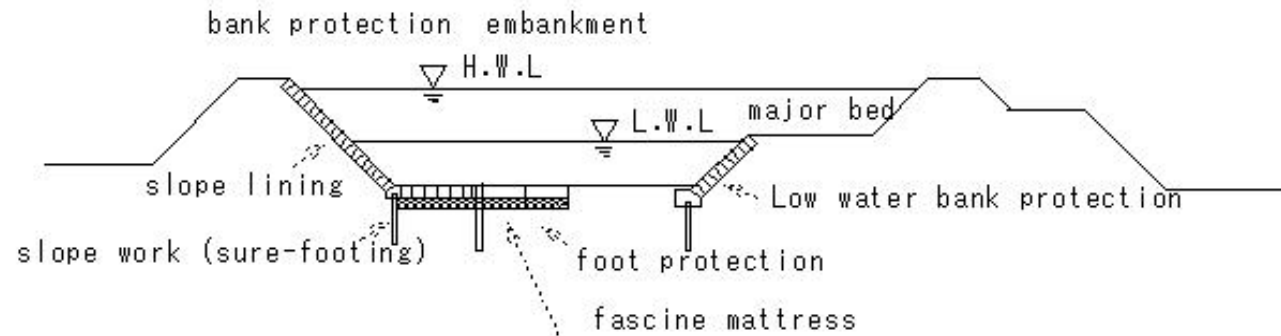
separation levee

- Confluence of two rivers
- Confluence point - Lower downstream
- Flow resistance - decrease
- Flood water level - decrease
- Confluence point - fan-shaped topography - prevention of sedimentation



(R253)foot protection(mattress)

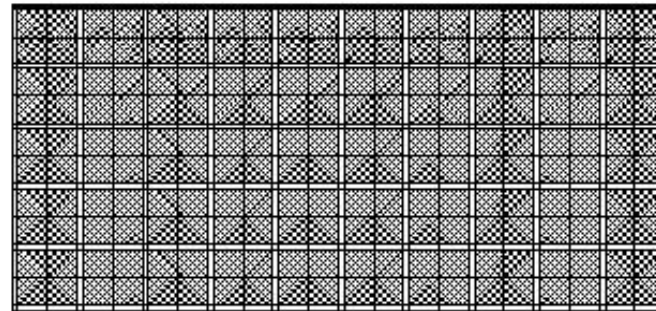
(R253)foot protection(mattress)



foot protection

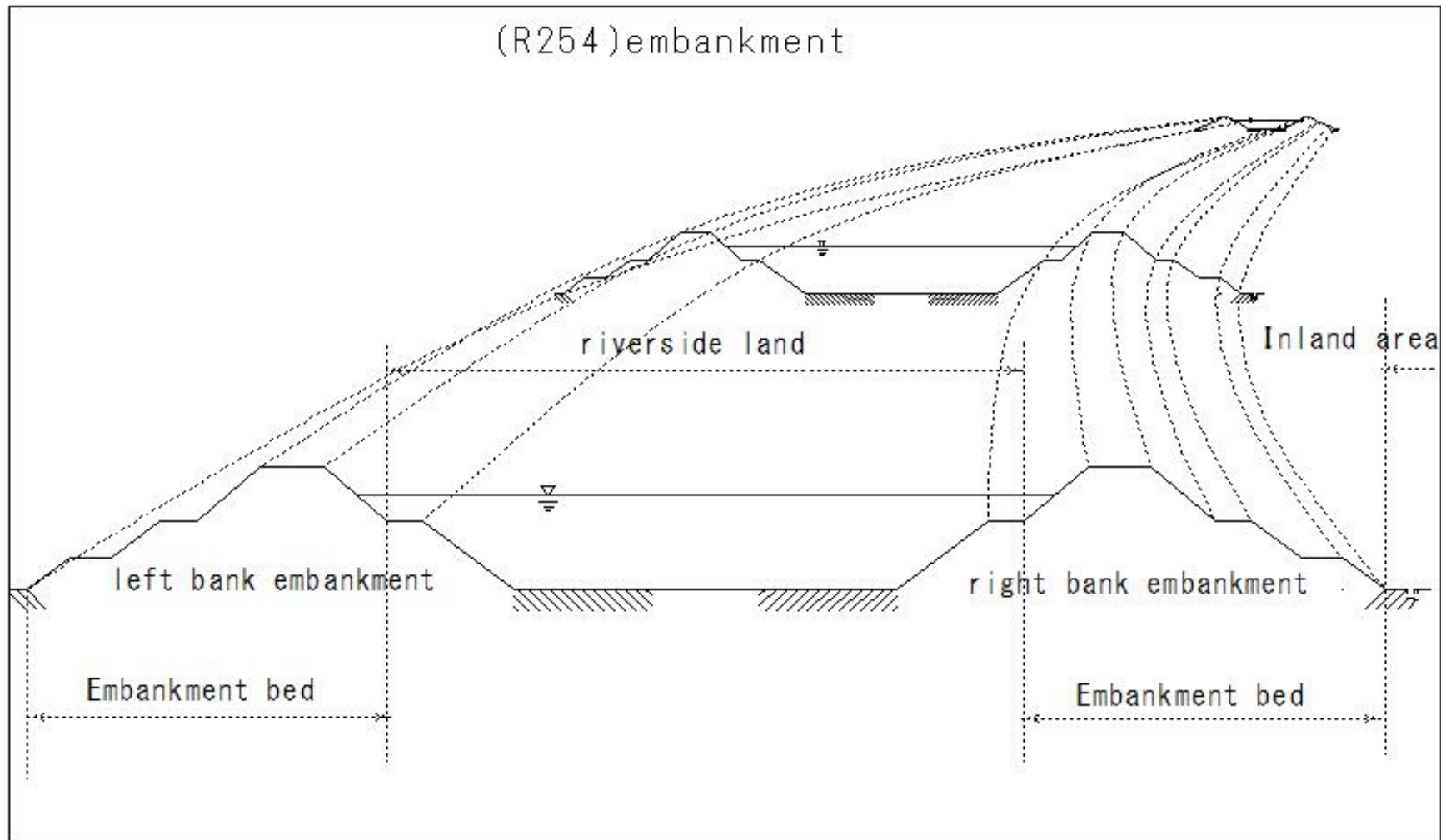
ground sill consolidation works

- Reducing river flow speed
- Preventing riverbed scouring
- Embankment leg - submersion



fascine mattress
wood mattress

(R254)embankment

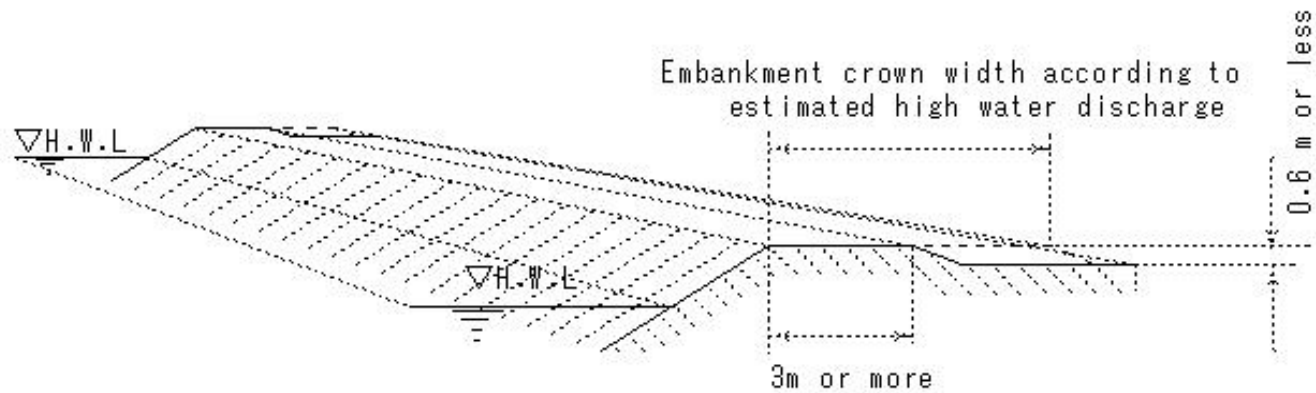


(R255)embankment(Embankment crown)

(R255)embankment(Embankment crown)

Embankment top width

estimated high water discharge	crown width (unit: m)
less than 500	3
500-2000	4
2000-5000	5
5000-10000	6
10000-	7



(R256)embankment(margin height /extra embankment)

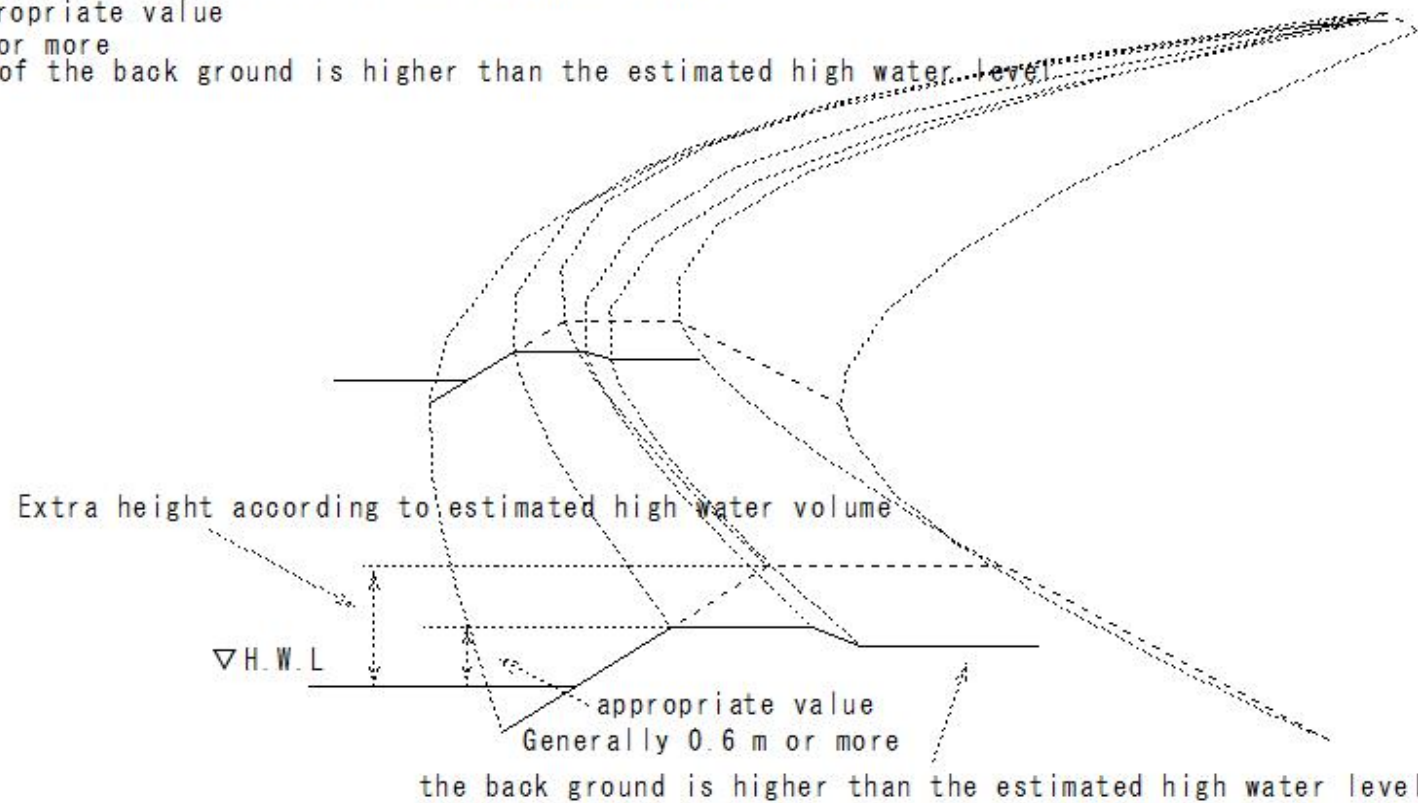
(R256) embankment (margin height /extra embankment)

margin height (extra embankment)

- Margin height according to design flood discharge
- Appropriate value

0.6m or more

case of the back ground is higher than the estimated high water level



(R257) permeable groin

(R257) permeable groin

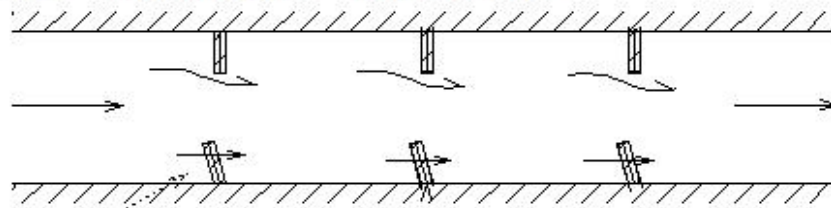
permeable groin

Prevention of scouring around the height of permeable groin

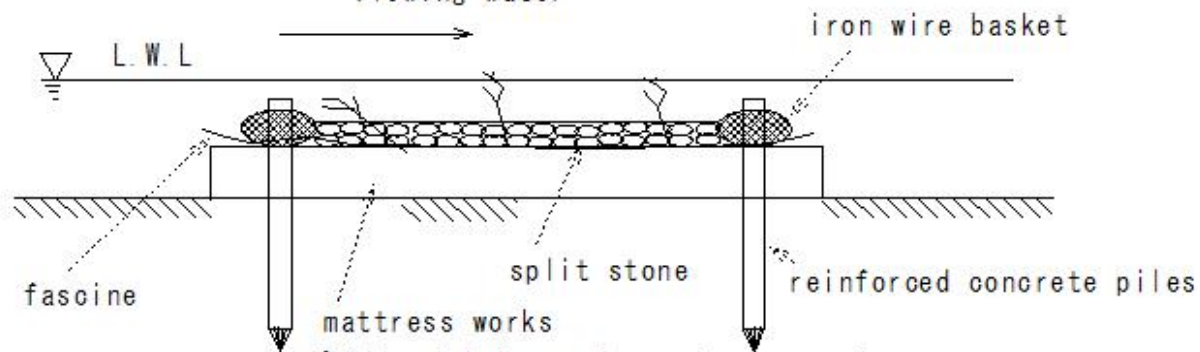
Prevention of scouring around the height of permeable groin

Prevention of scouring around the height of permeable groin

• Full water flow - no collision - flowing down



Permeable groin
flowing water



① Pile driving and overlaying groin

Permeable groin

(R258) permeable groin

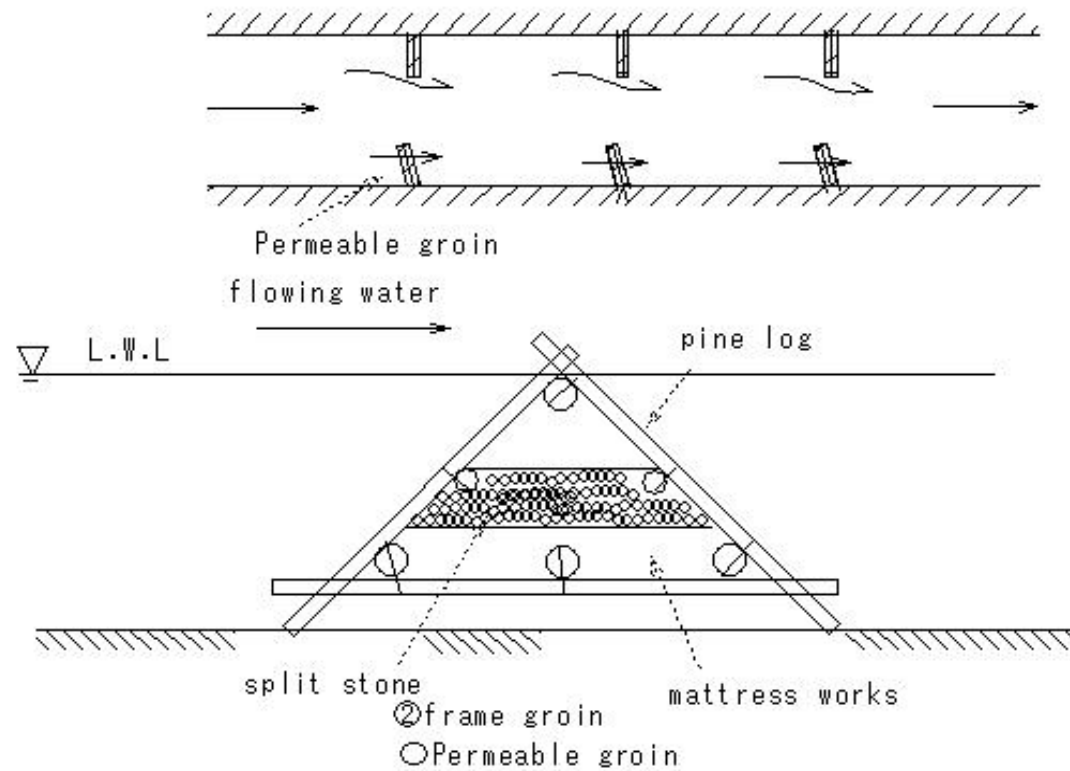
permeable groin

(R258) permeable groin

Prevention of scouring around the height of permeable water system

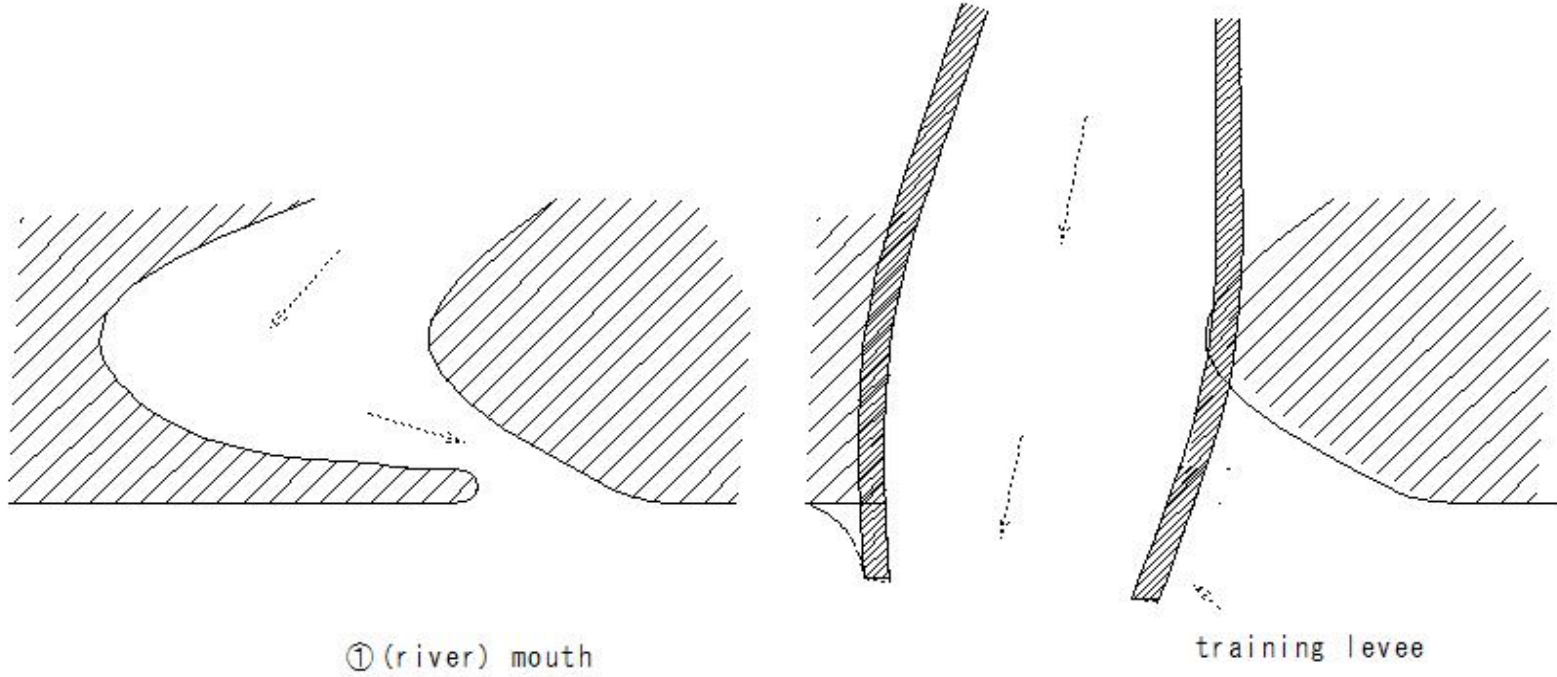
• Full water flow - no collision - flowing down

② frame groin

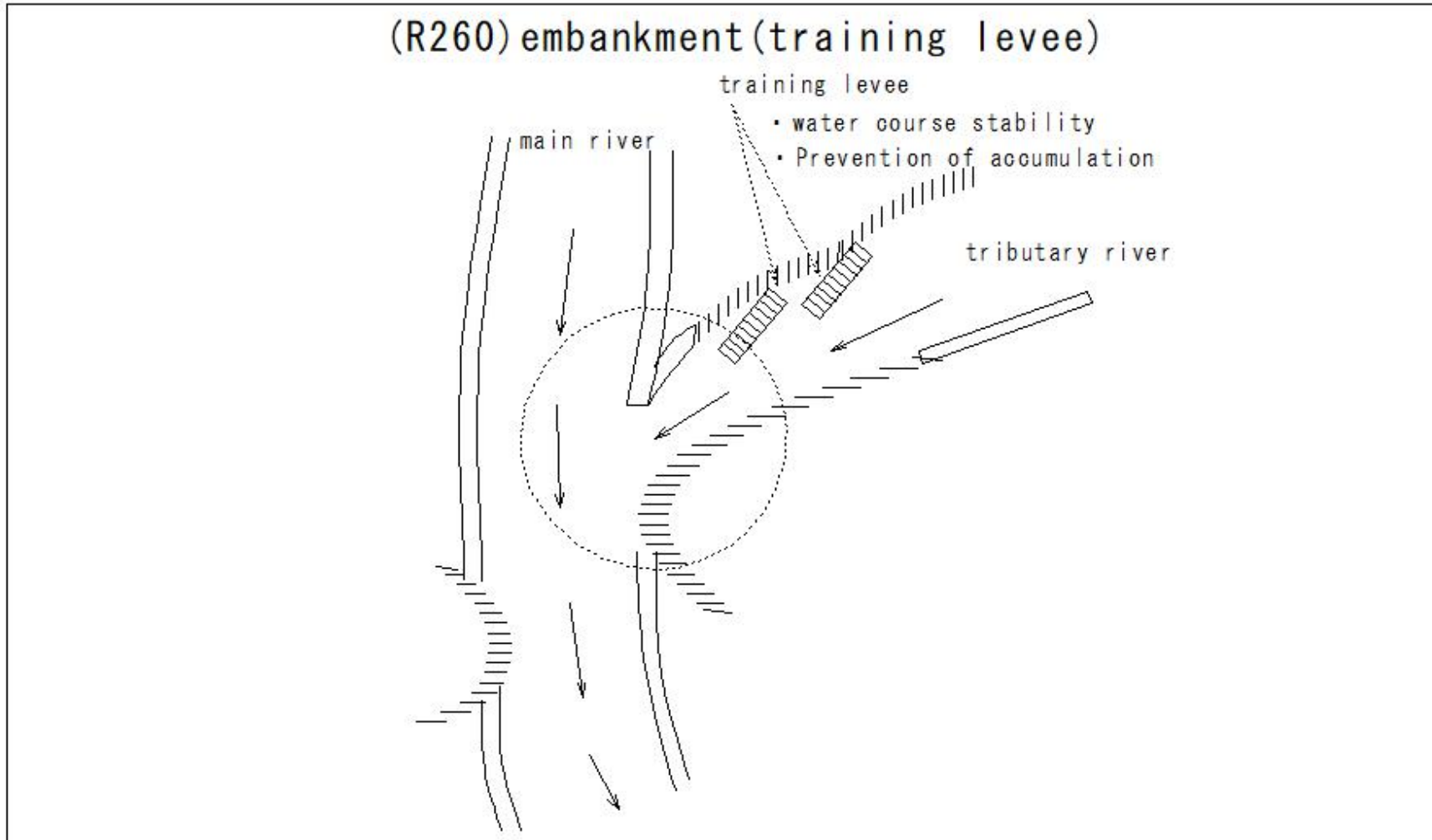


(R259)embankment(training levee)

(R259) embankment(training levee)



(R260)embankment(training levee)



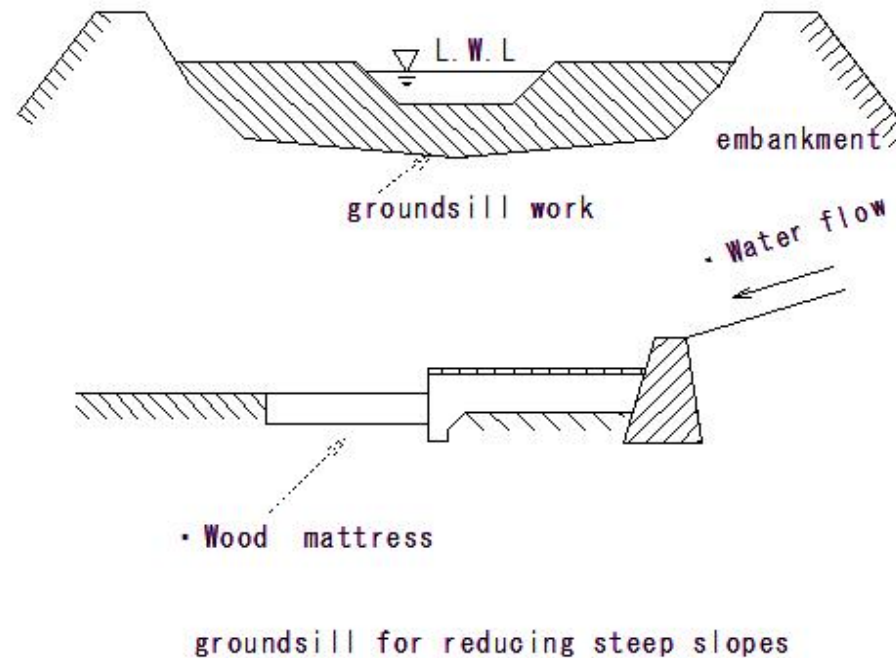
(R261)bank protection(ground sill consolidation)

(R261)bank protection(ground sill consolidation)

ground sill consolidation works

- Prevention of river bed erosion
- River bed maintenance
- River bed slope change - prevention of scouring

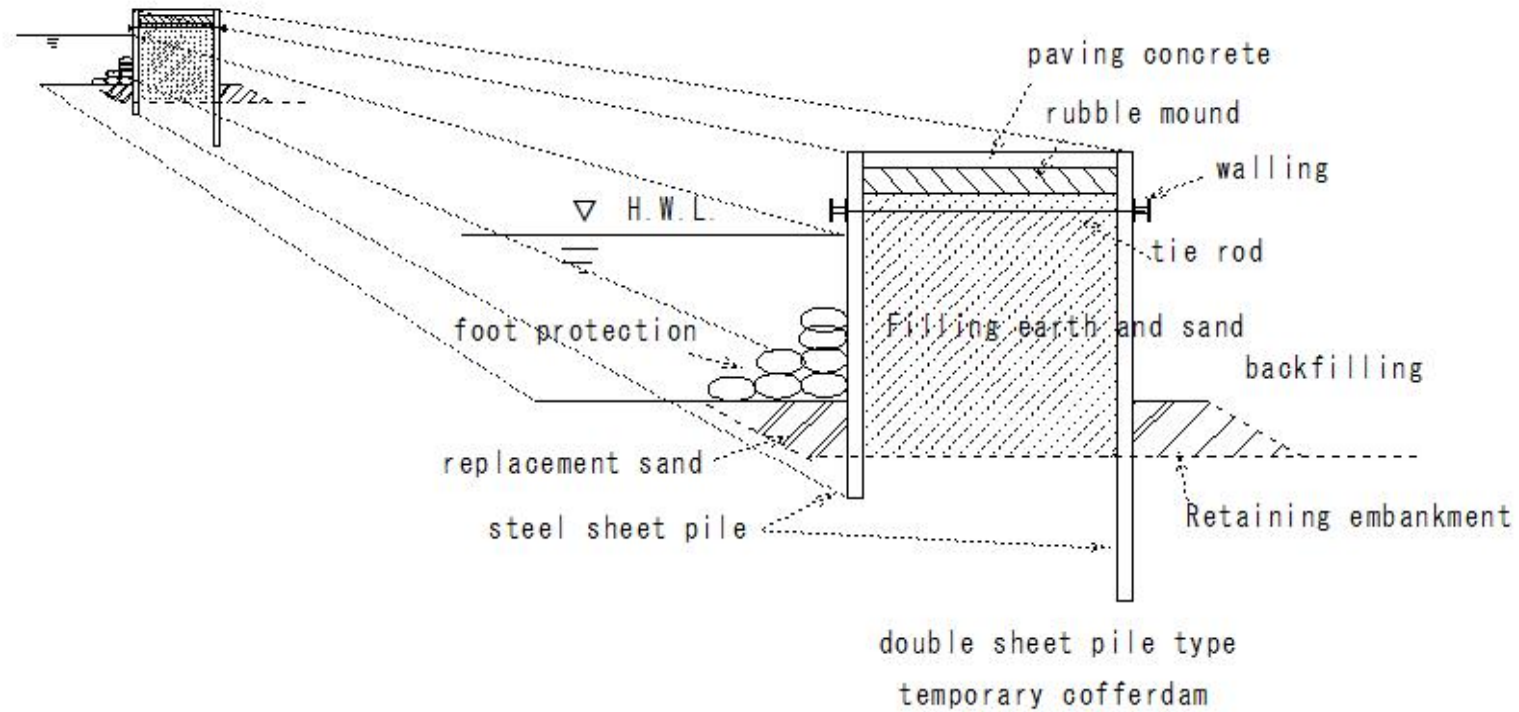
- ① Concrete ground sill consolidation works
- ② Stone masonry (pitching) work
- ③ riverbed girdle
- ④ mattress



(R262)temporary cofferdam(ground sill consolidation)

(R262)temporary cofferdam(ground sill consolidation)

temporary cofferdam(double steel sheet pile closing)

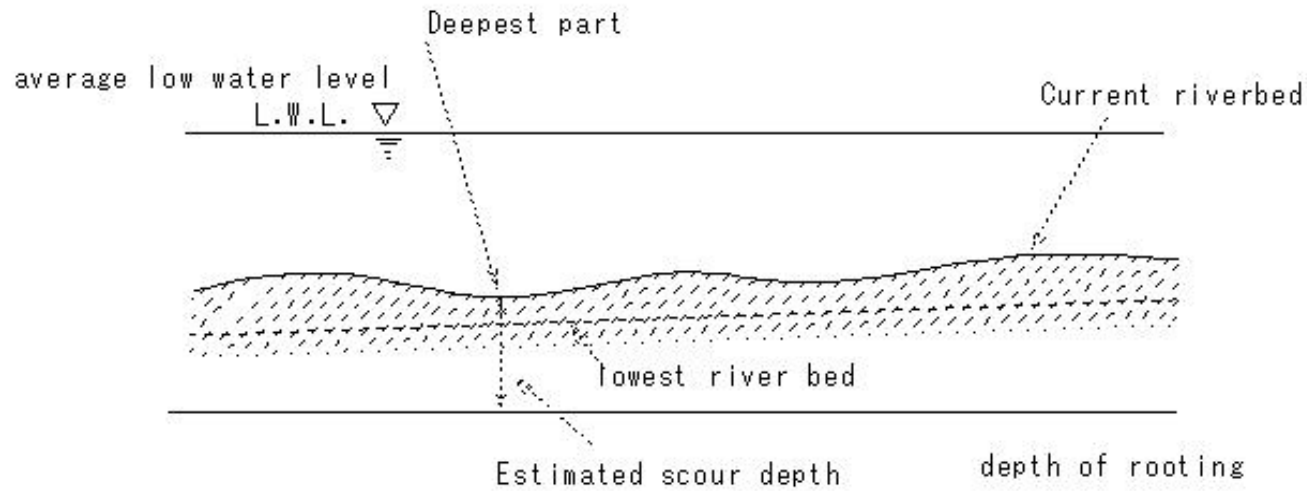


(R263)riverbed(penetration depth)

(R263)riverbed(penetration depth)

penetration depth

Depth from riverbed level to foundation



$$\text{Penetration} = \text{minimum river bed} + \text{estimated scour depth}$$

(R264)foot protection

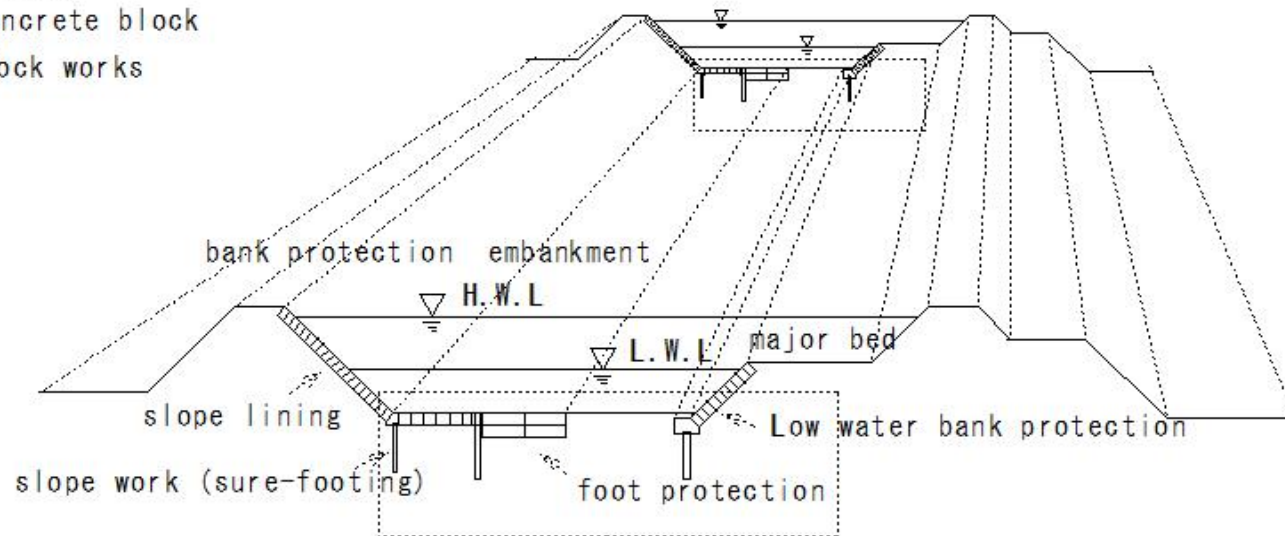
(R264) foot protection

foot protection

- Constructed on the front of the slope foot protection
- Prevention of scouring of the slope tip

type

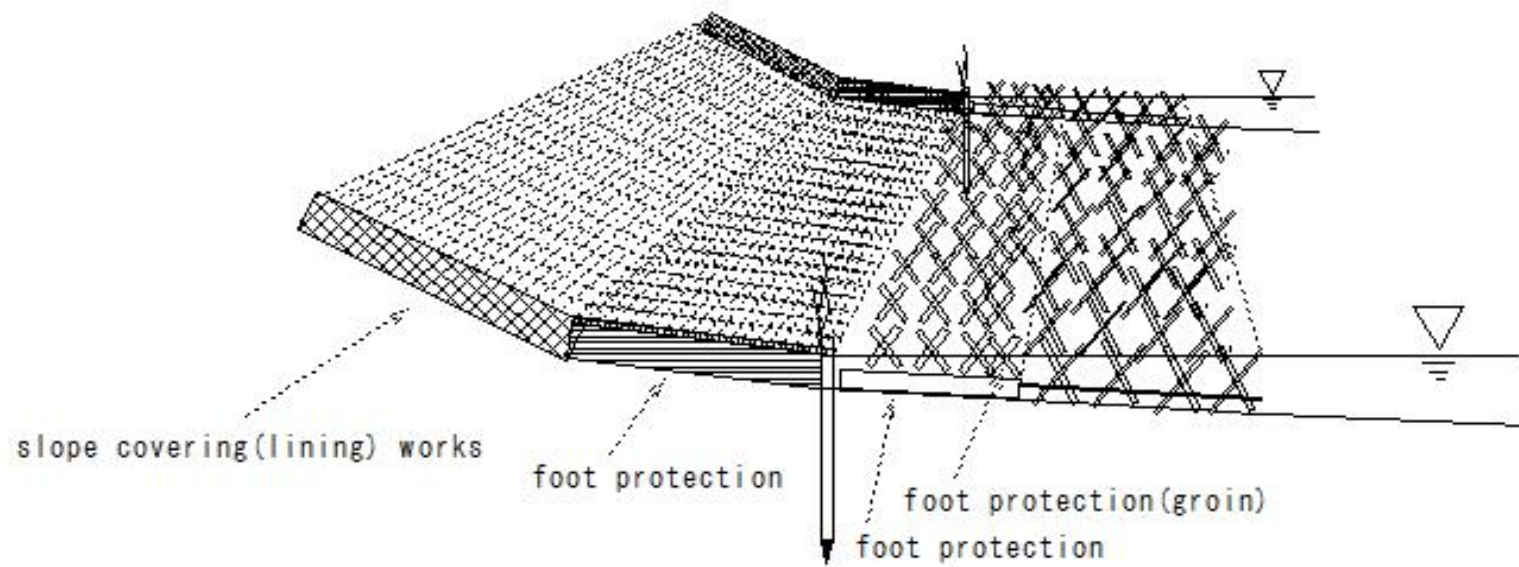
- ① rubble mound
- ② wire cylinder masonry work (gabion)
- ③ mattress
- ④ slope crib work
- ⑤ Deformed concrete block
- ⑥ Concrete block works



(R265)foot protection(groin)

(R265)foot protection(groin)

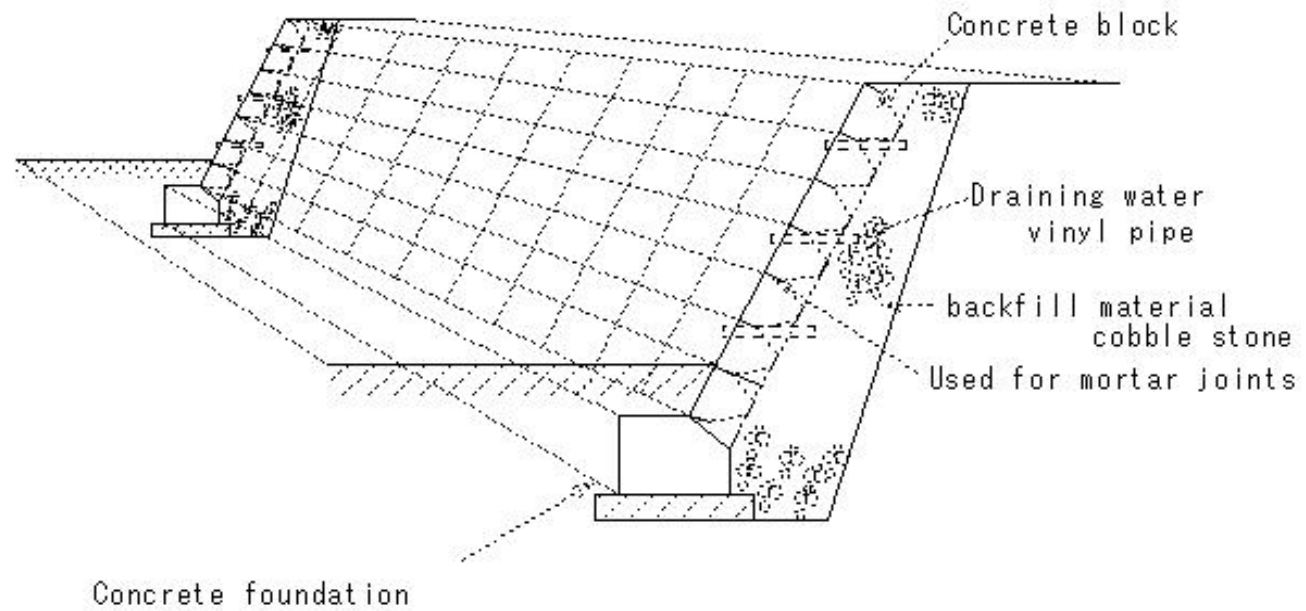
foot protection(groin)



(R266)stone masonry

(R266)stone masonry

stone masonry

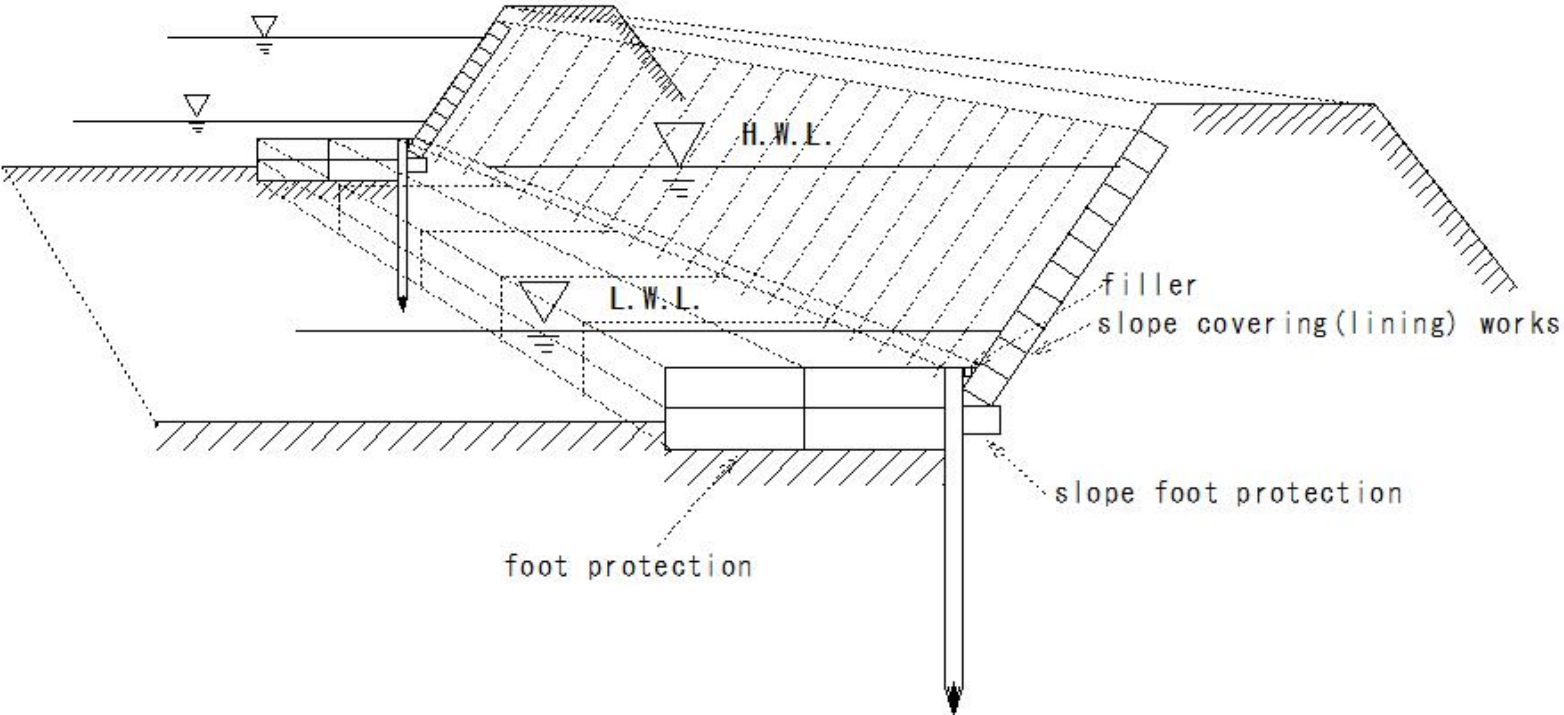


(R267)foot protection(slope foot protection)

(R267) foot protection (slope foot protection)

slope foot protection

- Foundation of slope covering(lining) works
- Insulate the slope stopper and foot protection

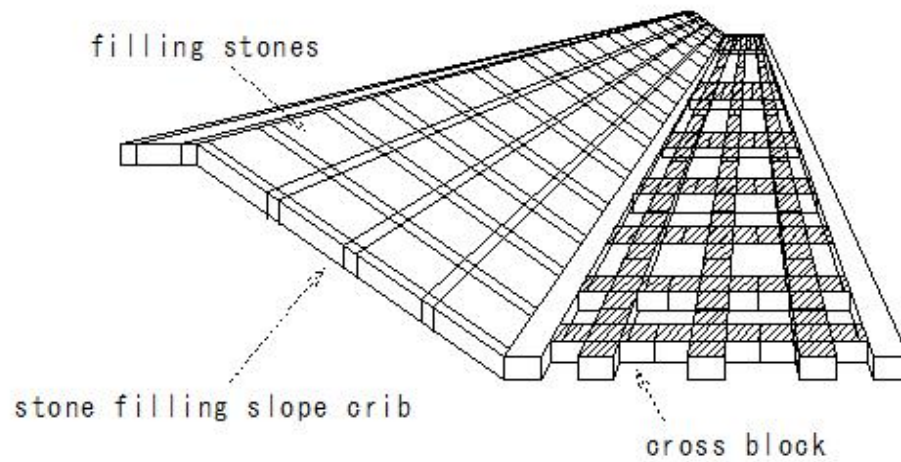


(R268)slope crib work

(R268)slope crib work

slope crib work (made of concrete)

- Prevention of slope collapse
- Preventing peeling
- Gradient 1:0.8



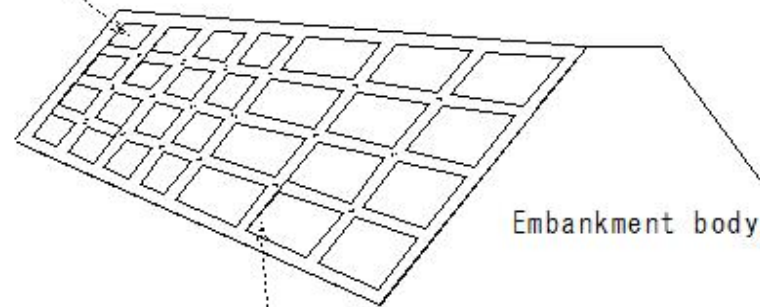
(R269)slope crib work

(R269) slope crib work

concrete slope crib work

- crib work (made of concrete)
- filling stones
- Prevention of slope collapse
- Preventing peeling
- Gradient 1:0.8

Vegetation work



Embankment body

② Concrete crib work
concrete block crib work

(R270)sluice

(R270)sluice

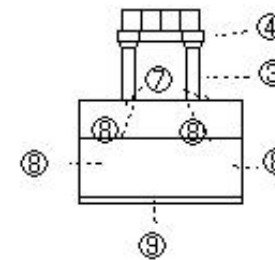
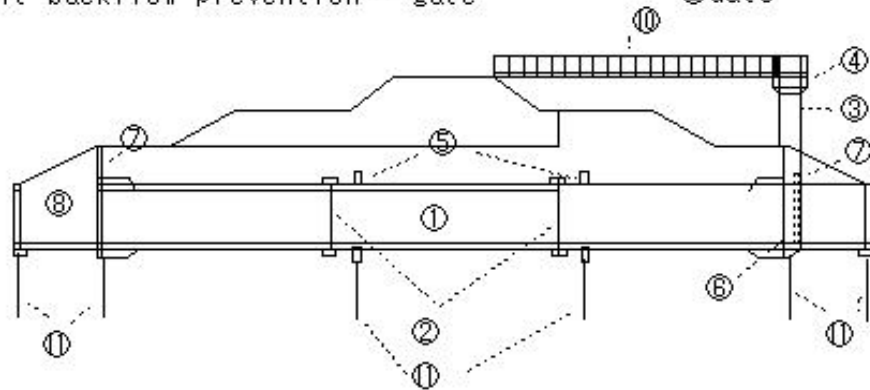
sluice

- Culvert that crosses under the embankment
- Width 2m or more - sluice
- Diameter 2m or less - sluice pipe
- Intake of agricultural water drainage
- Exit backflow prevention - gate

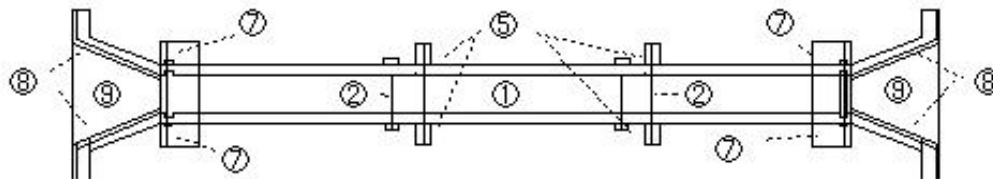
Sluice, sluice pipe

- ① Box ditch
- ② Joint
- ③ Gatepost
- ④ Gate operation table
- ⑤ Impermeable wall
- ⑥ Gate

- ⑦ Battlements
- ⑧ Wing wall
- ⑨ Water tapping
- ⑩ Management bridge
- ⑪ Waterproof work



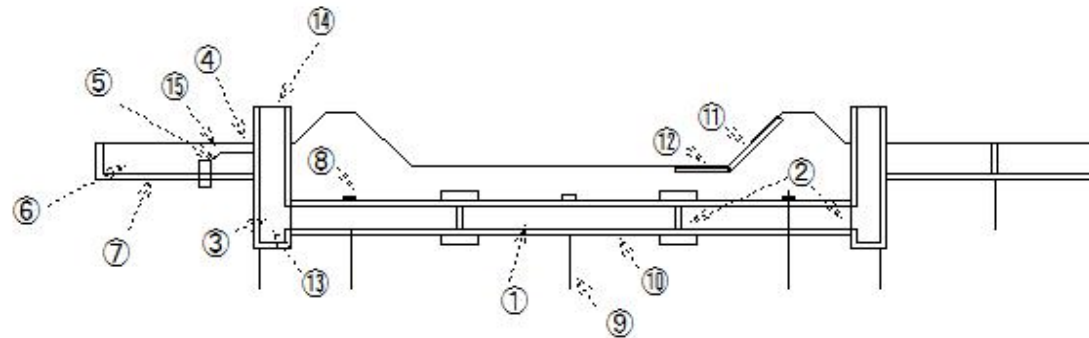
Front view



(R271)siphon culvert

siphon culvert
drainage canal
Crossing under rivers and canals
sand pond
dust removal screen

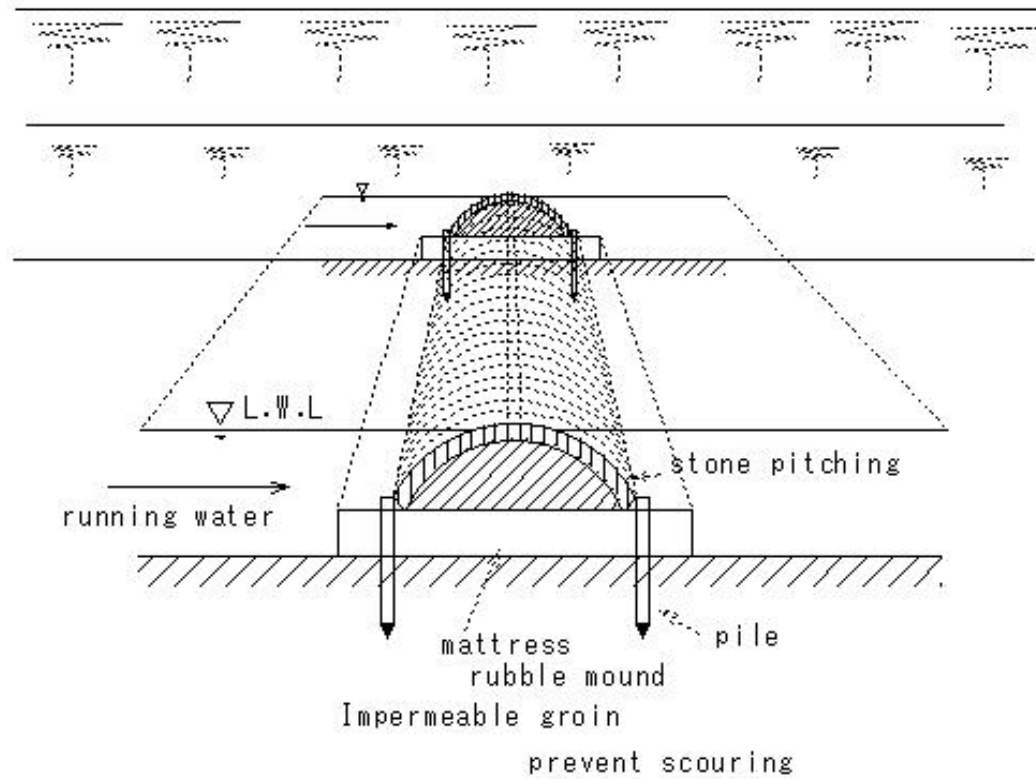
(R271)siphon culvert



- | | |
|----------------------|--------------------------|
| ① siphon culvert | ⑨ impermeable sheet pile |
| ② Expansion joint | ⑩ foundation |
| ③ Manhole | ⑪ bank protection |
| ④ Water control gate | ⑫ bed protection |
| ⑤ Screen | ⑬ Sand pool |
| ⑥ Wing wall | ⑭ Operation stand |
| ⑦ apron | ⑮ Managed bridge |
| ⑧ impermeable wall | |

(R272)siphon culvert

(R272) Impermeable groin

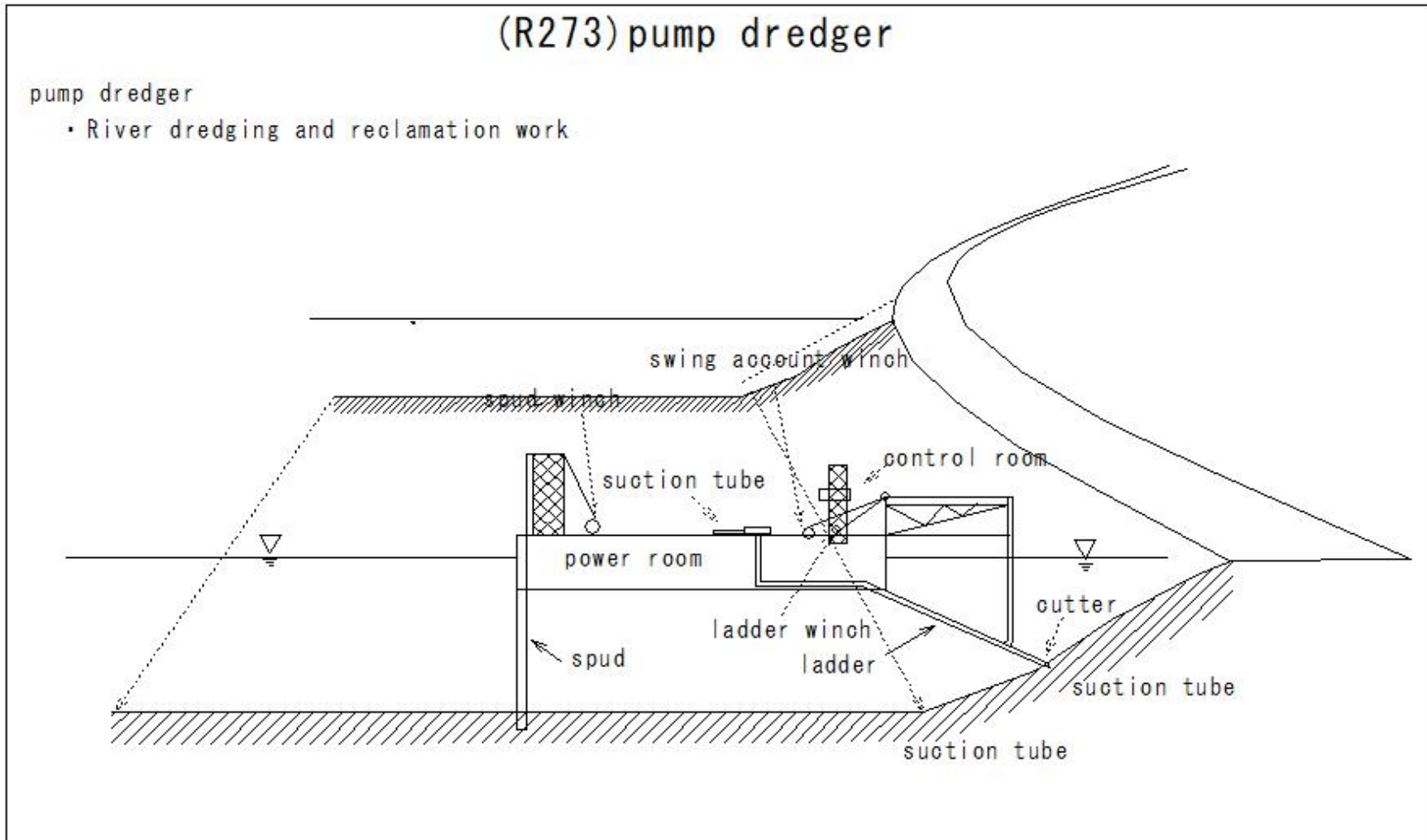


(R273) Impermeable groin

(R273) pump dredger

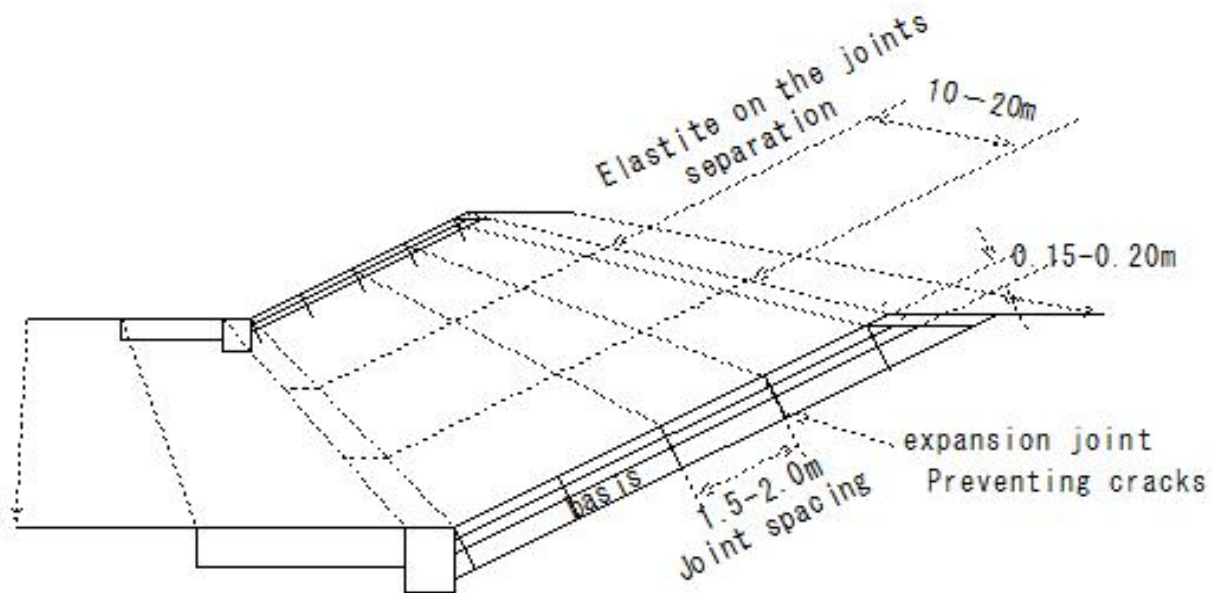
pump dredger

- River dredging and reclamation work



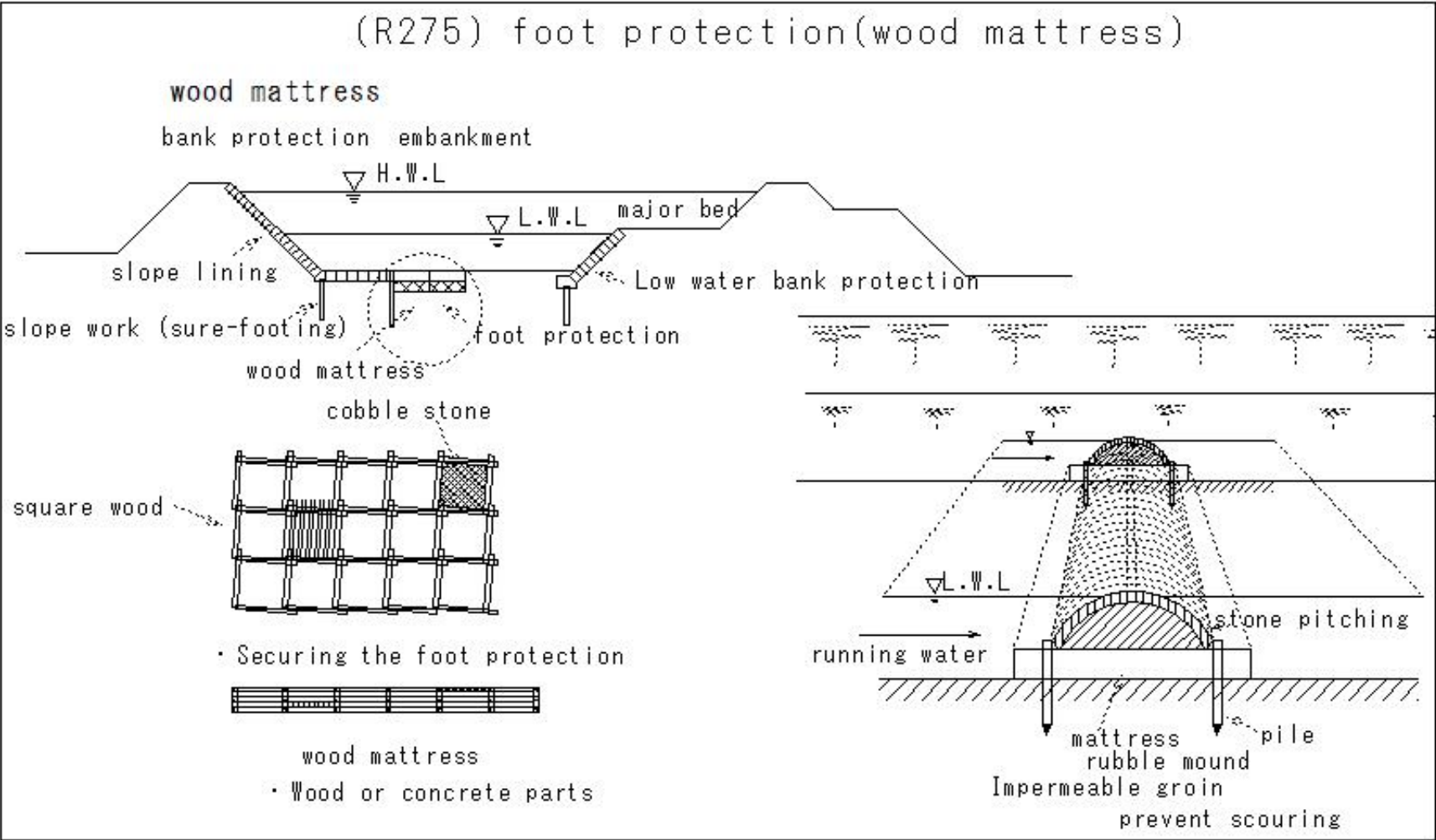
(R274)Concrete pitching bank protection(Joint spacing)

(R274)Concrete pitching bank protection(Joint spacing)



Concrete pitching bank protection

(R275) foot protection(wood mattress)

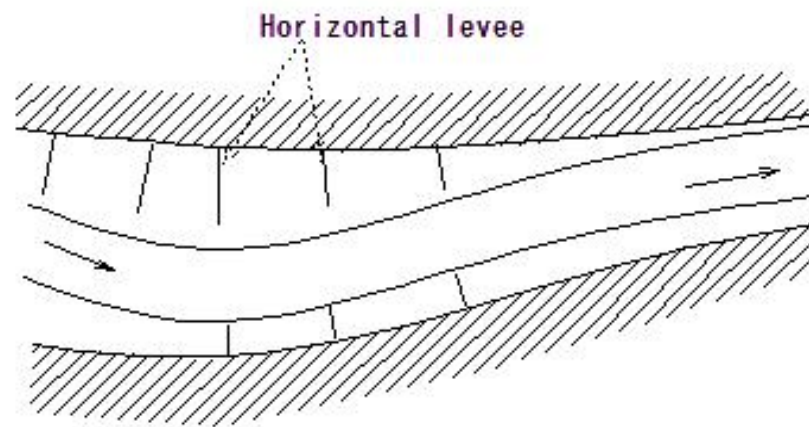


(R276)Horizontal levee

(R276)Horizontal levee

Horizontal levee

- Reduced flow velocity even during floods
- Protection of agricultural land

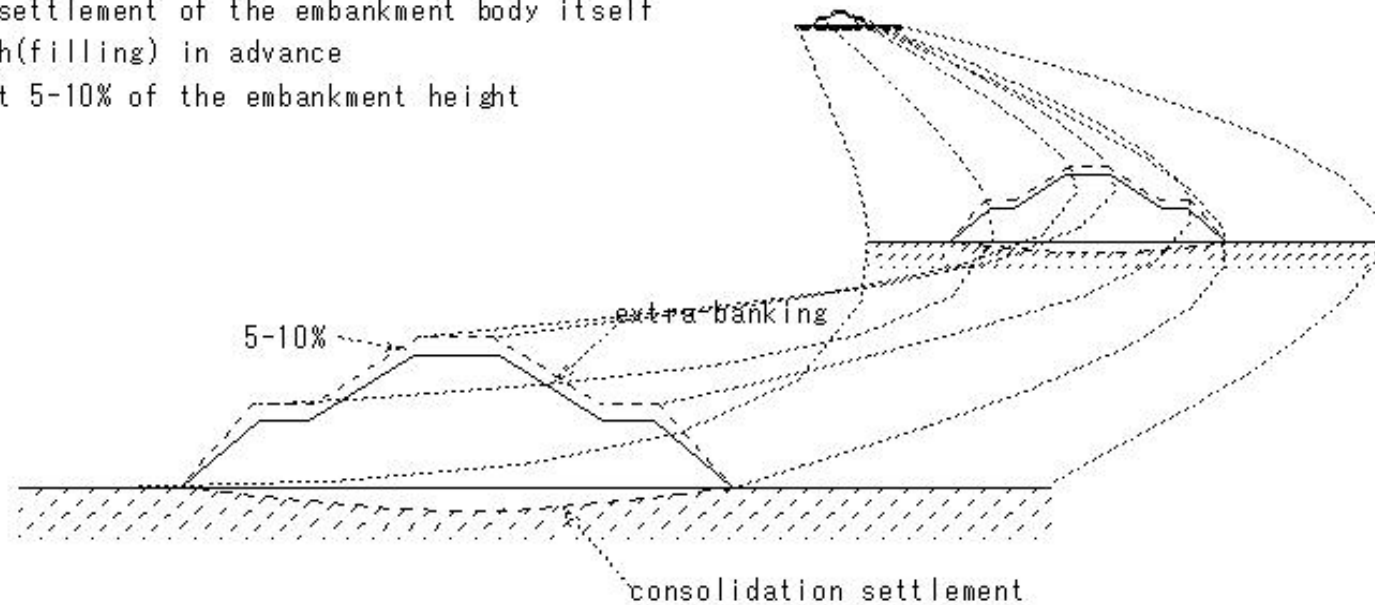


(R277) margin height (extra embankment/extra-banking)

(R277) margin height (extra embankment/extra-banking)

Extra embankment: Embankment body consolidation settlement

- consolidation settlement after embankment
- consolidation settlement of the embankment body itself
- Add extra earth(filling) in advance
- Generally about 5-10% of the embankment height



(R278)margin height (extra embankment)

(R278)margin height (extra embankment)

Embankment cross section

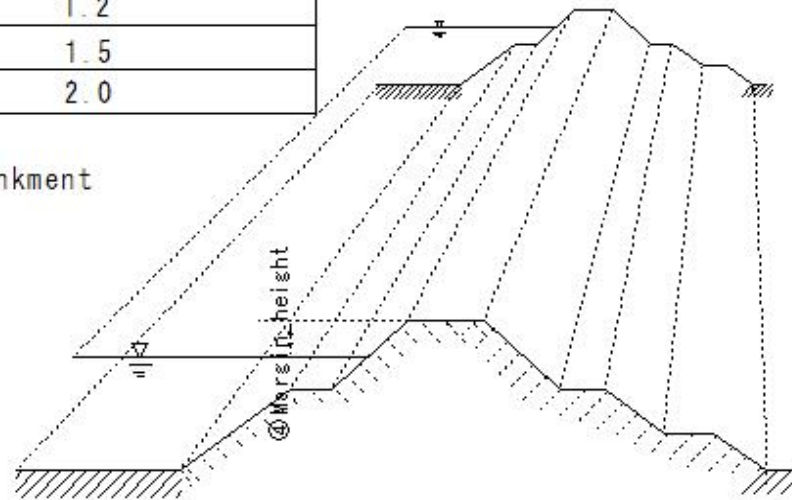
Embankment height/margin height

Margin height of embankment

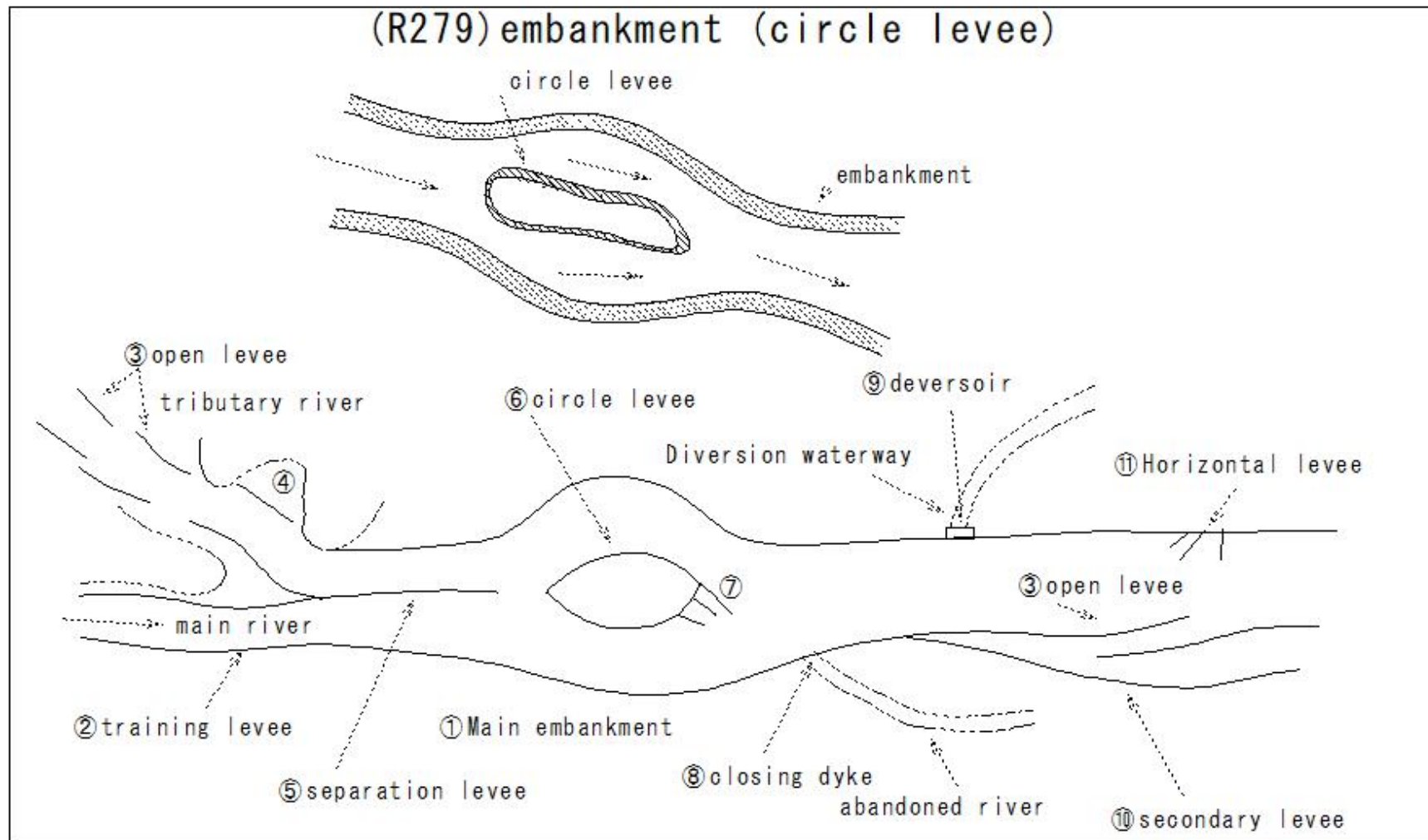
estimated high water flow (unit: m ³ /s)	Extra height (unit: m)
less than 200	0.6
200 - 500	0.8
500 - 2000	1.0
2000 - 5000	1.2
5000 - 10000	1.5
10000 -	2.0

Extra height for the free height of the embankment

- ① Important hinterland rivers
- ② Rivers with a lot of sediment runoff
- ③ Waves
- ④ Curved part of the river
- ⑤ Increase margin height



(R279)embankment (circle levee)

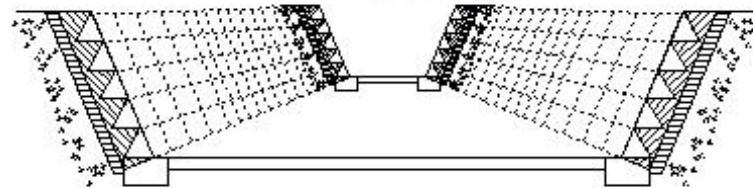


(R280)amenity

(R280) amenity

Amenity

• drought



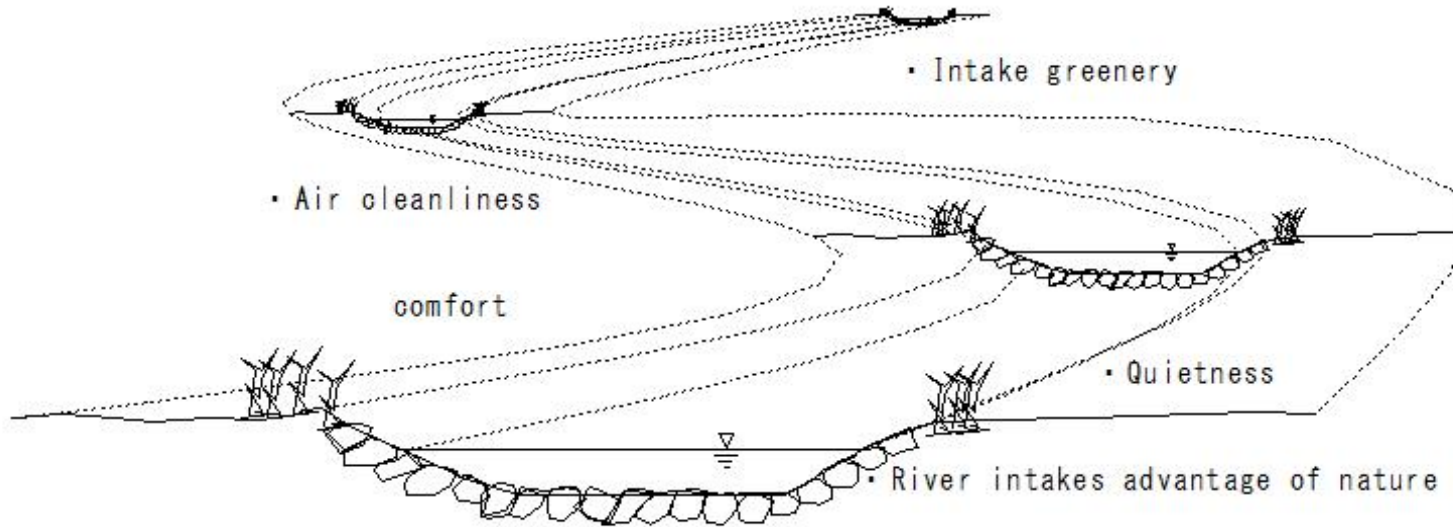
• Intake greenery

• Air cleanliness

comfort

• Quietness

• River intakes advantage of nature

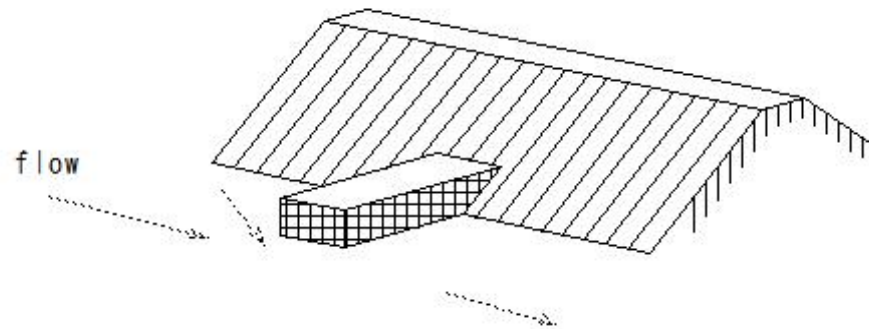


(R281)stone dyke(groin)

(R281)stone dyke(groin)

stone dyke(groin)

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

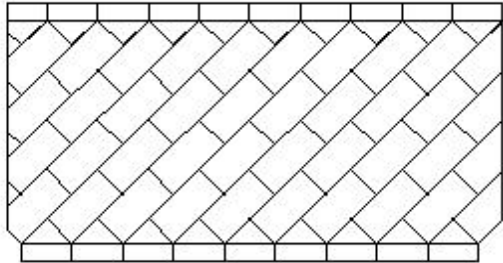
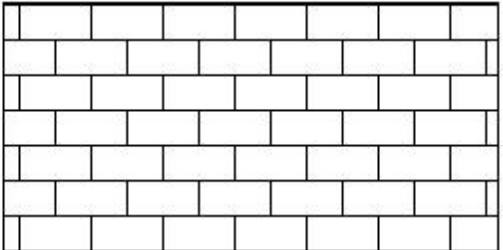
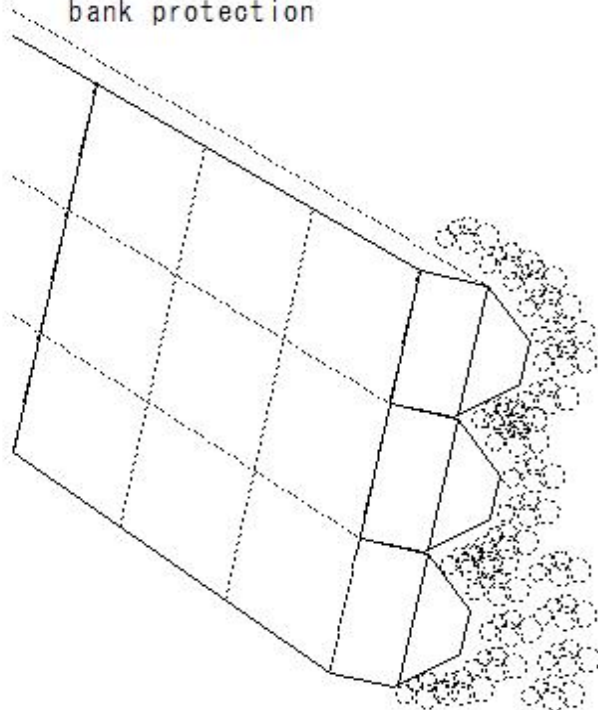


stone dyke(groin)
masonry
made of concrete

(R282)stone masonry

(R282) stone masonry

stone masonry
retaining stone wall
bank protection



stone masonry

(R283)rock crib work

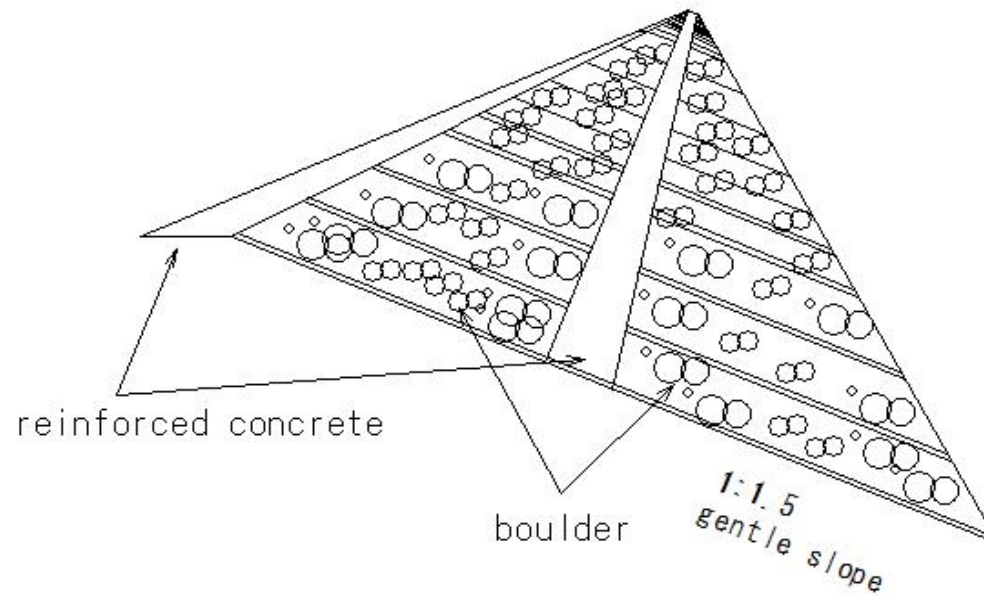
(R283) rock crib work

rock crib work

reinforced concrete crib work

Packing of cobblestones, gravel, and gravel

Assemble a frame on the slope of the embankment

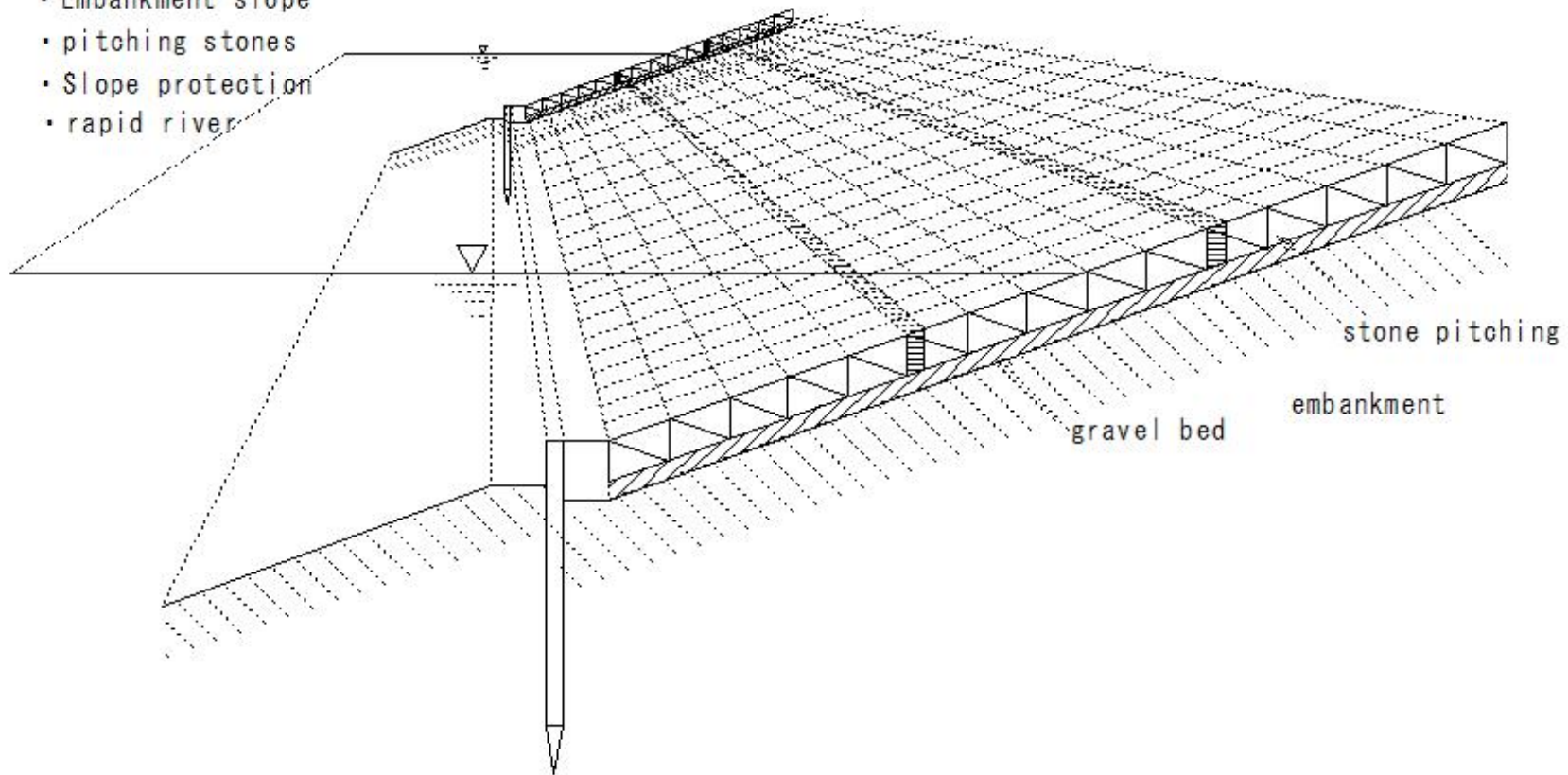


(R284)stone pitching work

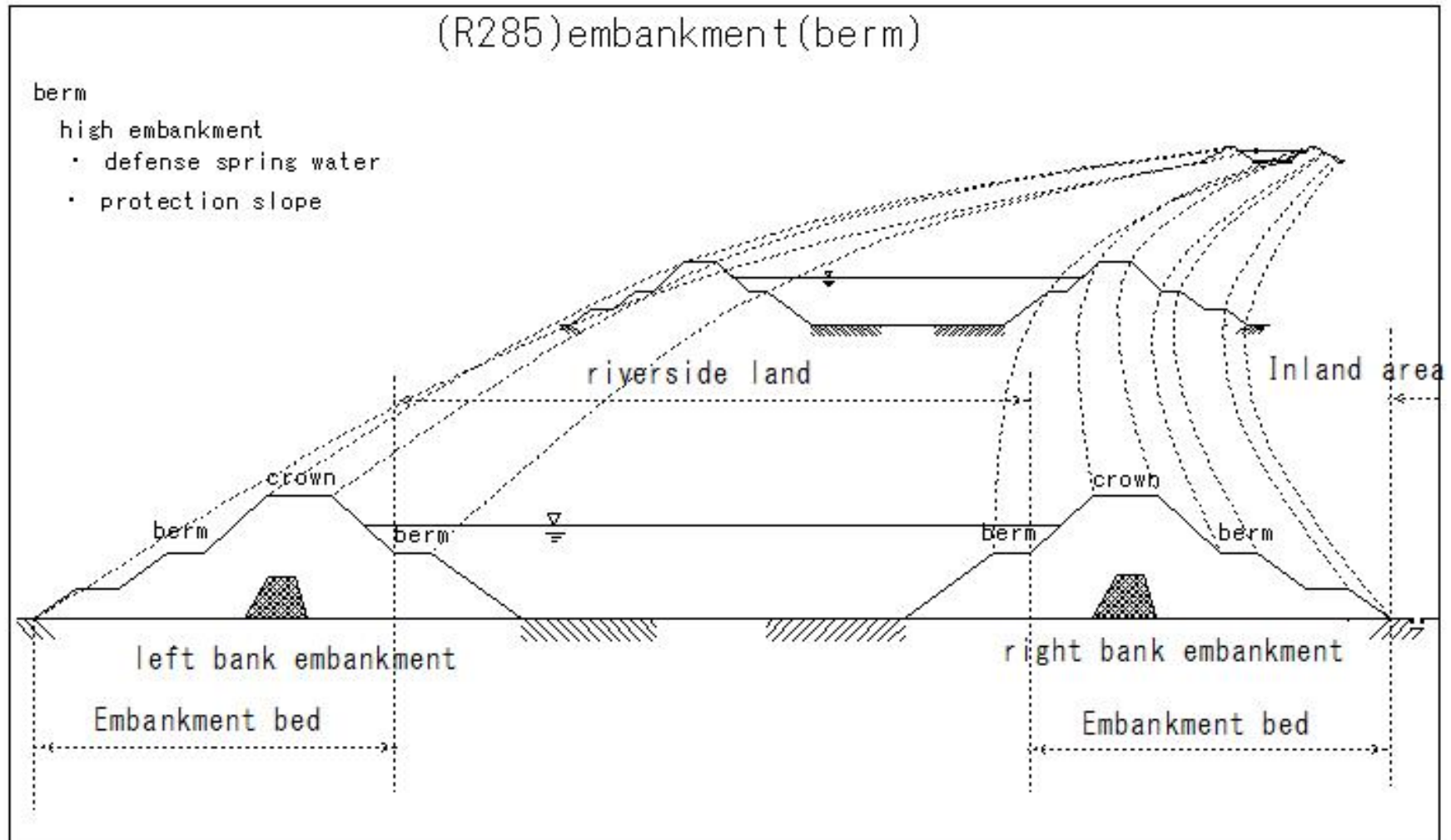
(R284) stone pitching work

stone pitching work

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



(R285)embankment(berm)

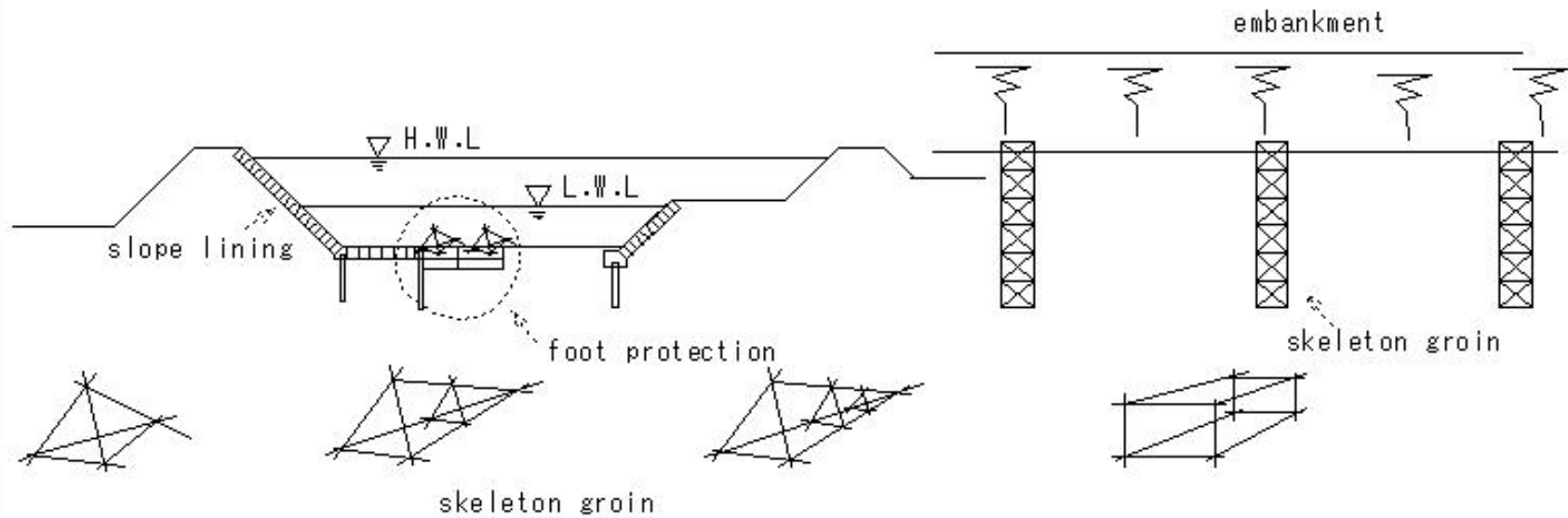
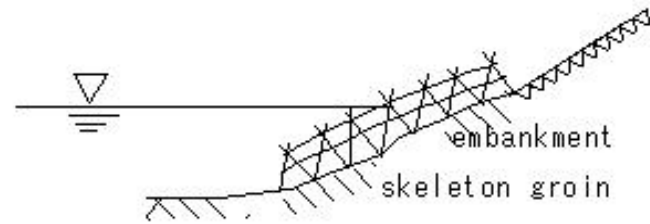


(R286)groin(skeleton)

skeleton

- Purpose of river construction
- foot protection groin
- skeleton groin
- wire cylinder masonry work(gabion)
- reinforced concrete column

(R286)groin(skeleton)

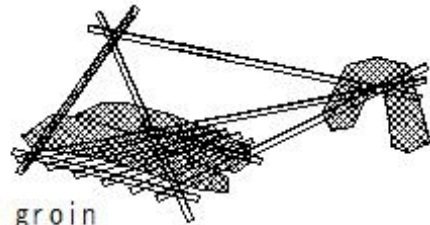


(R287)groin(skeleton)-wire cylinder masonry work(gabion)

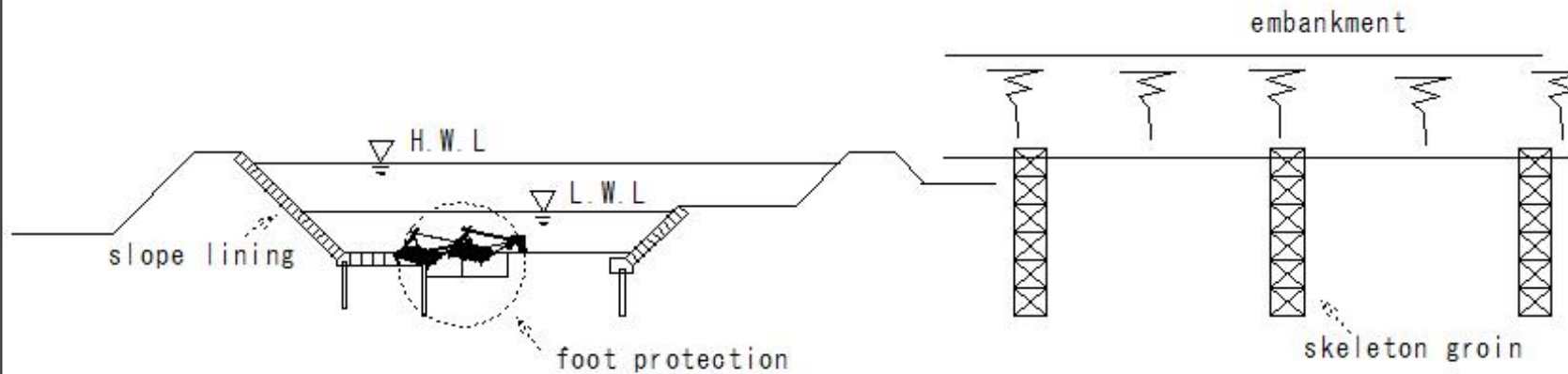
(R287)groin(skeleton)-wire cylinder masonry work(gabion)

skeleton

Purpose of river construction
foot protection groin



skeleton groin
wire cylinder masonry work(gabion)



(R288)slope protection(backing mat method)

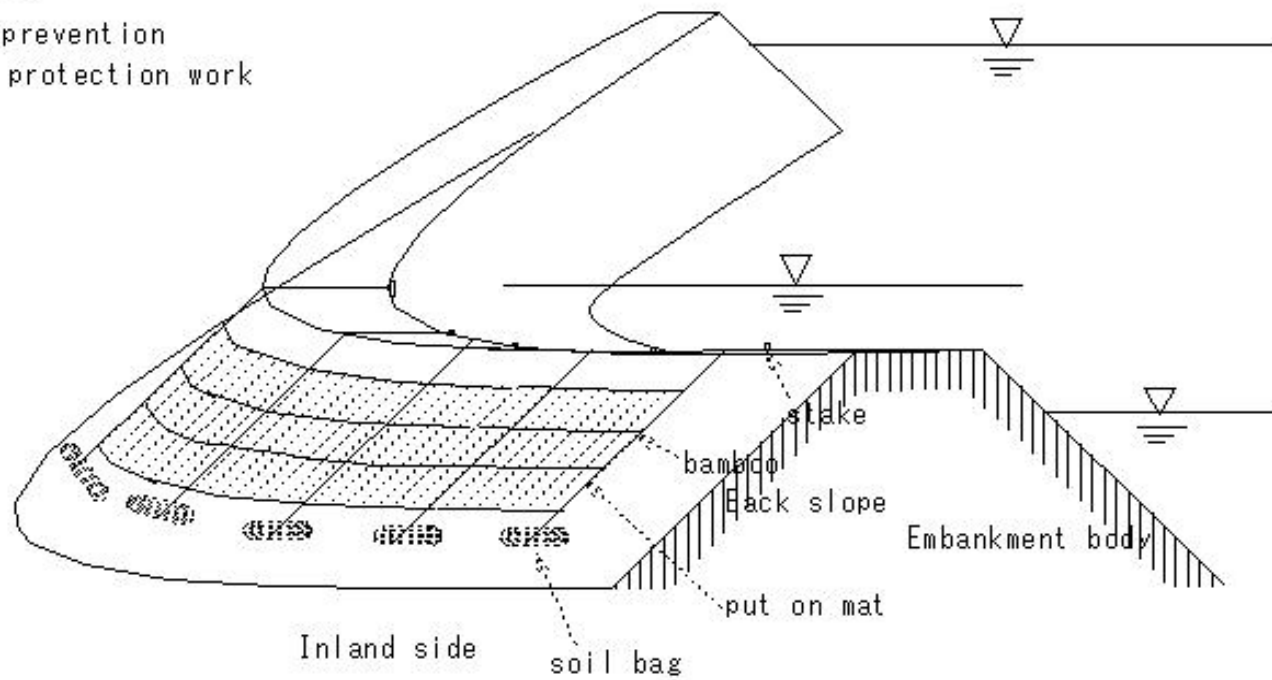
(R288)slope protection(backing mat method)

backing mat method

case of flood

Water leak prevention

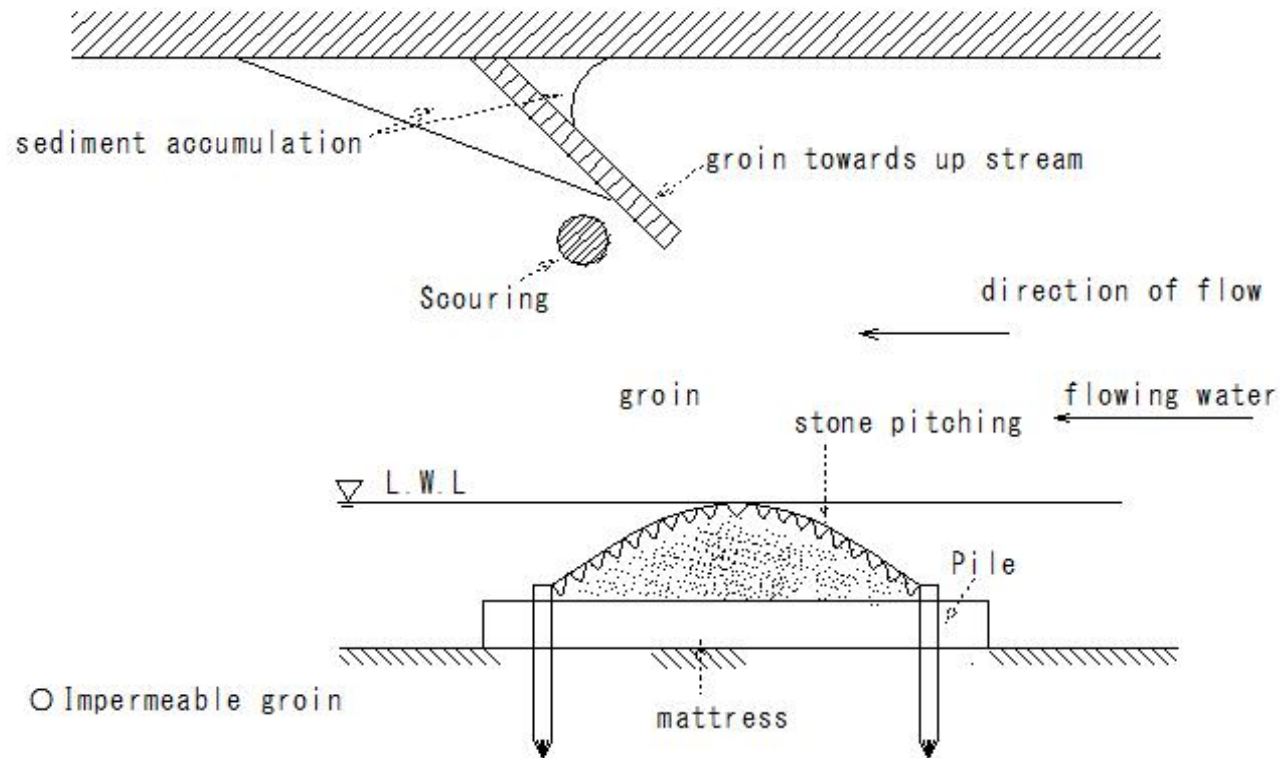
Back slope protection work



(R289)groin towards up stream

(R289)groin towards up stream

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



(R290)carrying operation

(R290)carrying operation

carrying operation

Solvent: Dissolving and flowing in water

Floating current: floating and flowing in water

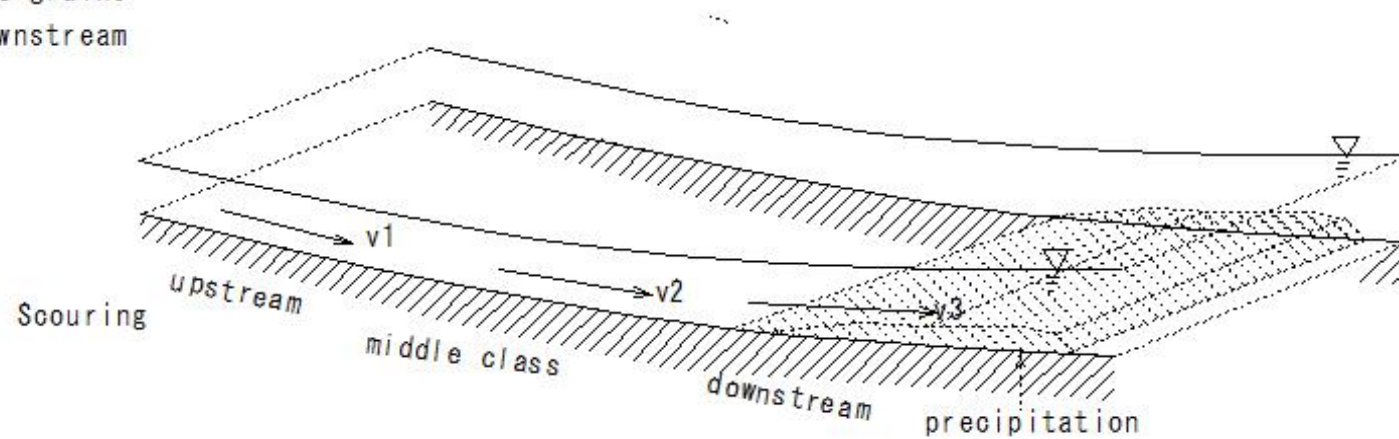
Sweep: Flowing by rolling on the river bed

river

erosion effect

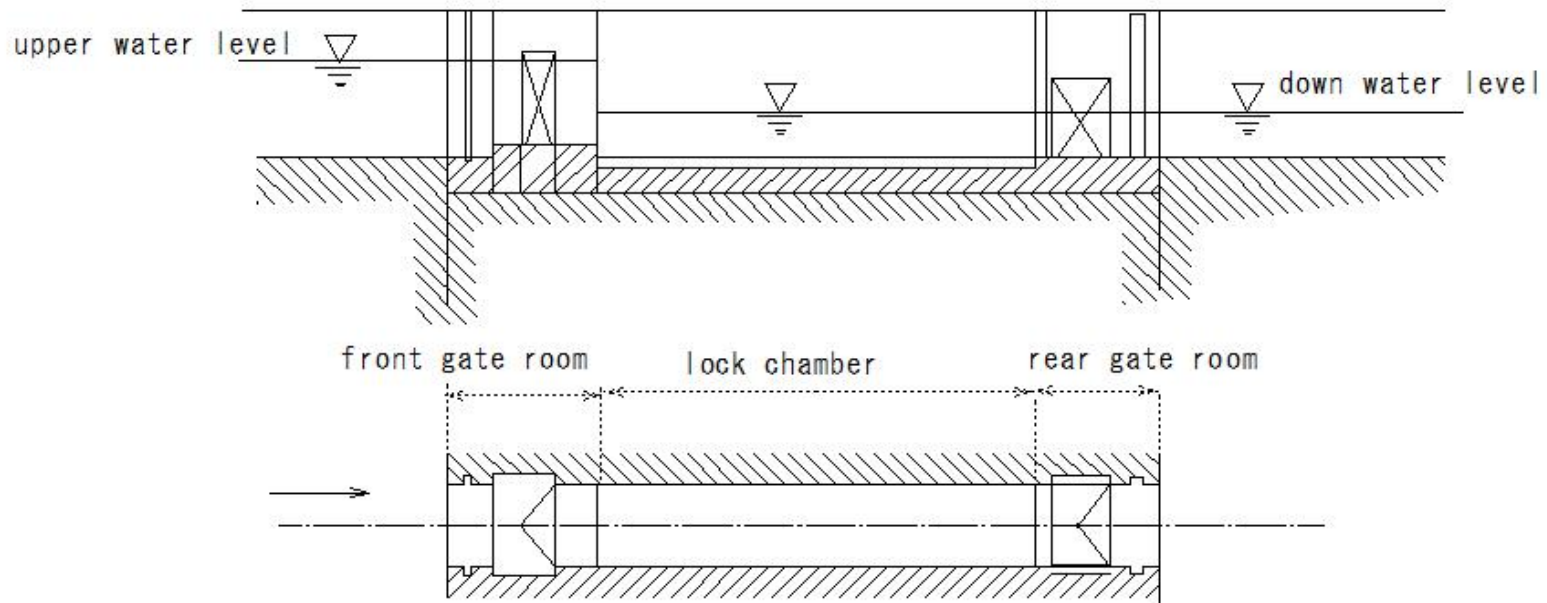
Sediment grains

flow downstream



(R291)lock

(R291) lock



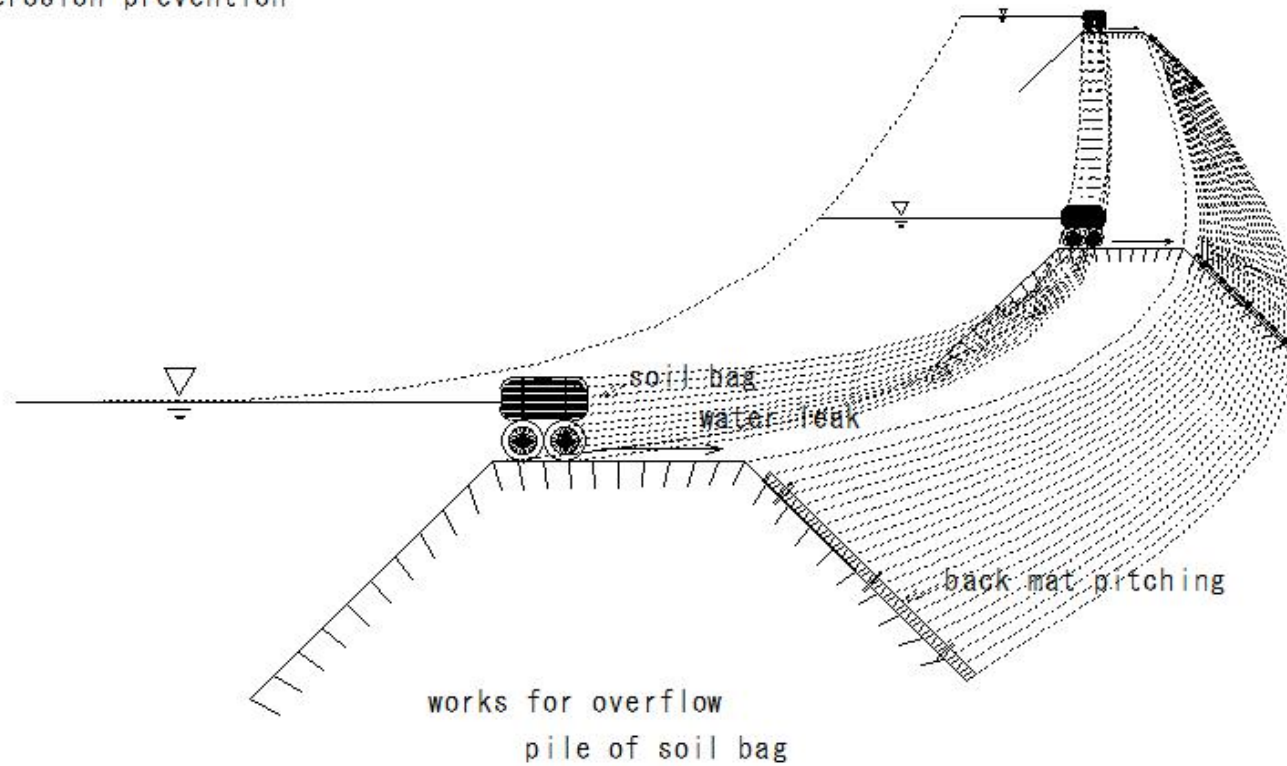
Sailing between two waters with a difference in head
lock

(R292)works for overflow

(R292)works for overflow

works for overflow

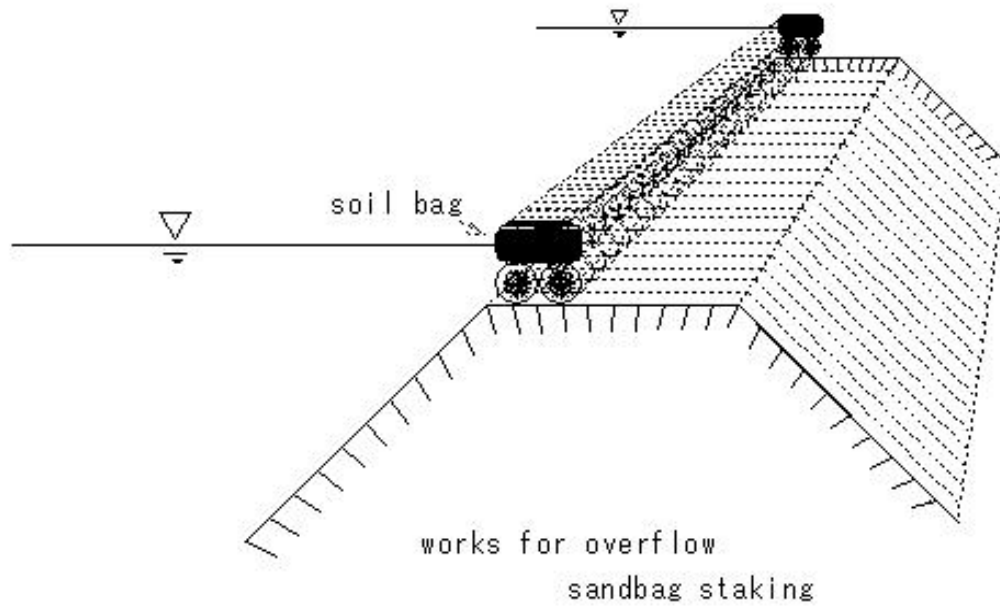
Preventing water from overflowing on the embankment
erosion prevention



(R293)works for overflow

(R293)works for overflow

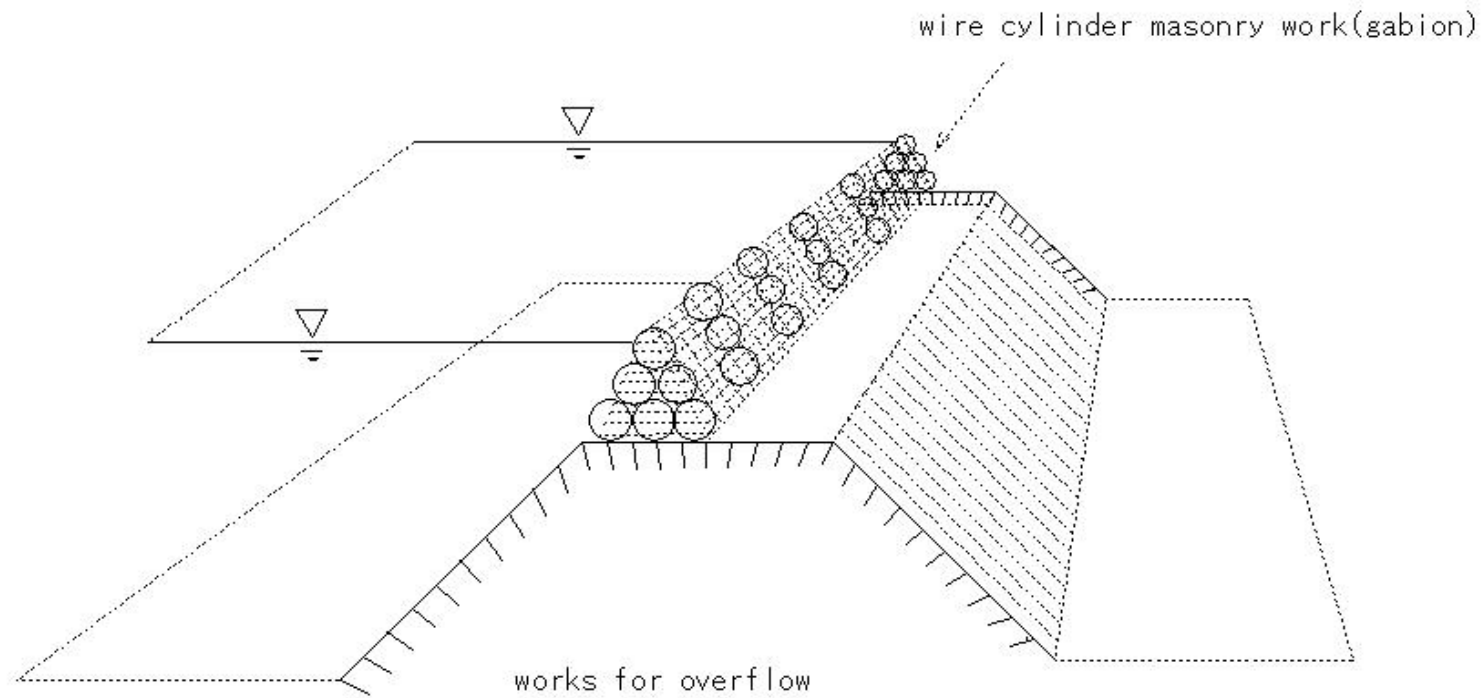
works for overflow
sandbag staking
Flood overflow prevention



(R294)works for overflow(wire cylinder masonry work(gabion))

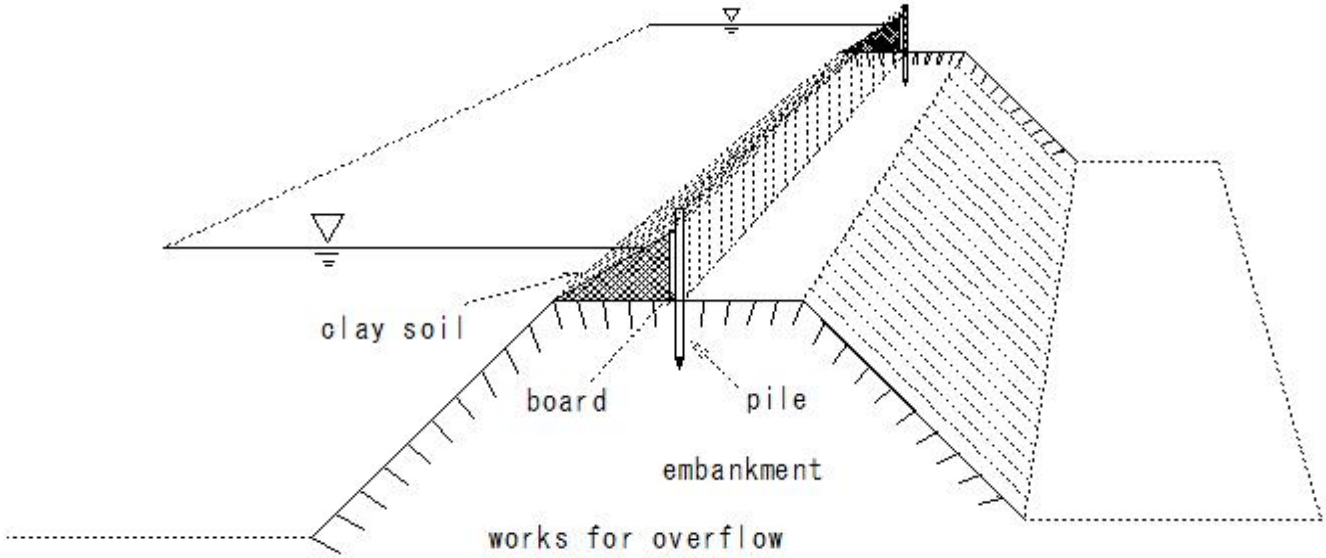
(R294)works for overflow(wire cylinder masonry work(gabion))

works for overflow
wire cylinder masonry work(gabion)



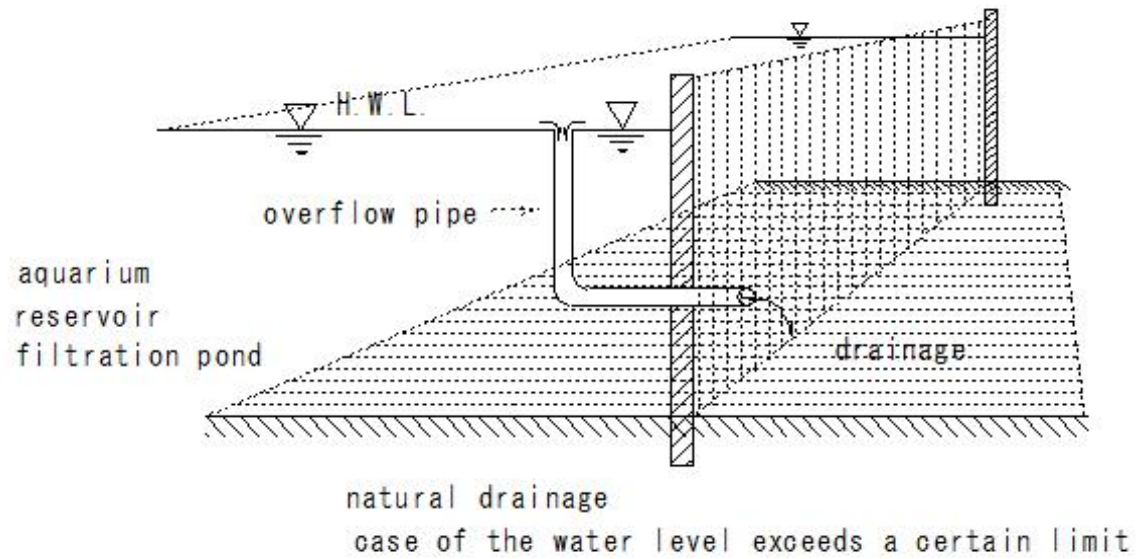
(R295)works for overflow(board work)

(R295)works for overflow(board work)

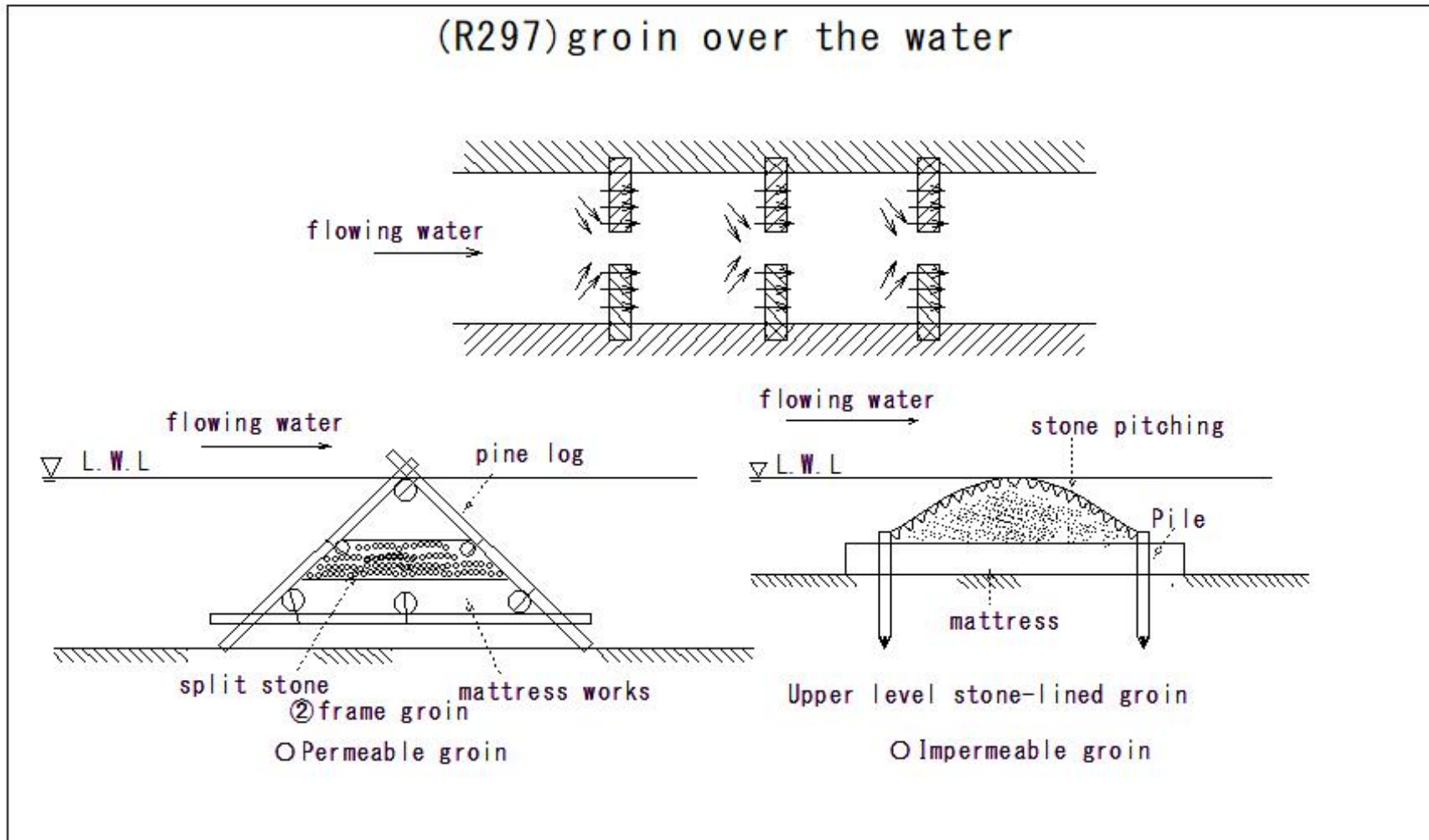


(R296) overflow pipe

(R296) overflow pipe



(R297)groin over the water

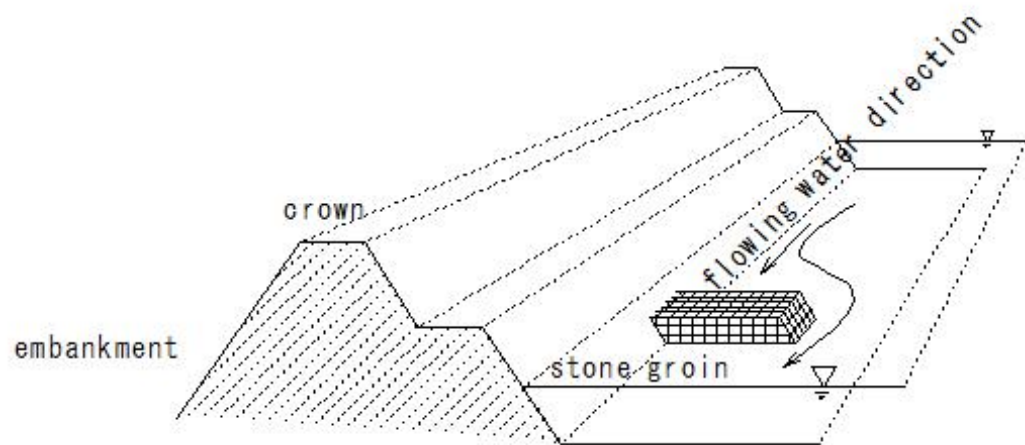


(R298)Impermeable groin(solid spur)

(R298) Impermeable groin(solid spur)

Impermeable water system

Water system that water cannot pass through



Resistance - large

Scouring - big

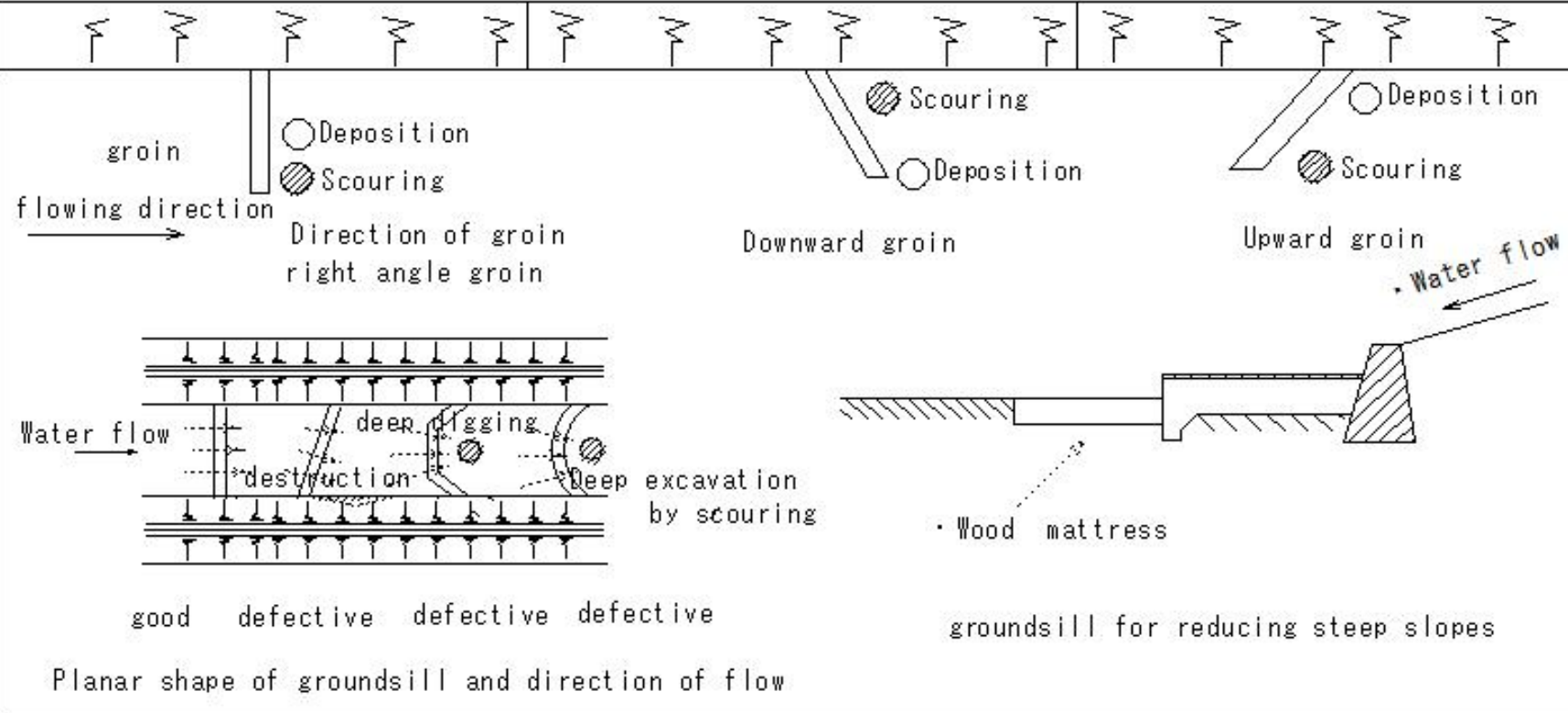
Water control effect - large

(R299)scour

(R299)scour

Scouring

Riverbank, riverbed, washed by running water

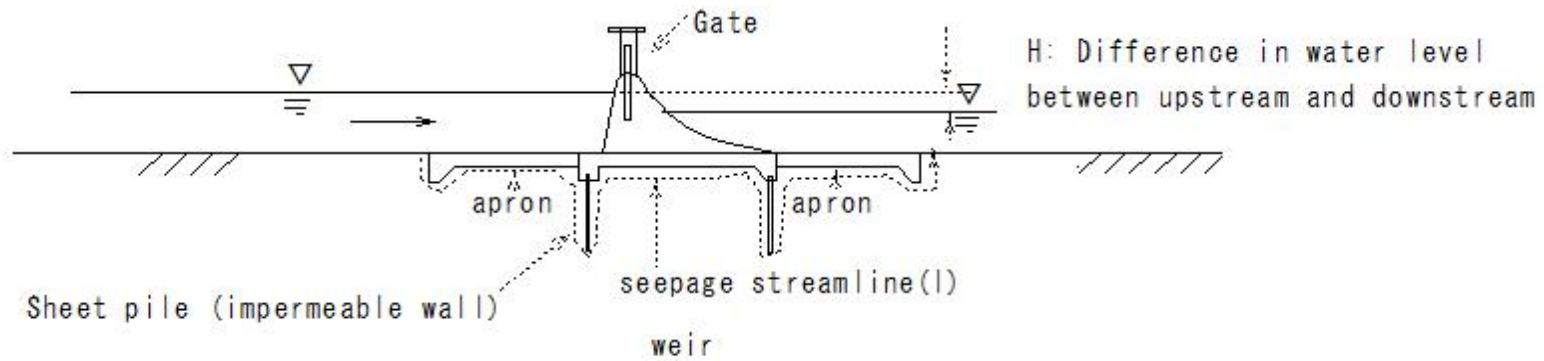
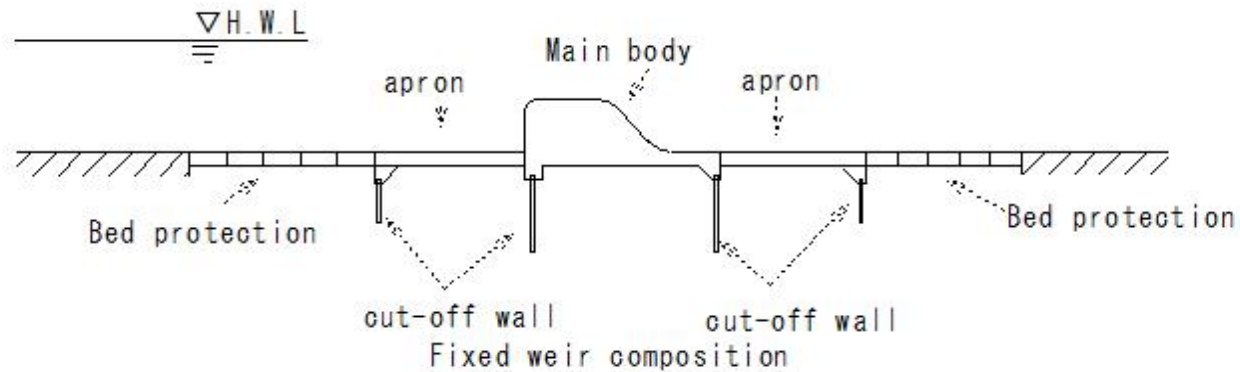


(R300) overflow weir

(R300) overflow weir

overflow weir

Water flows over the top



(R301)triangular weir

(R301) triangular weir

triangular weir

Overflow section

Water flow cross section

triangular weir

discharge: Q

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

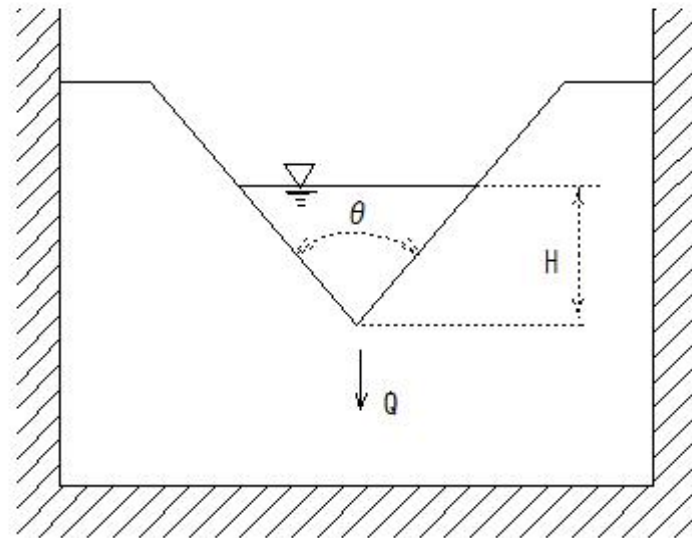
C : discharge coefficient

g : gravitational acceleration

H : Overflow water depth

discharge-a little

Accurate flow measurement



(R302)weir

(R302) weir

weir

irrigation

water supply

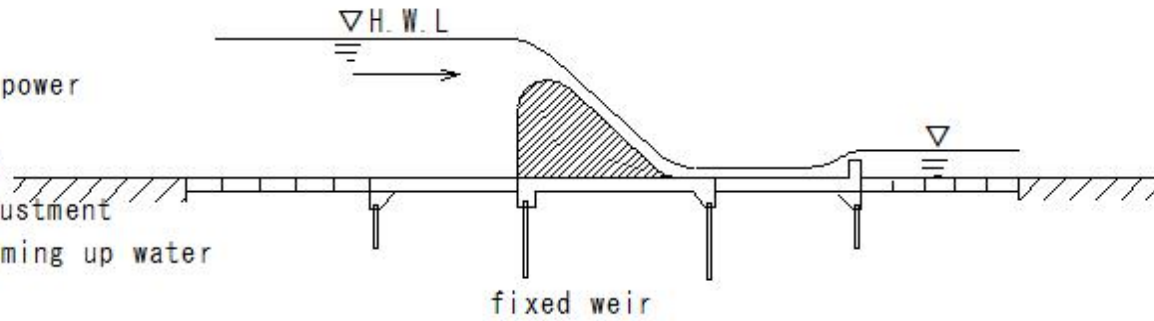
hydroelectric power

Water intake

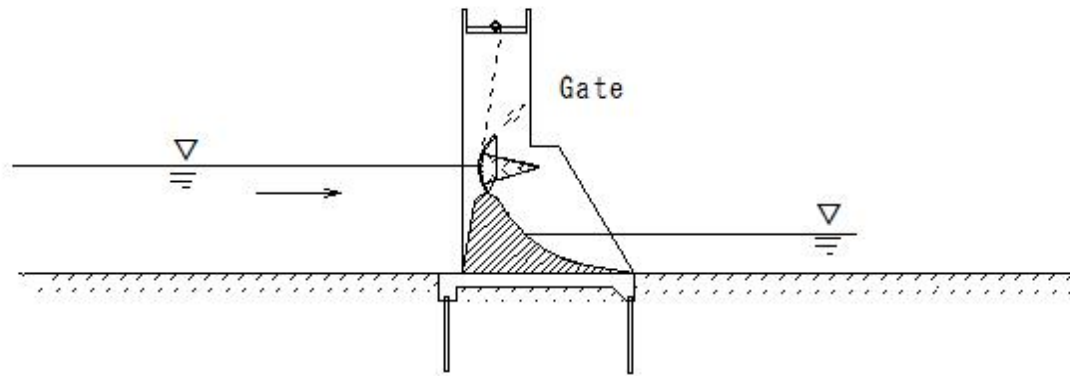
boat transport

high water adjustment

Waterway - damming up water



fixed weir



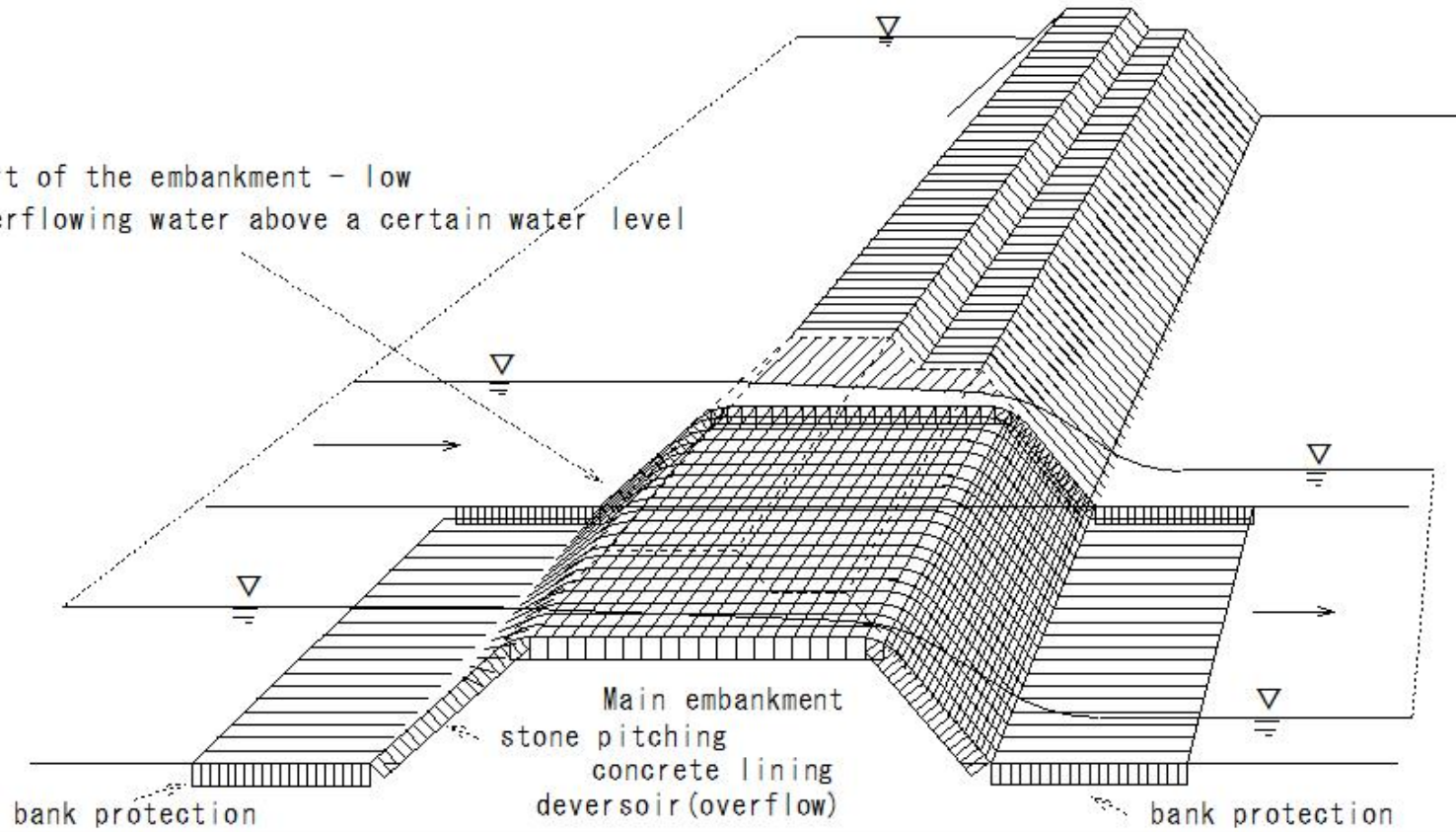
Movable weir

(R303)deversoir(overflow)

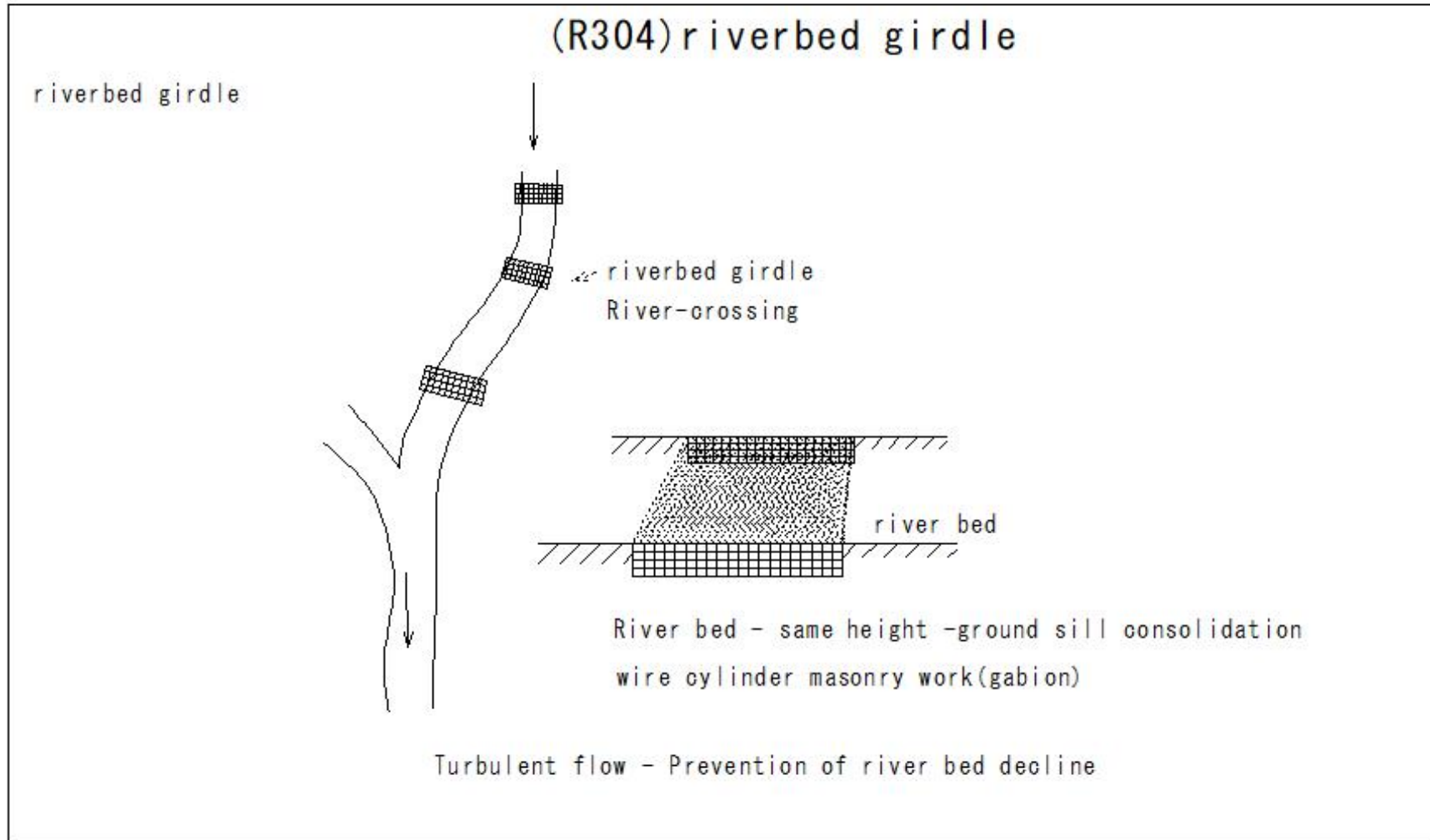
(R303) deversoir (overflow)

deversoir (overflow)

Part of the embankment - low
Overflowing water above a certain water level

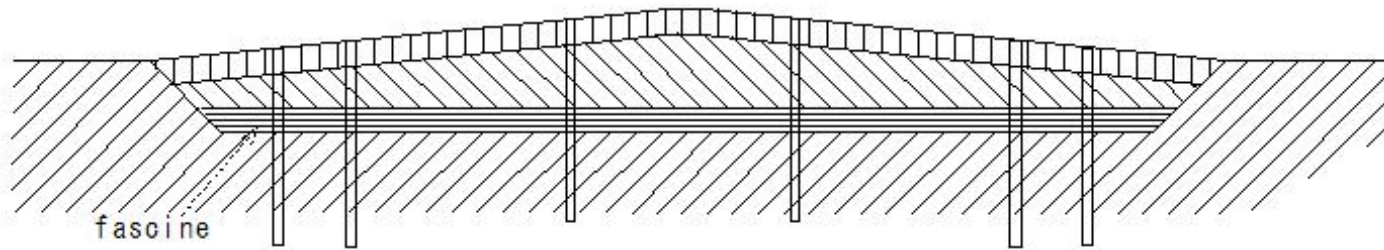
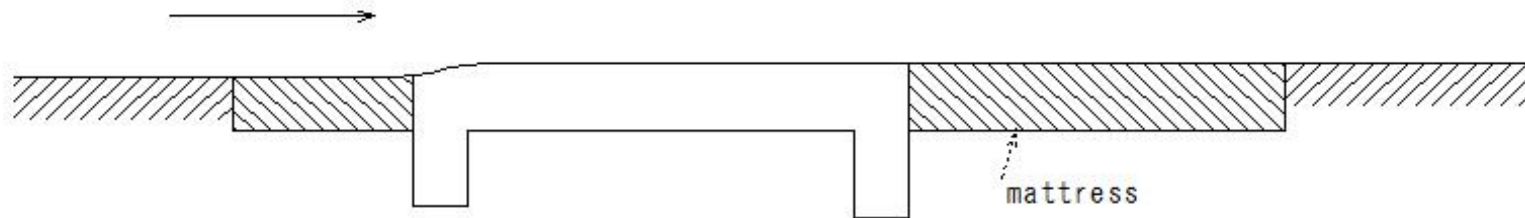


(R304)riverbed girdle



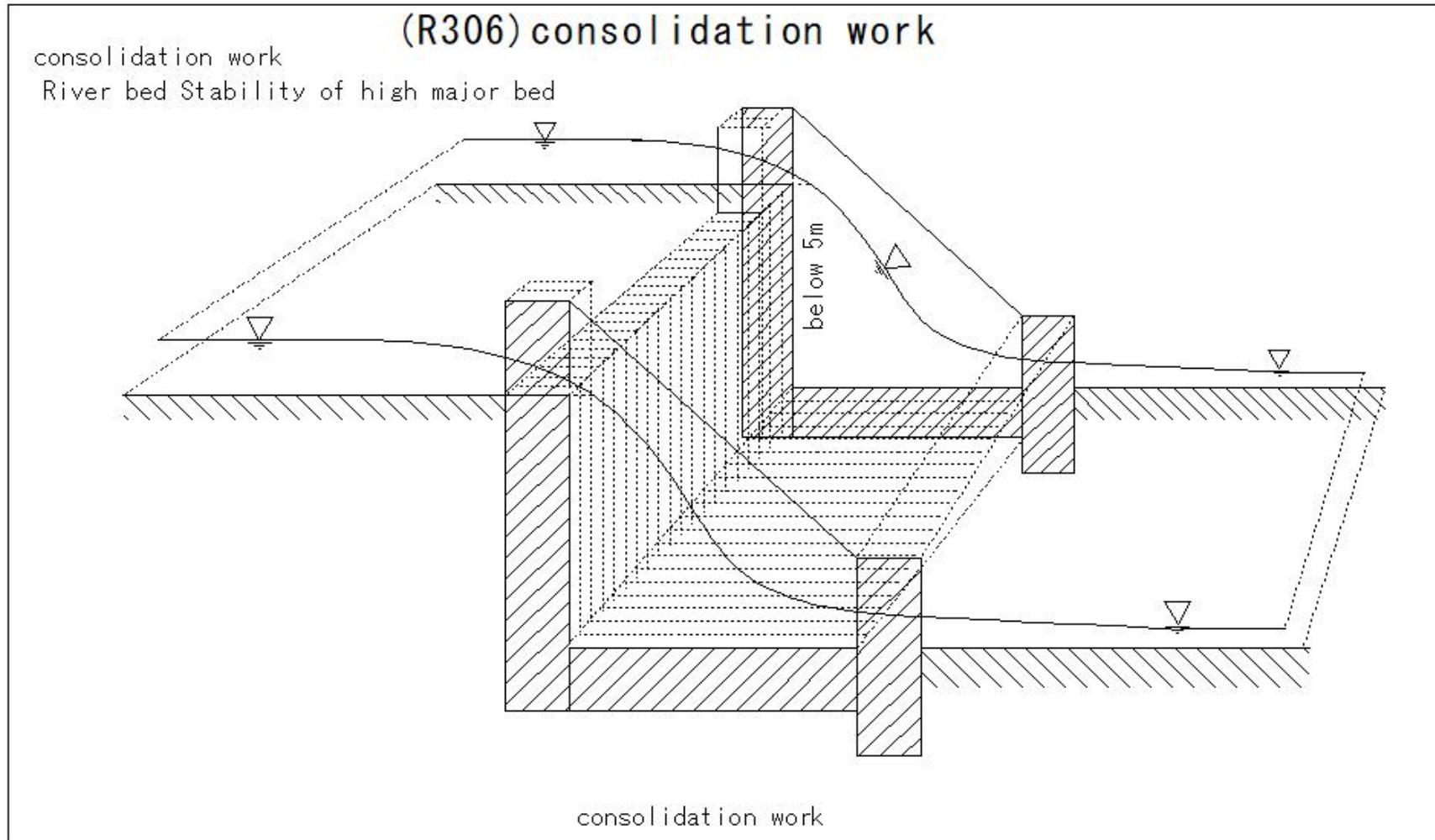
(R305) consolidation works

consolidation work
River bed Stability
river crossing

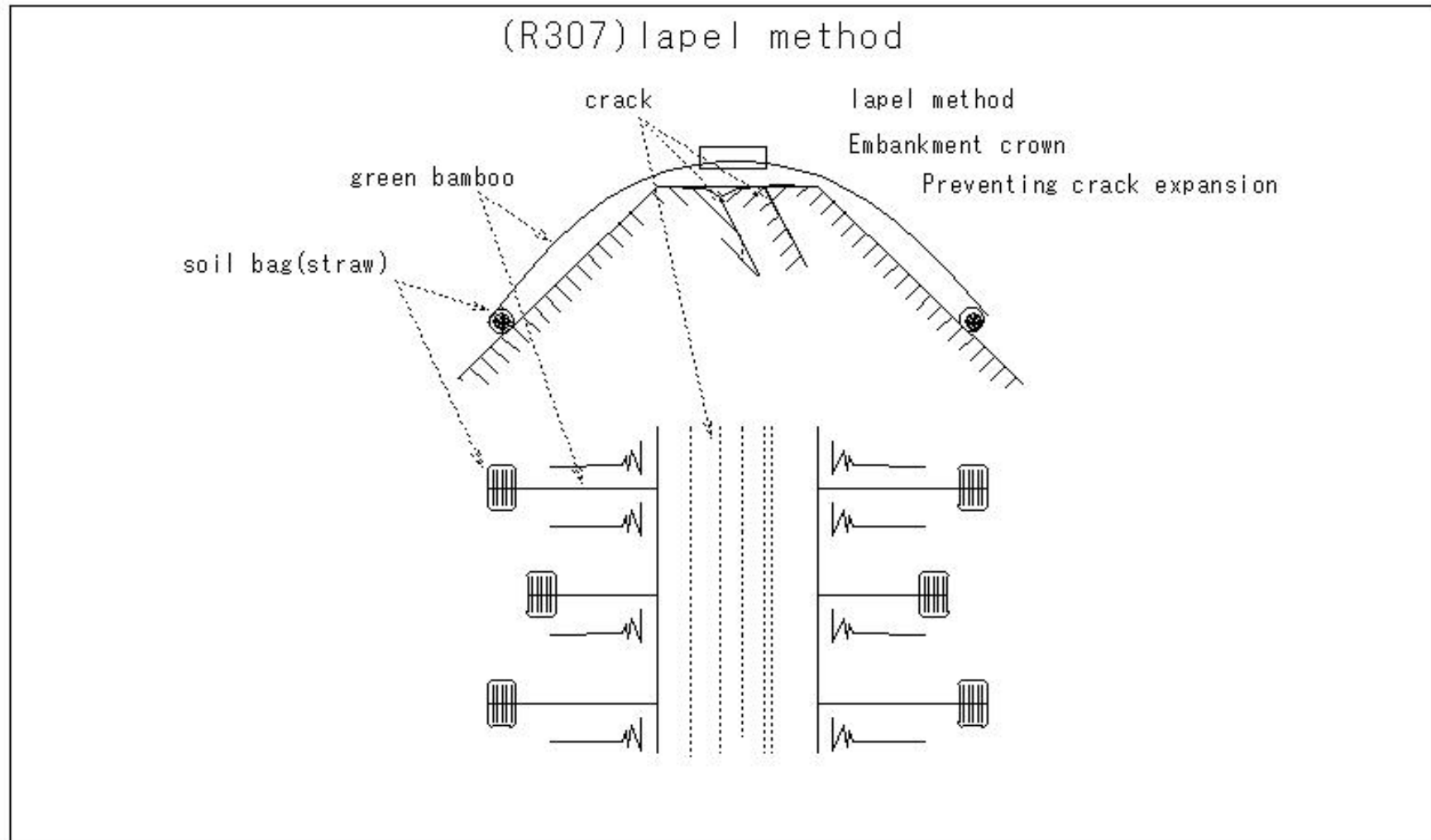


consolidation work

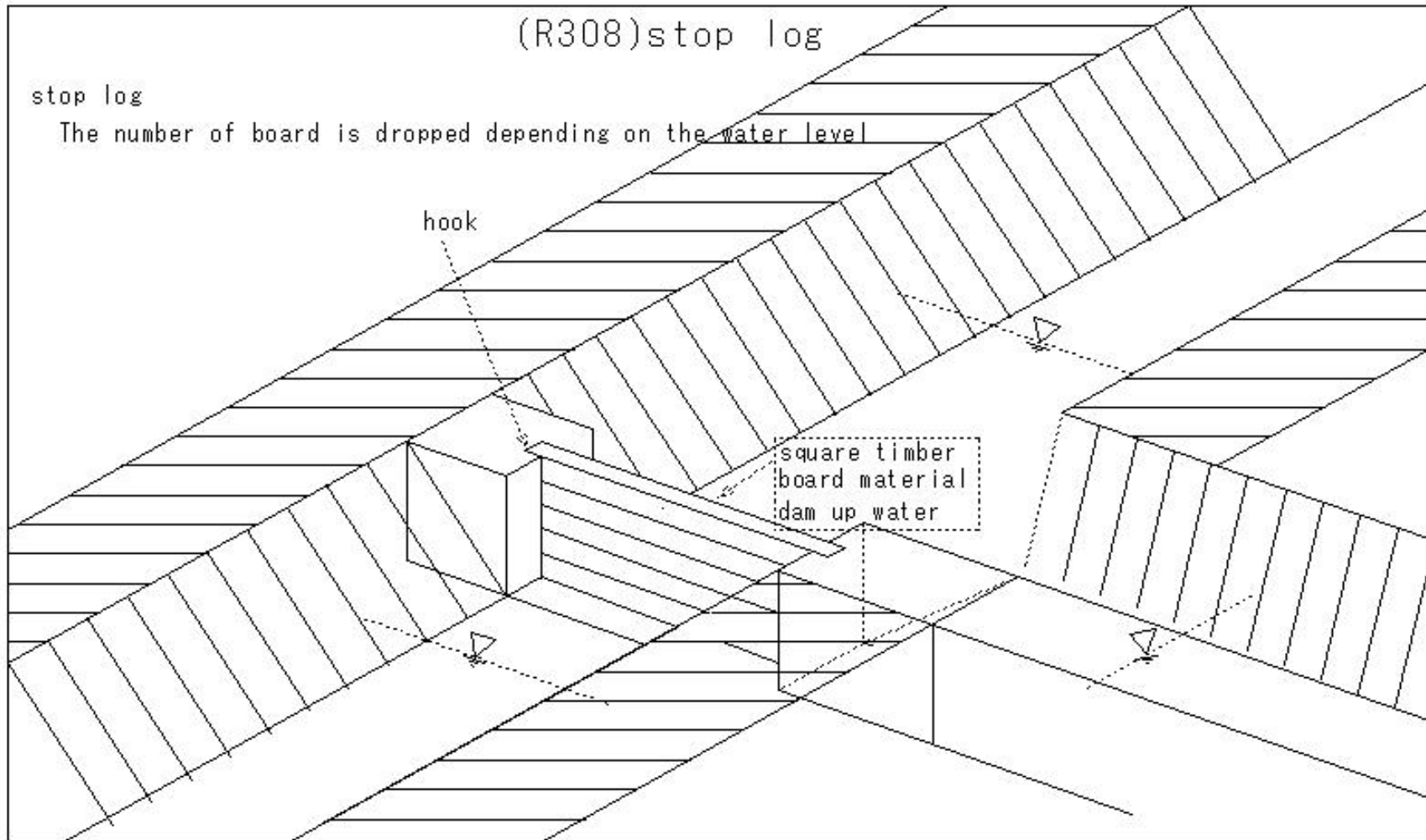
(R306)consolidation work



(R307)lapel method



(R308)stop log



(R309)estuary improvement

(R309) estuary improvement

sand control

Near the river mouth

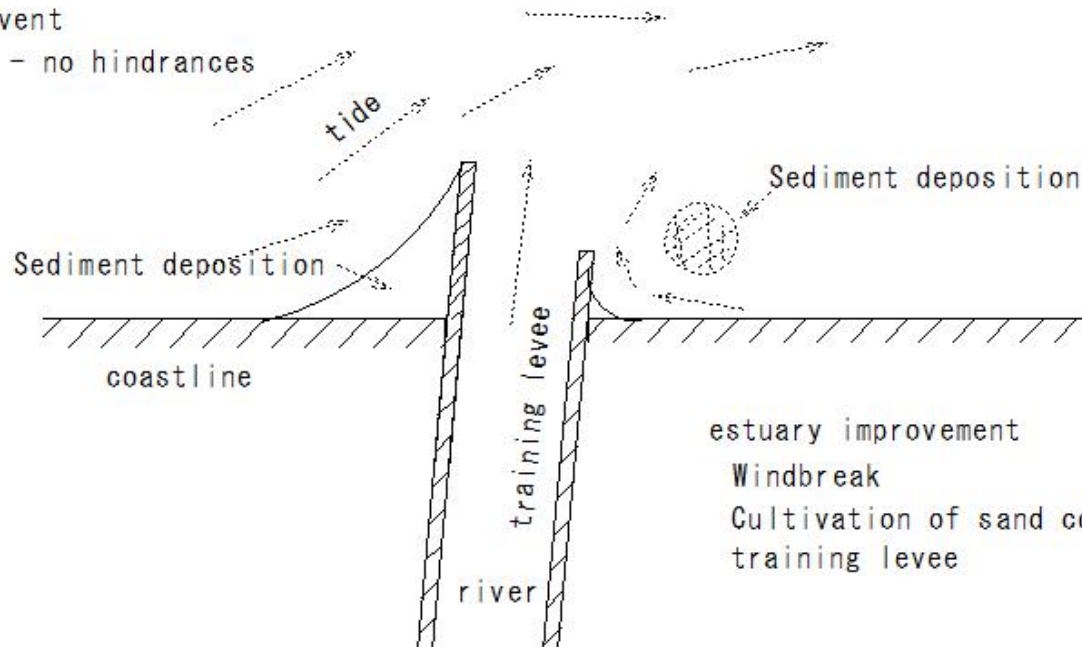
river quicksand

drifting sand on the coast

flying sand

Blockage - prevent

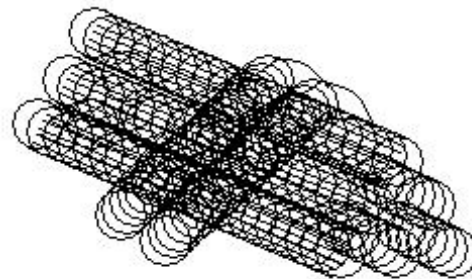
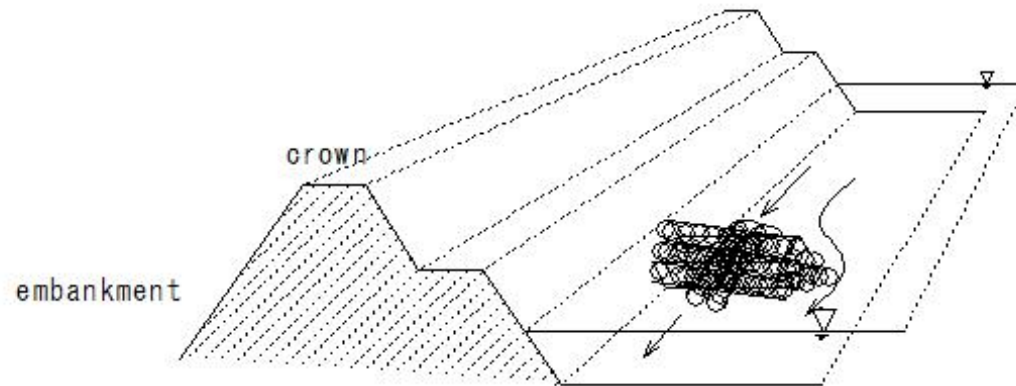
ship transport - no hindrances



(R310)Semi-permeable groin -wire cylinder masonry work(gabion)

(R310)Semi-permeable groin -wire cylinder masonry work(gabion)

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



Semi-permeable groin
wire cylinder masonry work(gabion)

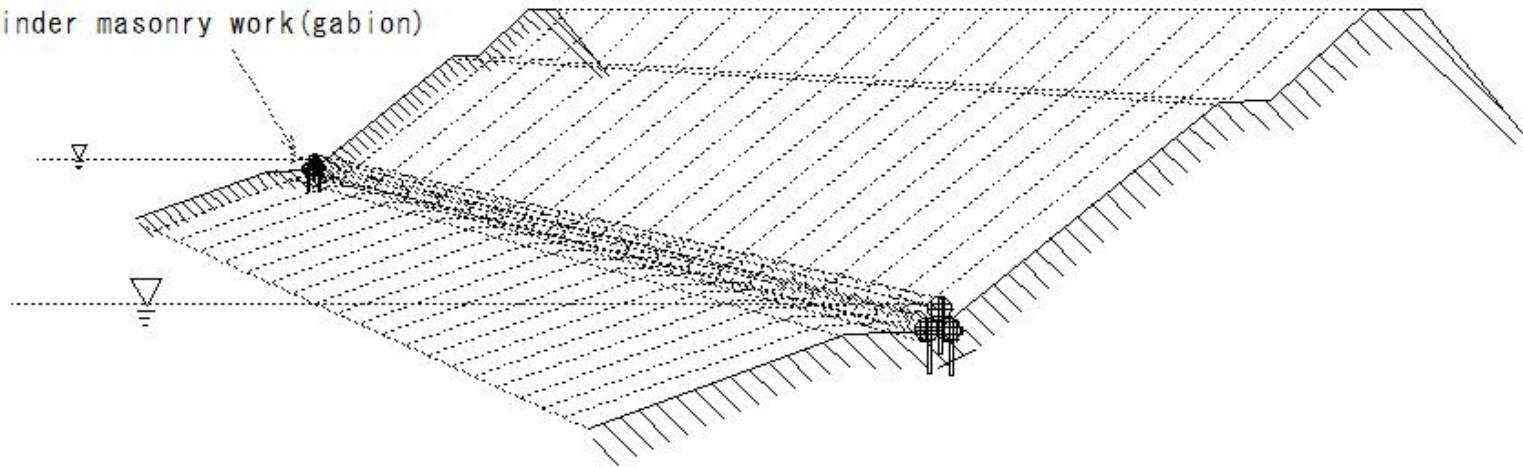
(R311)Semi-permeable groin -wire cylinder masonry work(gabion)

(R311) Semi-permeable groin -wire cylinder masonry work(gabion)

Semi-permeable groin -slope foot protection

slope foot protection

wire cylinder masonry work(gabion)

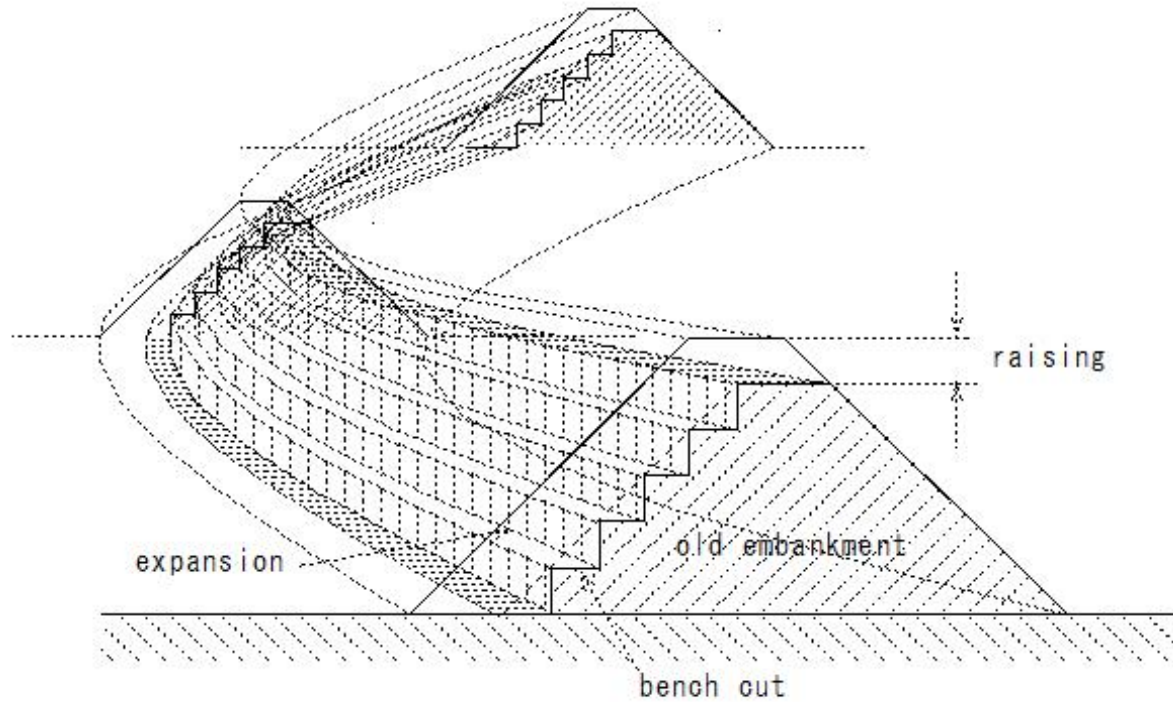


(R312)embankment(raising)

(R312) embankment (raising)

raising

Embankment crown increases



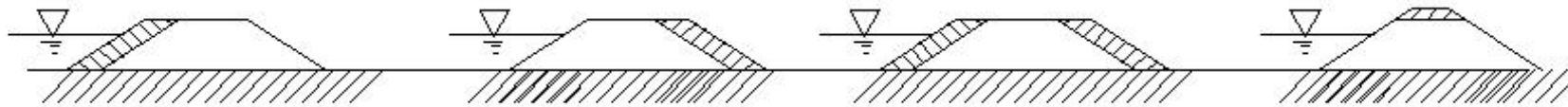
(R313)embankment(raising)

(R313) embankment (raising)

Levee - High - Soft - Raised

Settling part - raising

levee widening



front

under

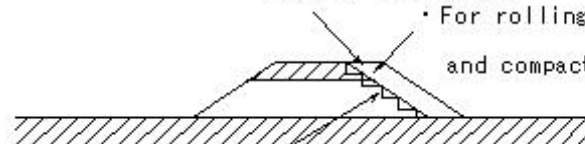
both sides attached

Raise

• Walling embankment to existing embankment

• Walling embankment

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



• Step cutting - adhesion

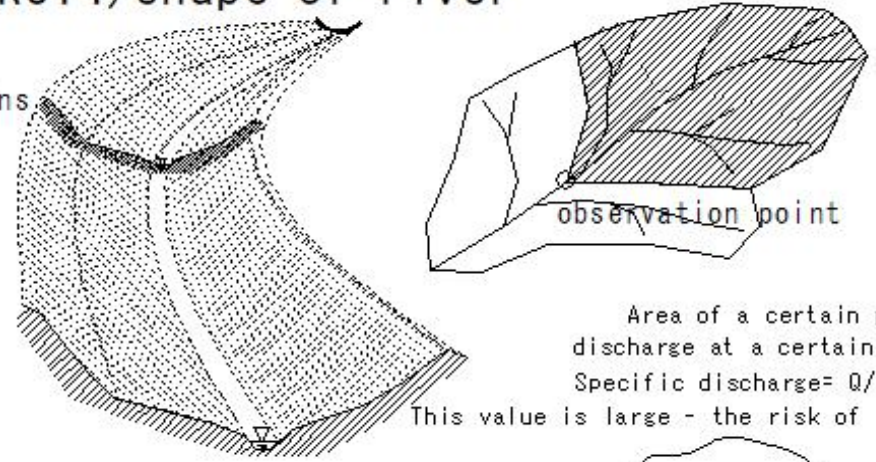
• Soft ground - whole embankment - Settlement

(R314)shape of river

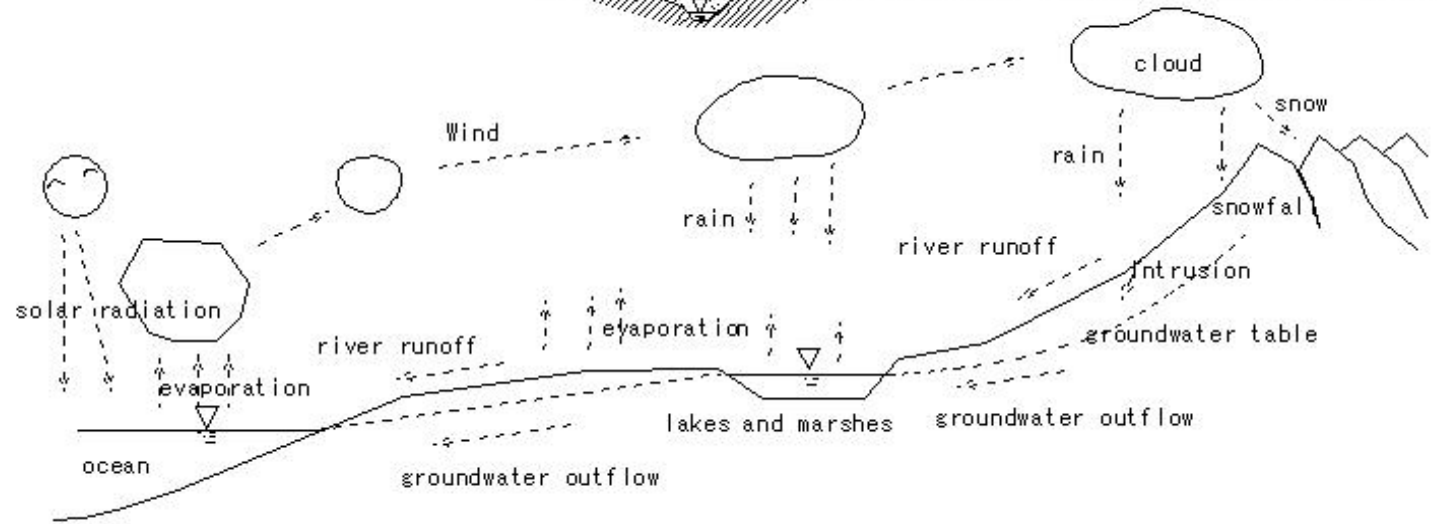
(R314) shape of river

shape of river

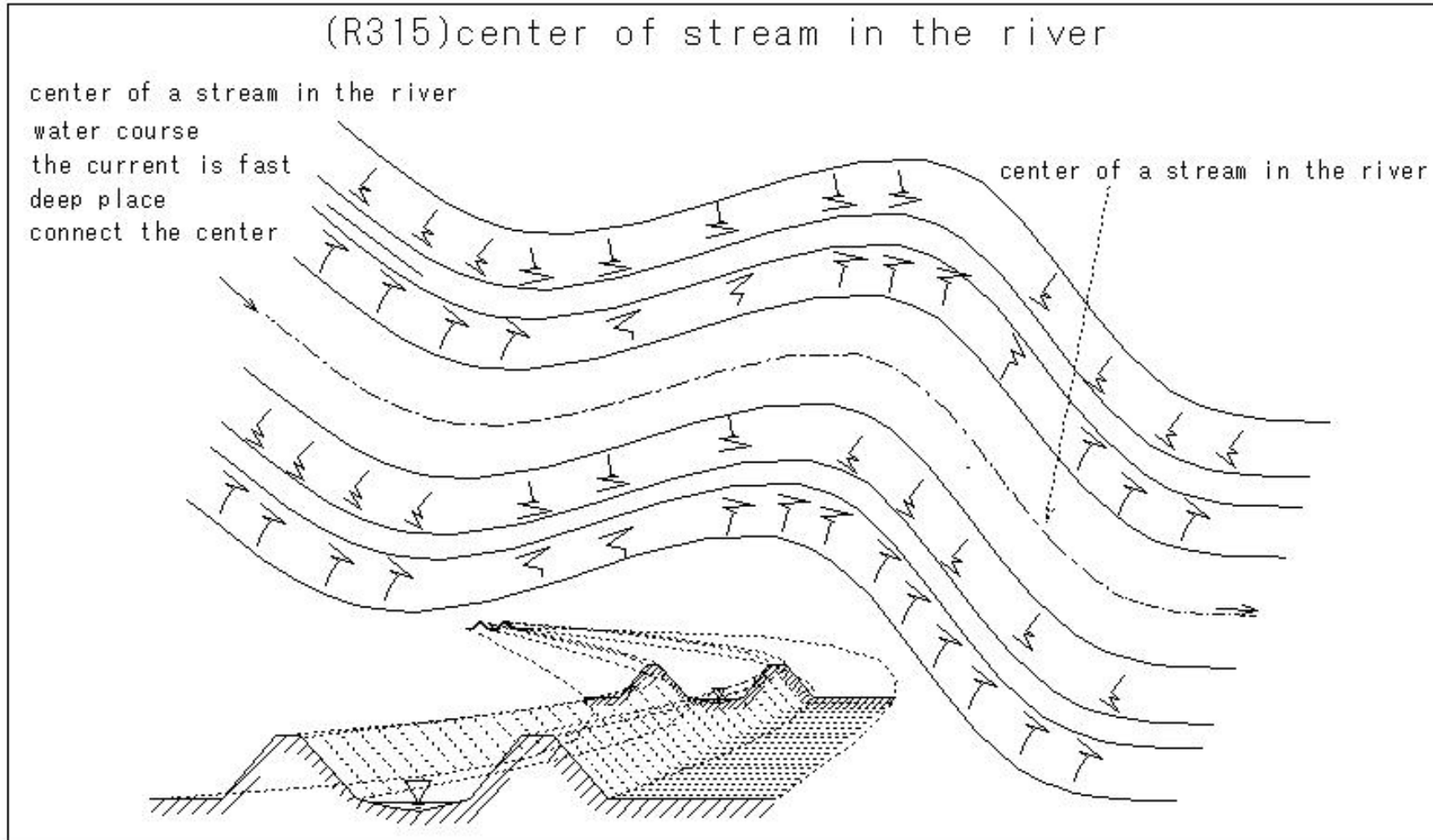
Runoff condition in river basins



Area of a certain point: A
discharge at a certain point: Q
Specific discharge = Q/A
This value is large - the risk of flooding is large



(R315)center of a stream in the river



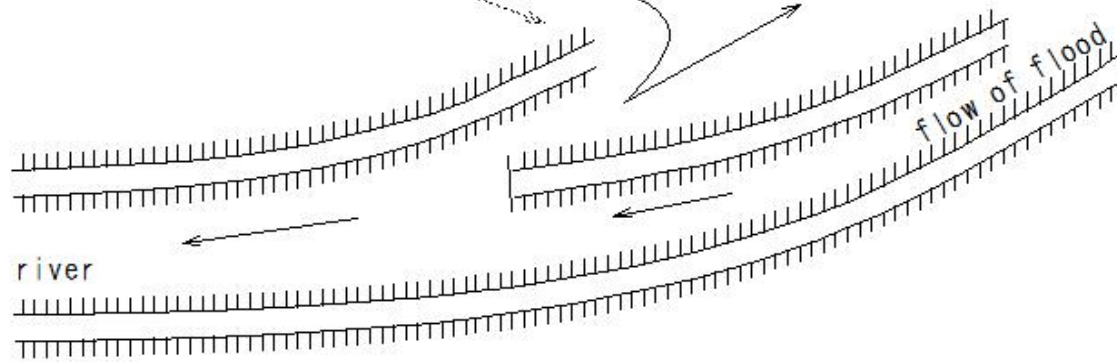
(R316)open levee

(R316) open levee

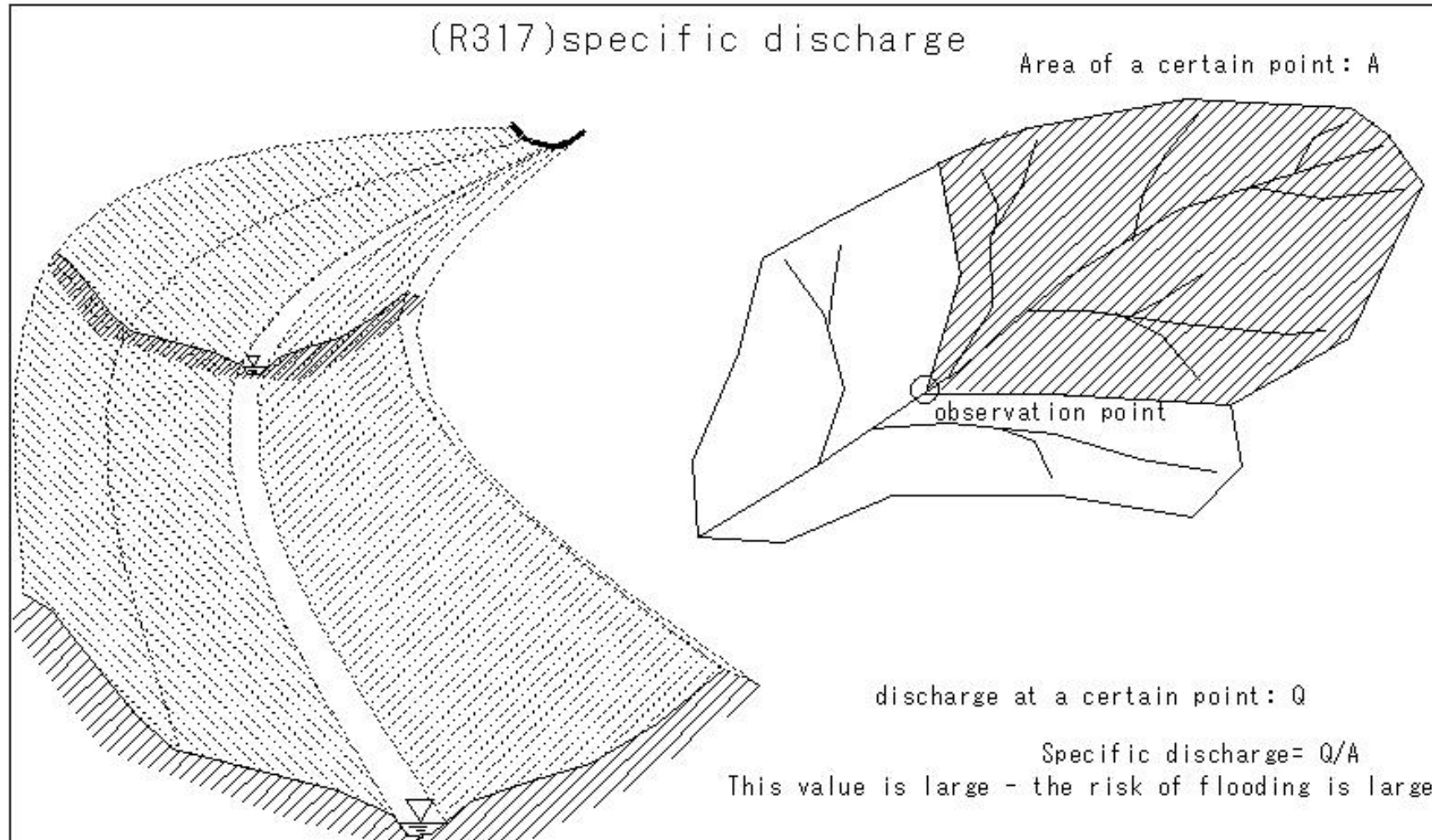
Prevention of damage from flood

open levee

Inland area



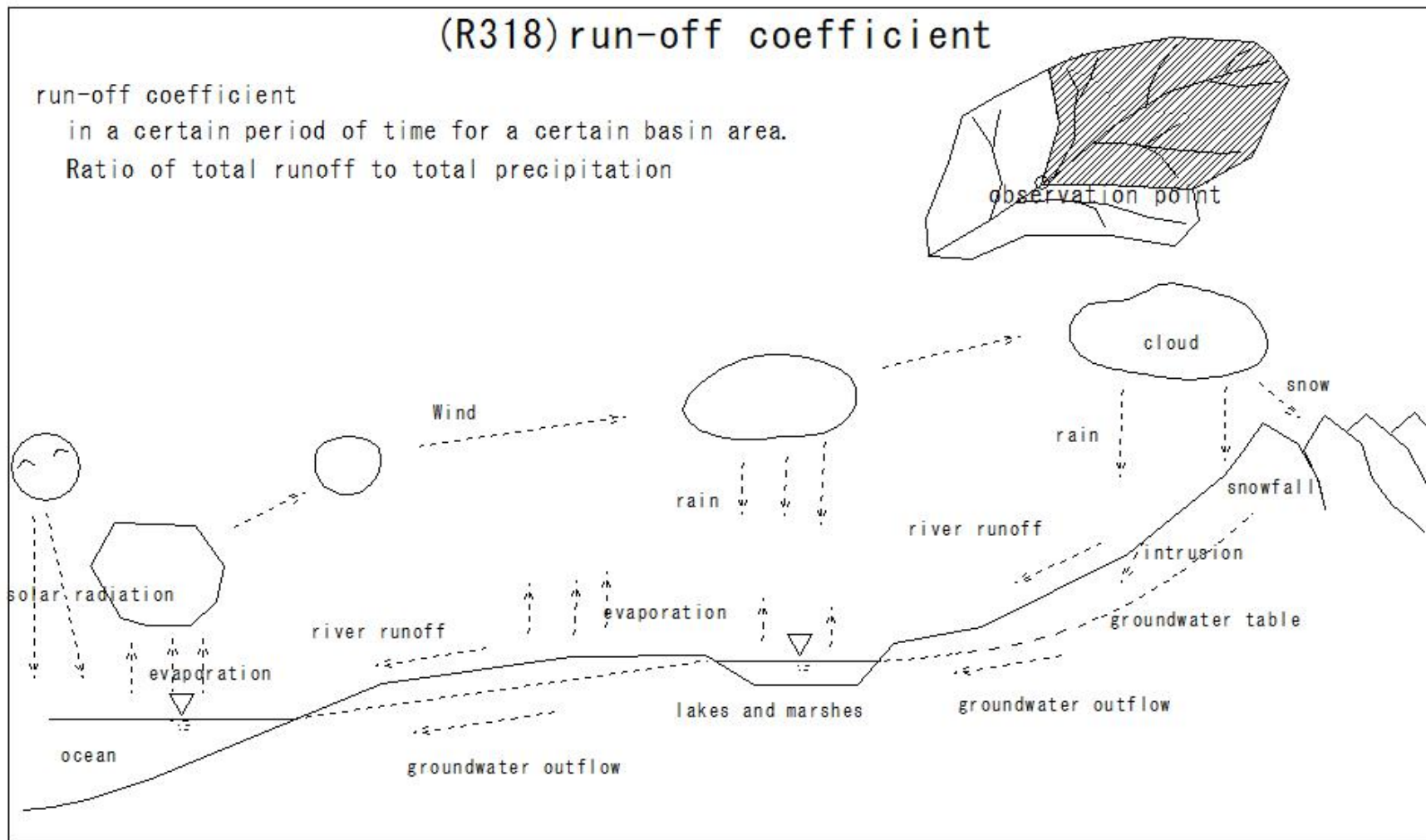
(R317)specific discharge



(R318)run-off coefficient

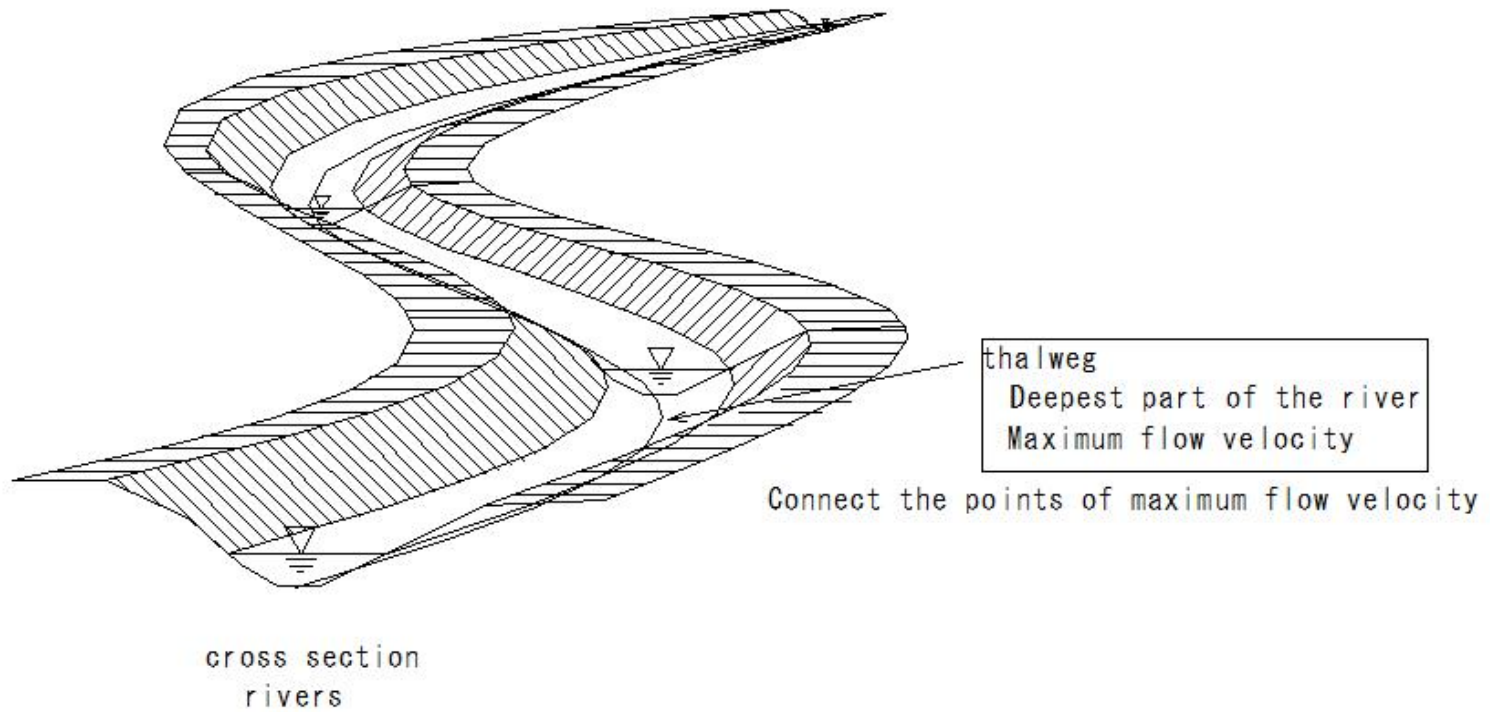
(R318)run-off coefficient

run-off coefficient
in a certain period of time for a certain basin area.
Ratio of total runoff to total precipitation



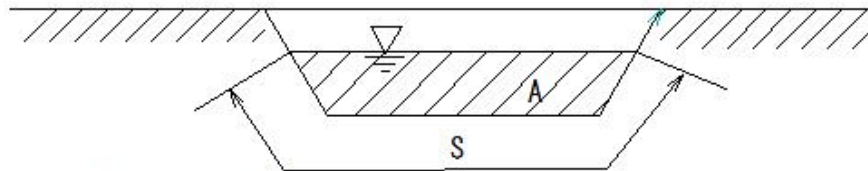
(R319)thalweg

(R319) thalweg



(R320)cross sectional area of stream

(R320)cross sectional area of stream



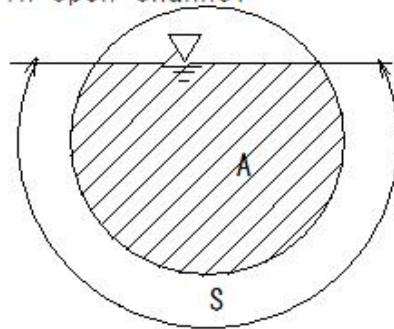
cross sectional area of stream

Channel cross section

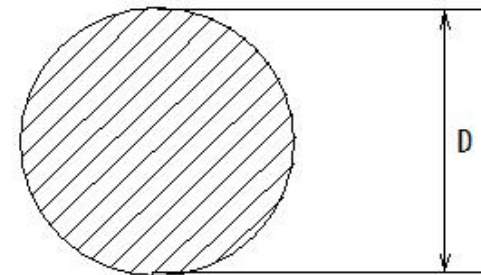
Area : water actually flows

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

(R321)stream line

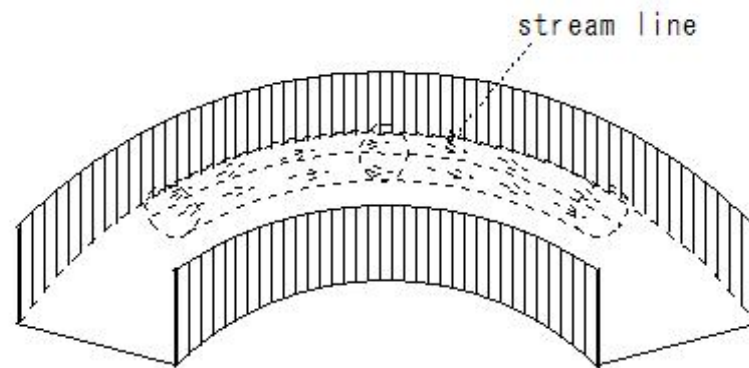
(R321)stream line

stream line

steady flow

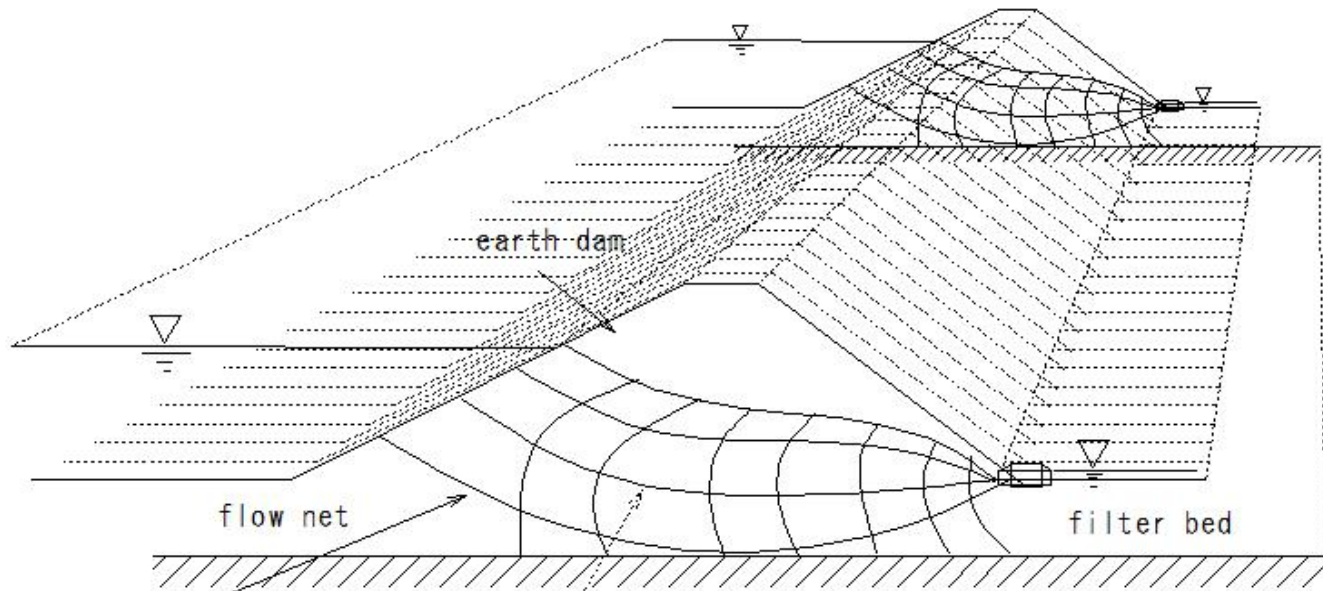
Water particles - moving path

direction of flow



(R322)flow net

(R322) flow net



flow(Streamline): Migration path of water particles

Impermeable layer

Equipotential: equal points in the head of the water

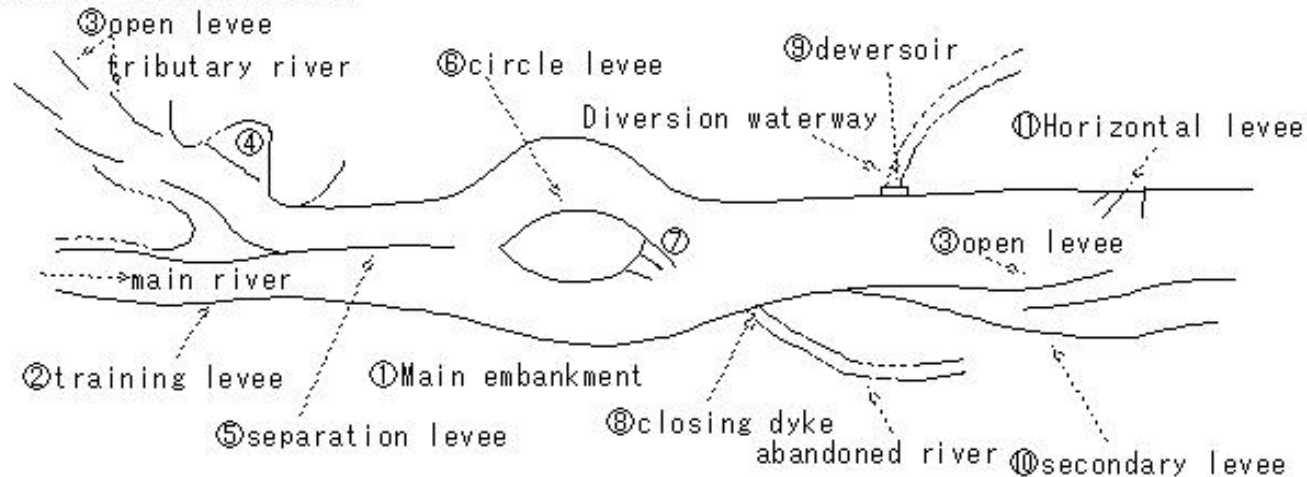
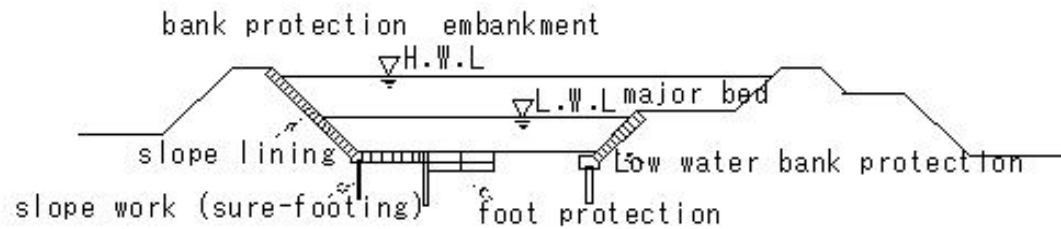
(R323)river works

river works

(R323)river works

- High water construction
- River channel repair work
- Bank protection/groin
- Water control work
- diversion channel
- Spillway

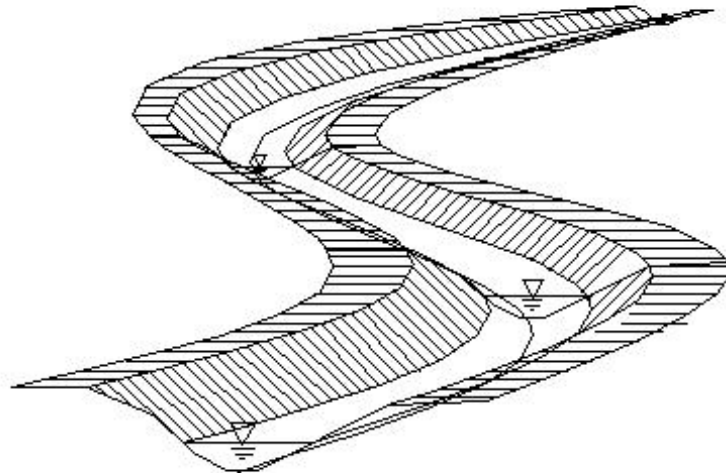
- low water construction
- Construction work to make it easier to use for irrigation and boat transportation



(R324)equilibrated grade of river

(R324) equilibrated grade of river

equilibrated grade of river



equilibrated grade of river

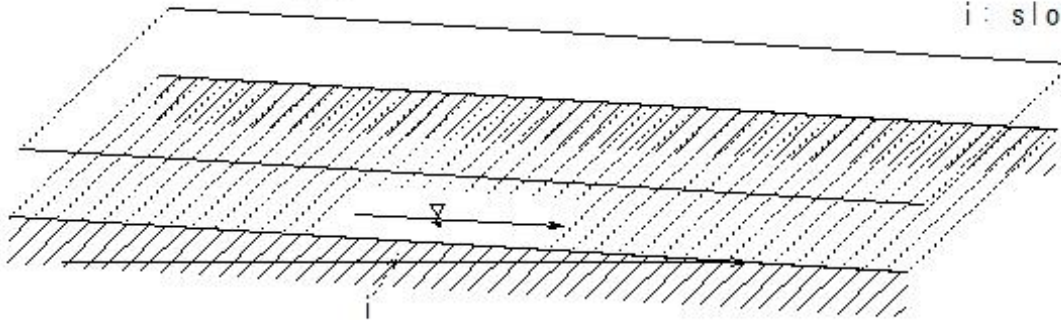
$$v=C\sqrt{Ri}$$

v: flow velocity

C: runoff coefficient

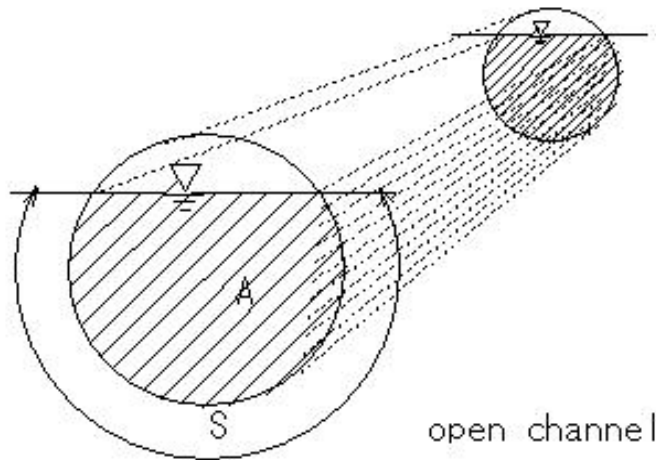
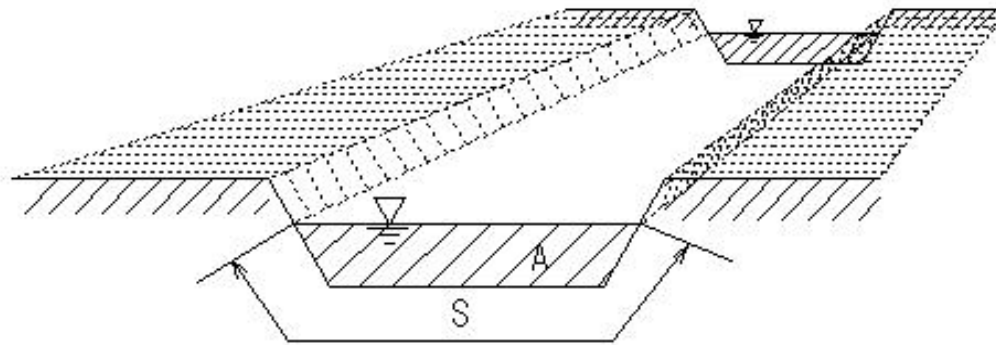
R: hydraulic radius

i: slope of river bed

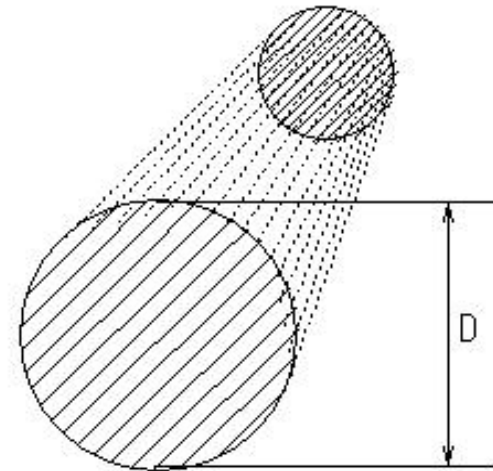


(R325)equilibrated grade of river

(R325)equilibrated grade of river



open channel



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

pipeline

Cross-sectional area of flow: A

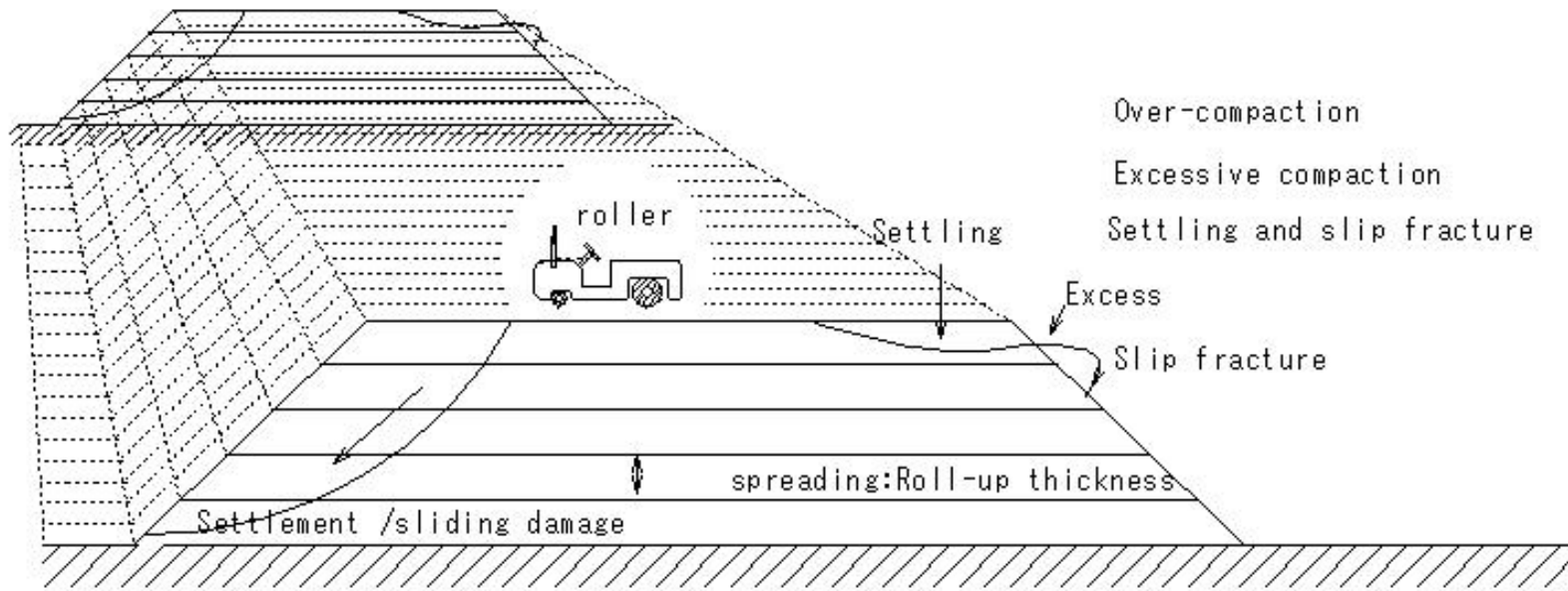
Hydraulic radius: R

$$R = A/S$$

Wetted perimeter: S

(R326)embankment(over compaction)

(R326)embankment(over compaction)



Over-compaction
Excessive compaction
Settling and slip fracture
Excess
Slip fracture

spreading:Roll-up thickness

Settlement /sliding damage

embankment

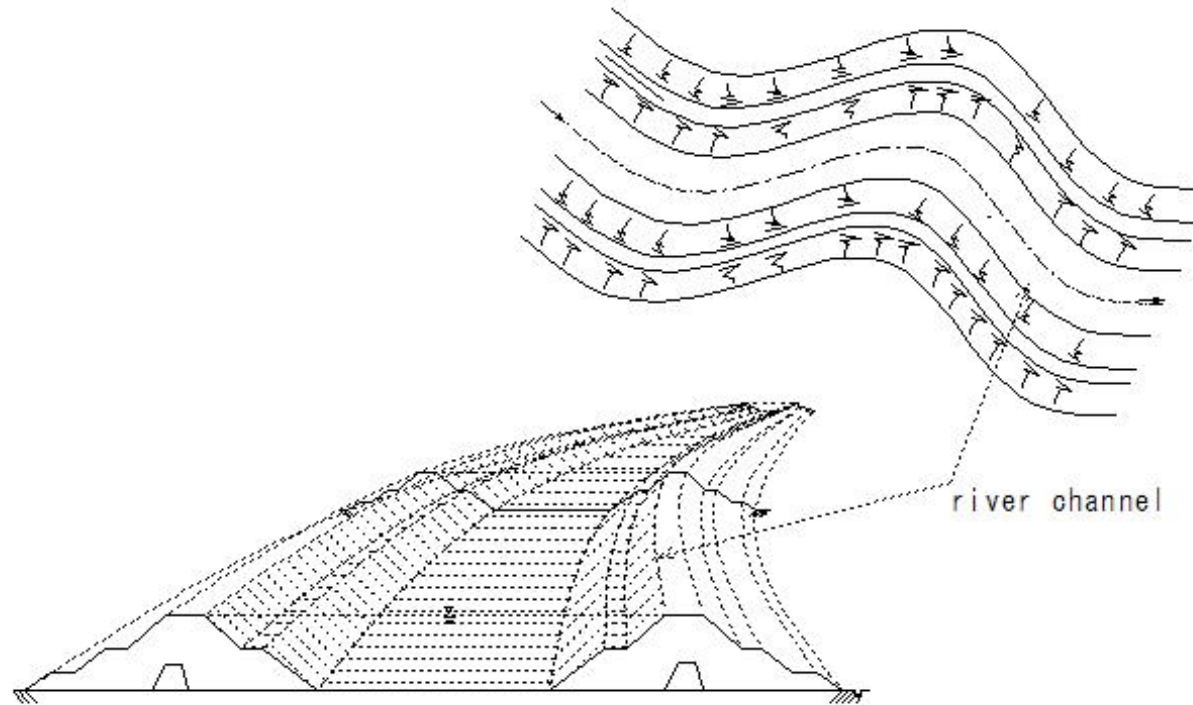
- Cause of over-rolling pressure
- ①High water content
 - ②Rolling machine - unsuitable
 - ③Number of rolling compactions - too many
 - ④Thickness of rolling out - small

(R327)river channel

(R327) river channel

river channel

water course through which river water flows



(R328)river channel improvement

(R328) river channel improvement

river channel improvement

Flood prevention

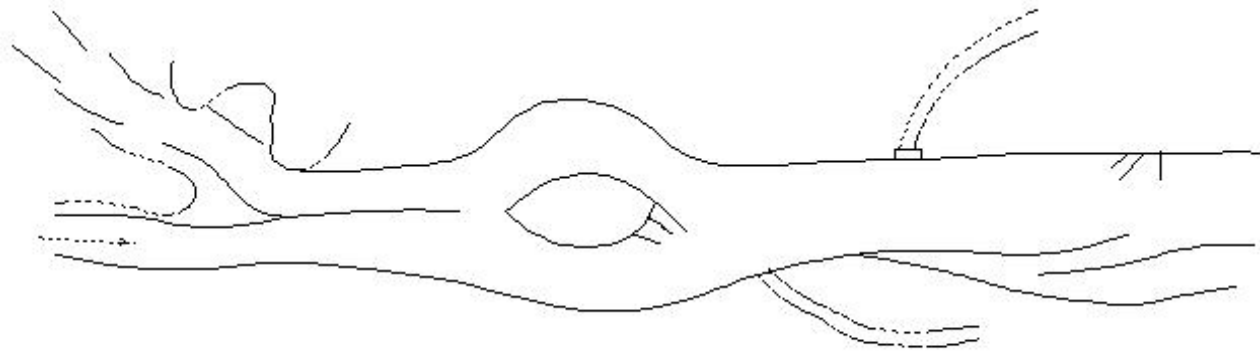
river channel improvement

High water construction

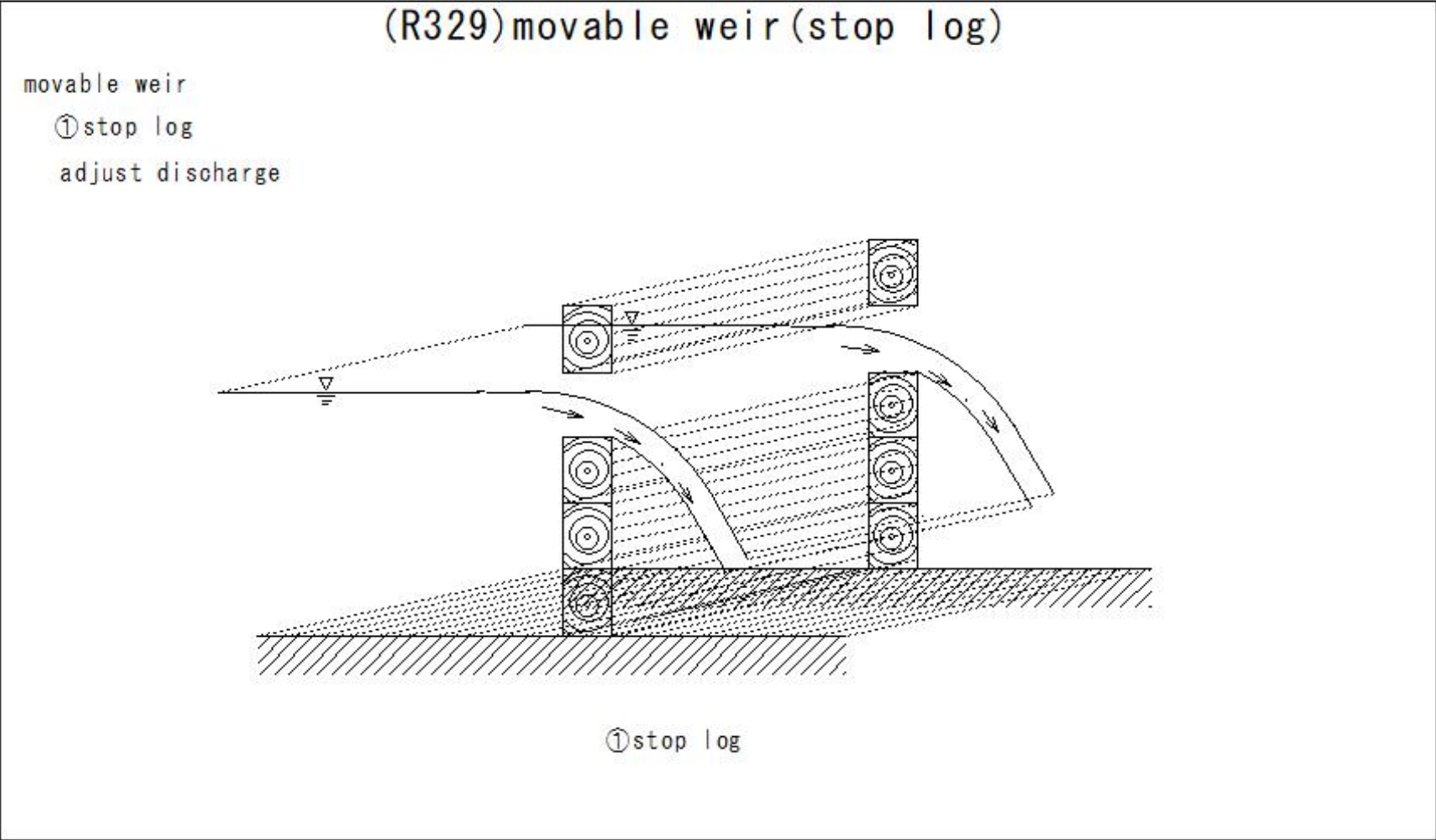
river channel improvement

High water control work

low water construction



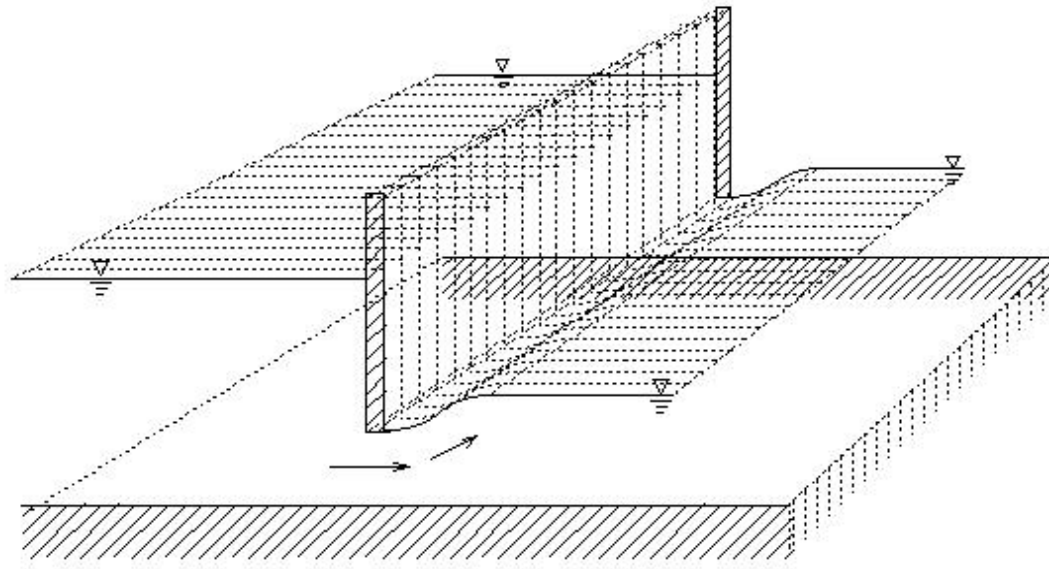
(R329)movable weir(stop log)



(R330)movable weir(Sluice gate)

(R330)movable weir (Sluice gate)

movable weir
adjust discharge

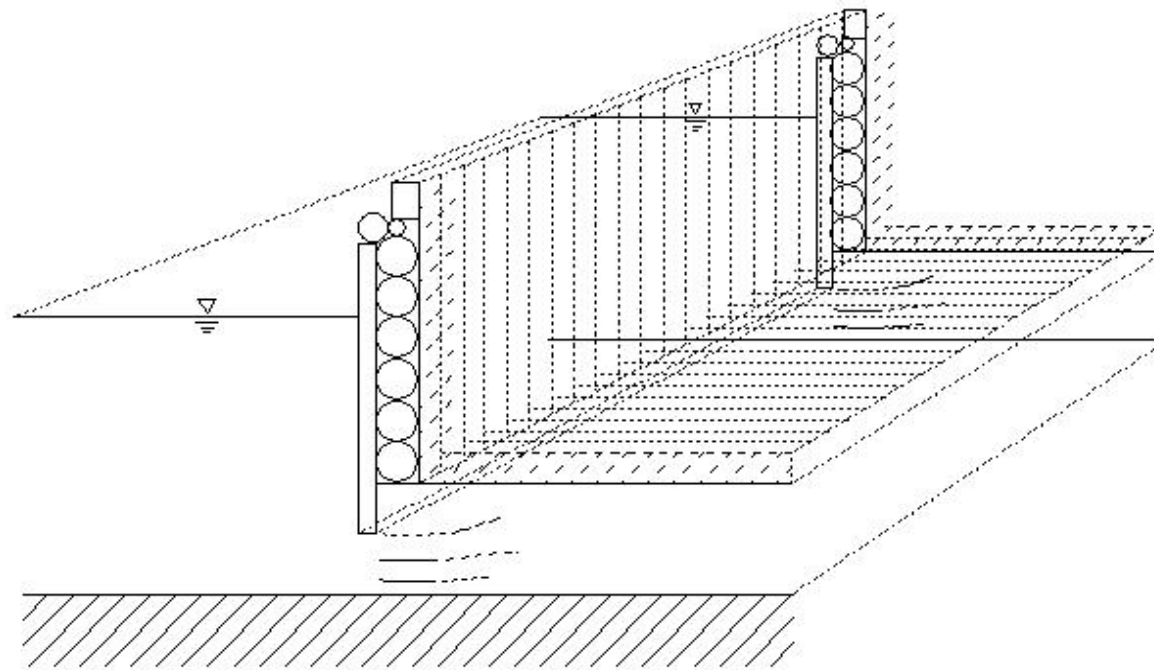


② Sluice gate

(R331)movable weir(Stoney Weir)

(R331)movable weir (Stoney Weir)

movable weir
adjust discharge
③ Stoney Weir

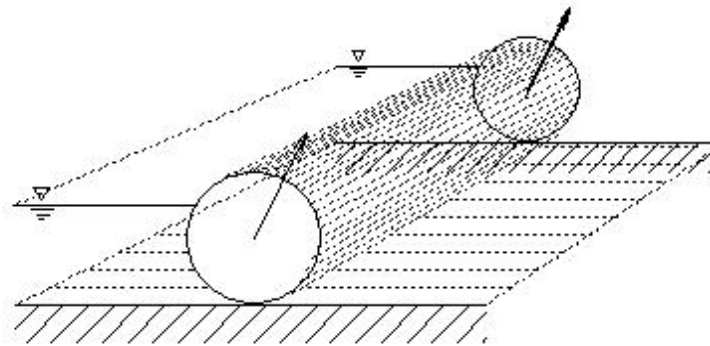


③ Stoney Weir

(R332)movable weir(Rolling gate)

(R332) movable weir (Rolling gate)

movable weir
adjust discharge
④Rolling gate
Don't let the water overflow



④Rolling gate

(R333)movable weir(Tentergate)

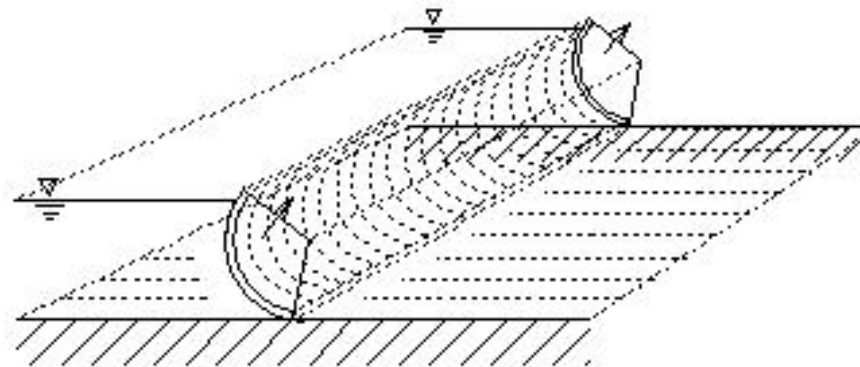
(R333)movable weir(Tentergate)

movable weir

adjust discharge

Don't let the water overflow

⑤Tentergate

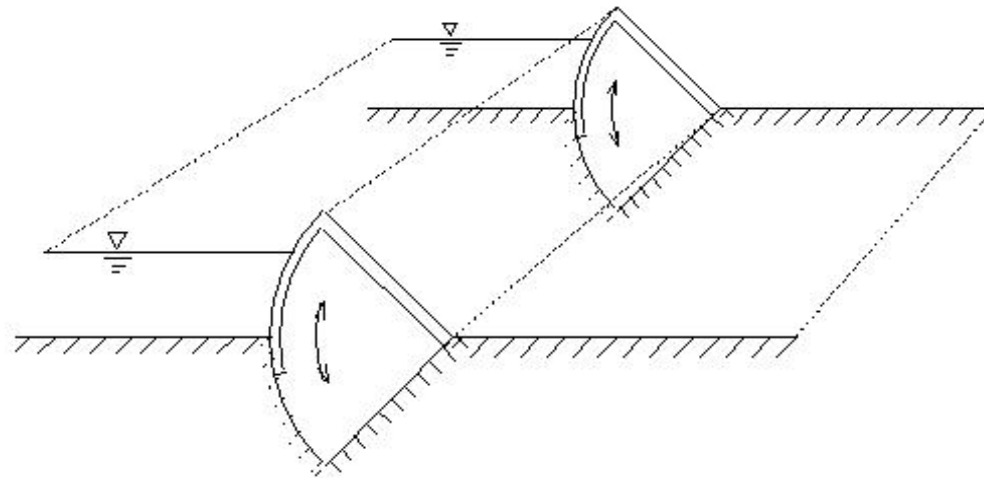


④Rolling gate

(R334)movable weir(Drum gate)

(R334)movable weir(Drum gate)

movable weir
adjust discharge
⑥ Drum gate



⑥ Drum gate

(R335)movable weir(Overturning weir)

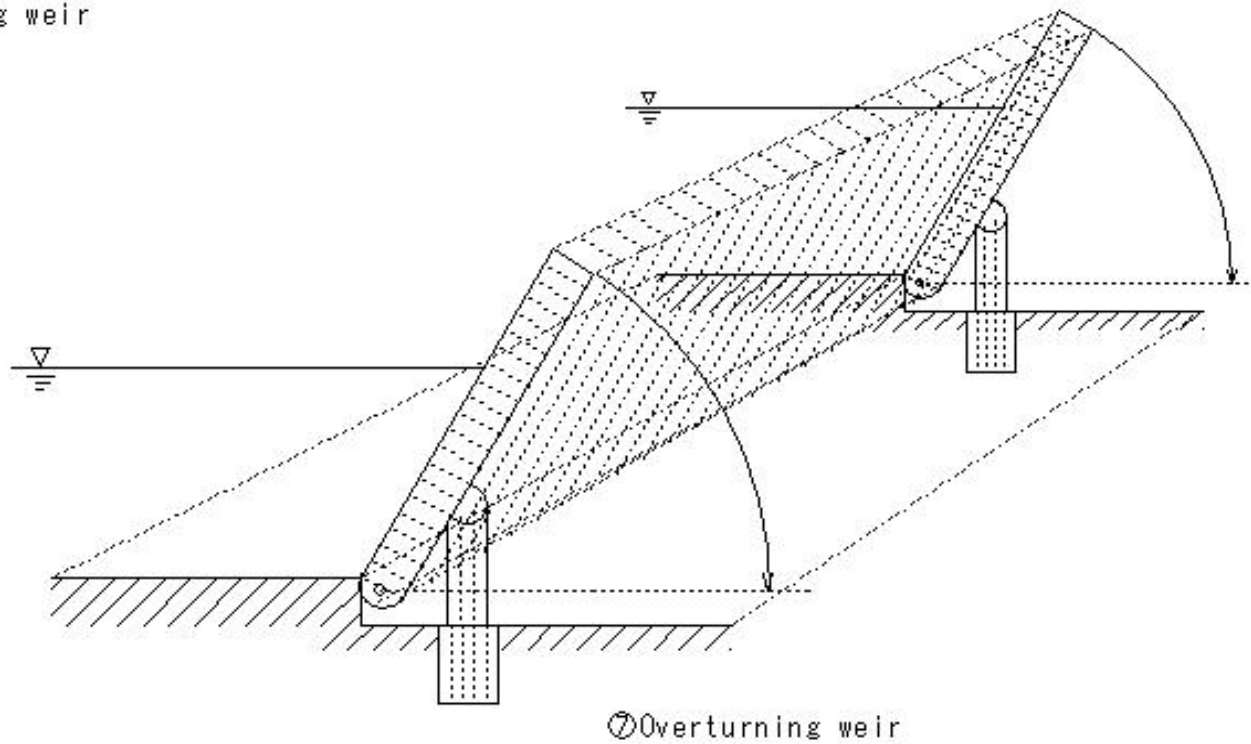
(R335)movable weir(Overturning weir)

movable weir

adjust discharge

Don't let the water overflow

⊙Overturning weir

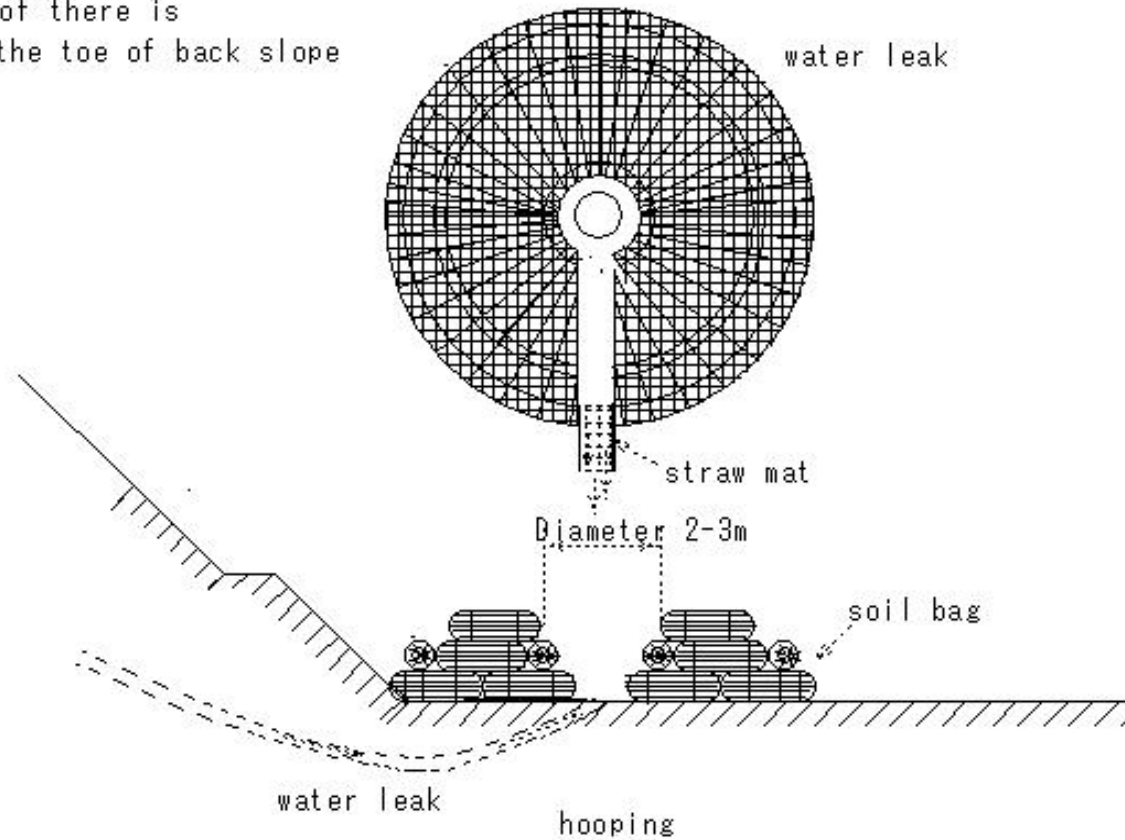


(R336)embankment-drainage method(hooping)

(R336)embankment-drainage method(hooping)

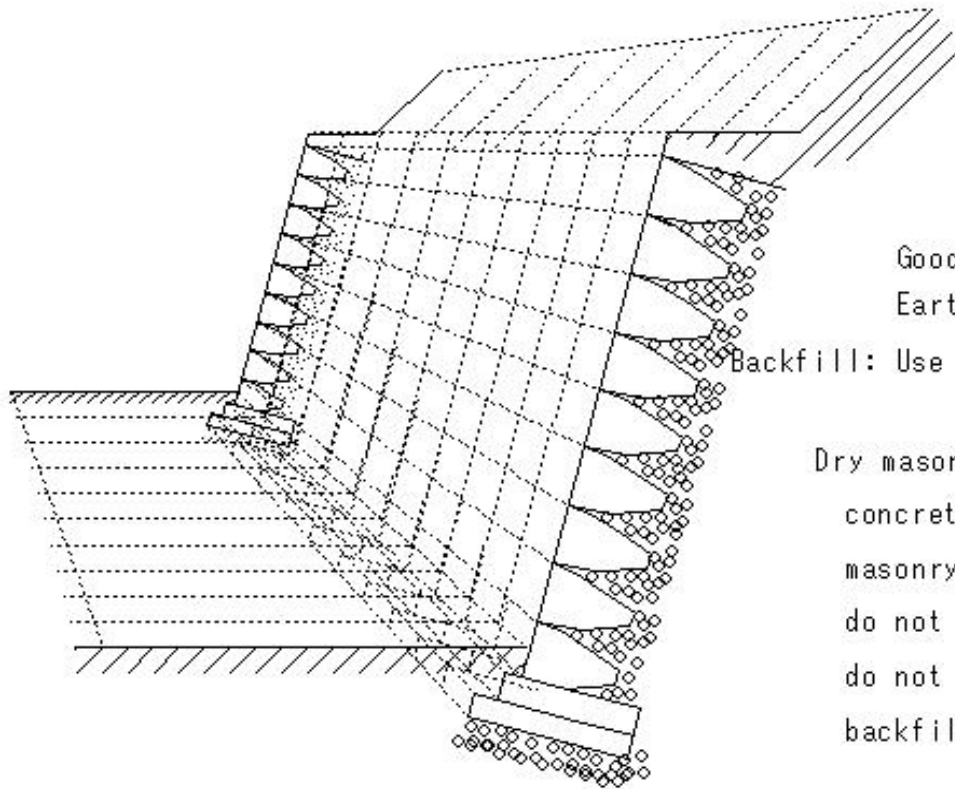
hooping

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



(R337)masonry (dry masonry)

(R337)masonry (dry masonry)



Good drainage

Earth pressure does not increase

Backfill: Use cobble stone instead of concrete

Dry masonry

concrete block

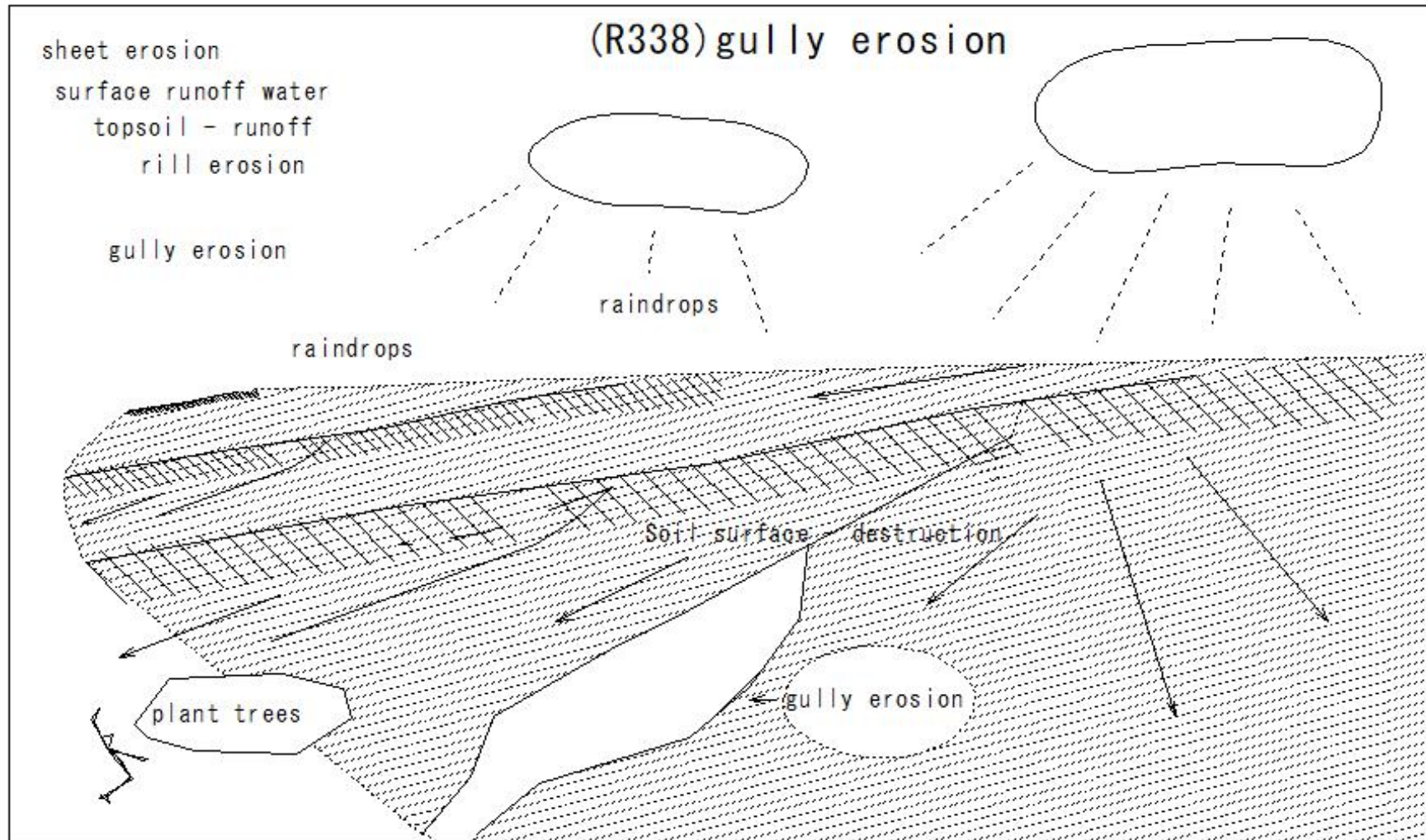
masonry

do not use mortar or concrete

do not use mortar for joints

backfill - cobblestone

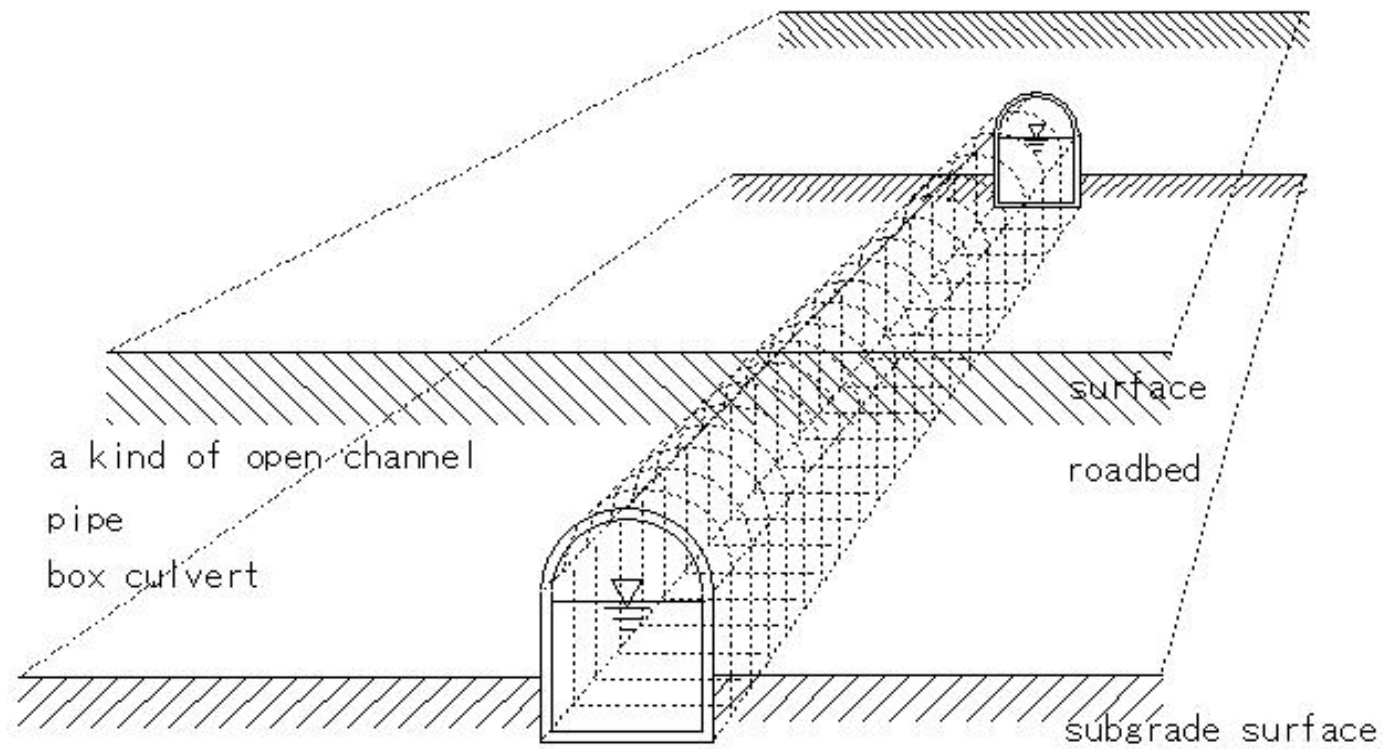
(R338)gully erosion



(R339)culvert

(R339)culvert

Culvert



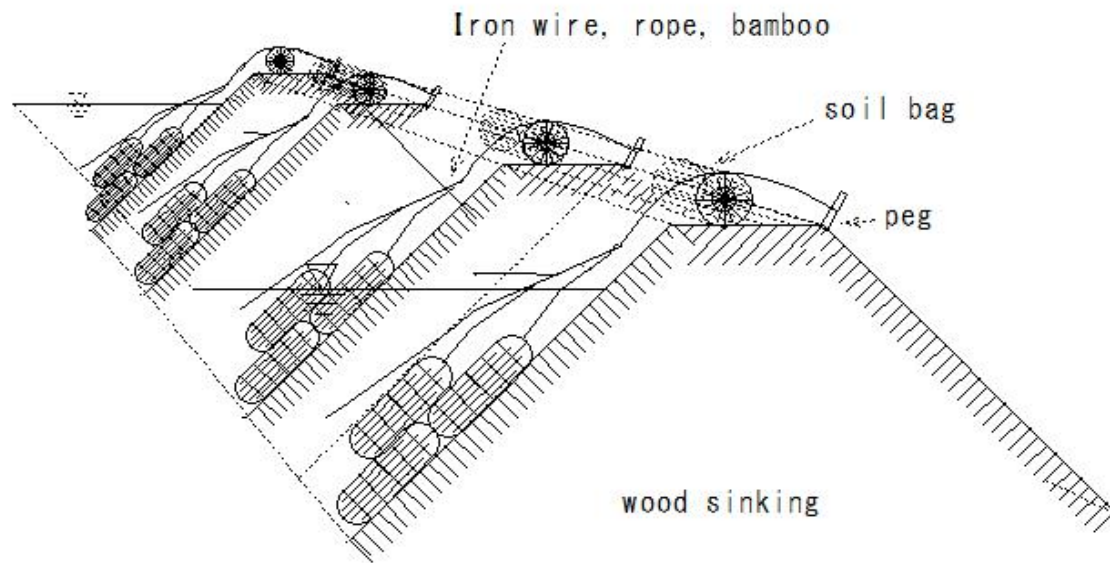
(R340)embankment (wood sinking)

(R340) embankment (wood sinking)

wood sinking

River embankment collapse prevention method

slope protection



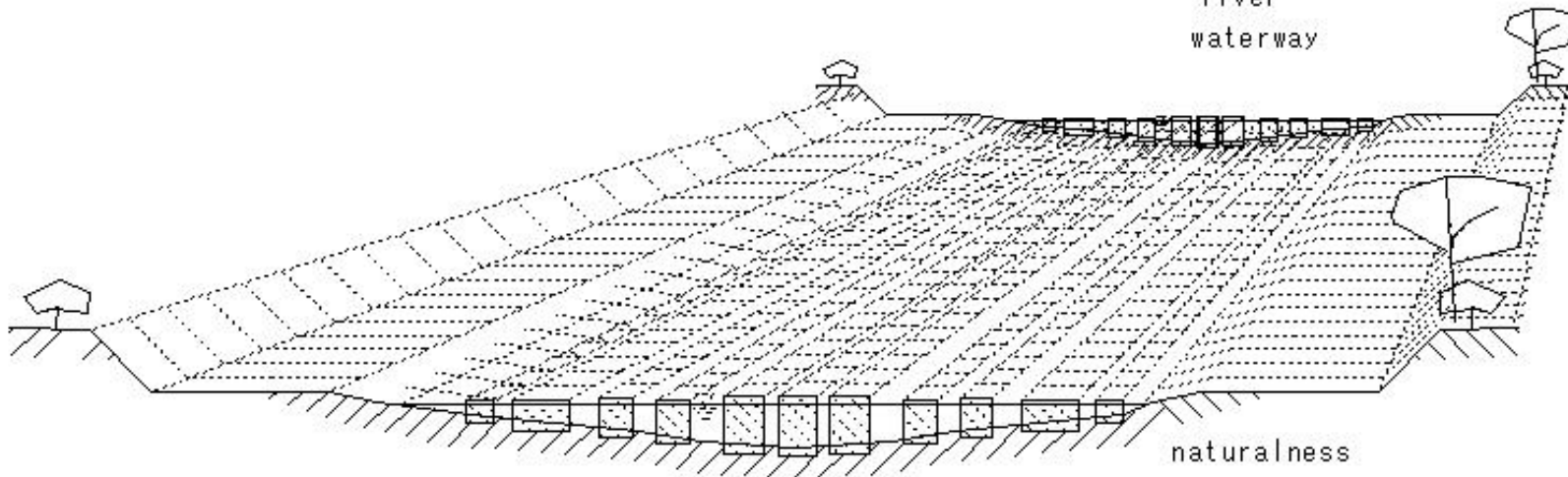
(R341)environment irrigation water

(R341)environment irrigation water

environment irrigation water

river
waterway

naturalness
hydrophilic
artificially drain water



(R342)reclamation in water area

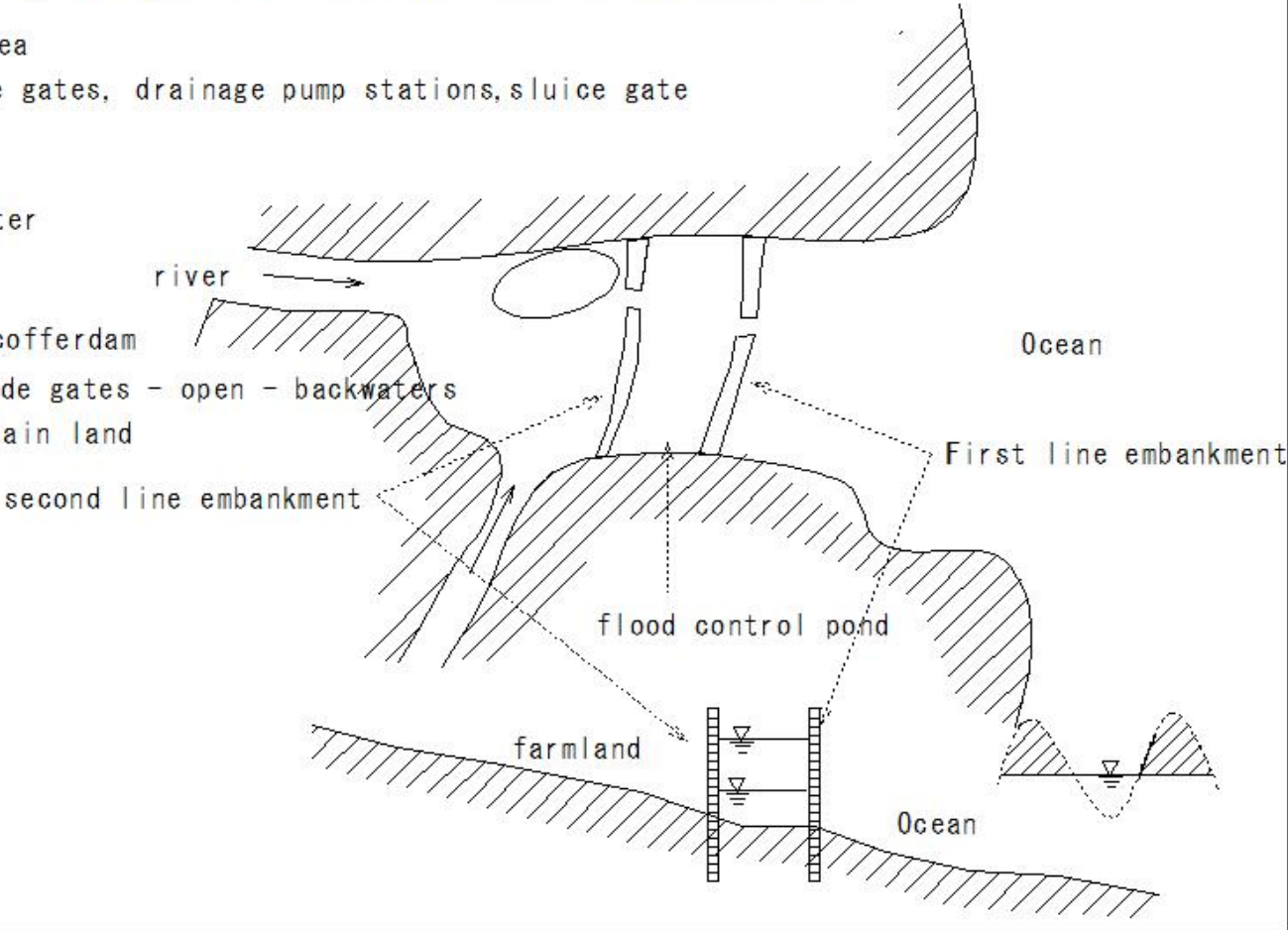
(R342)reclamation in water area

reclamation in water area

Embankments, drainage gates, drainage pump stations, sluice gate
Ocean

lakes and marshes
Drain the inside water
Bottom - Farmland

- Low wetland-levee-cofferdam
- During low tide, tide gates - open - backwaters
- Pump drainage - obtain land

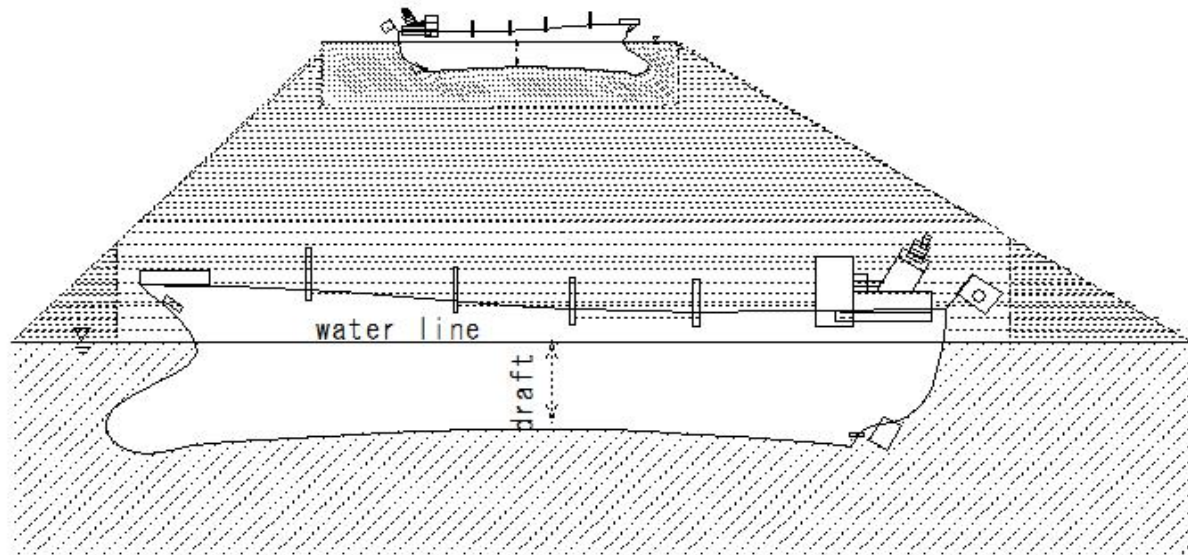


(R343)draft

(R343) draft

Buoyancy: Volume of object below the water line:

Weight of water: Buoyancy



(R344)cavitation

(R344) cavitation

cavitation

Power plant

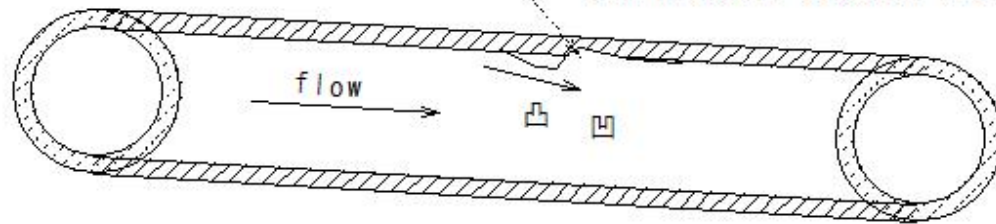
pipe waterway

凹凸 on the wall of the waterway

Flowing water - low pressure section vacuum section

Wall - erosion

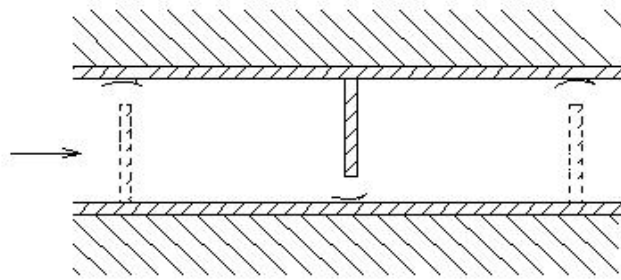
Low pressure section (wall damaged)



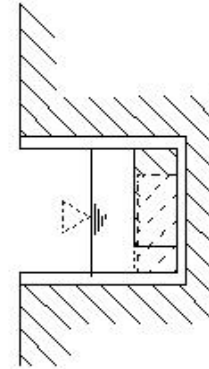
(R345)fishladder

(R345) fish ladder

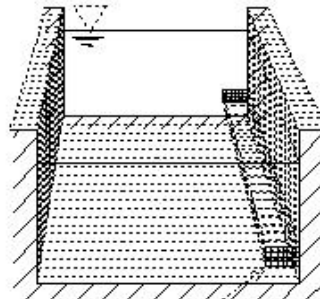
fish aisle



fishladder



fish ladder

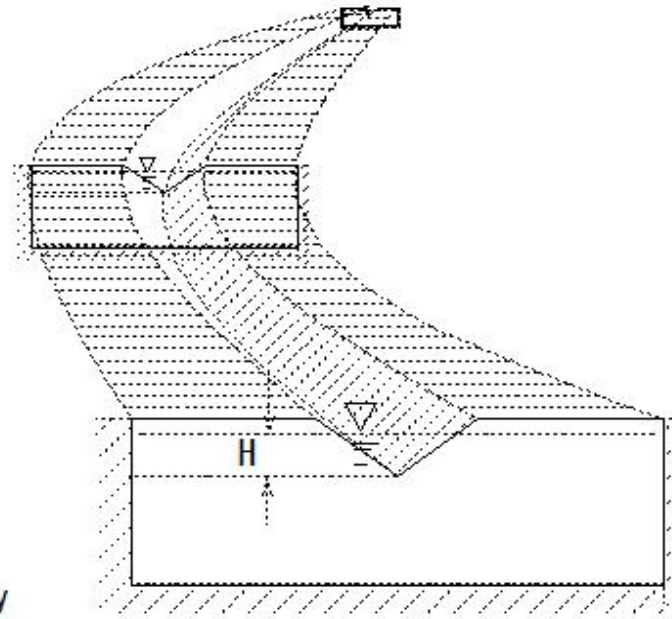
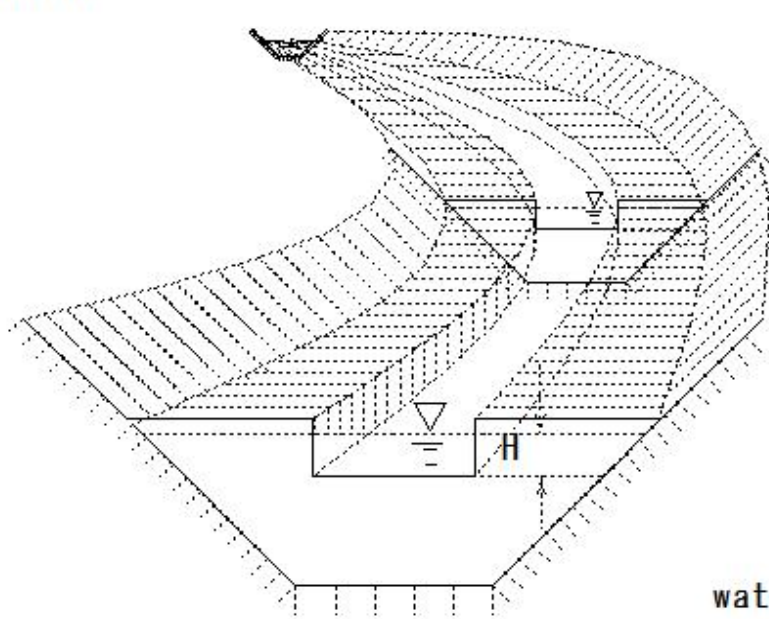


Eel aisle

(R346)weir(notch)

(R346) weir (notch)

notch



waterway

square shape - cut out

Triangular shape - cut out

Overflow water depth measurement - discharge

Square shape - square weir

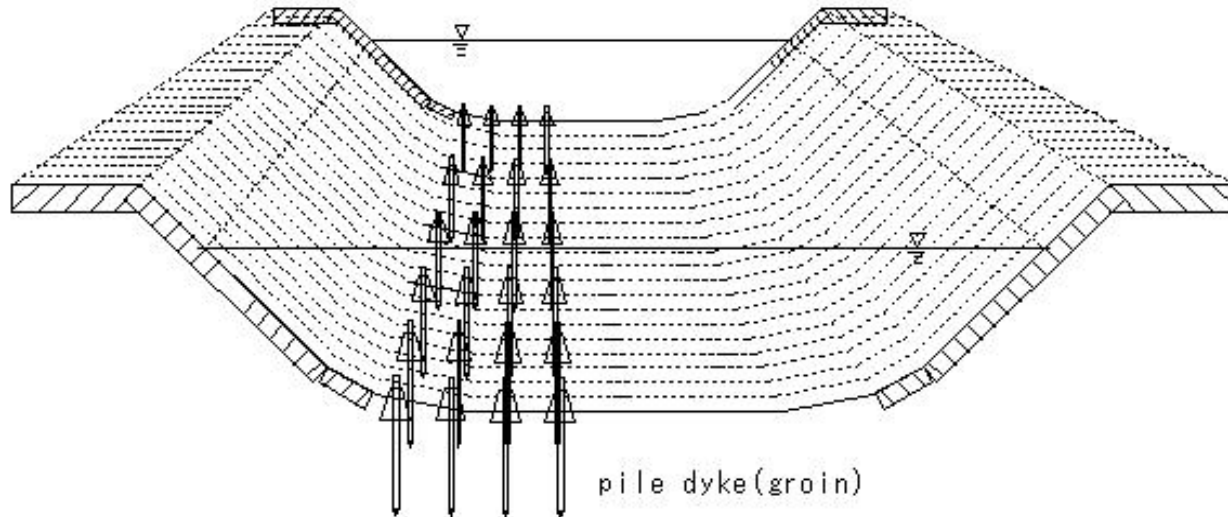
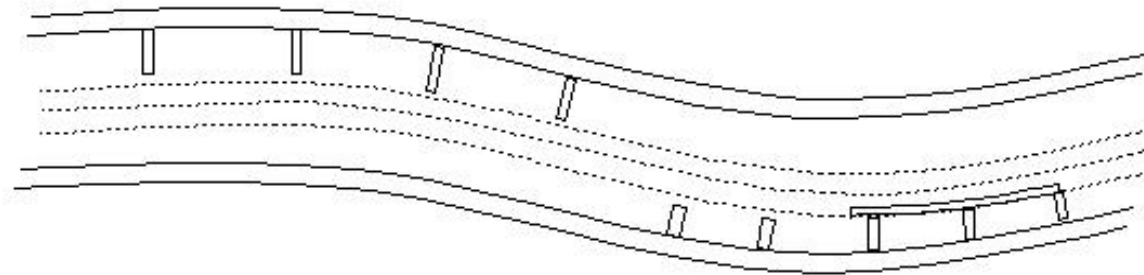
Triangular shape - triangular dam

H: Overflow water depth

(R347)pile dyke(groin)

(R347)pile dyke(groin)

pile dyke(groin)
wooden pile
reinforced concrete piles



(R348)spur dyke(groin)

(R348)spur dyke(groin)

spur dyke(groin)

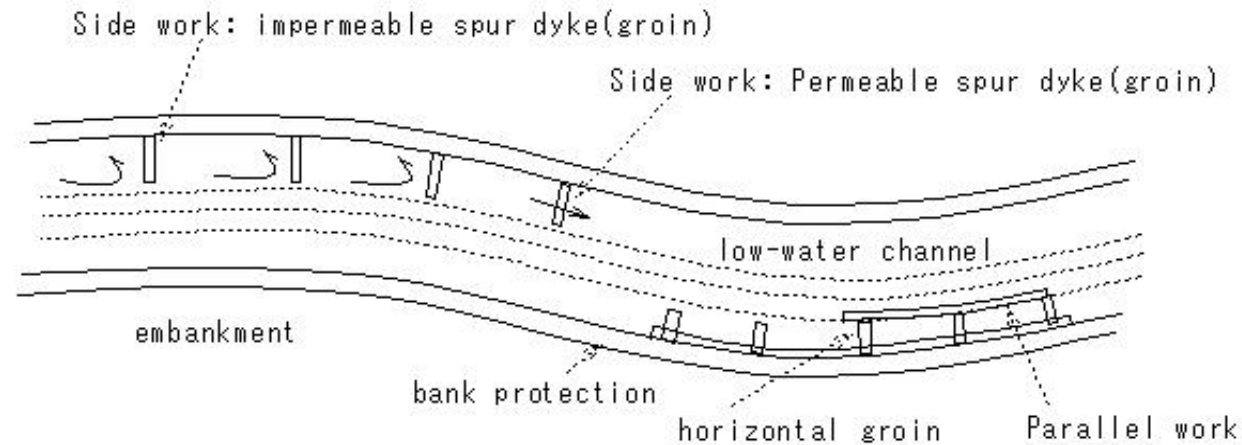
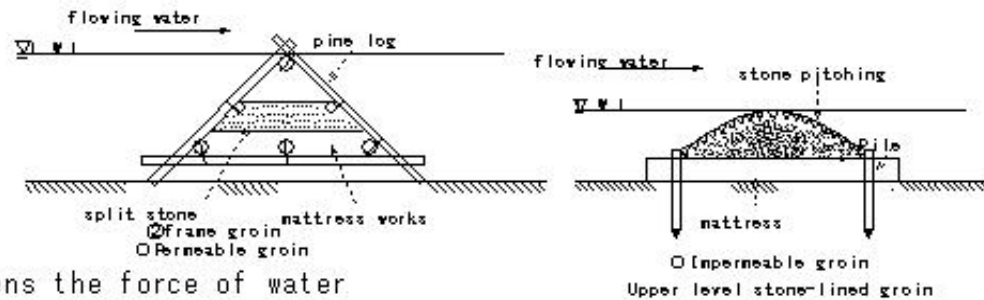
weaken the water force

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



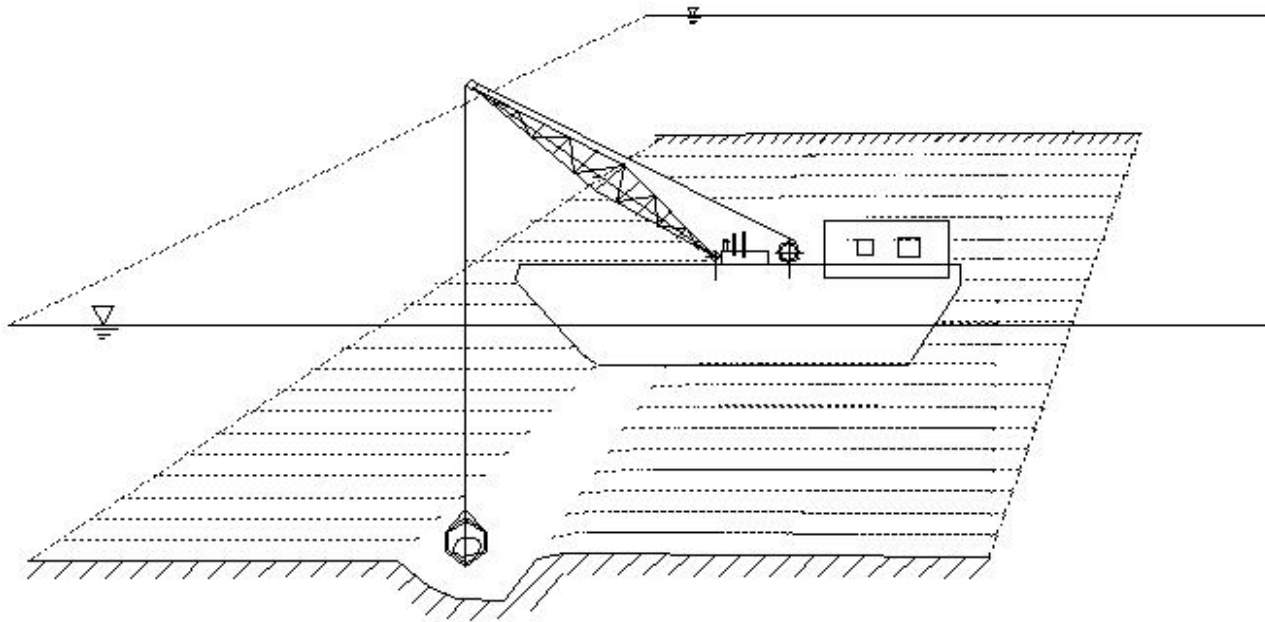
(R349) arab dredger

(R349) grab dredger

grab dredger

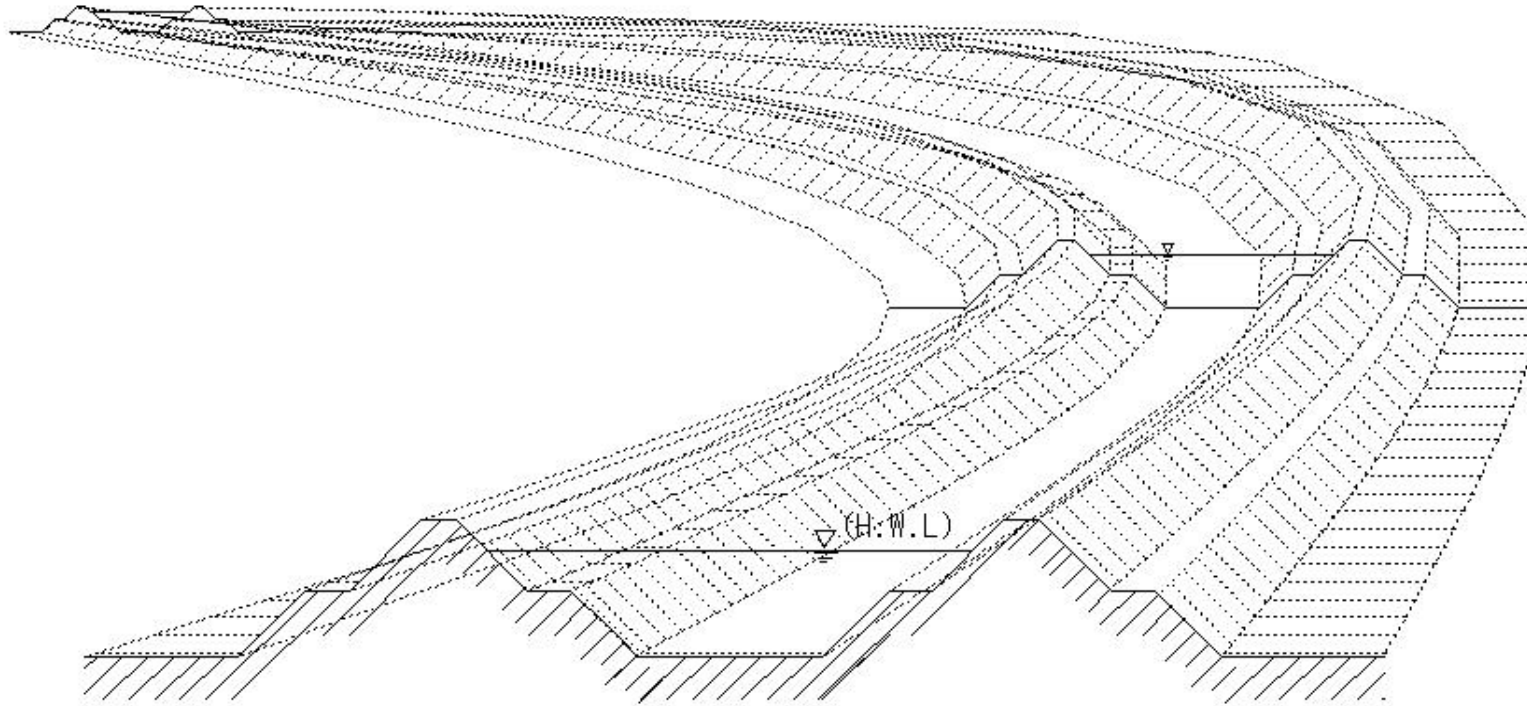
clamshell

- Dredging in deep areas



(R350)estimated high-water level,Designed high water level (H.W.L)

(R350) estimated high-water level, Designed high water level (H.W.L)



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

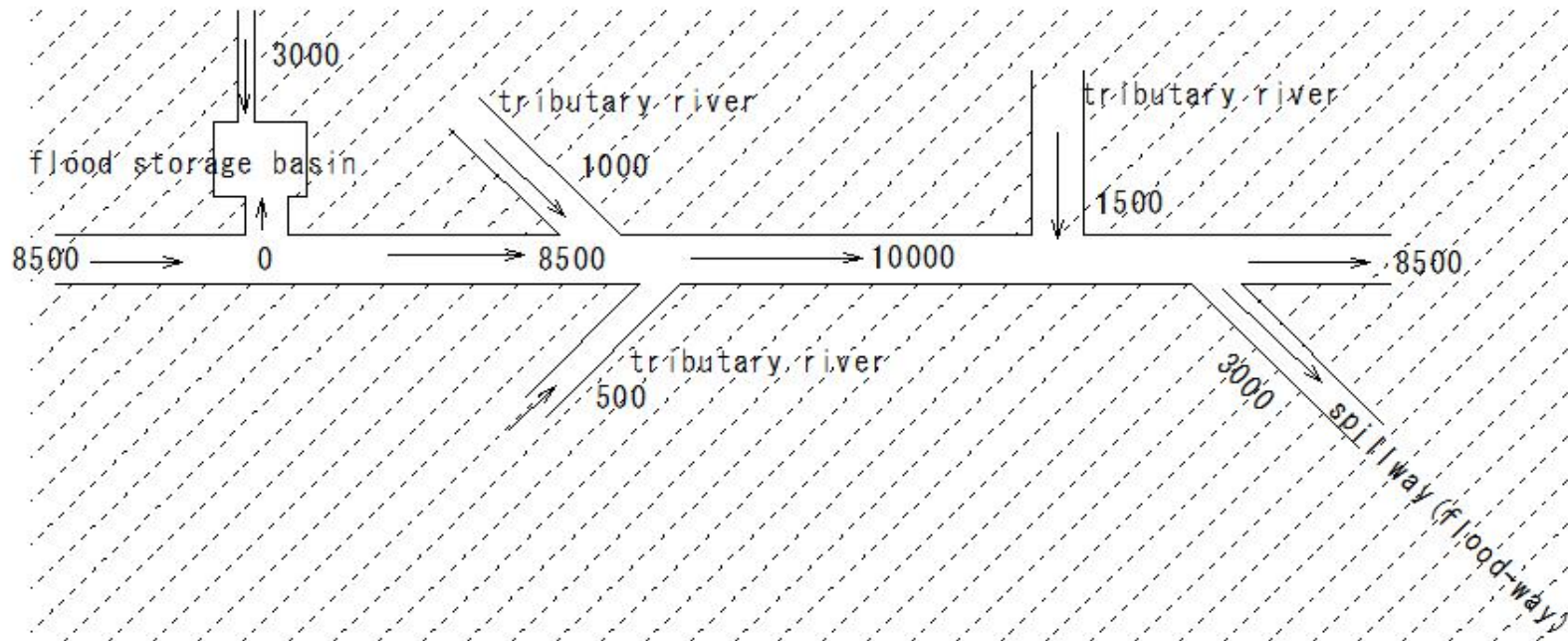
(R351)estimated high-water discharge,design high-water discharge

(R351)estimated high-water discharge,design high-water discharge

estimated high-water discharge

design high-water discharge

- River channel planning and design
 - Retarding pond(flood storage basin) planning
- design flood discharge(m³)



(R352)design flood discharge

(R352) design flood discharge

design flood discharge

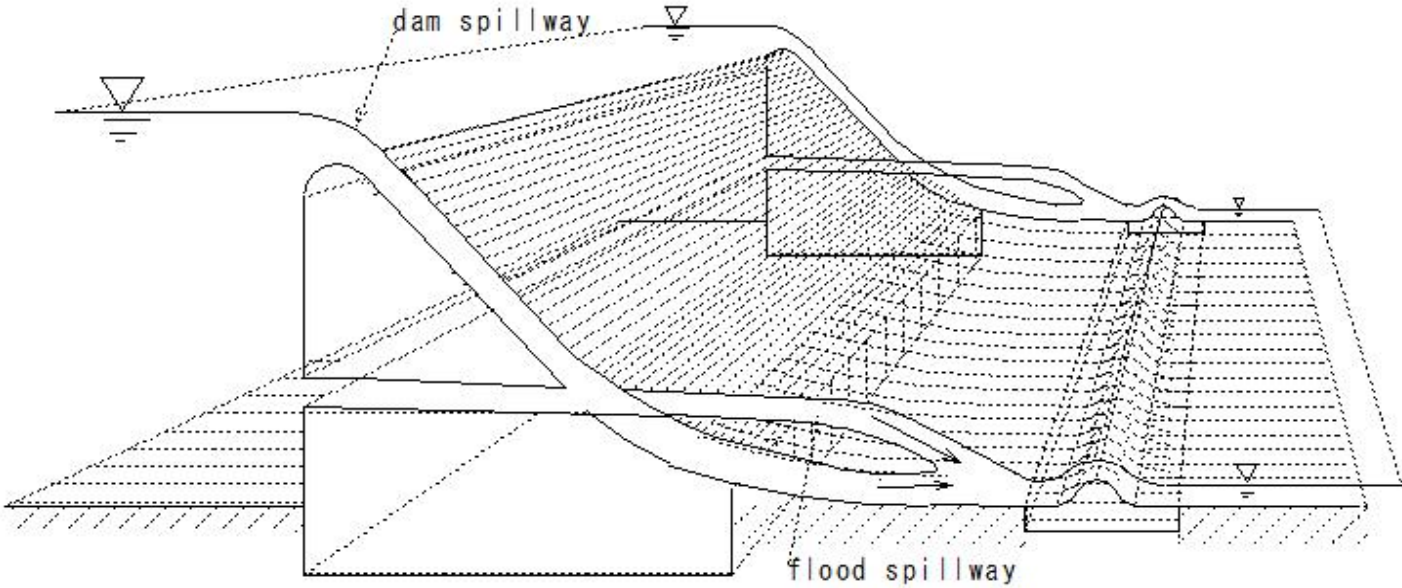
dam design

Concrete dam: once every 100 years

Field flood discharge once every 200 years

design flood discharge

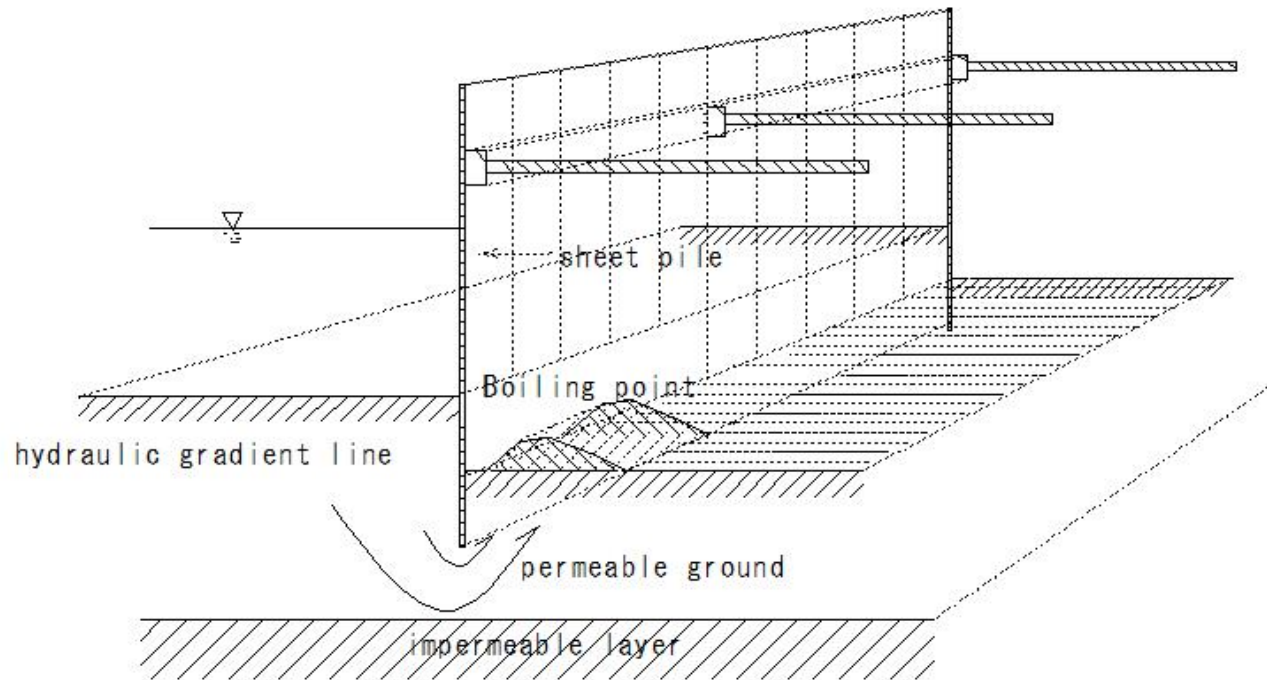
Designed for safe flow



(R353)quicksand

(R353) quicksand

quicksand



(R354)flood control

(R354) flood control

flood control

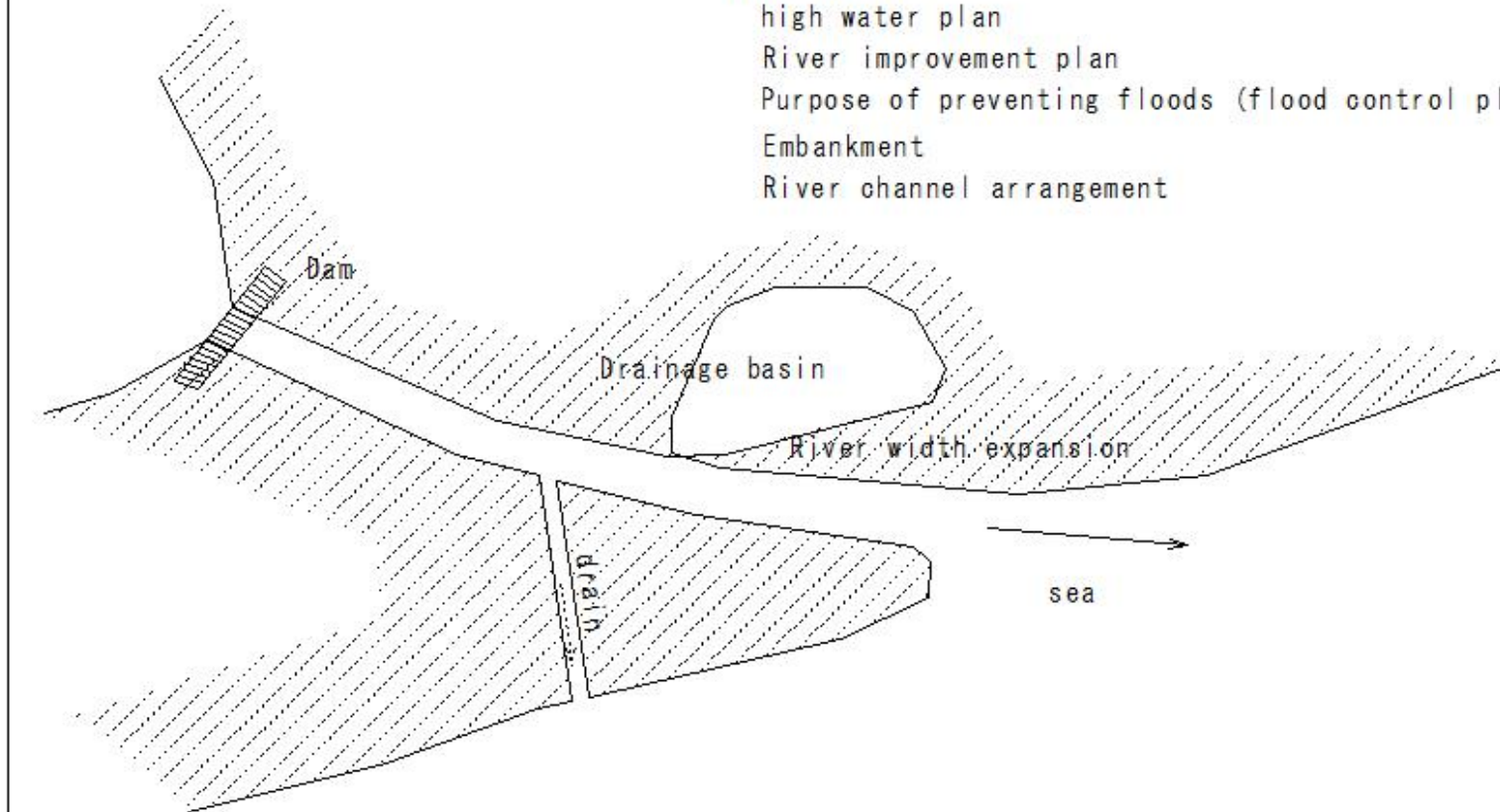
high water plan

River improvement plan

Purpose of preventing floods (flood control plan)

Embankment

River channel arrangement



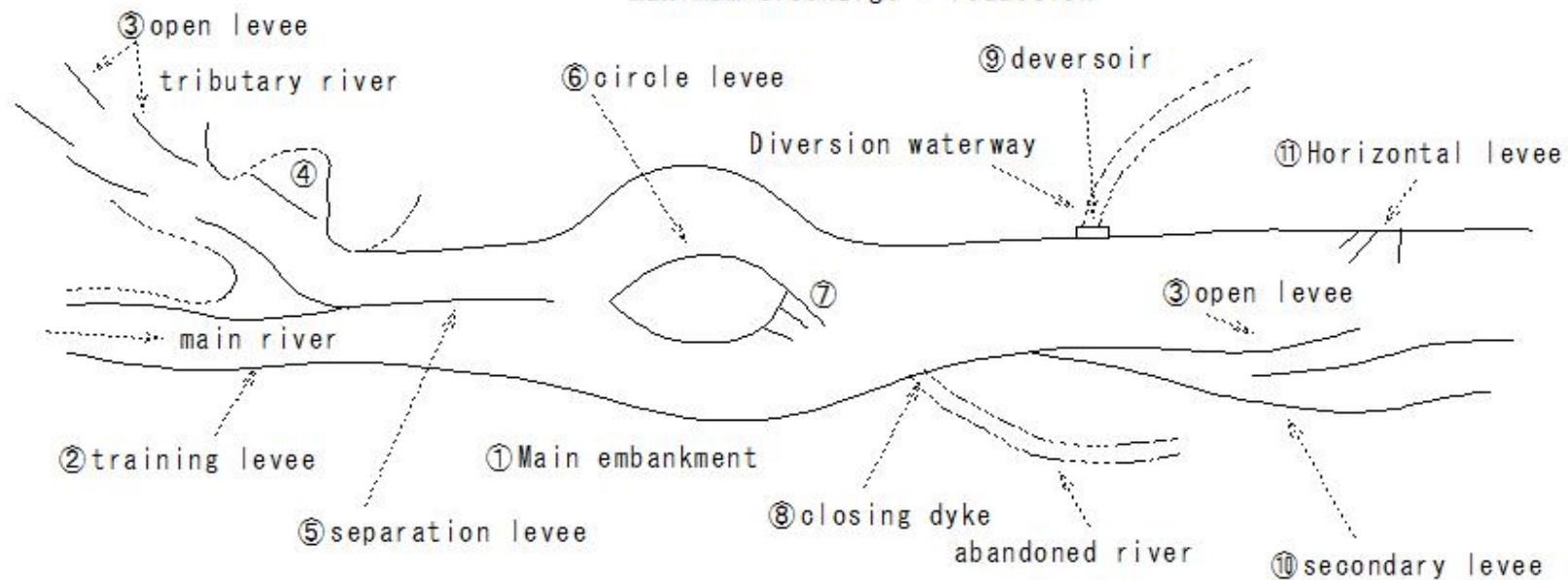
(R355)flood protection works

(R355) flood protection works

flood protection works

Construction work to prevent flooding

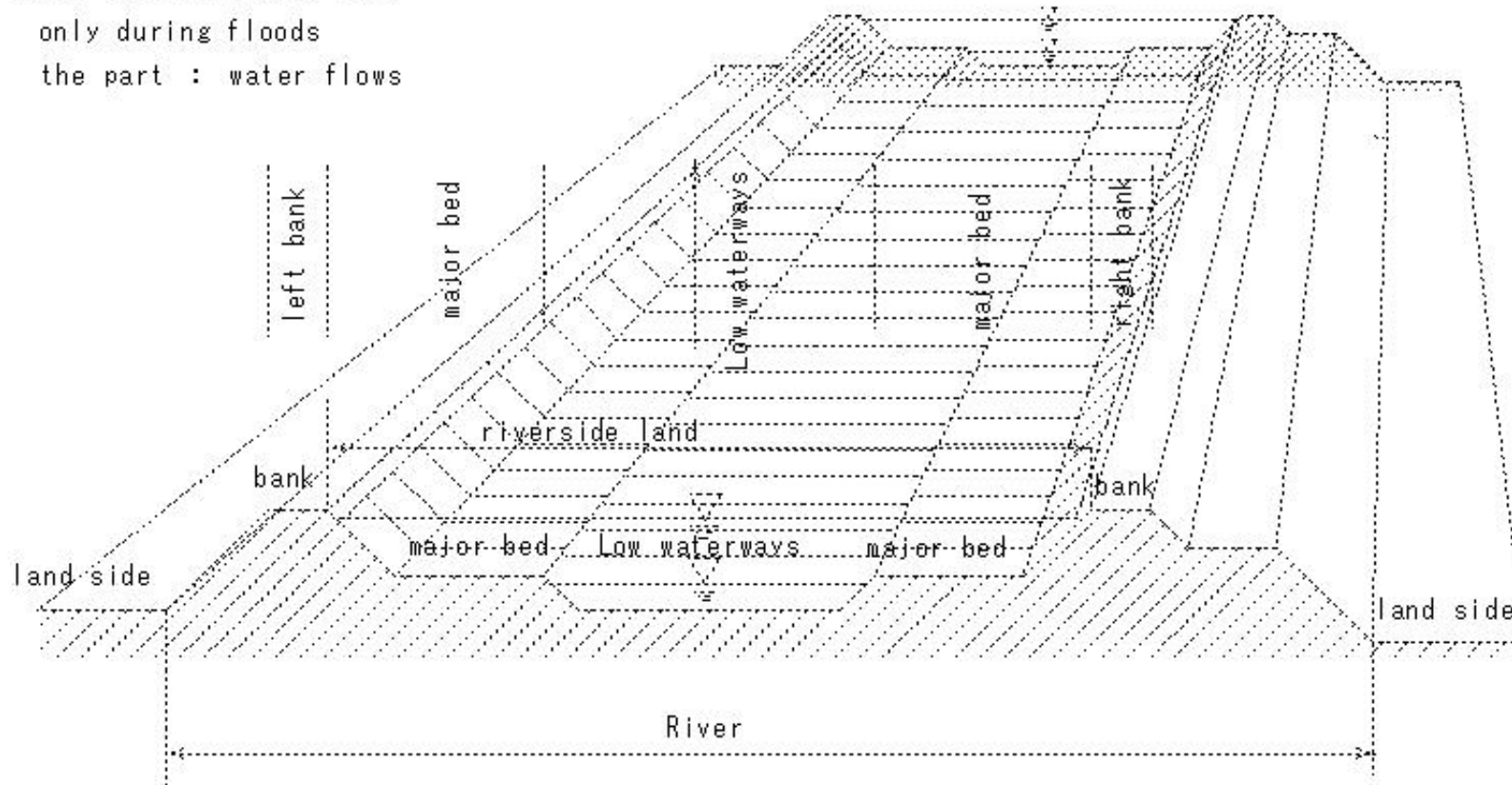
- river channel improvement work
- Flood control method
- embankment
- flood storage basin(Reservoir pond)
- River channel arrangement
- dam-Reservoir
- Flood prevention
- Part of the flood - water storage
- Maximum discharge - reduction



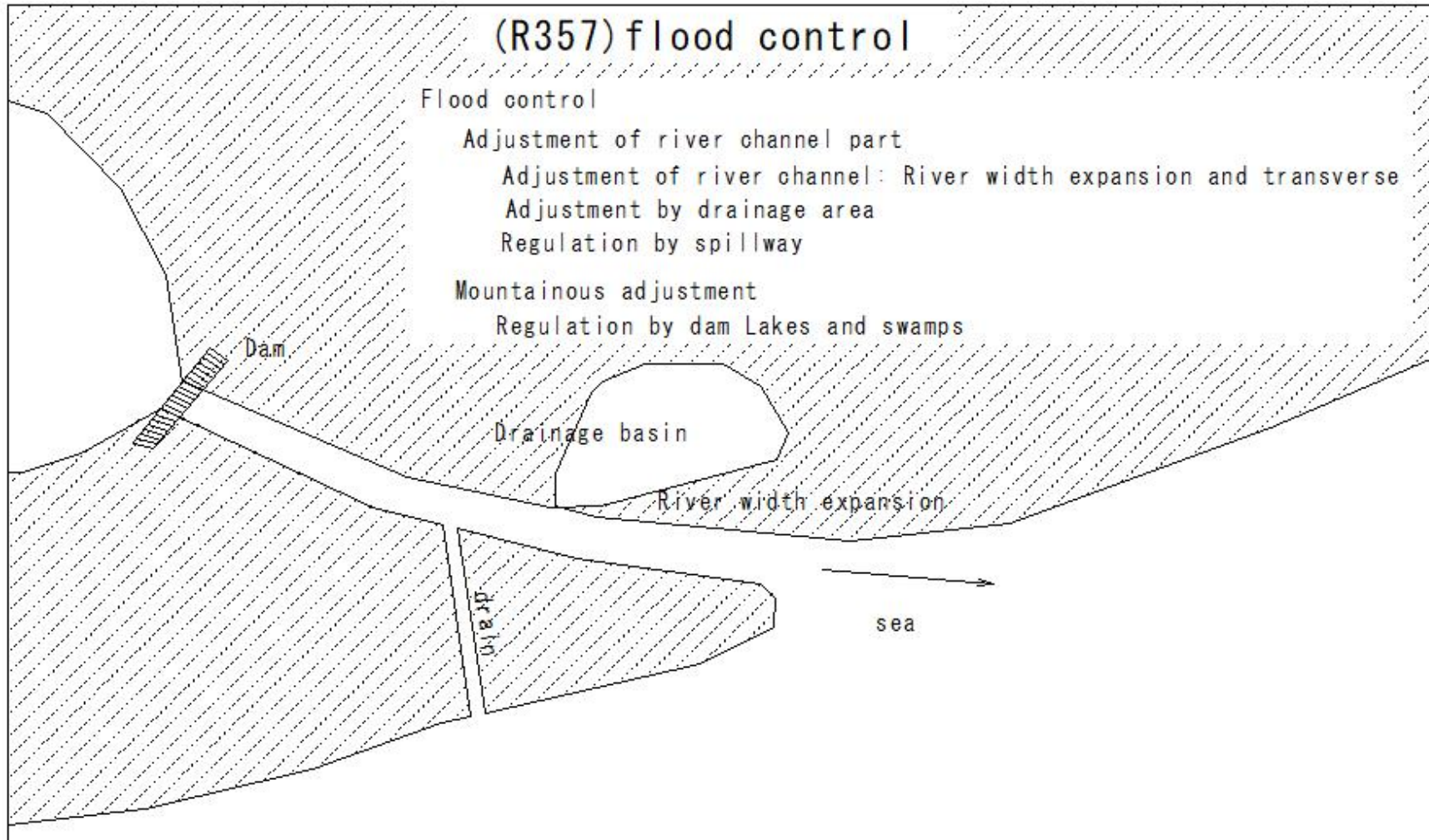
(R356)embankment(major bed)

(R356)embankment(major bed)

major bed(high water bed)
only during floods
the part : water flows



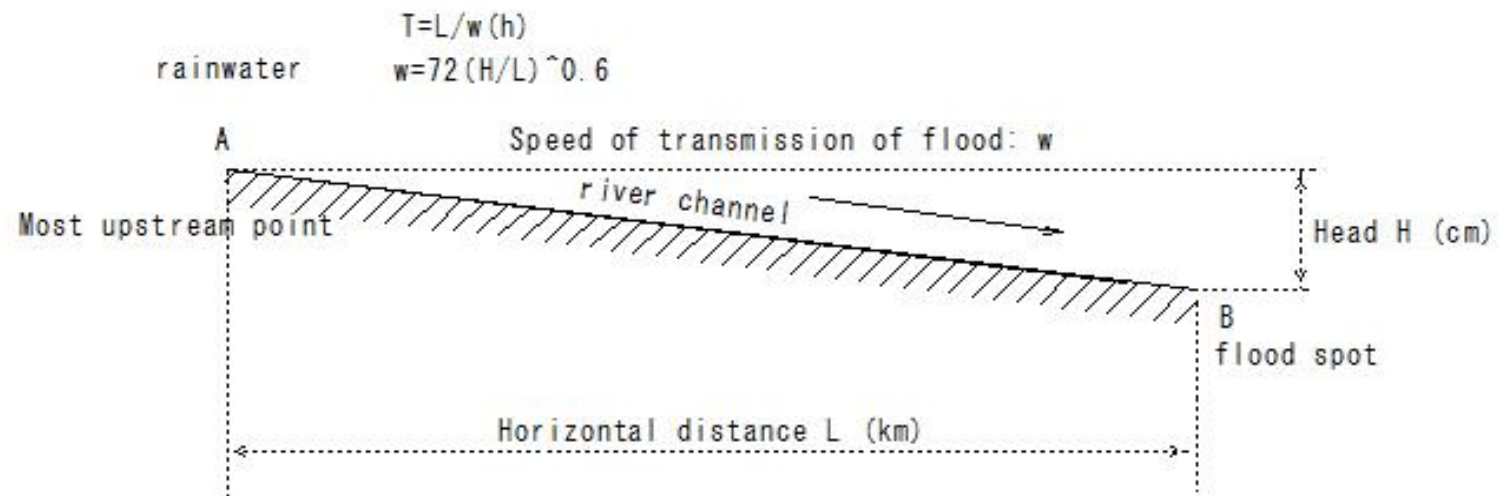
(R357)flood control



(R358)flood control

(R358)flood control

time of concentration of flood:T



(R359)broad-crested weir

(R359)broad-crested weir

broad-crested weir

velocity head

wide width

discharge Q

$$Q = CBH\sqrt{2g(H_0 - H)}$$

C : flow coefficient

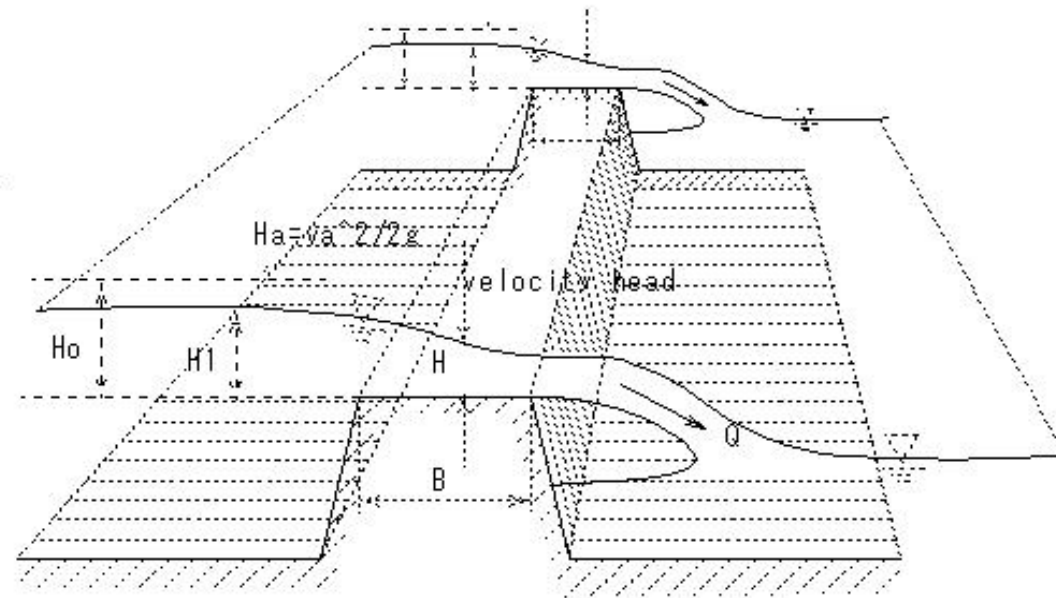
B : Weir width

H : Depth of water at crest

g : gravitational acceleration

H_0 : Overflow head ($H_1 + v_a^2/2g$)

v_a : Approach flow velocity



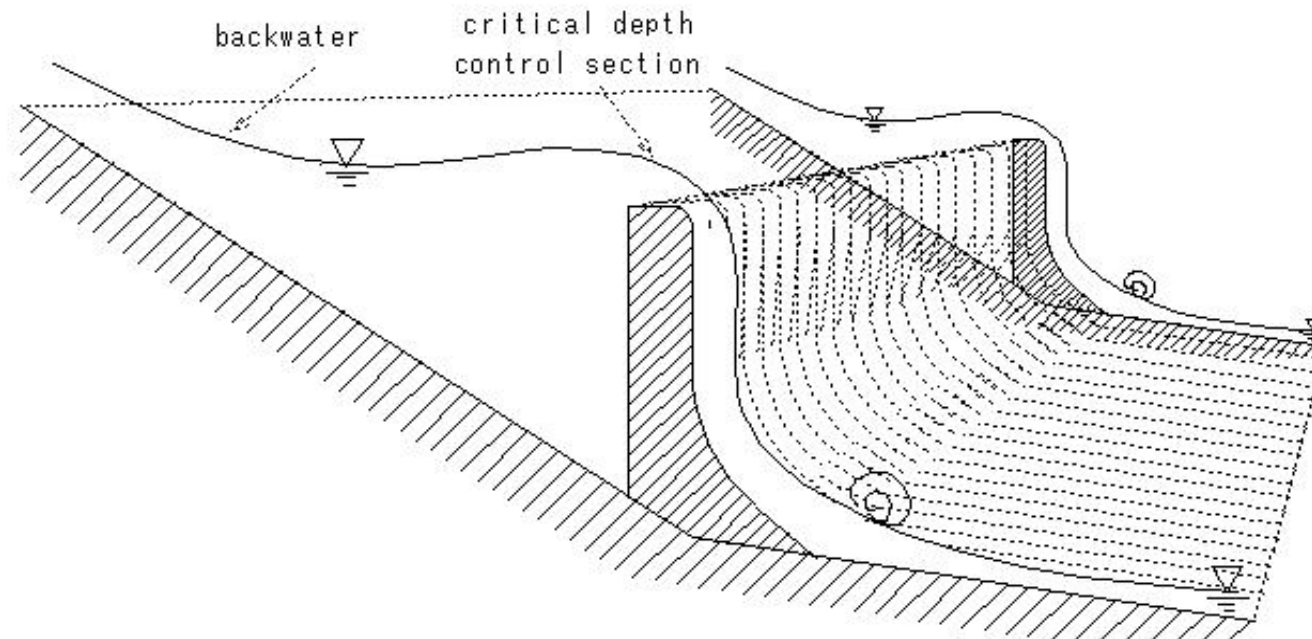
(R360)control section

(R360)control section

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

Governing the flow conditions in an open channel

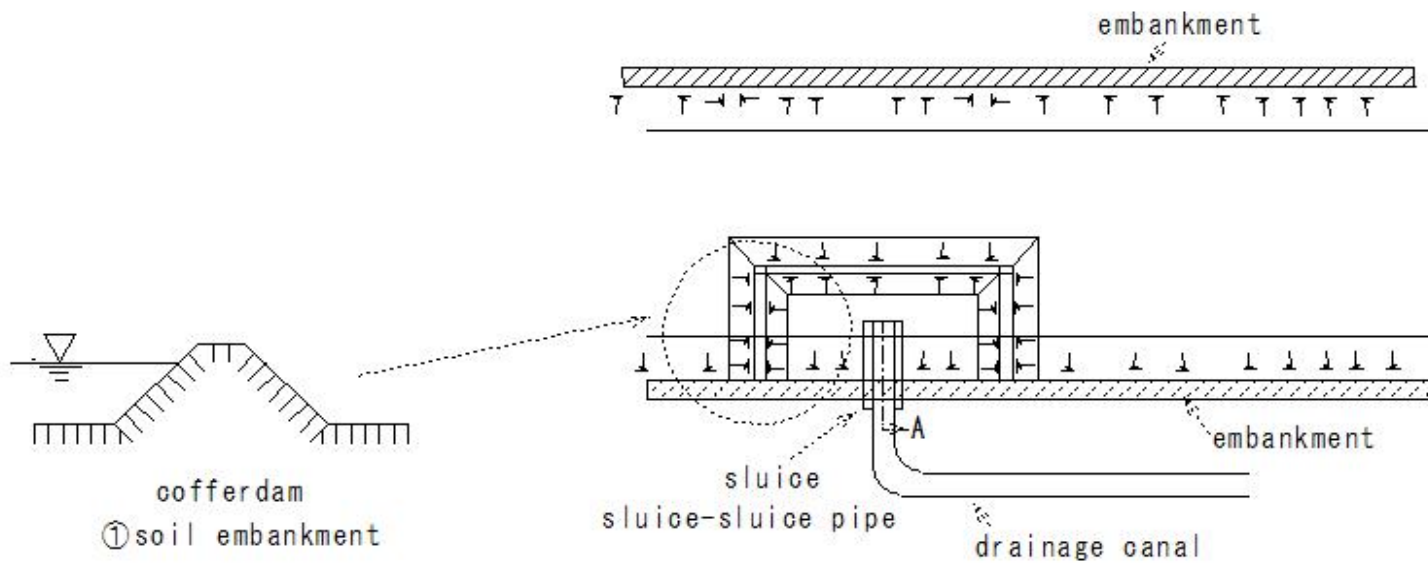
Serves as the starting point for calculating drainage curves.



(R361)cofferdam

(R361) cofferdam

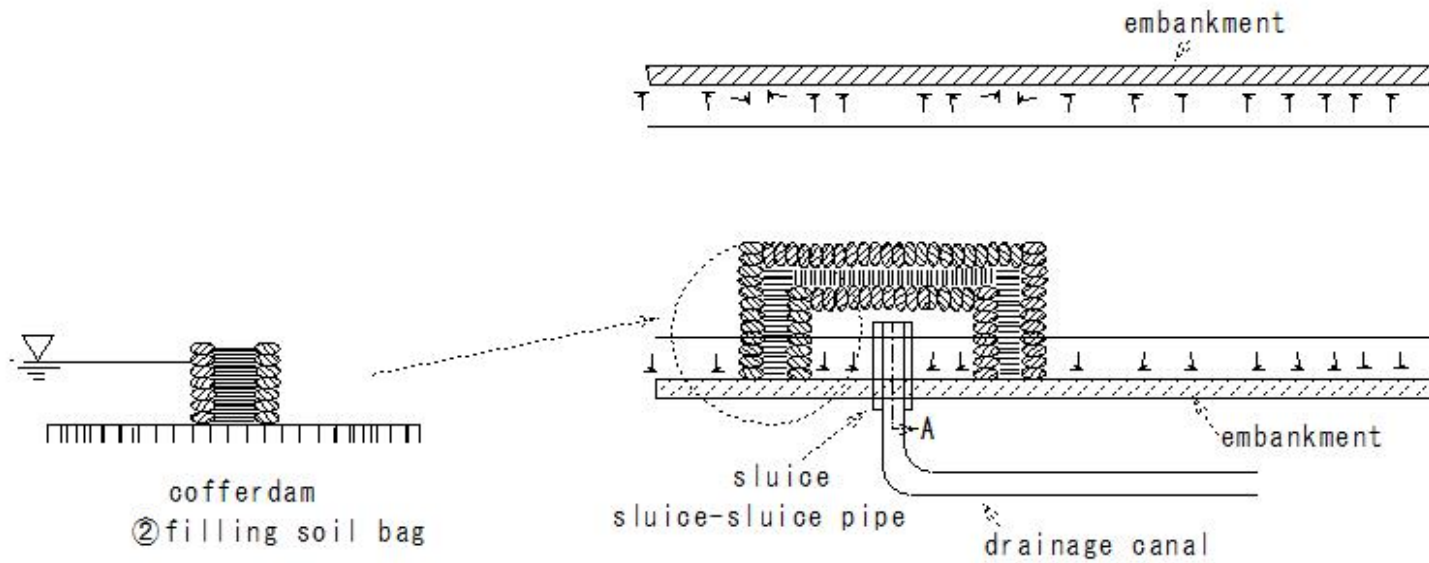
cofferdam
river construction
① soil embankment



(R362)cofferdam

(R362) coffer dam

cofferdam
river construction
②filling soil bag



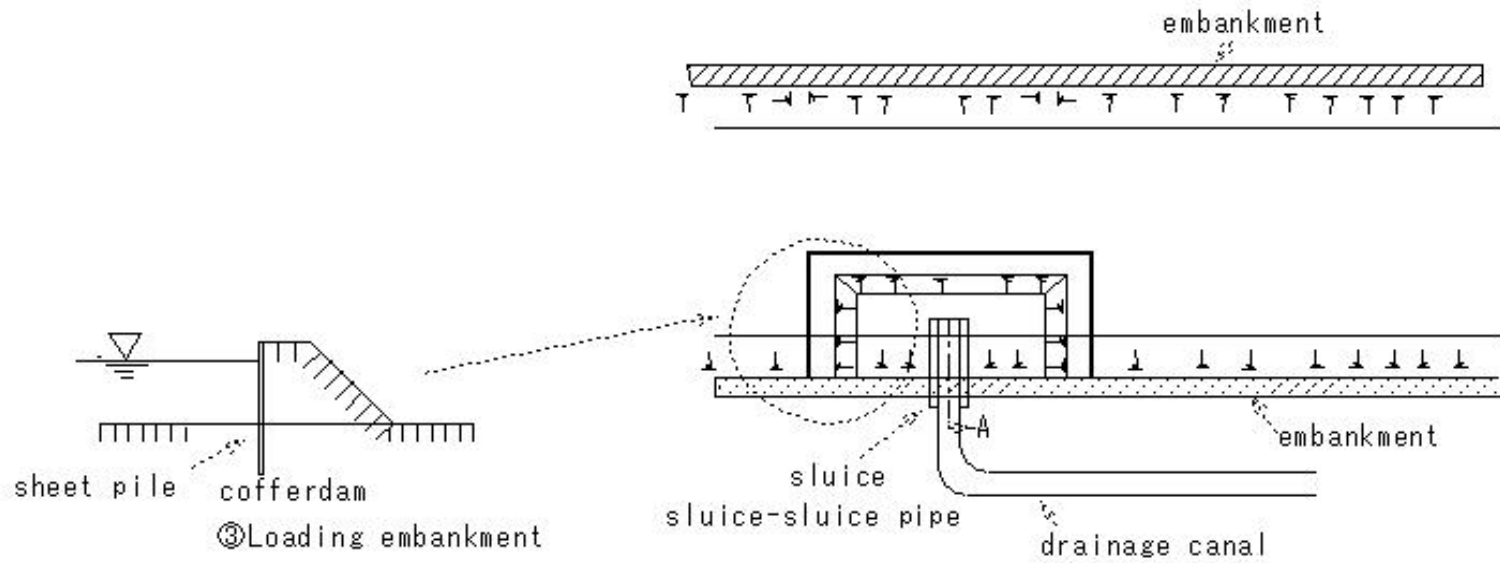
(R363)cofferdam

(R363)cofferdam

cofferdam

river construction

③Loading embankment



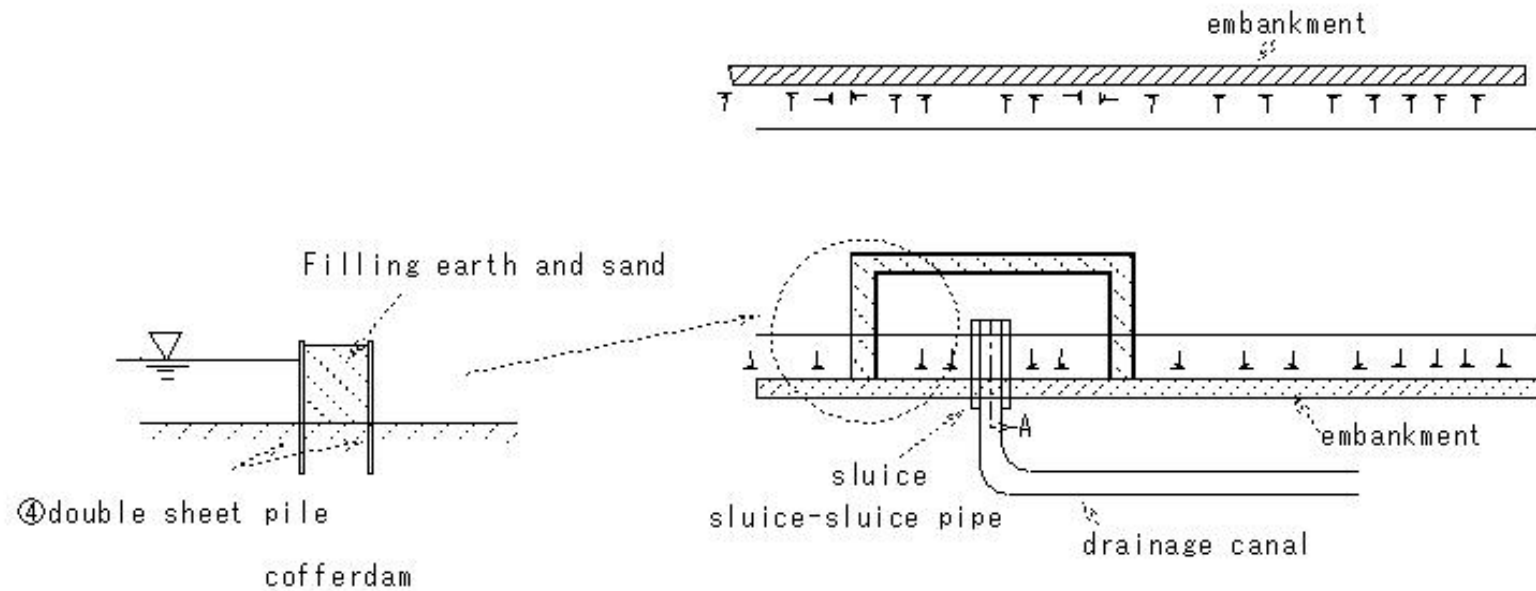
(R364)cofferdam

(R364)cofferdam

cofferdam

river construction

④double sheet pile



(R365)closing dyke

(R365)closing dyke

closing dyke

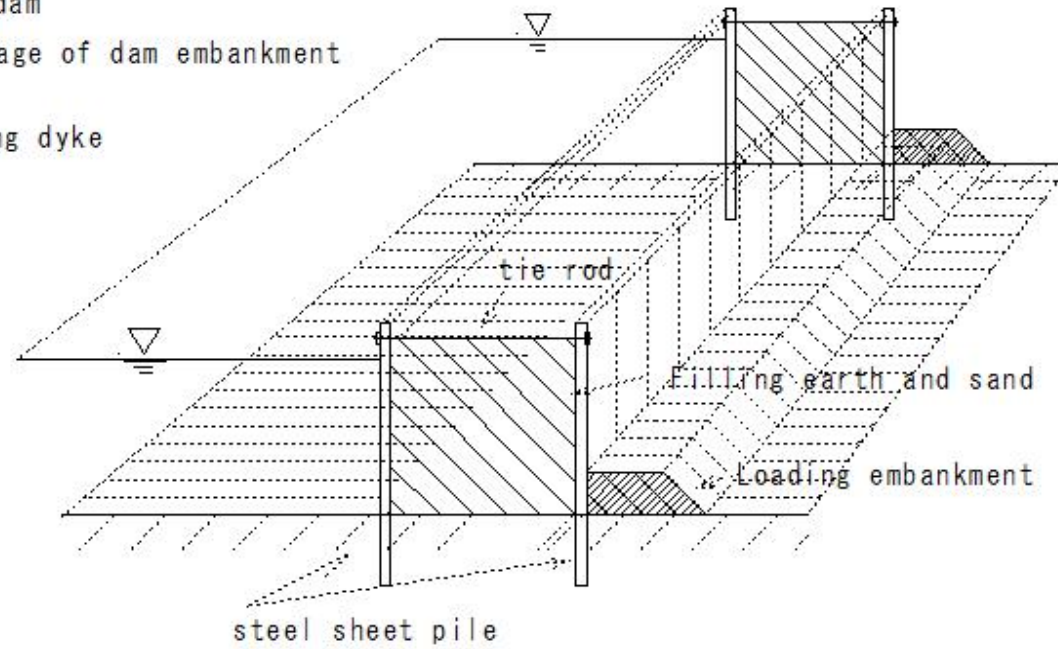
Changing the waterway

Tributary river cofferdam

Purpose of water stoppage of dam embankment

river cross section

Steel sheet pile closing dyke



(R366)wire cylinder(gabion)

(R366)wire cylinder(gabion)losing dyke

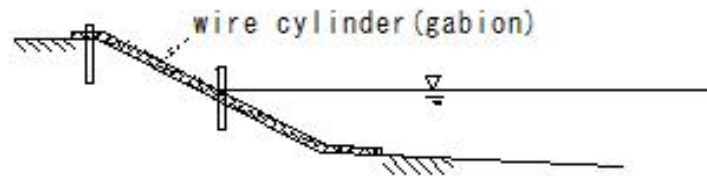
wire cylinder(gabion)

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)

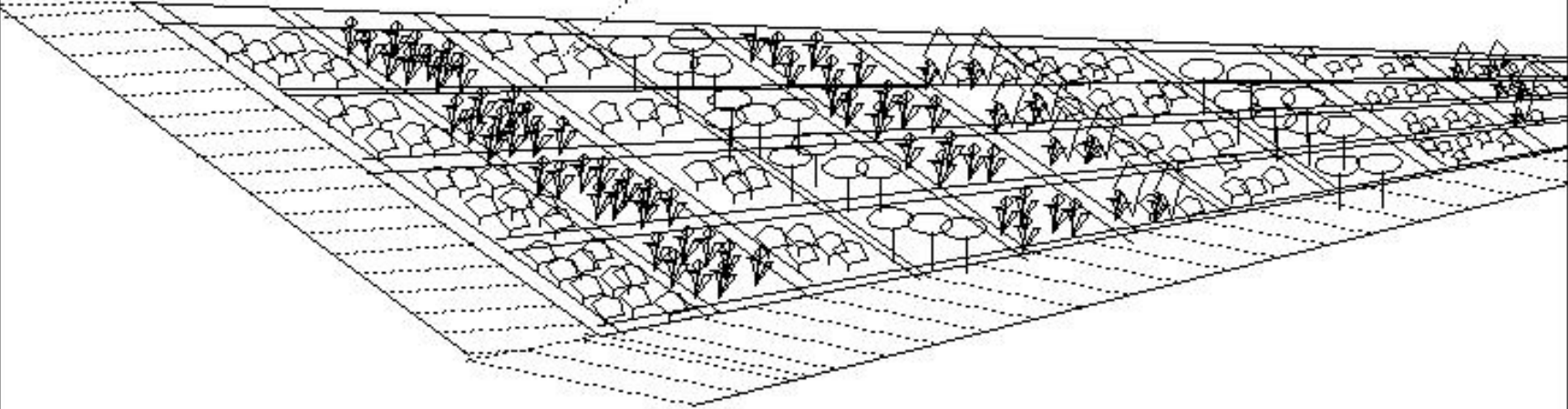
iron wire
Cobblestone/split stone
cylindrical basket
cobblestone
fill with broken stones

(R367)plantable bank protection

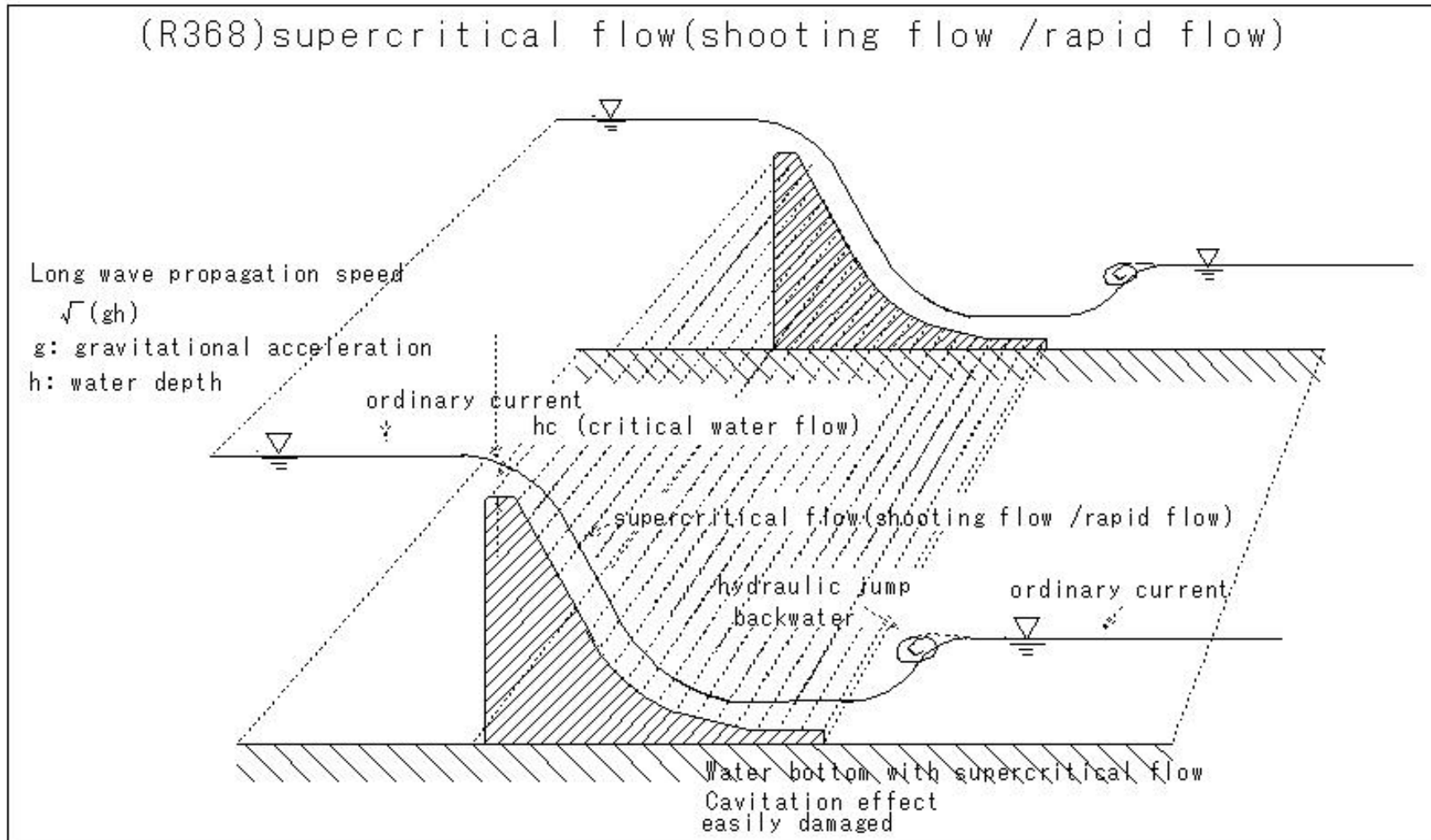
(R367)plantable bank protection

greening block bank protection

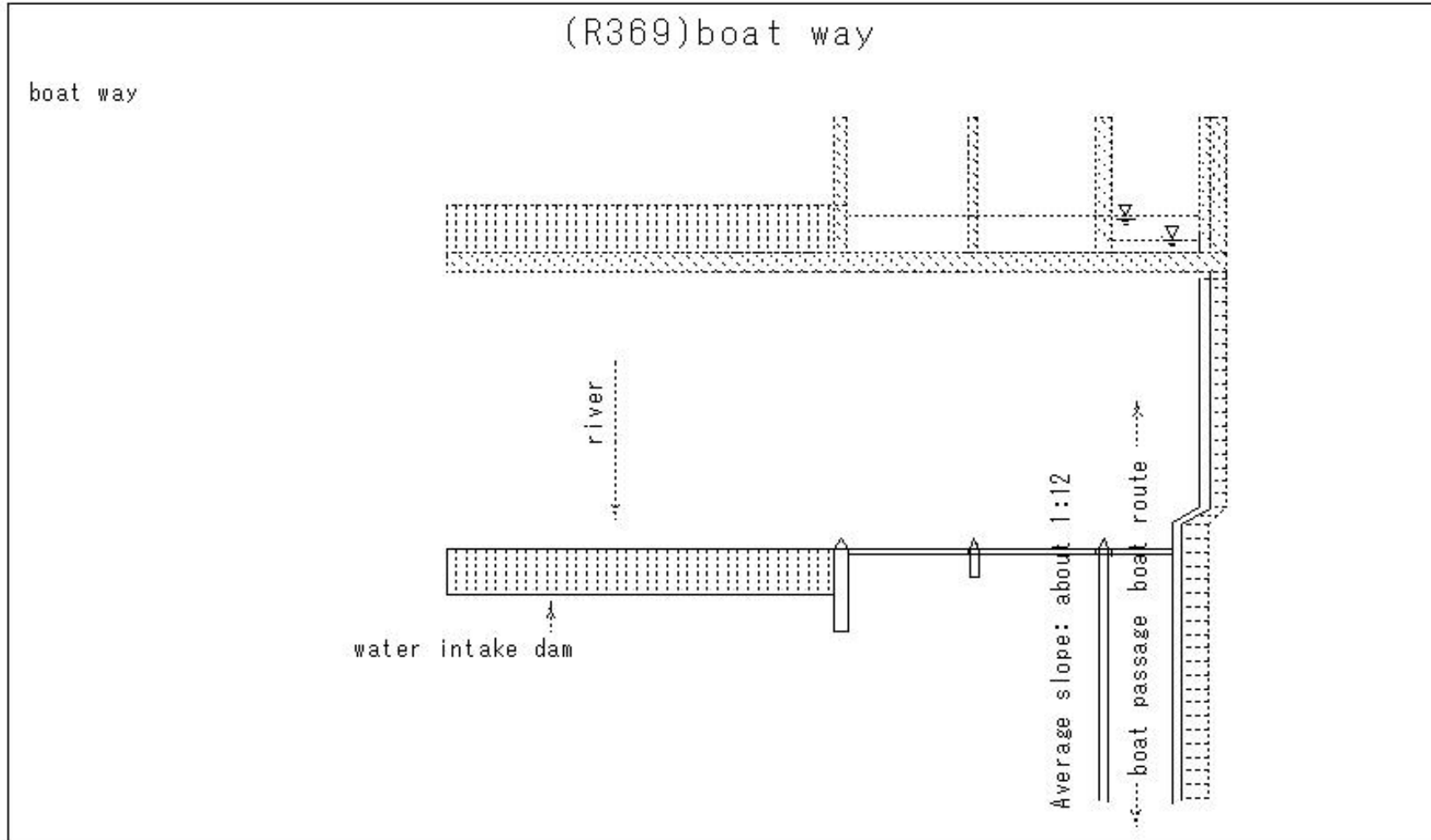
- bank protection slope
- greening
- inside-cavity
- soil
- plant - growth



(R368)supercritical flow(shooting flow /rapid flow)



(R369)boat way



(R370)free outflow

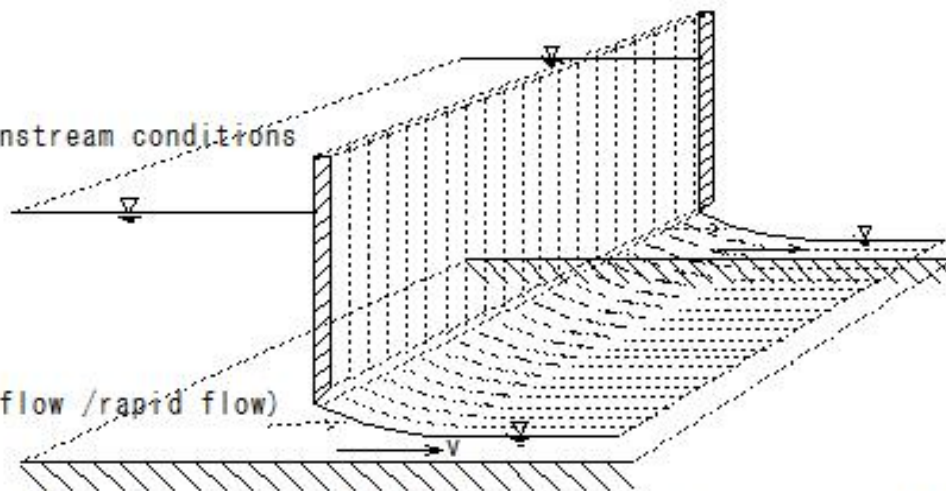
(R370)free outflow

free outflow

Runoff not controlled by downstream conditions

supercritical flow (shooting flow / rapid flow)

free outflow Water bottom with supercritical flow (shooting flow / rapid flow)
Runoff not controlled by downstream conditions



(R371)water intake

(R371)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

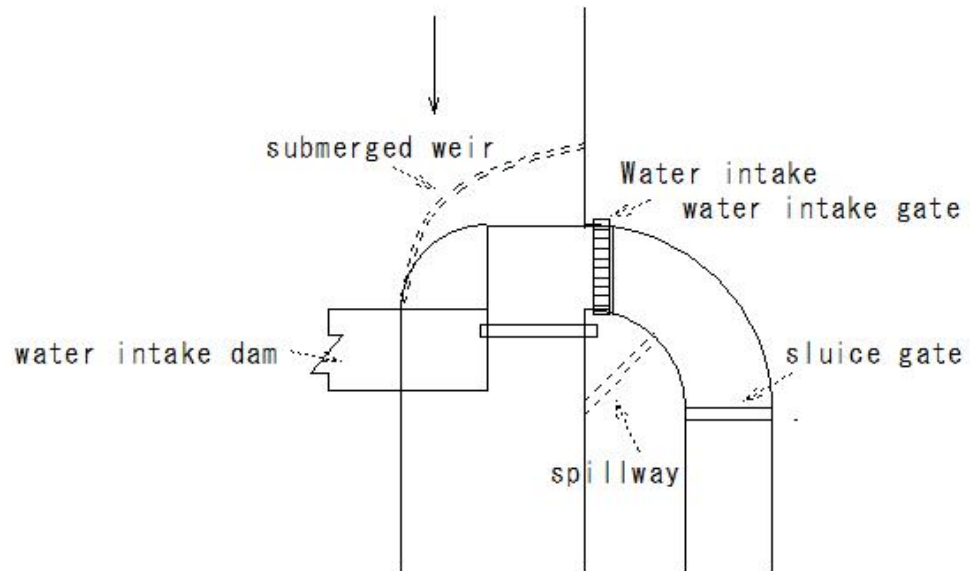
Power plant
water supply
industrial water
irrigation water

(R372)water intake

(R372) intake

intake

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



(R373)intake dam

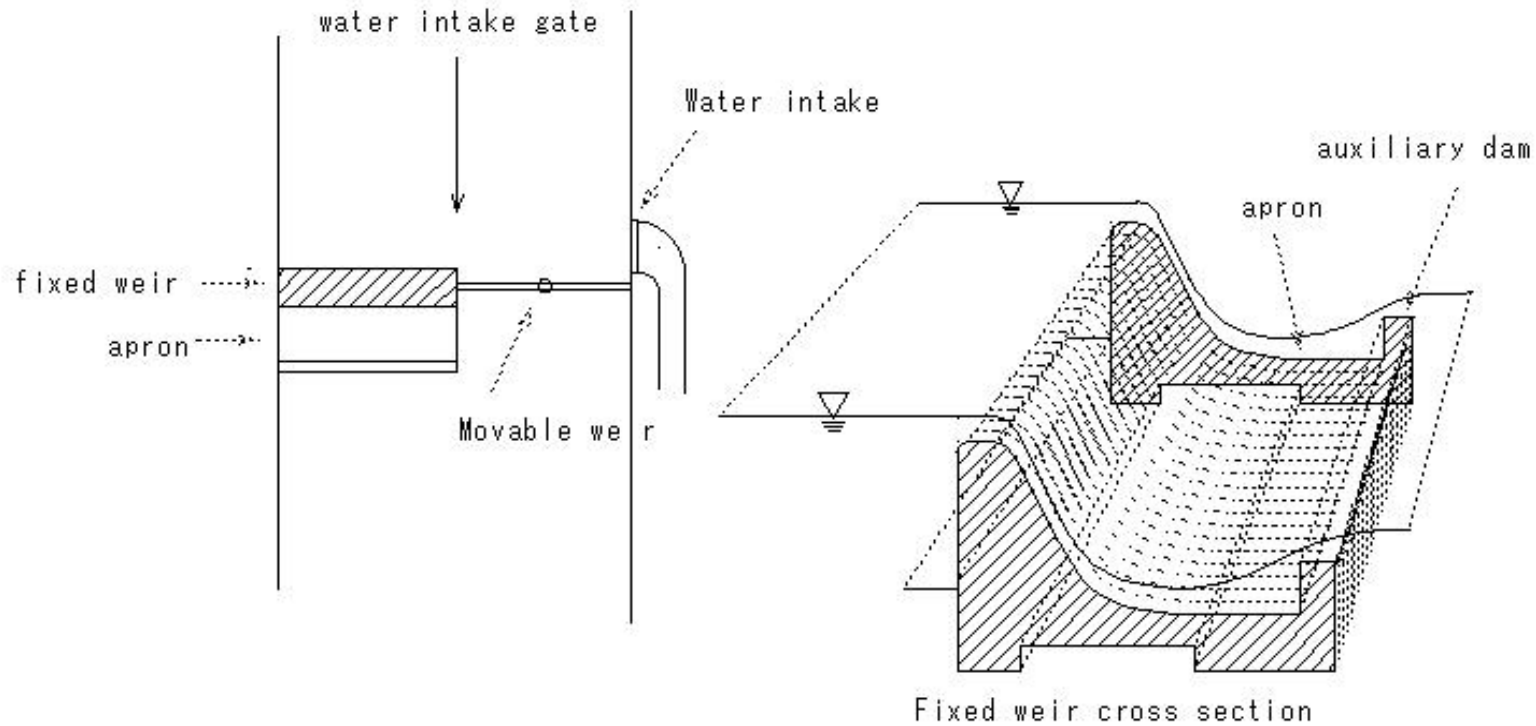
(R373) intake dam

intake dam

Dams to make it easier to introduce river water into waterways

A dam is an overflow-shaped weir.

Combined with mobile weir



(R374)intake tower

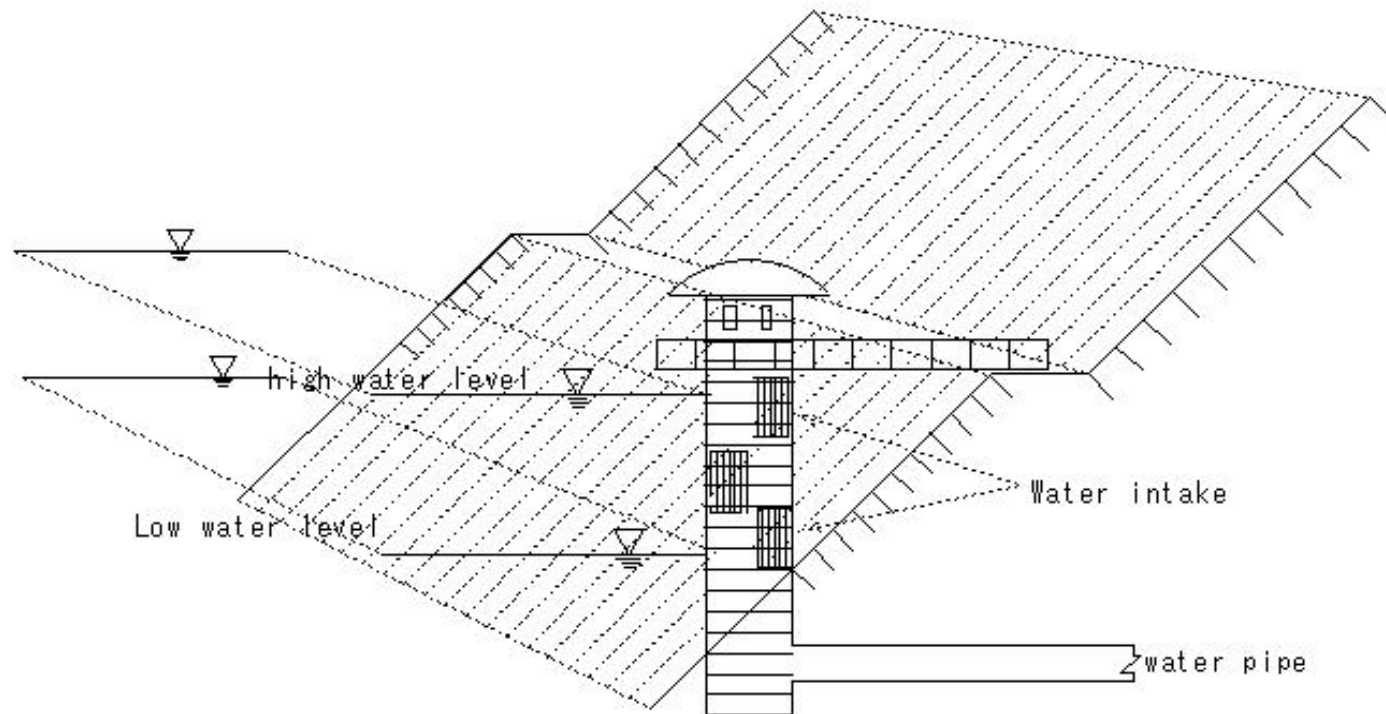
(R374)intake tower

intake tower

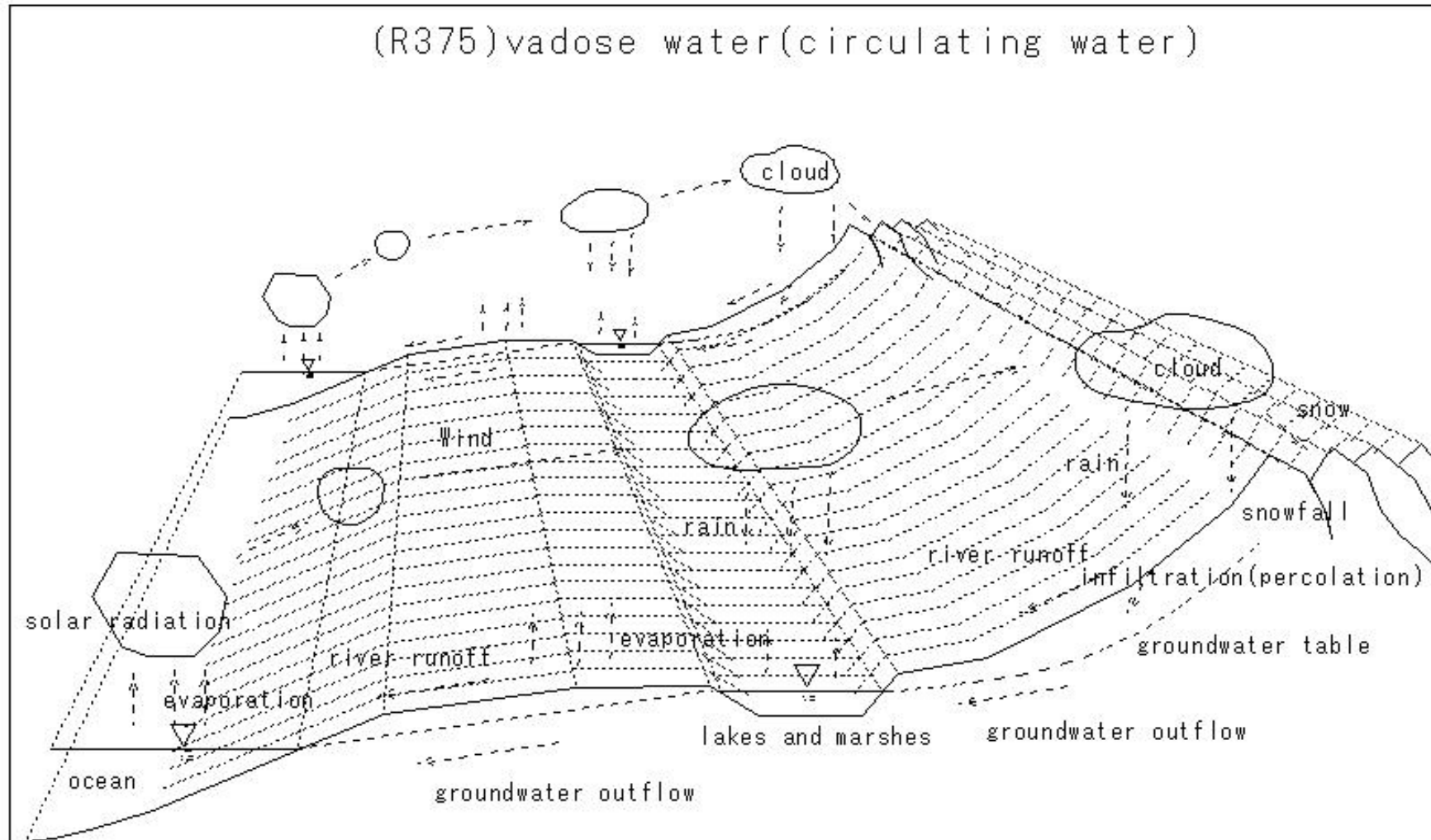
Tower for taking water at any depth from rivers, lakes, and reservoirs

A tower built underwater

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



(R375)vadose water(circulating water)



(R376)dredging(Pump dredger)

(R376)dredging(Pump dredger)

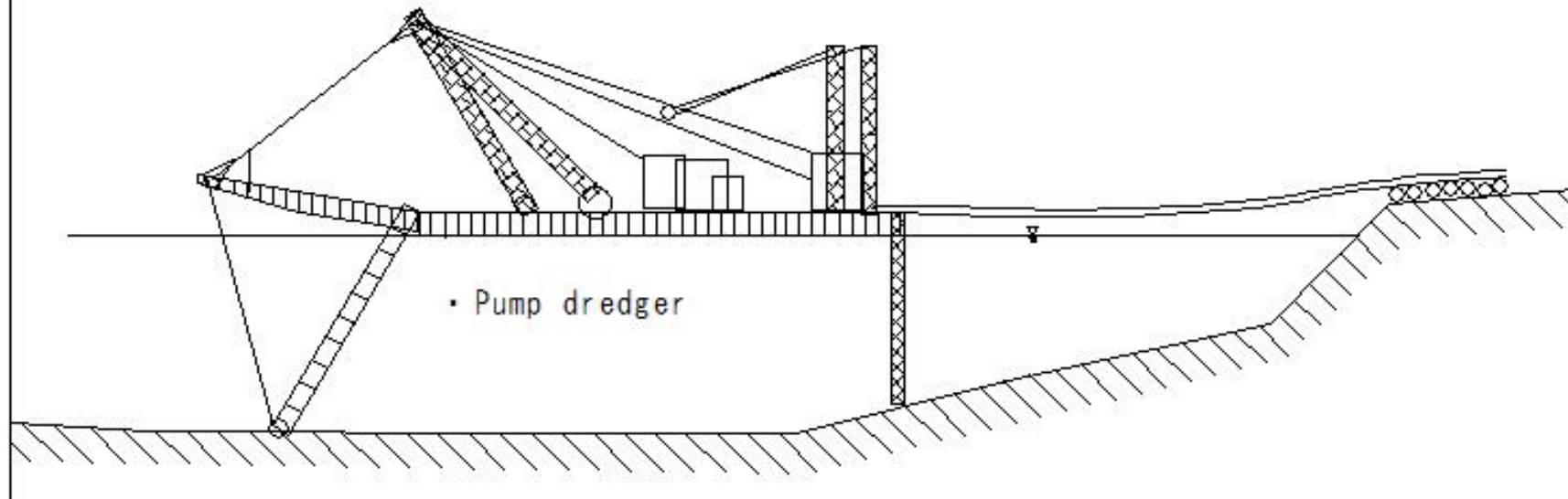
dredging

① Pump dredger

Suction up dirt etc. with a pump

Digging soil involves transportation and disposal work

working dredger



(R377)dredging(Bucket dredger)

(R377) dredging (Bucket dredger)

dredging

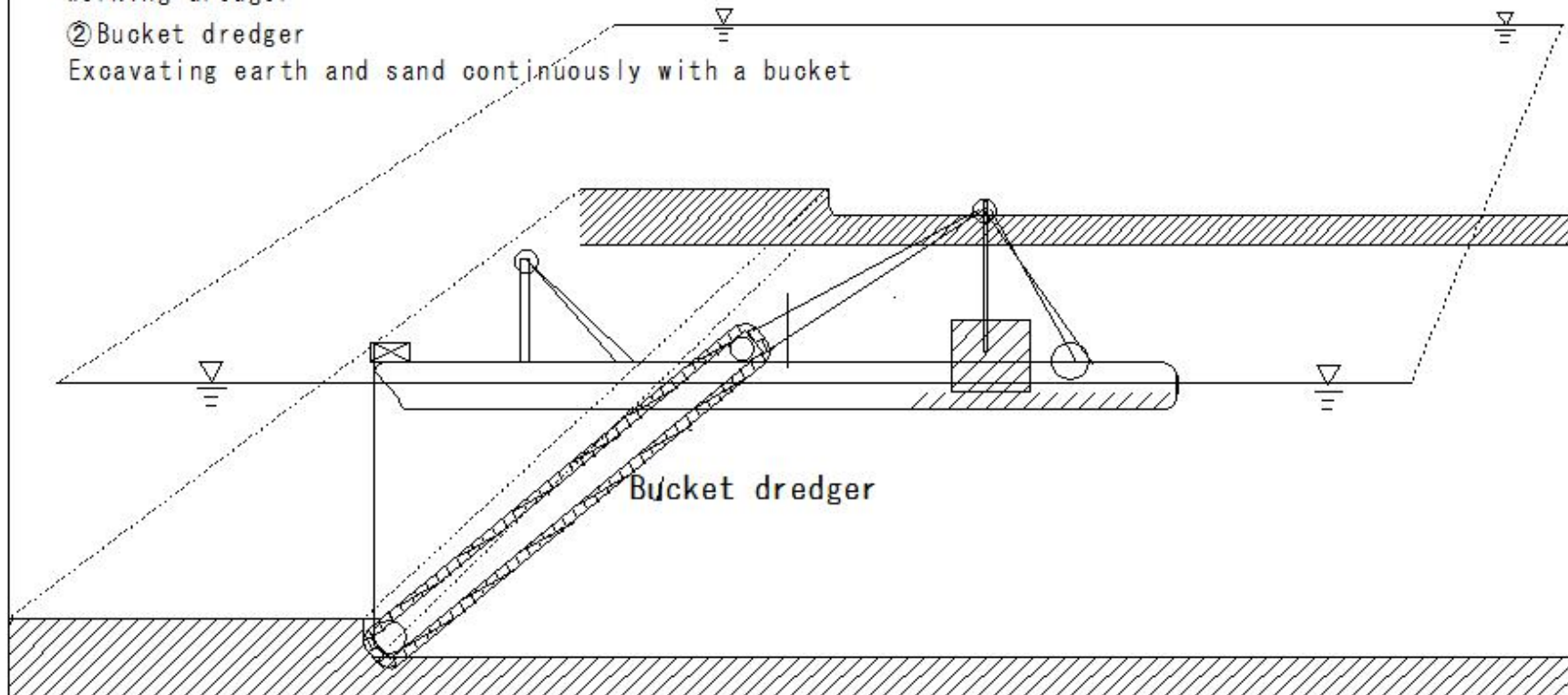
Digging soil involves transportation and disposal work

- Involves transportation and disposal work

working dredger

② Bucket dredger

Excavating earth and sand continuously with a bucket



(R378)dredging(Grab dredger)

(R378)dredging(Grab dredger)

grab dredger

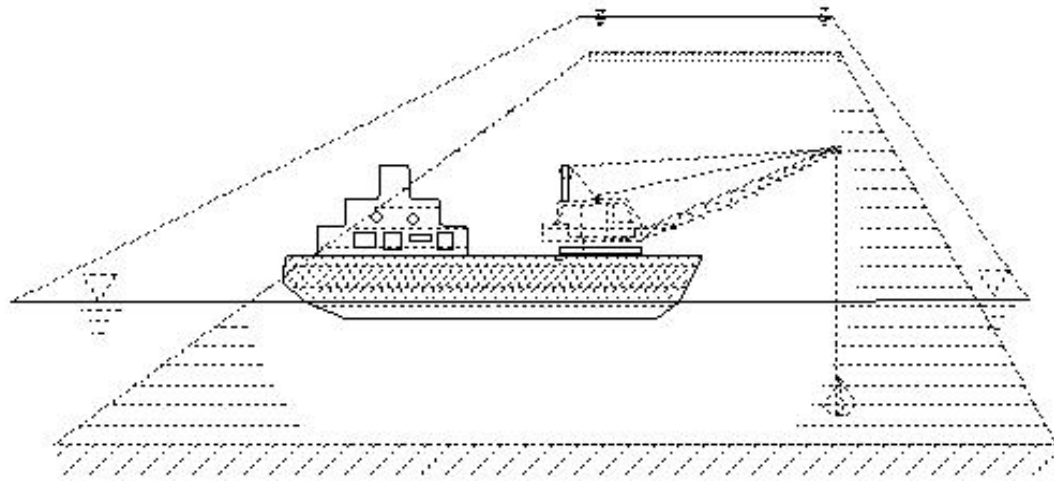
Digging soil involves transportation and disposal work

- Involves transportation and disposal work

working dredger

③ Grab dredger

excavating with a grab bucket



Grab dredger

(R379)dredging(Dipper dredger)

(R379) dredging (Dipper dredger)

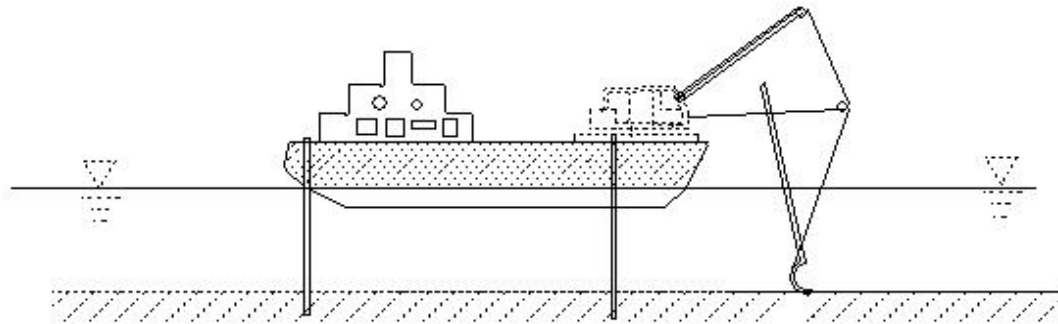
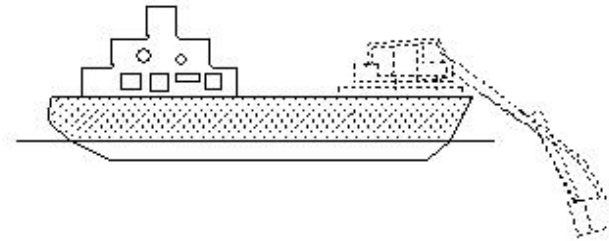
dredging

Digging soil involves transportation and disposal work

- Involves transportation and disposal work
- working dredger

④Dipper dredger

Excavating hard soil with a dipper

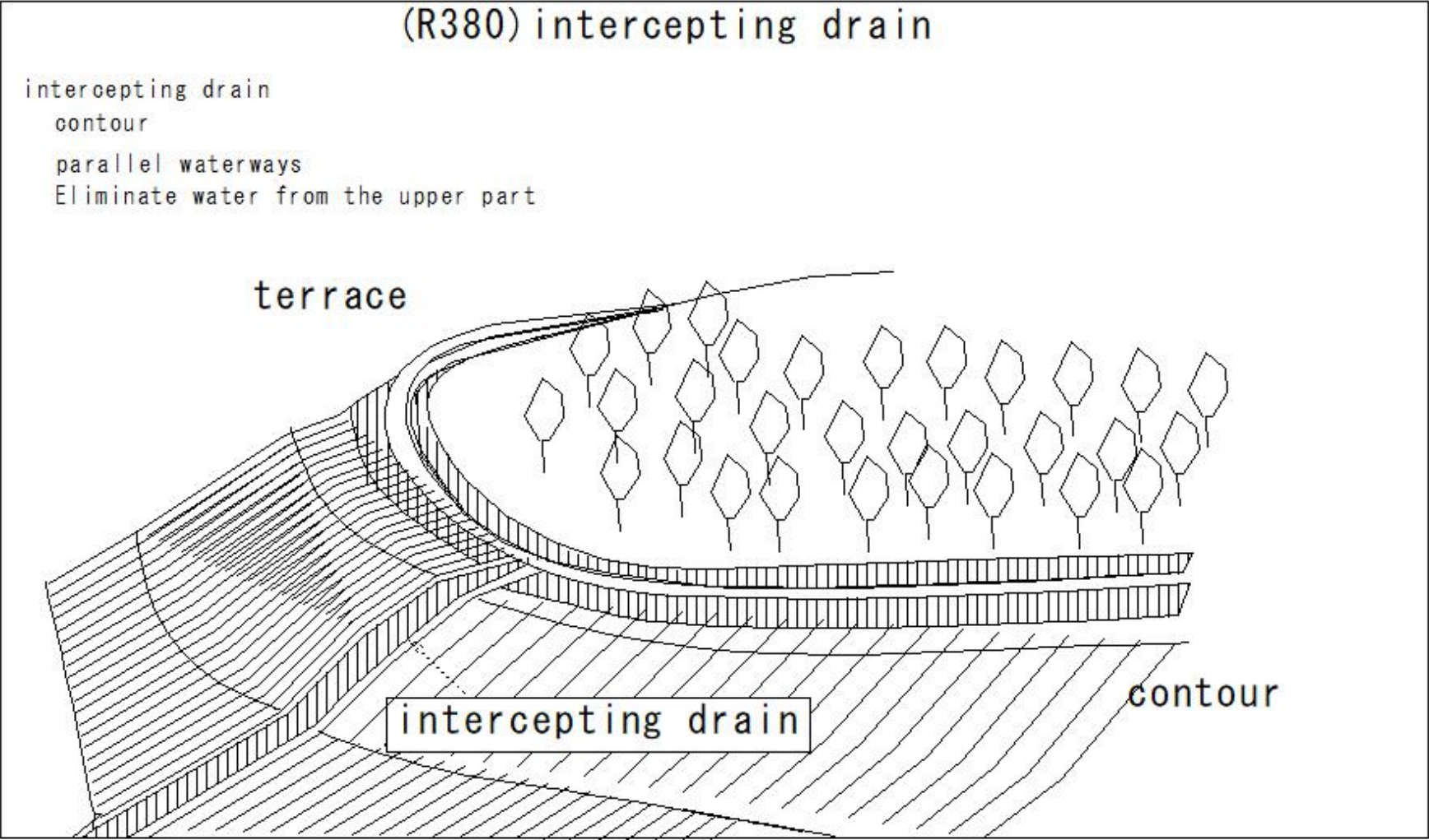


Dipper dredger

(R380)intercepting drain

(R380) intercepting drain

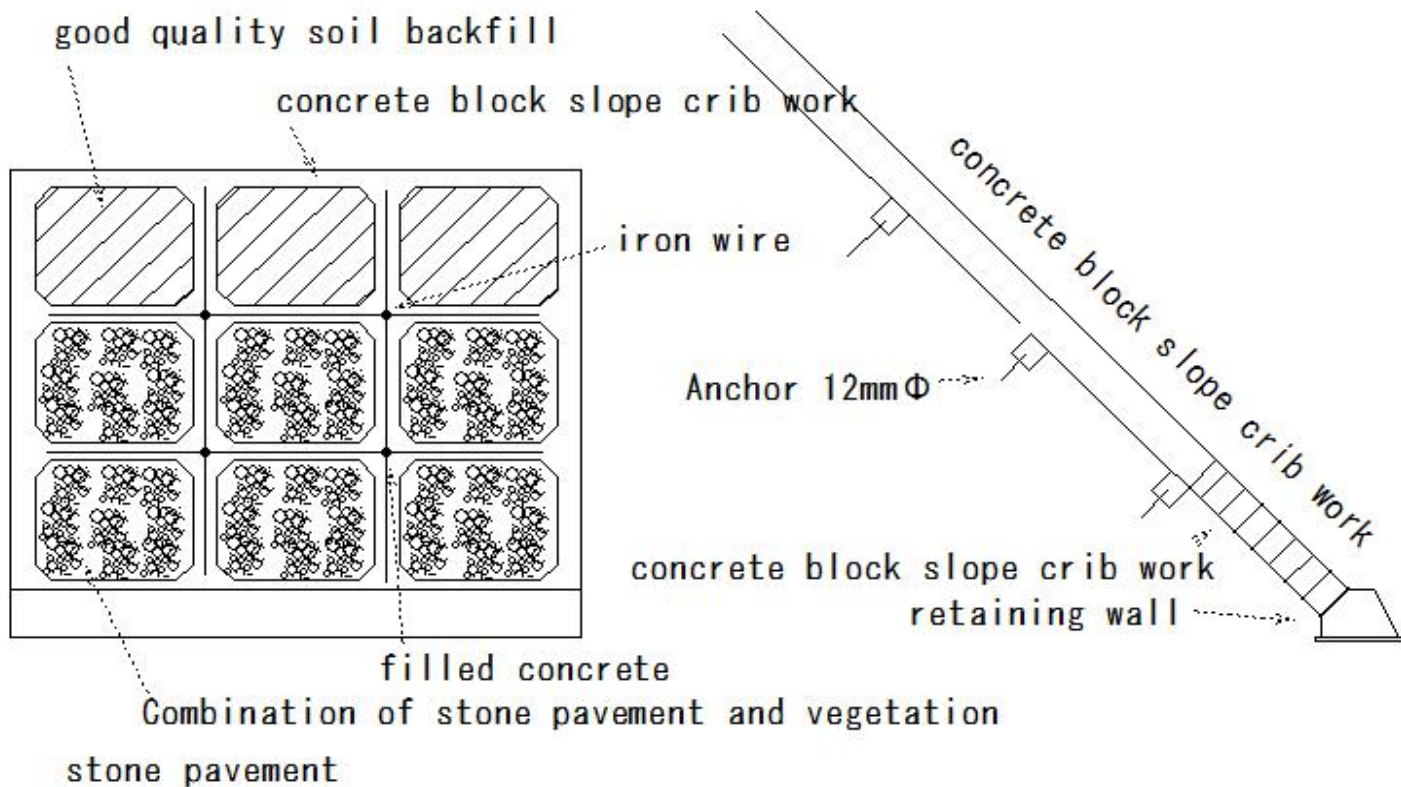
intercepting drain
contour
parallel waterways
Eliminate water from the upper part



(R381)slope crib work

(R381)slope crib work

slope crib work



(R382)river (cut-off)

(R382)river (cut-off)

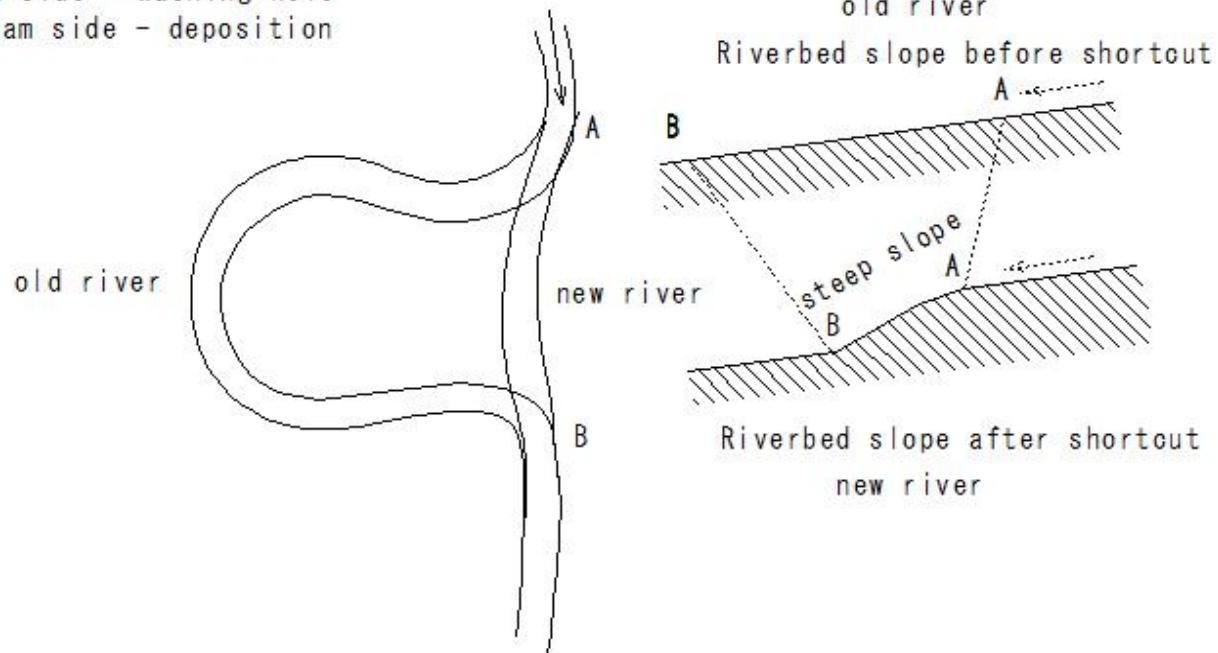
shortcut

Flow capacity - increase

short and connected

Upstream side - Washing hole

Downstream side - deposition



(R383)hydraulic pressure

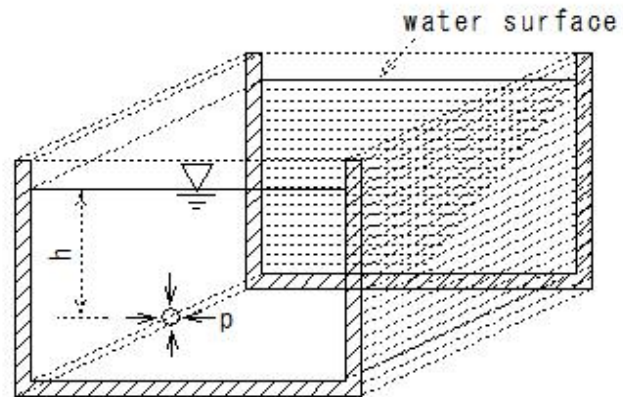
(R383)hydraulic pressure

hydraulic pressure

hydraulic pressure $p=wh$

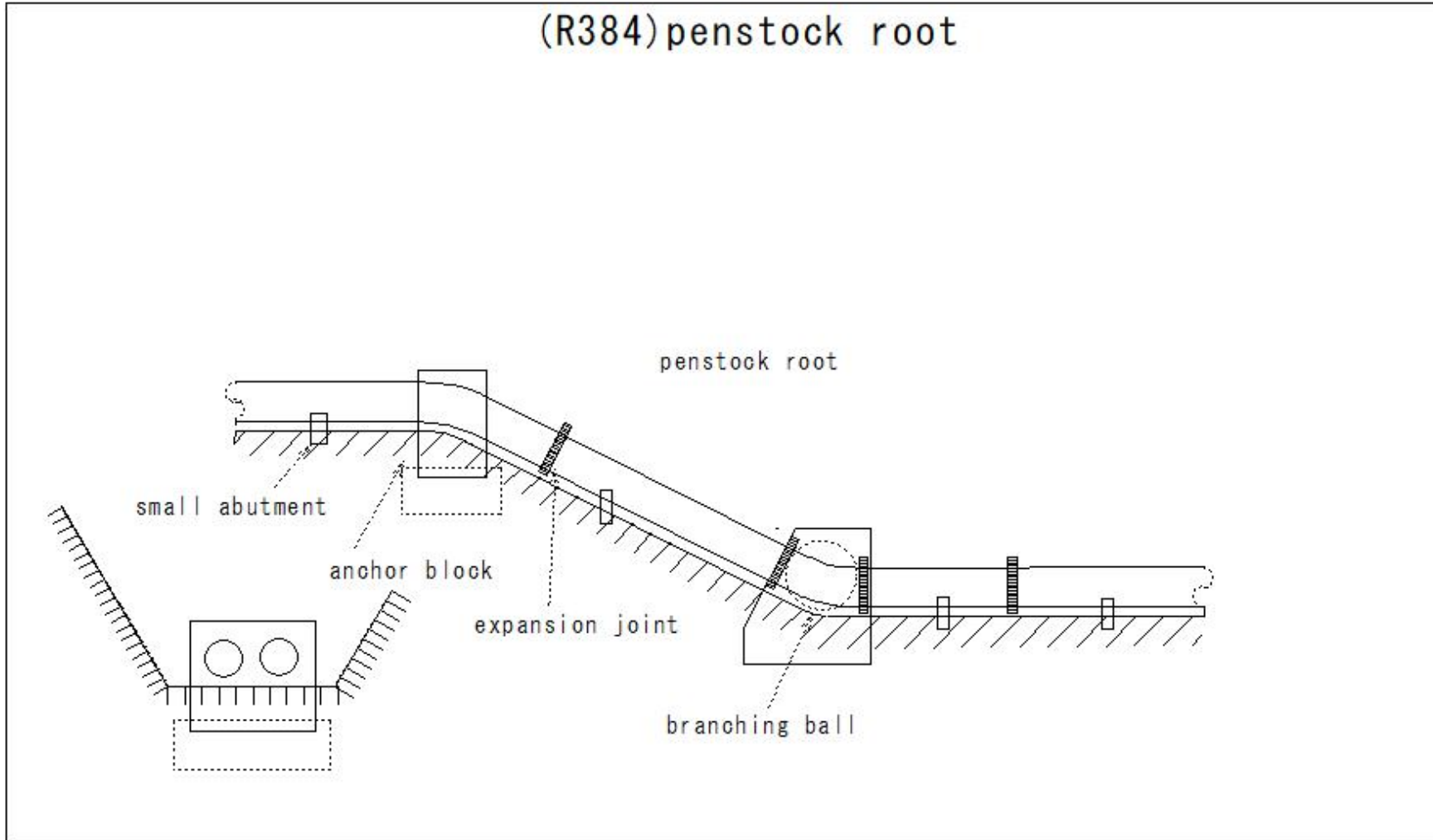
w: unit volume mass of water

h: water depth



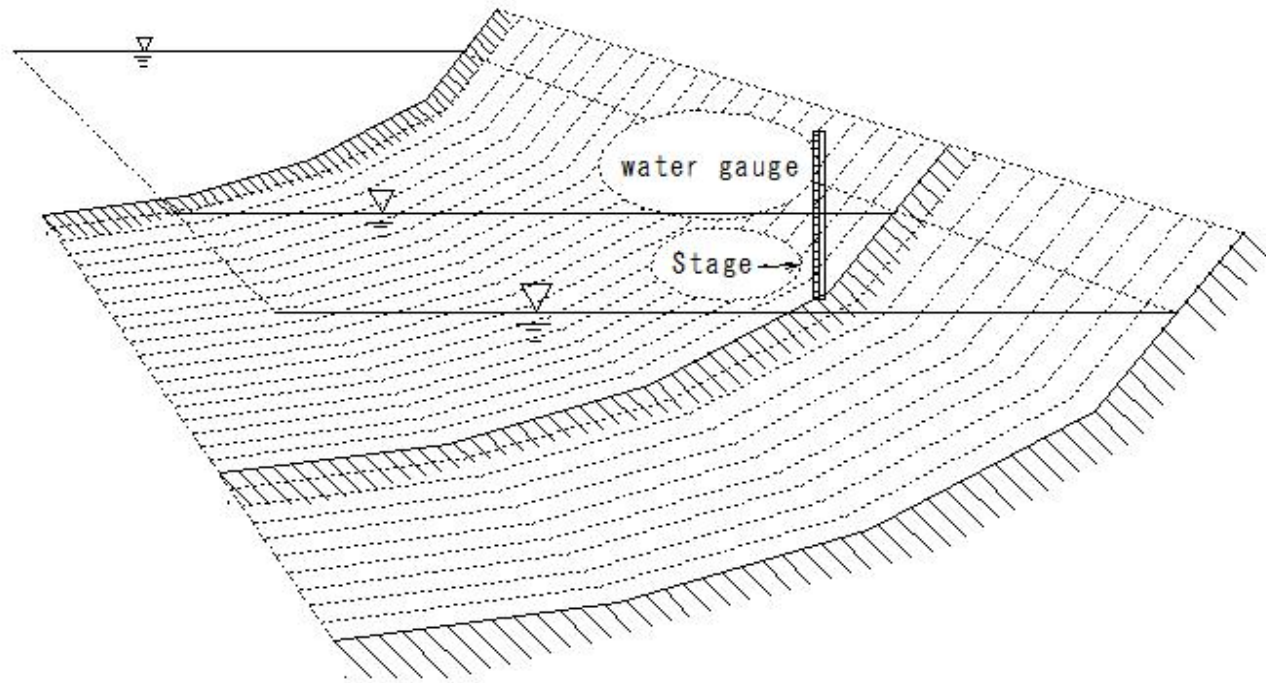
(R384)penstock root

(R384)penstock root



(R385)stage(water level)

(R385) stage (water level)



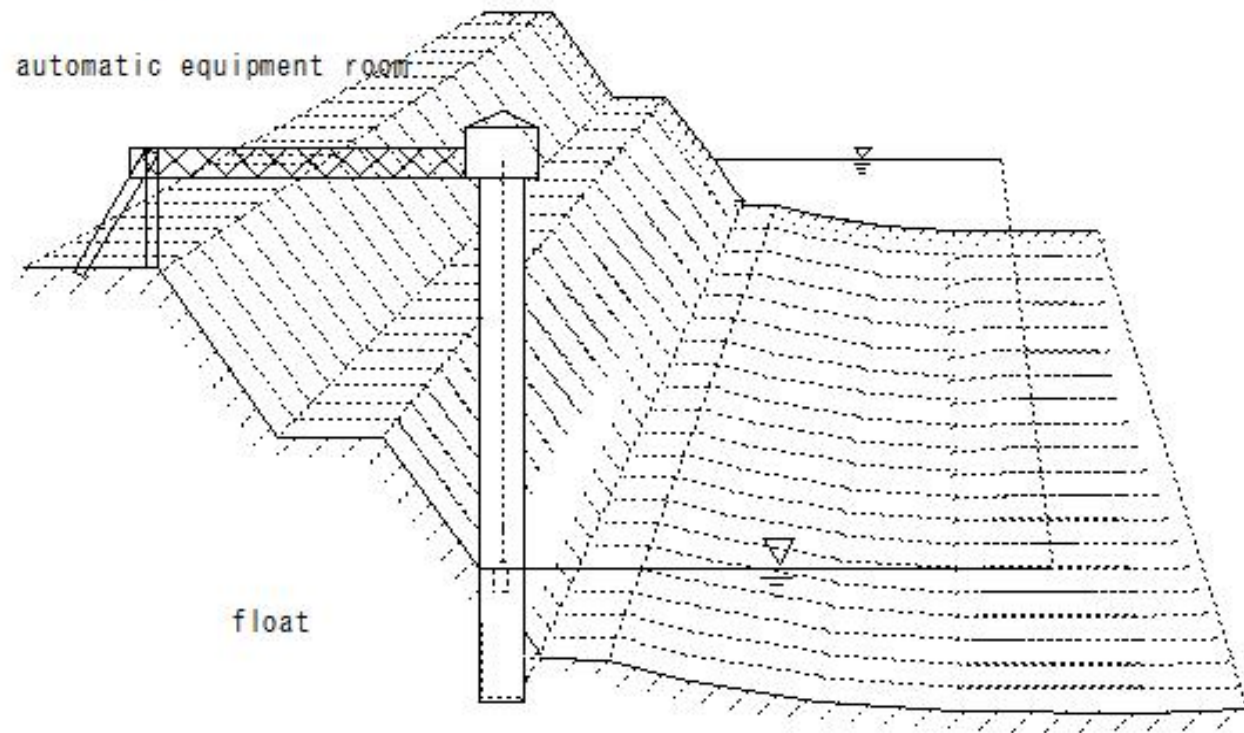
(R386)water-level recorder

(R386)water-level recorder

water-level recorder

instrument for measuring water level

Self-recording water level gauge



(R387)water hammmmer

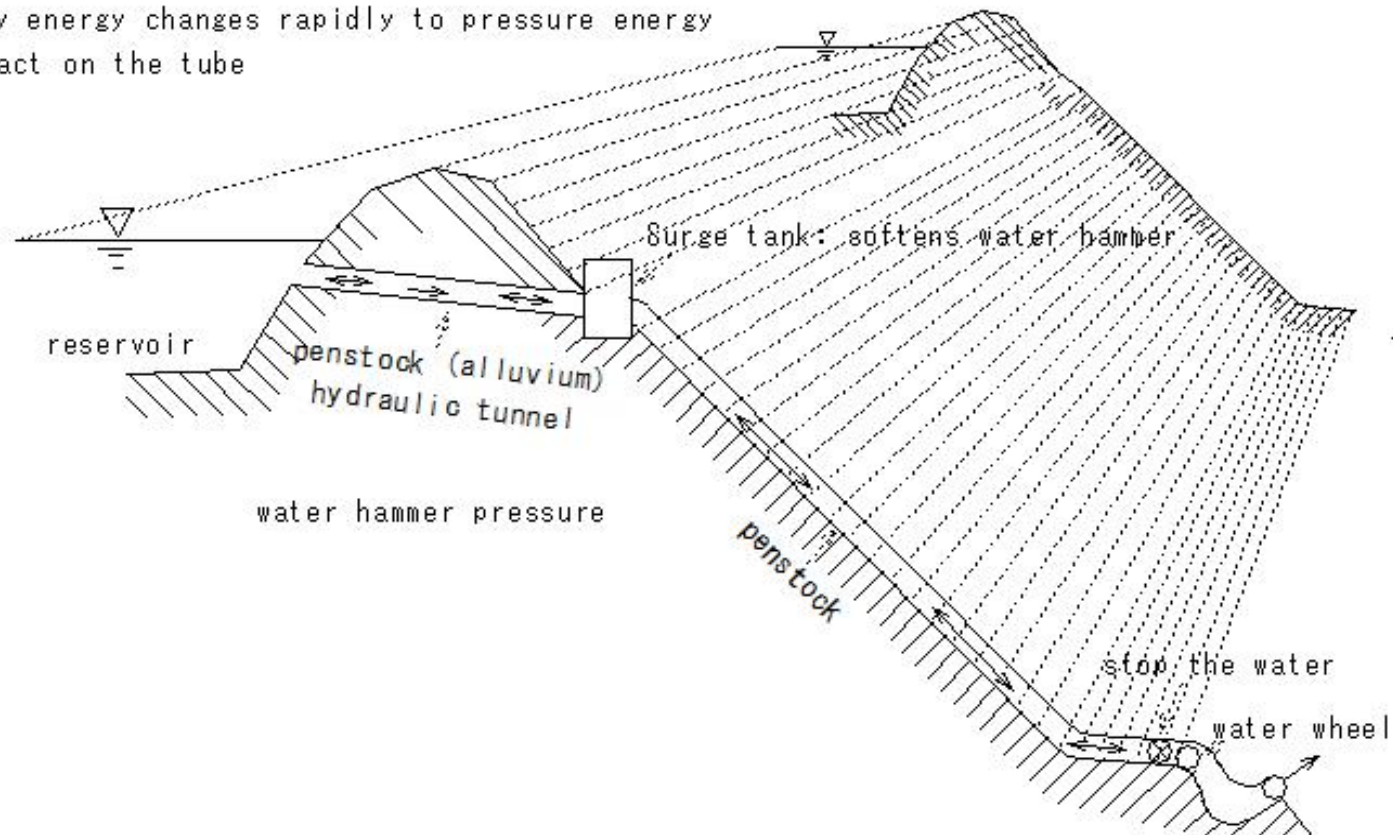
(R387)water hammmmer

water hammer

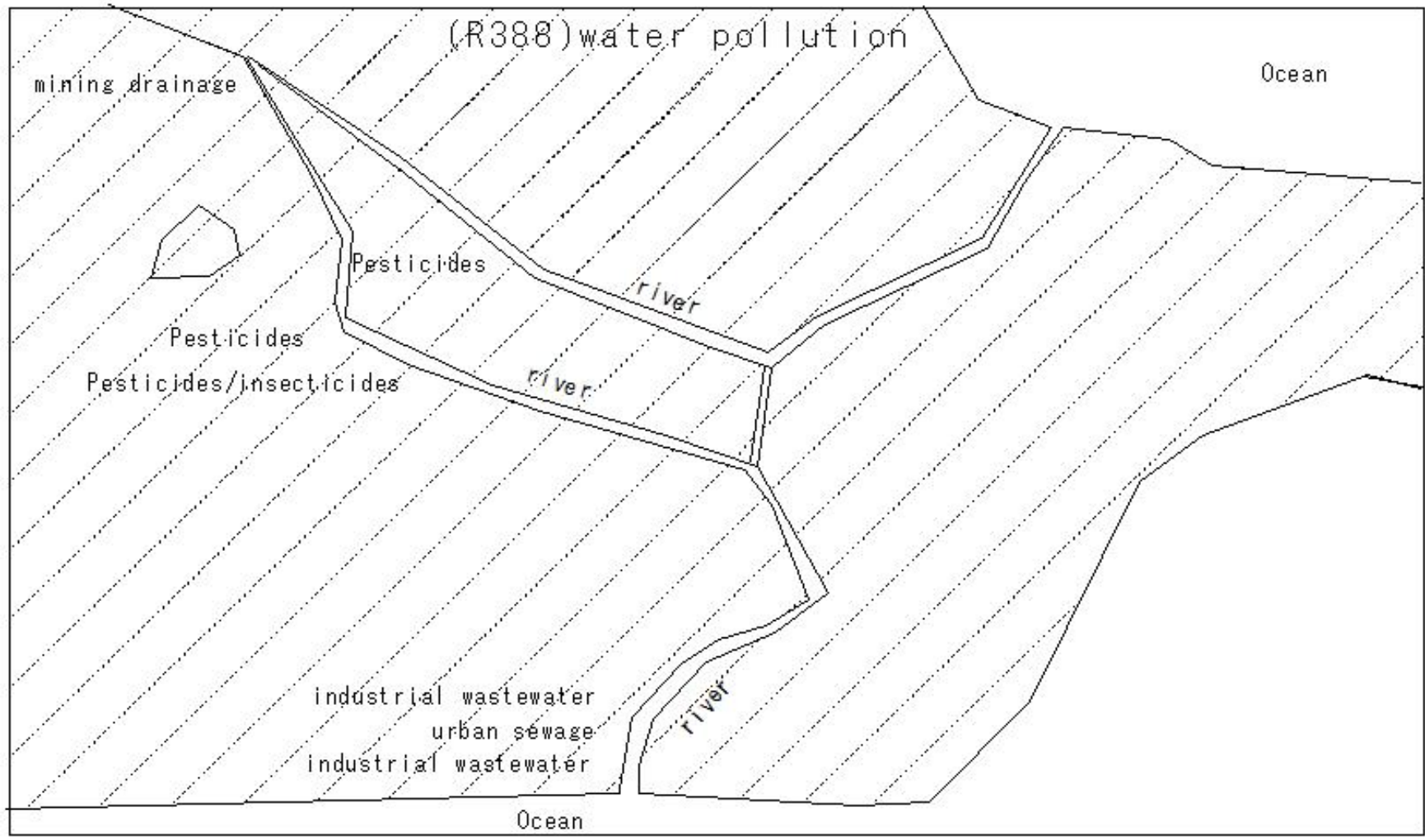
stop the water suddenly

Velocity energy changes rapidly to pressure energy

big impact on the tube



(R388)water pollution

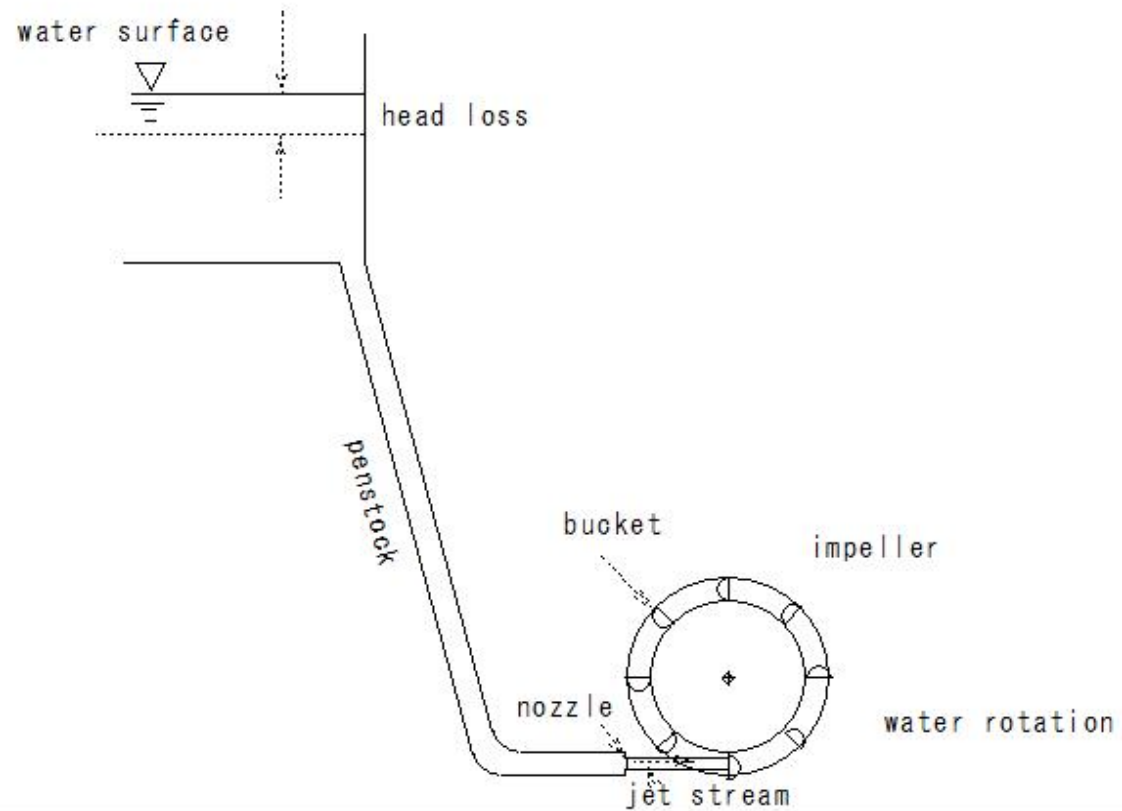


(R389)hydraulic turbine

(R389)hydraulic turbine

hydraulic turbine

Generate electricity by operating a directly connected generator



(R390)gate

(R390) gate

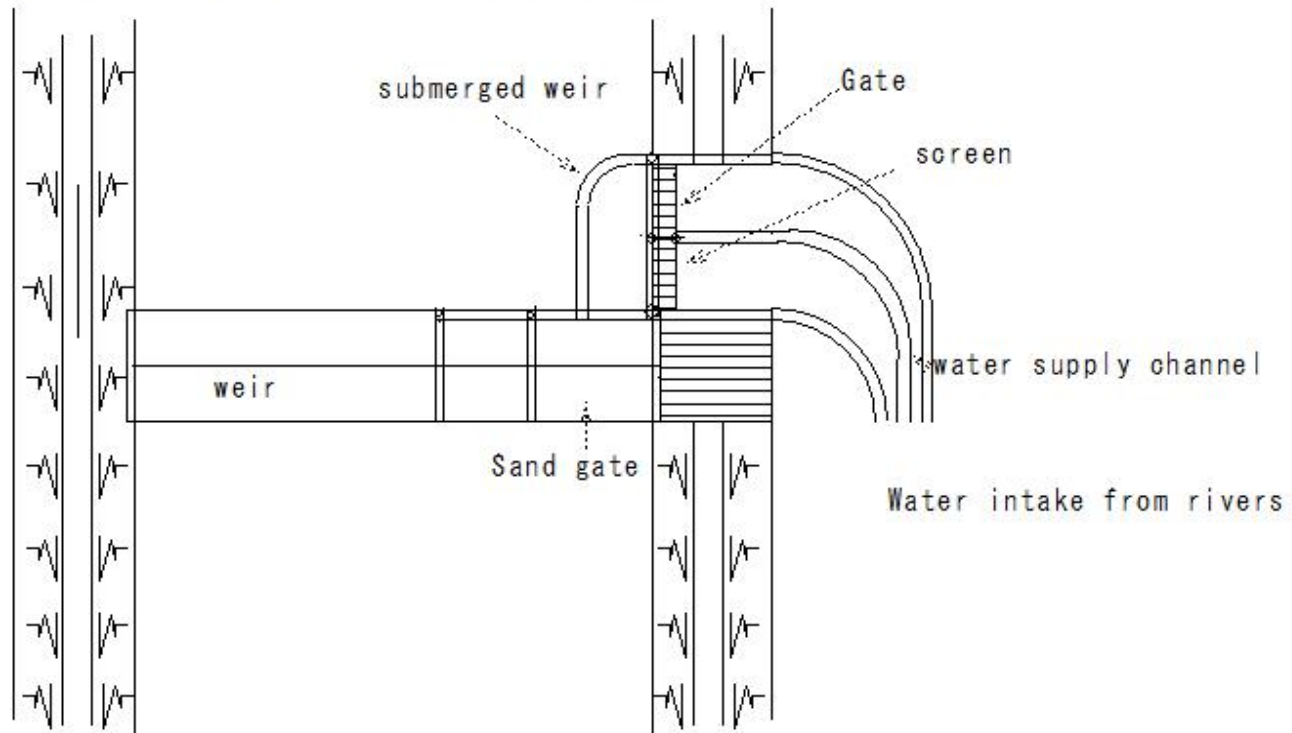
gate

discharge adjustment

water intake

for ship navigation

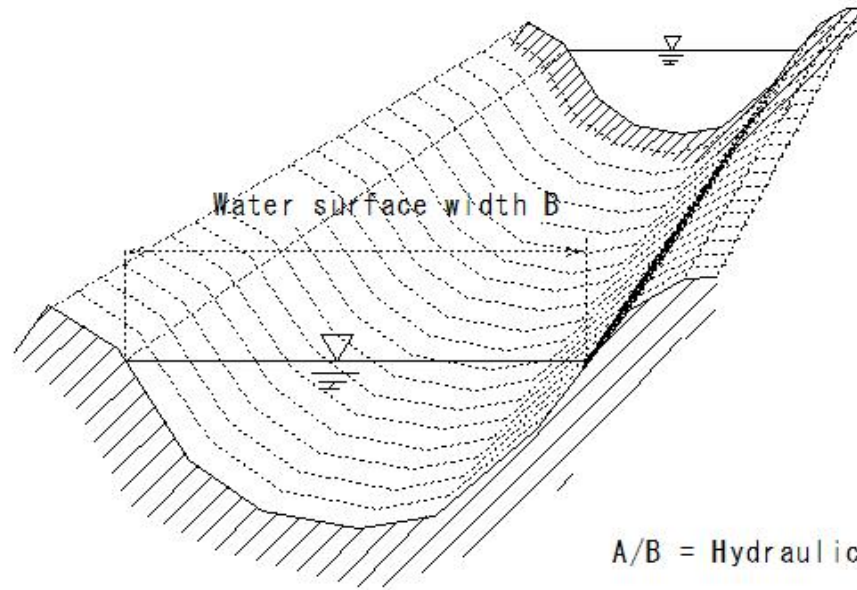
Movable doors installed across rivers, canals, and embankments



(R391)Hydraulic water depth

(R391)Hydraulic water depth

Hydraulic water depth



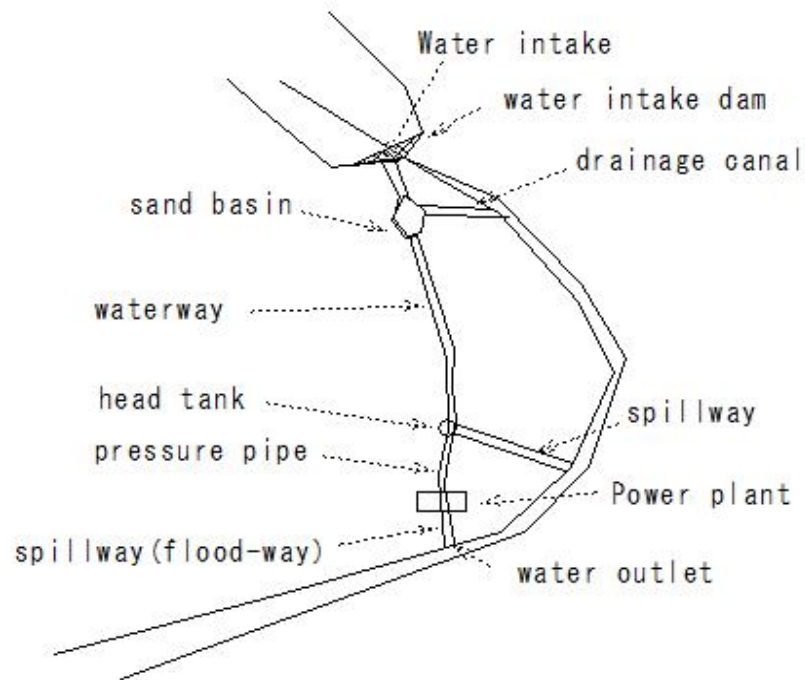
Cross-sectional area of flow A

(R392)conduct type water power

(R392)conduct type water power

conduct type water power

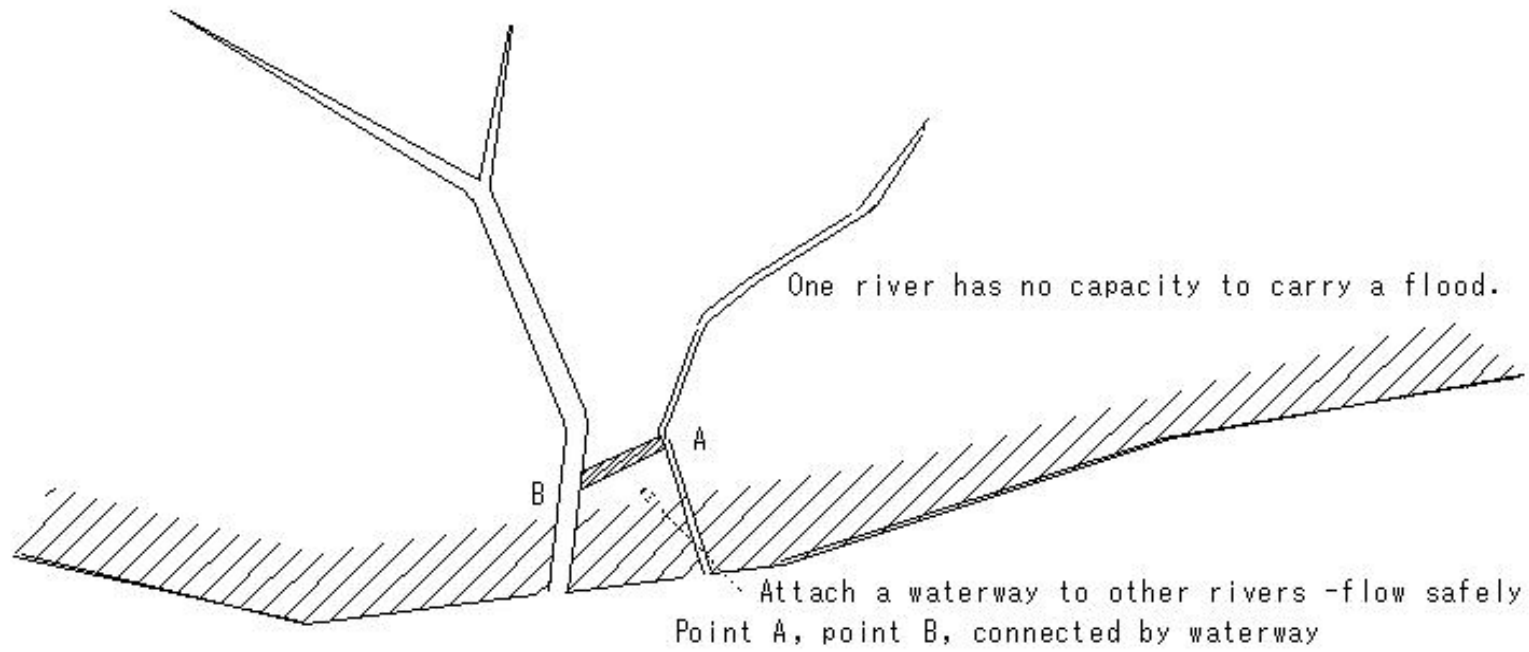
Guide river water through a channel to a point where a large head can be obtained.
Generate electricity by dropping it down with a pressure tube



(R393)diversion of water channel

(R393)diversion of water channel

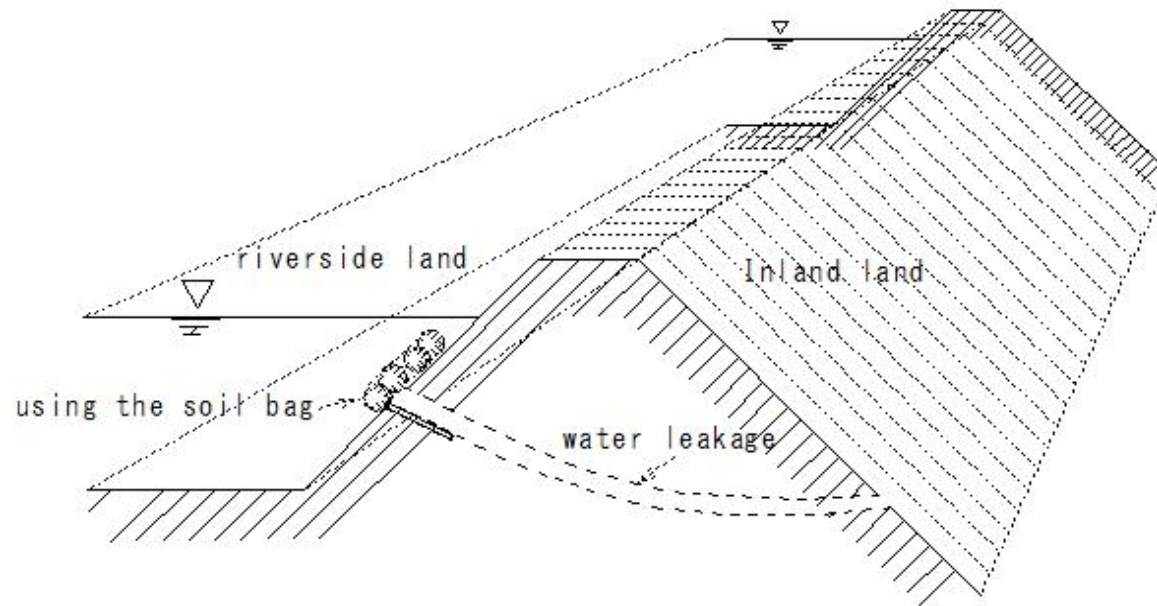
diversion of water channel
Flood measures



(R394) Preventing water leakage from embankments

(R394) Preventing water leakage from embankments

Preventing water leakage from embankments



(R395)stoney gate weir

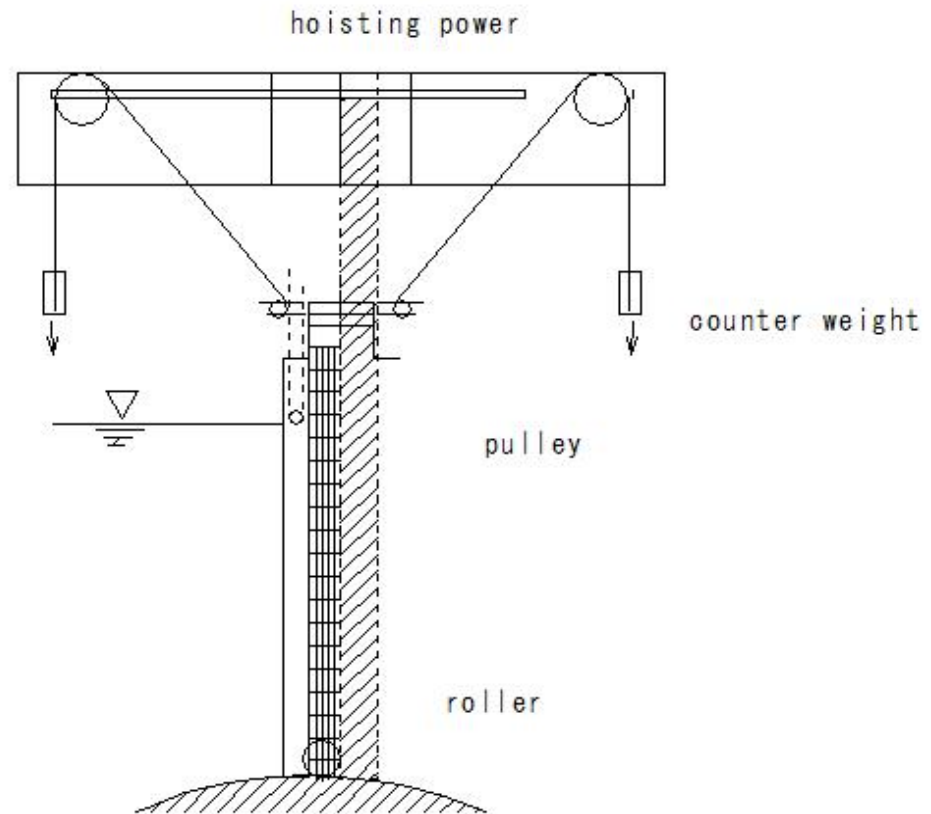
(R395) stoney gate weir

stoney gate weir

sluice gate

series of rollers

- The top and bottom open and close smoothly.

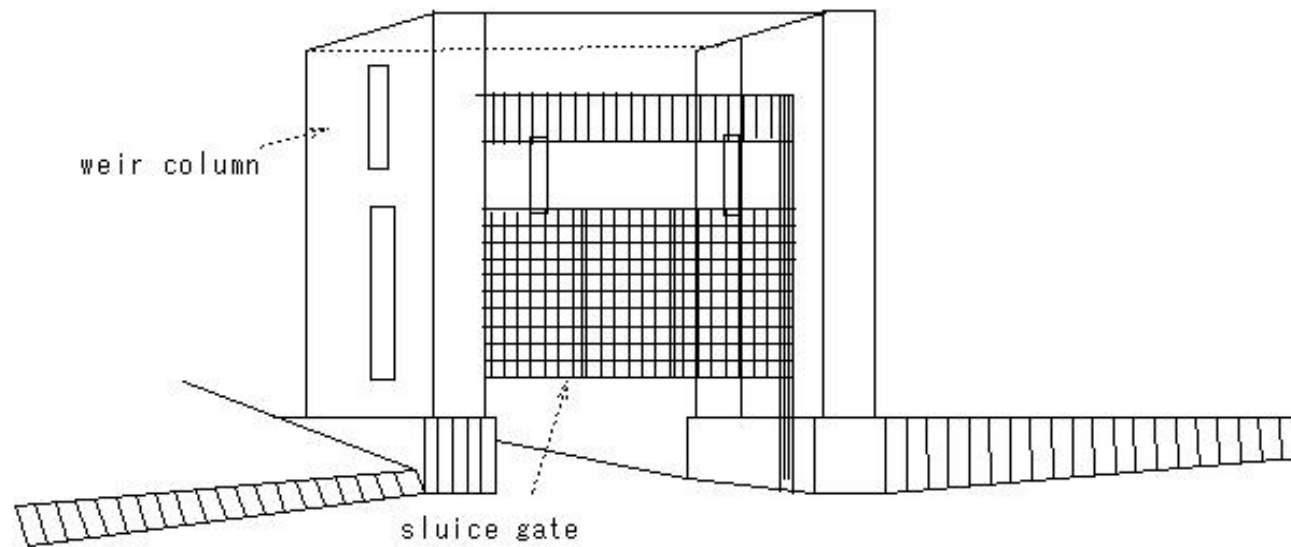


(R396)sluice gate

(R396)sluice gate

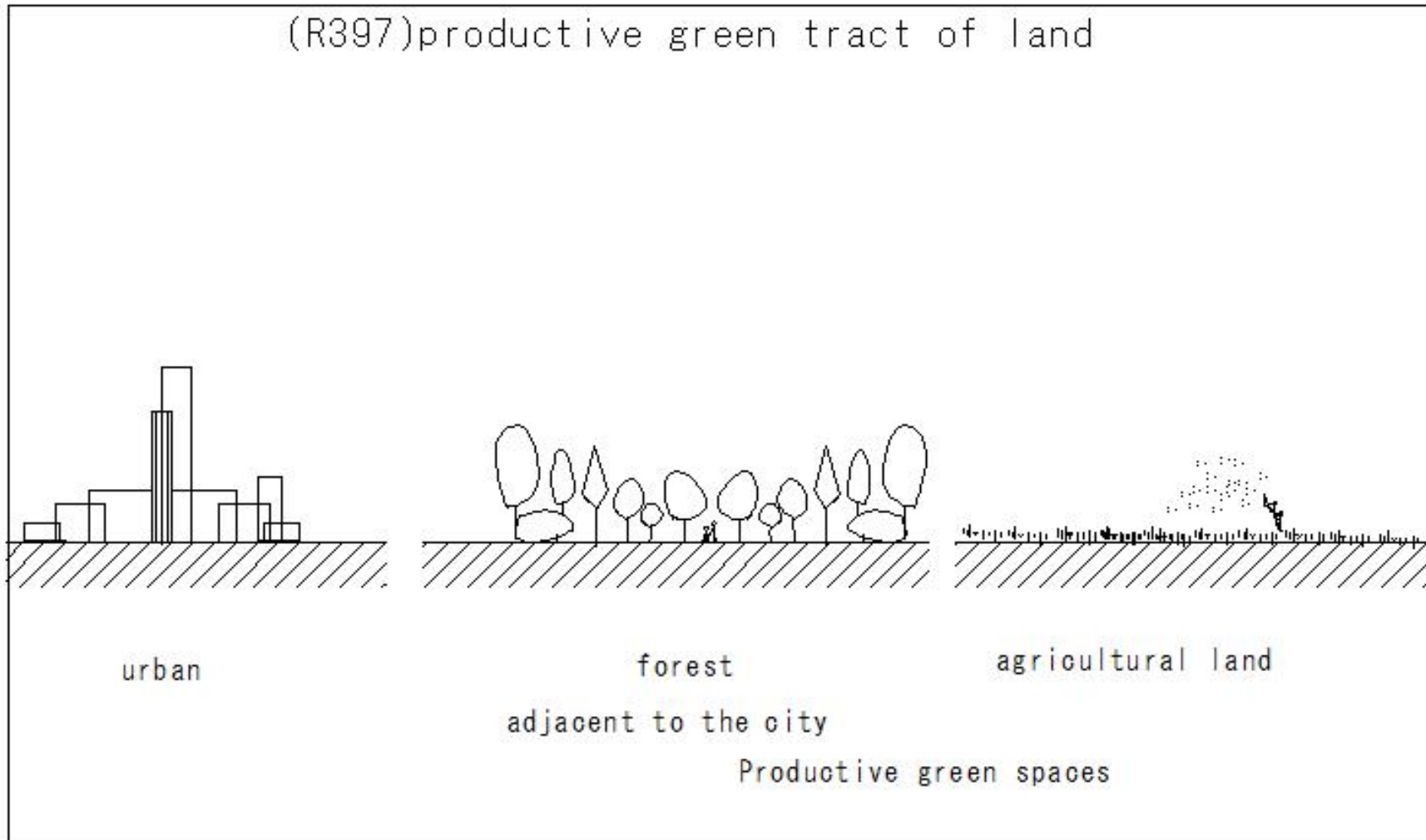
sluice gate

Rectangular gate that can be opened and closed up and down



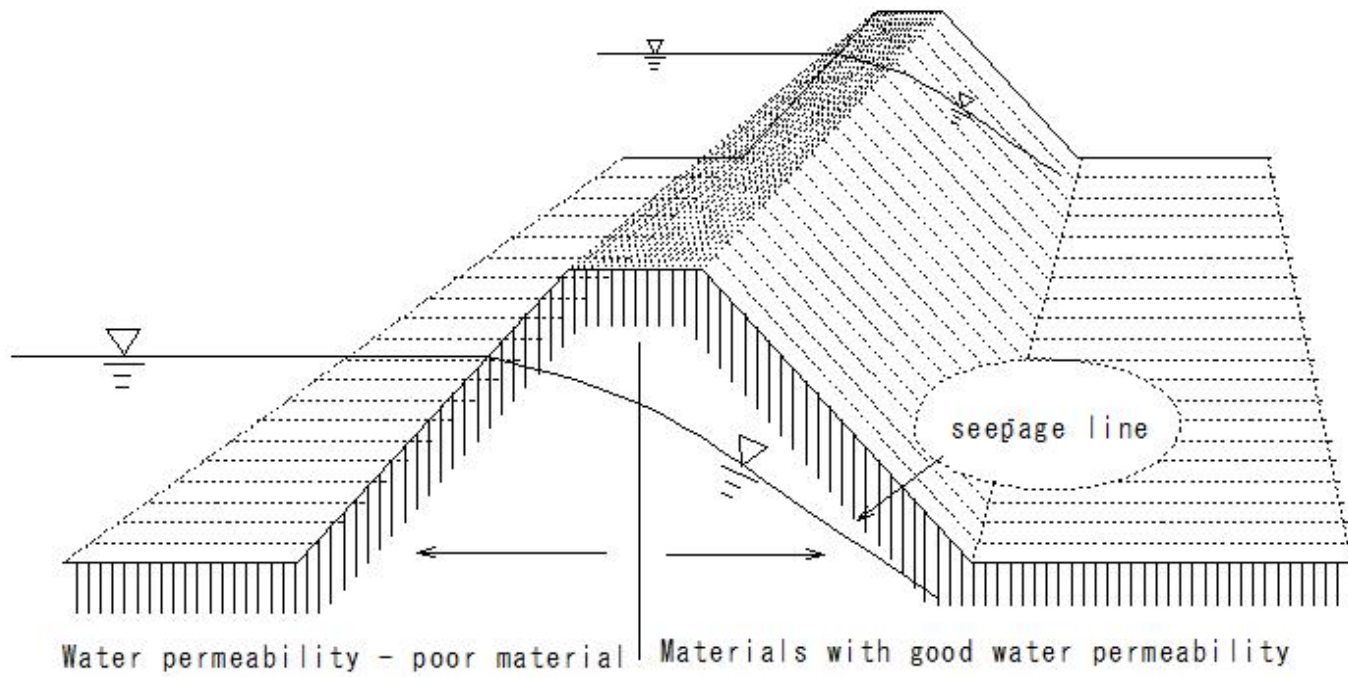
(R397)productive green tract of land

(R397)productive green tract of land



(R398)seepage line

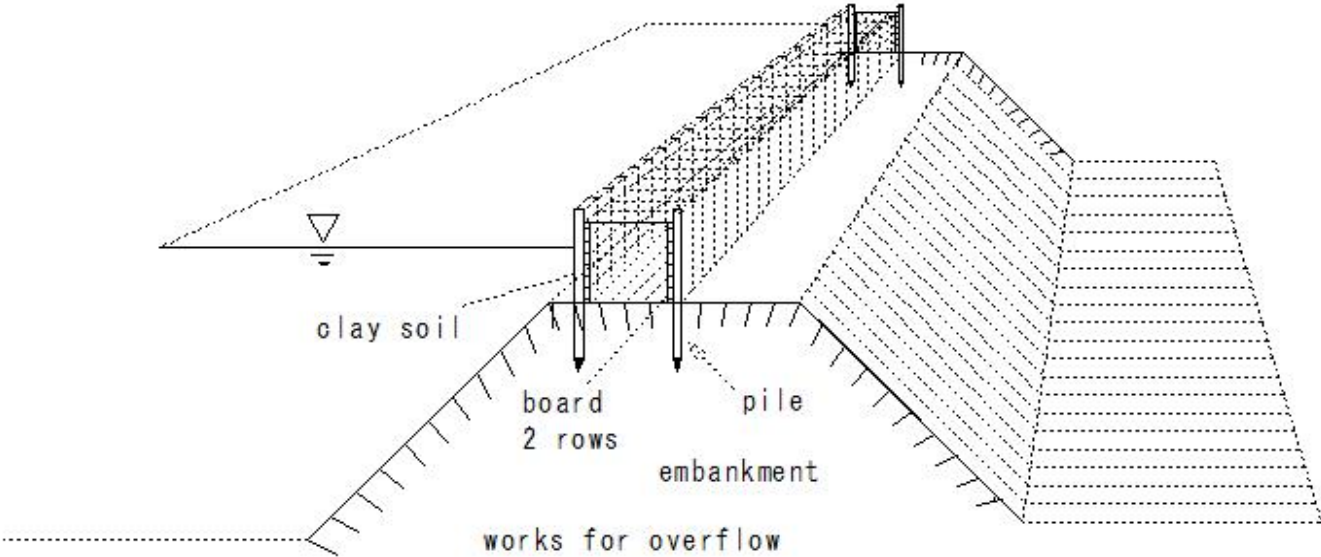
(R398)seepage line



(R399)works for overflow(board work)

(R399)works for overflow(board work)

works for overflow(board work)
A type of flood prevention method

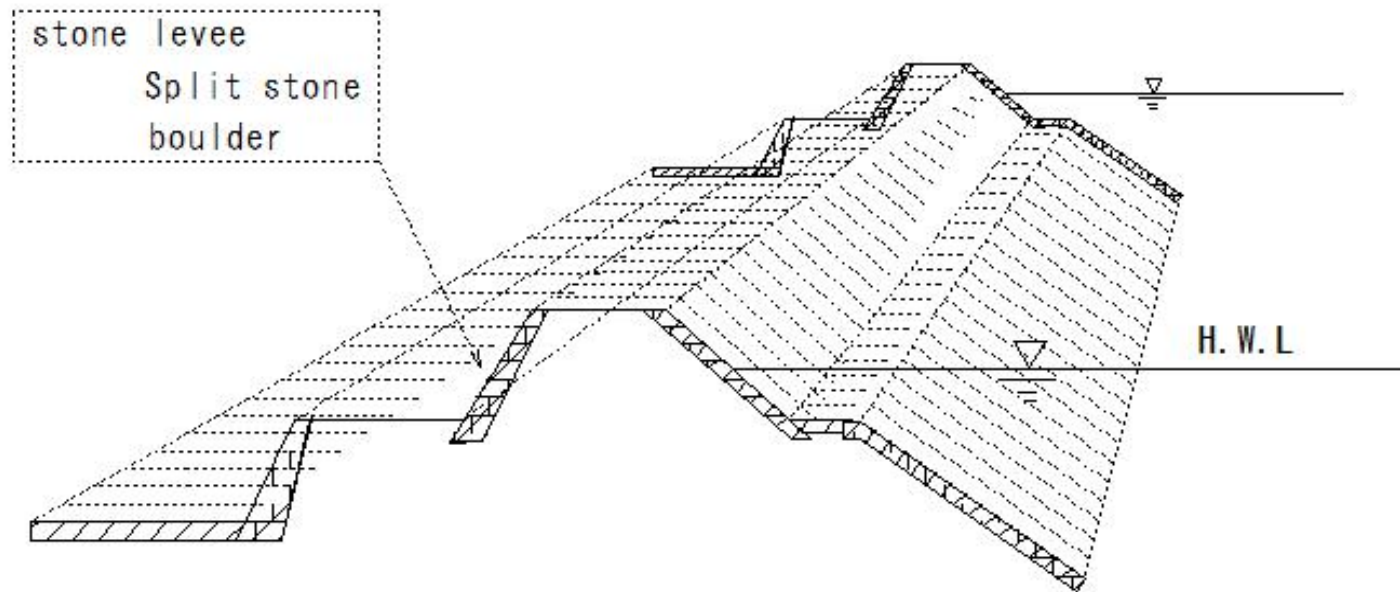


(R400)stone levee

(R400)stone levee

stone levee

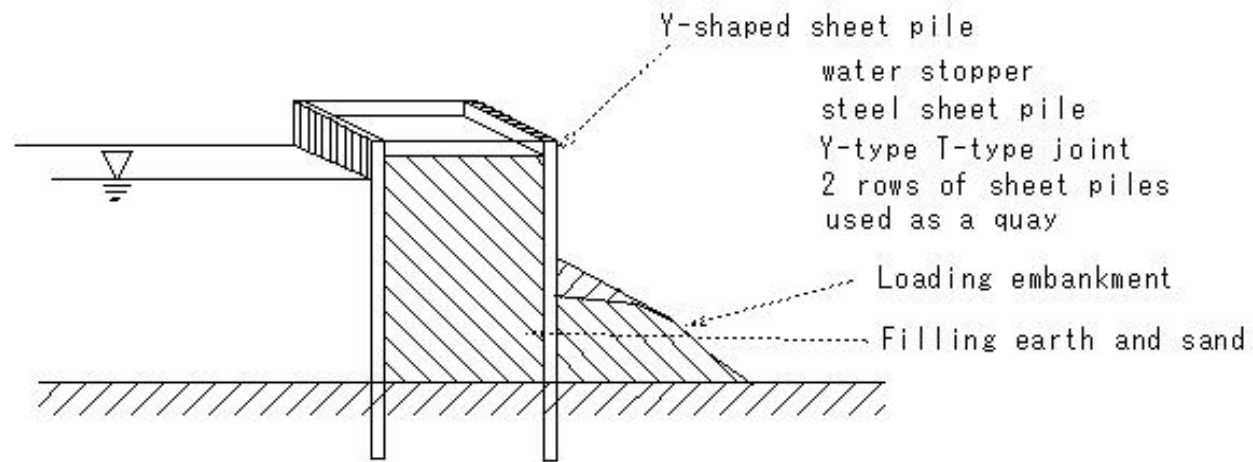
The slope of an embankment is made of broken stones, cobbles, etc.



(R401)cellular sheet pile

(R401)cellular sheet pile

cellular sheet pile



(R402)separation levee

(R402)separation levee

separation levee

To move the confluence downstream
Embankment between both rivers

Conditions requiring installation

both rivers

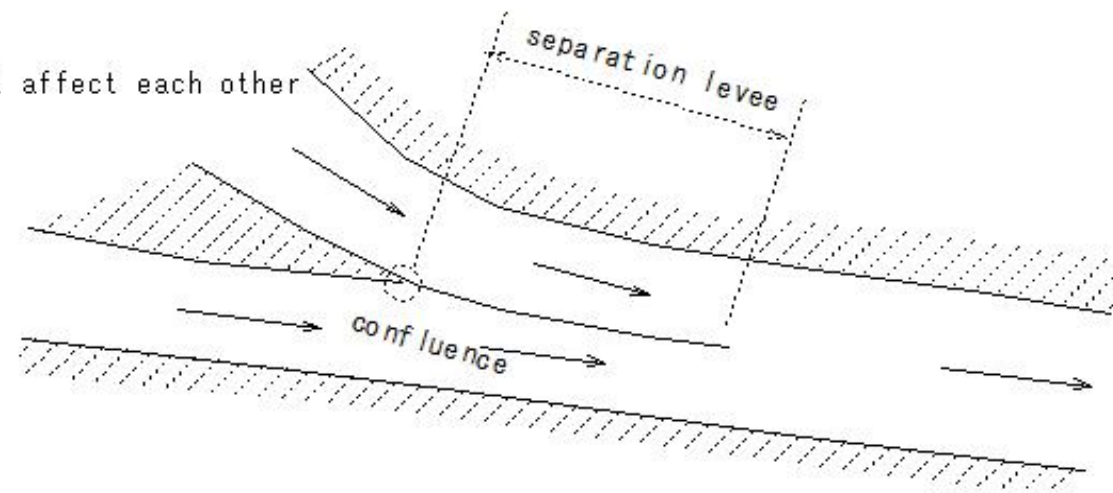
①River bed slope

②discharge

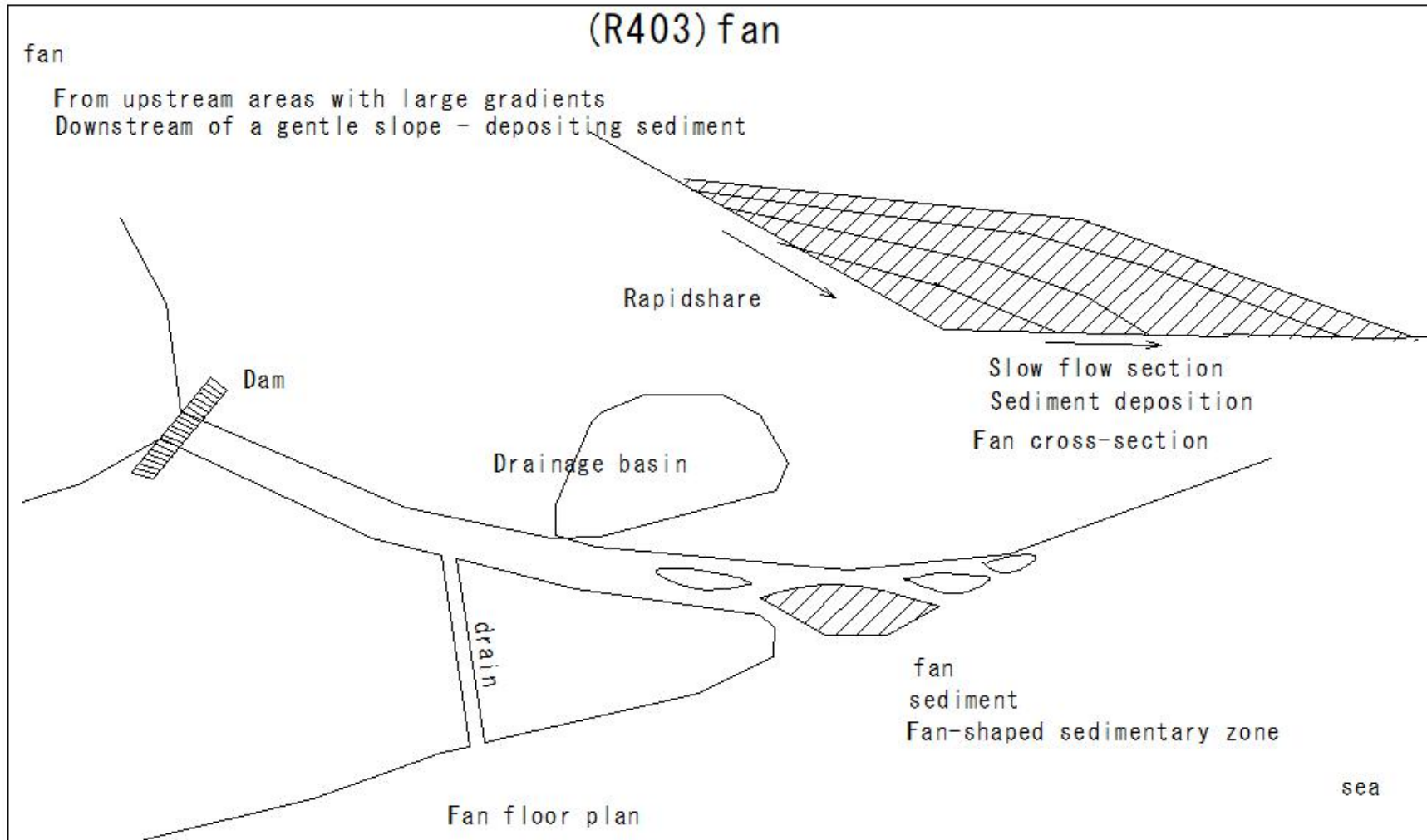
huge difference

separation levee

Extend to a position : do not affect each other



(R403)fan



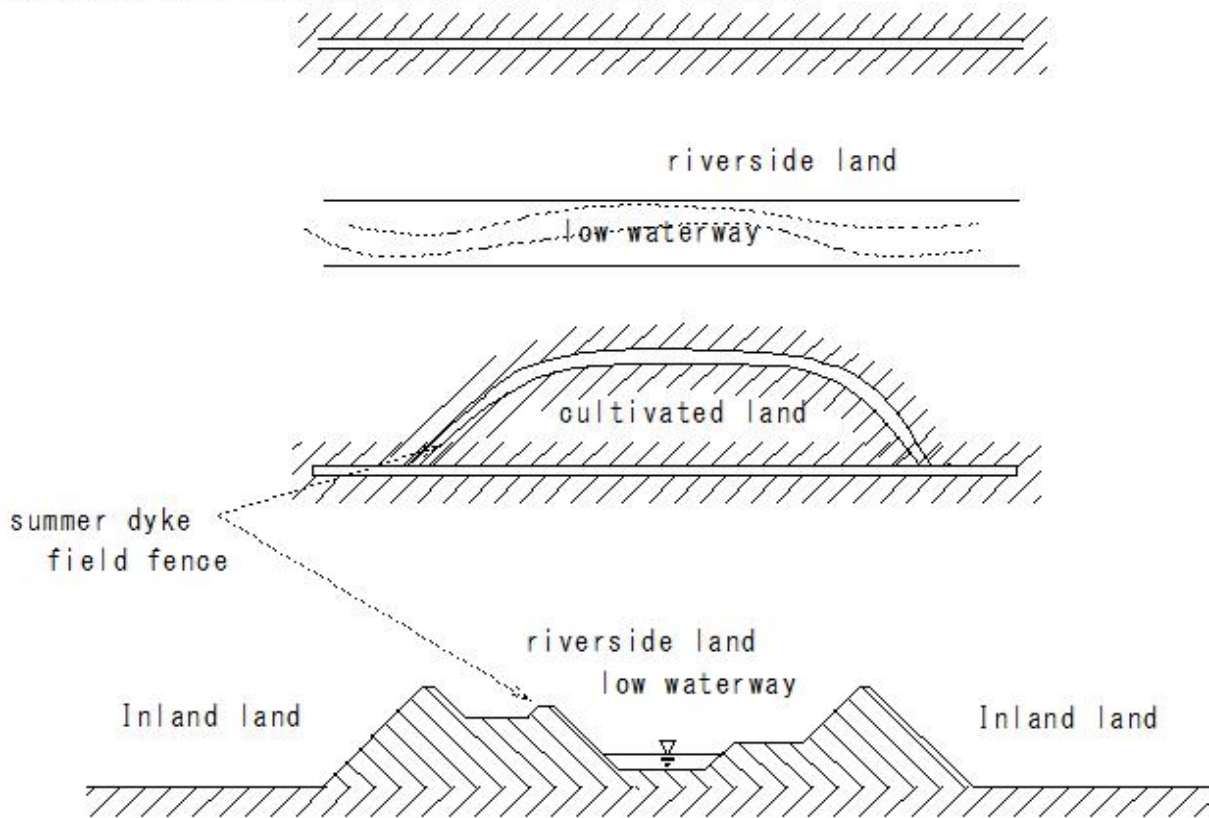
(R404)summer dyke

(R404) summer dyke

summer dyke

Protecting cultivated riverside land the embankment from minor flooding

Inland land

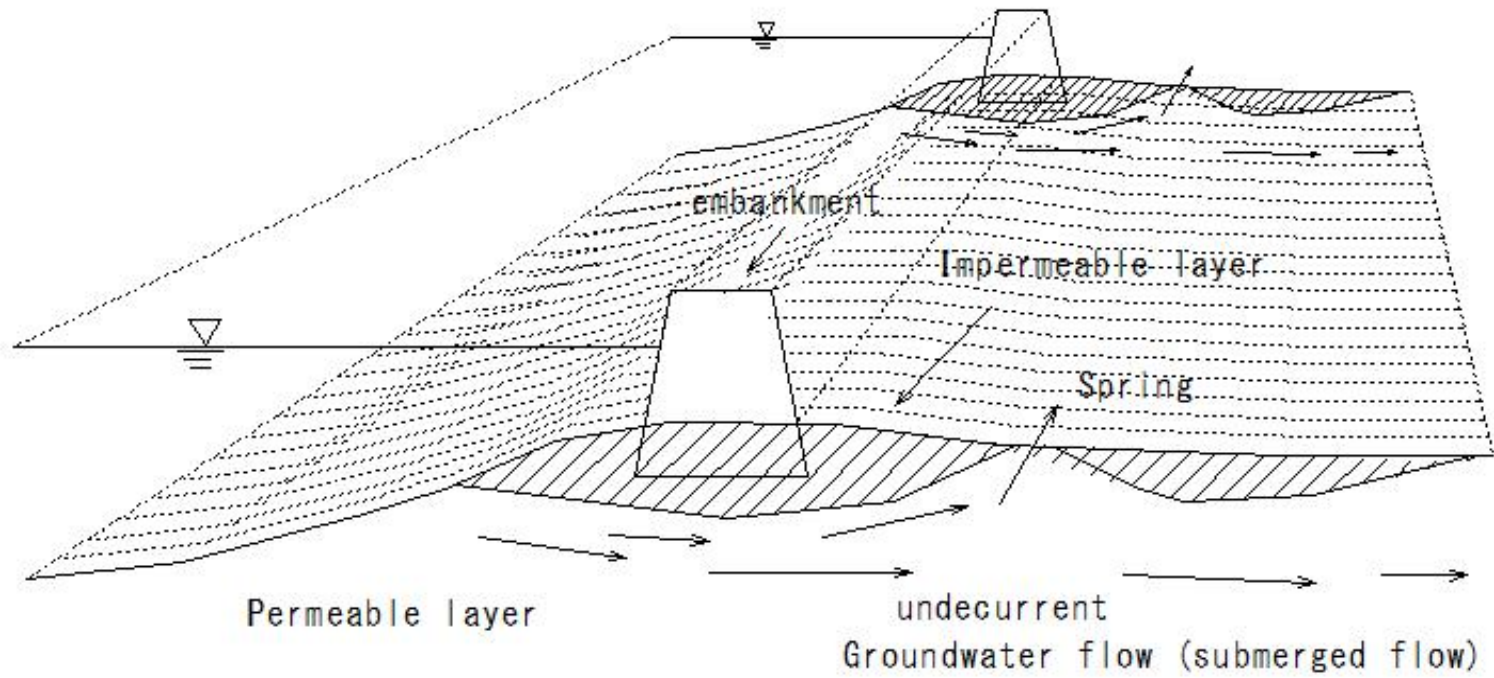


(R405)undercurrent

(R405)undercurrent

undercurrent

Water flowing under the gravel layer of the river bed



(R406)sodding

(R406) sodding

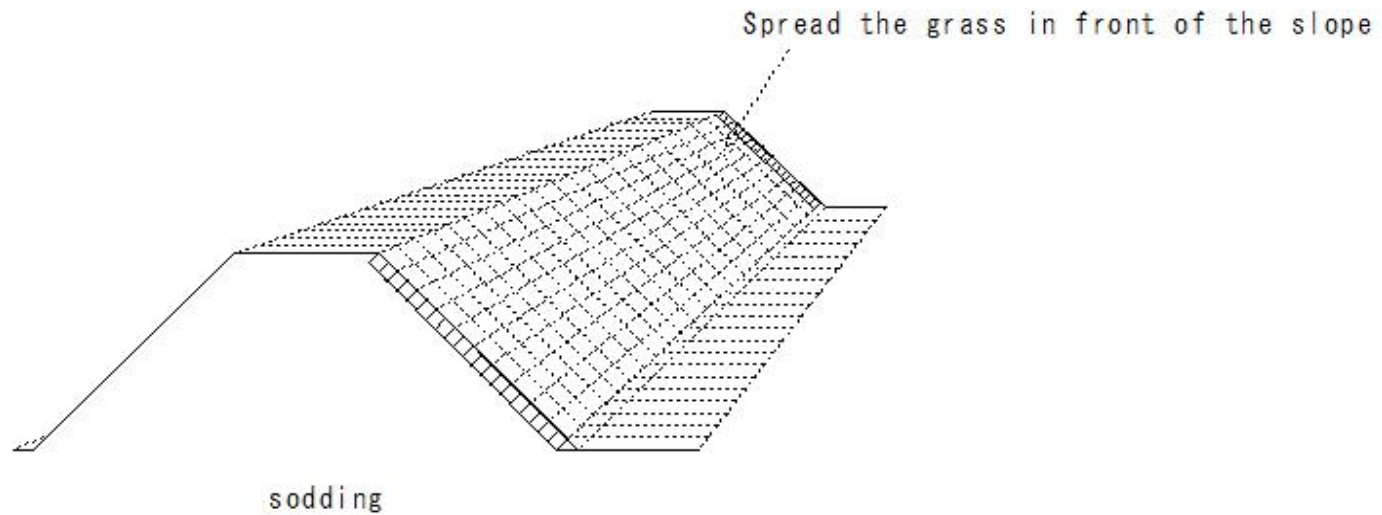
sodding

slope protection

plant grass in front

slope covering(lining) works

Used on river surface of river embankment



(R407)traction

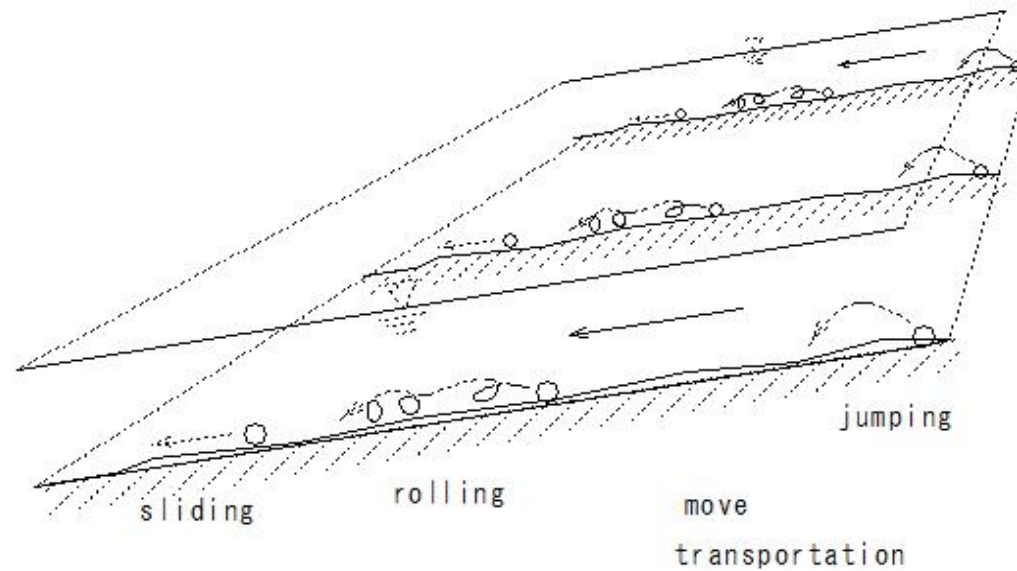
(R407)traction

traction: Flowing by rolling on the river bed

Sediment on the riverbed is Scouring

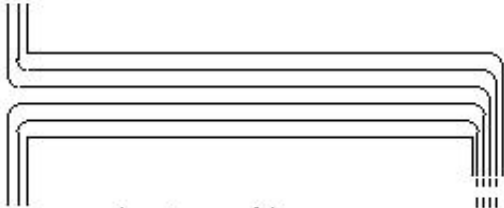
flow out

Sediment on the river bed



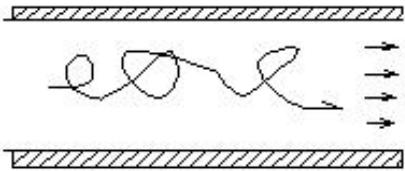
(R408)laminar flow

(R408)laminar flow

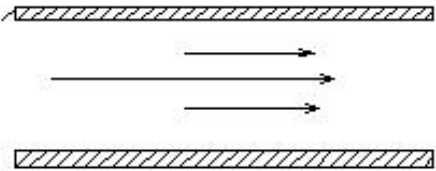


laminar flow

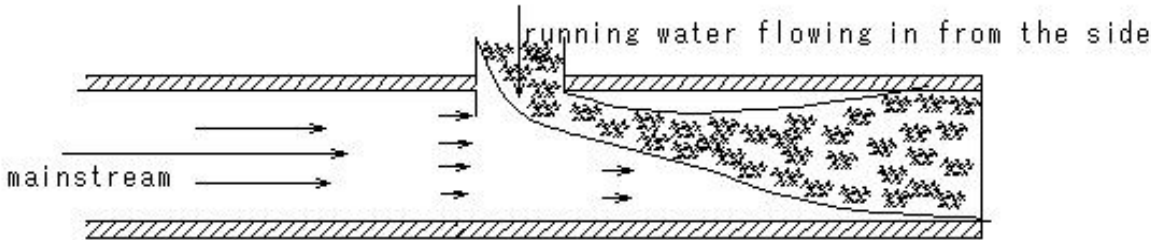
The layers of the flow do not get mixed up.
flows in not mix



turbulent flow



laminar flow



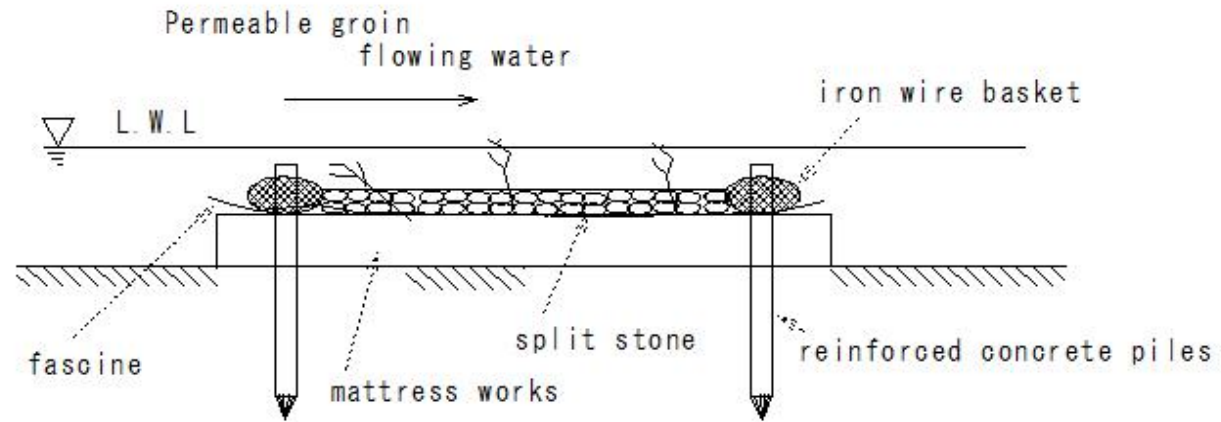
running water flowing in from the side

water diffusion phenomenon

(R409)fascine

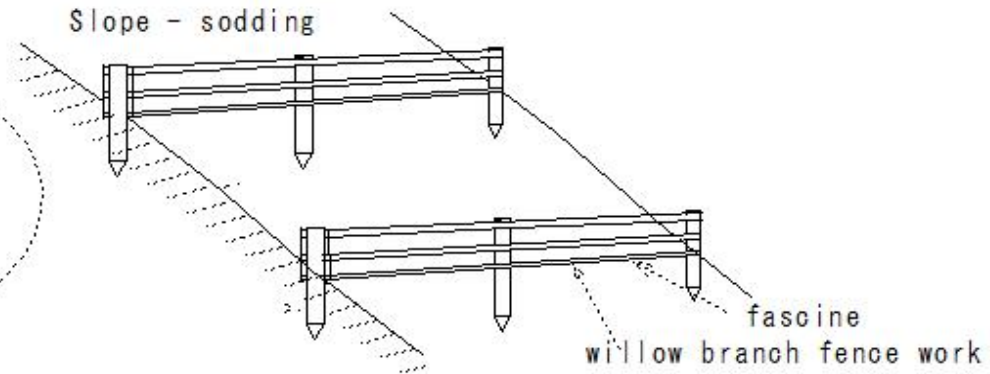
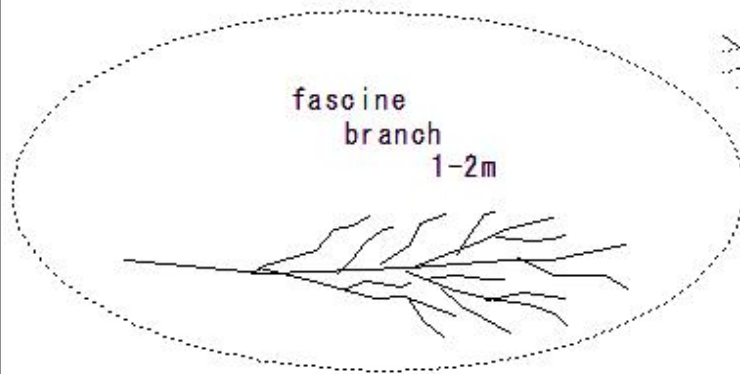
(R409) fascine

fascine
mountainside
bank protection
groin
Flood protection



Used as material for landslide prevention facilities

Slope - sodding



(R410)flowing through capability

(R410)flowing through capability

flowing through capability

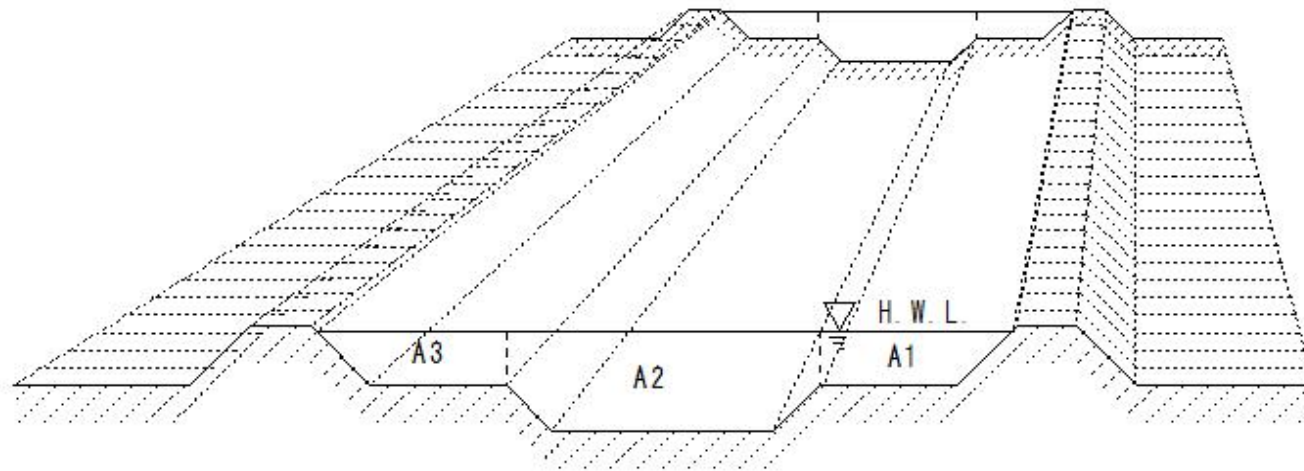
The limit to which rivers can safely carry flood waters

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

$$Q=A_1v_1+A_2v_2+A_3v_3$$



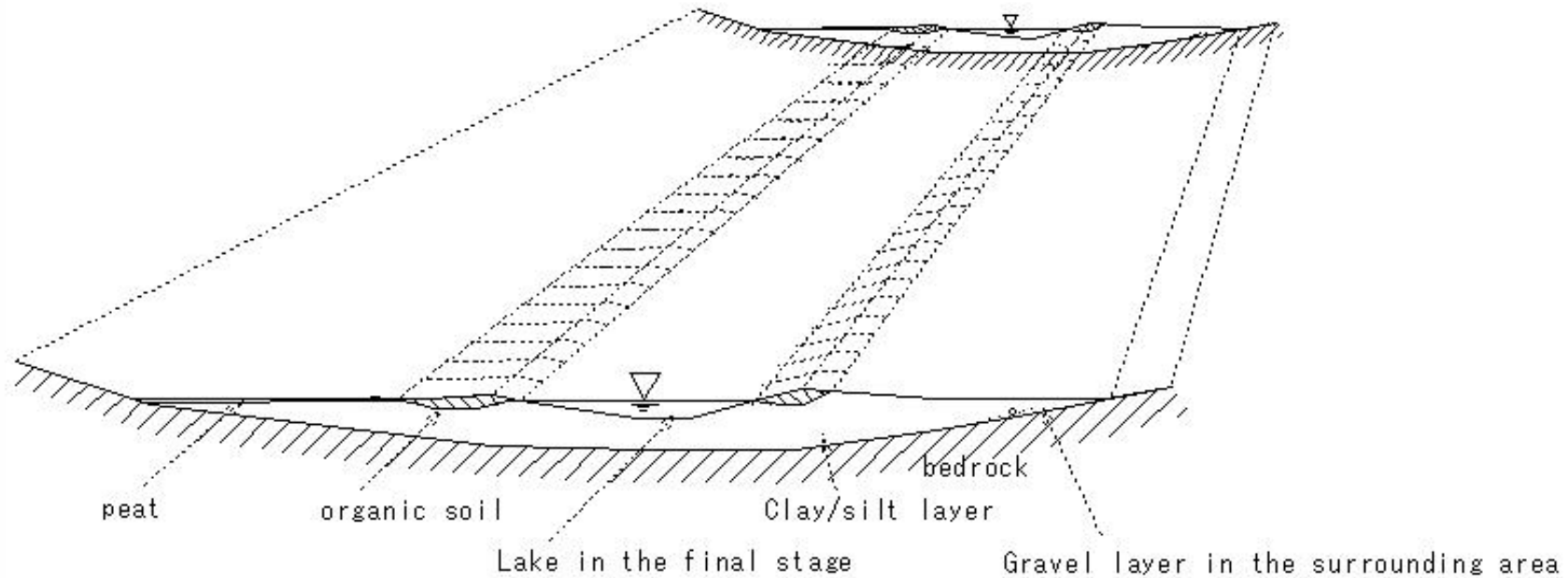
(R411)deposition

(R411)deposition

deposition

Rocks eroded by running water
transported and deposited

Formation of lacustrine sedimentary soil



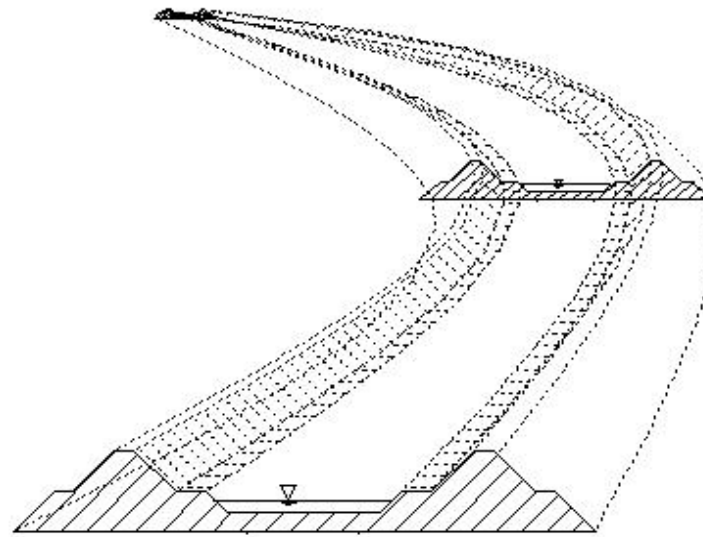
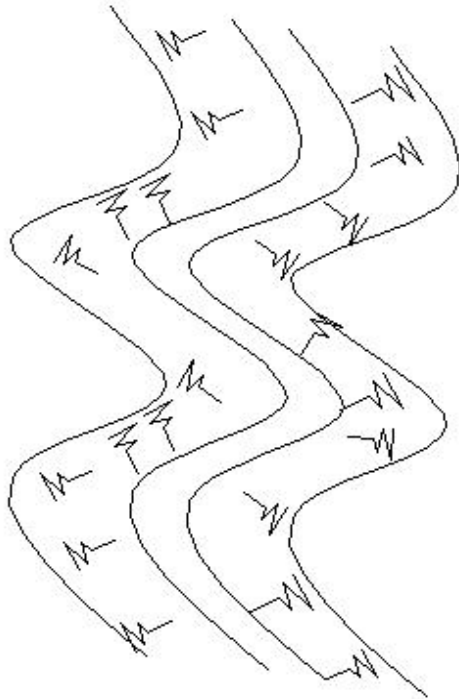
(R412)meandering

(R412) meander ing

meandering

River - meandering like a snake

The river flow -natural slope.



(R413)Vertical wire cylinder masonry work(gabion)

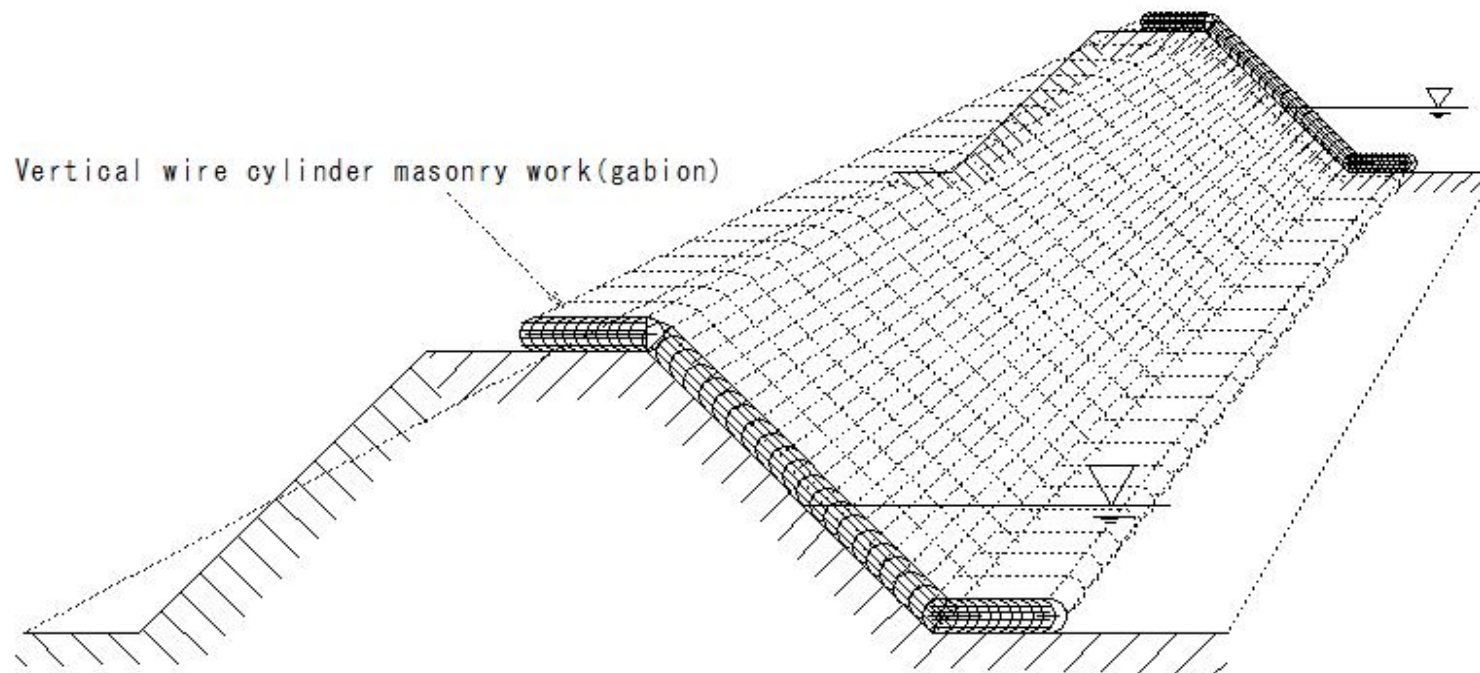
(R413)Vertical wire cylinder masonry work(gabion)

Vertical wire cylinder masonry work(gabion)

slope lining work of bank protection

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

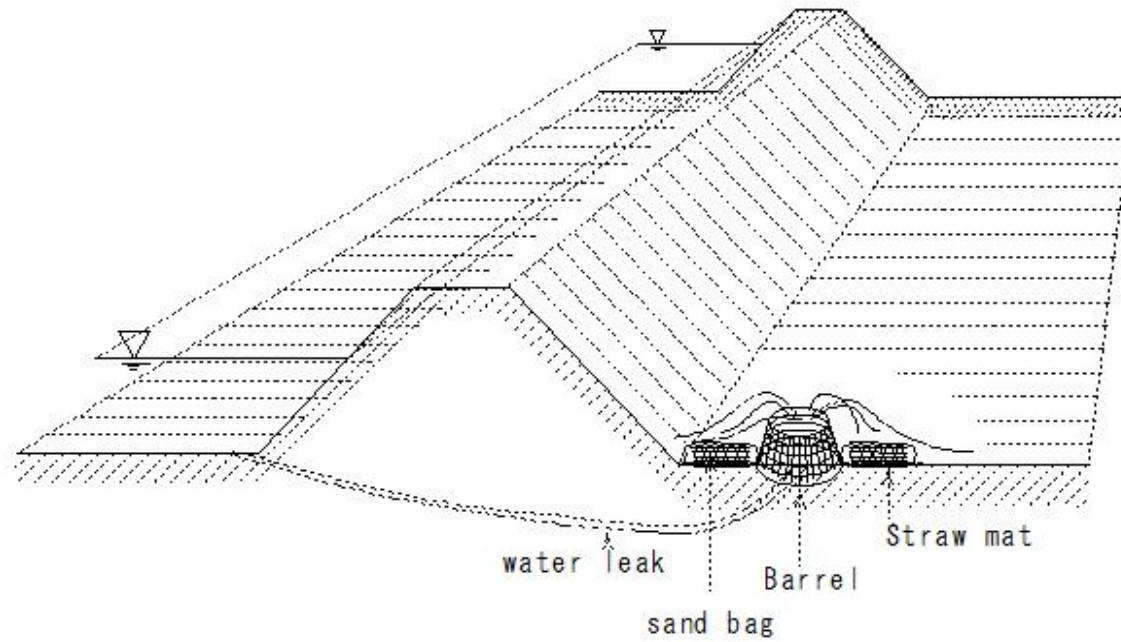
Embankment slope



(R414)prevent water leakage

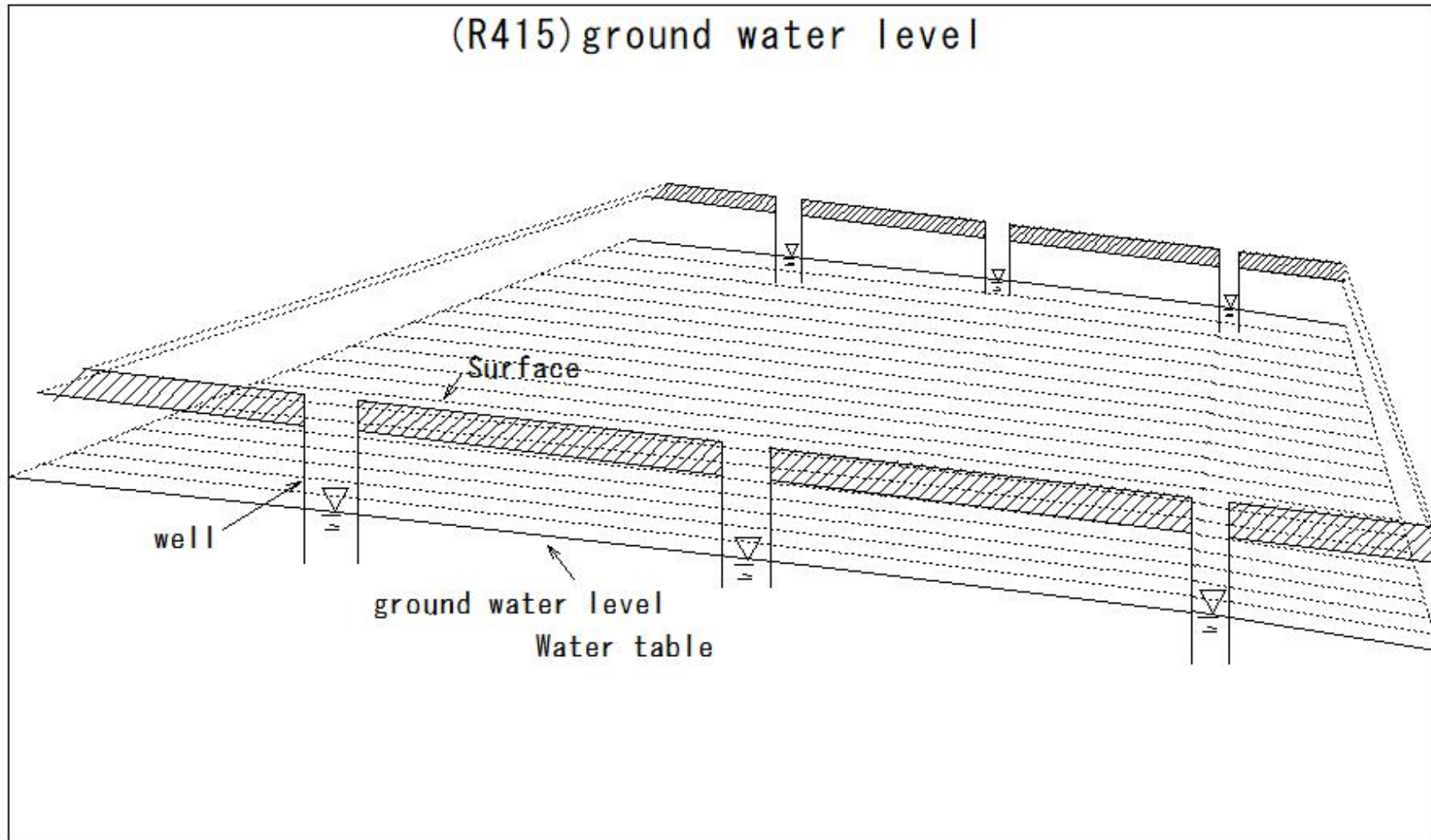
(R414)prevent water leakage

prevent water leakage



(R415)ground water level

(R415)ground water level

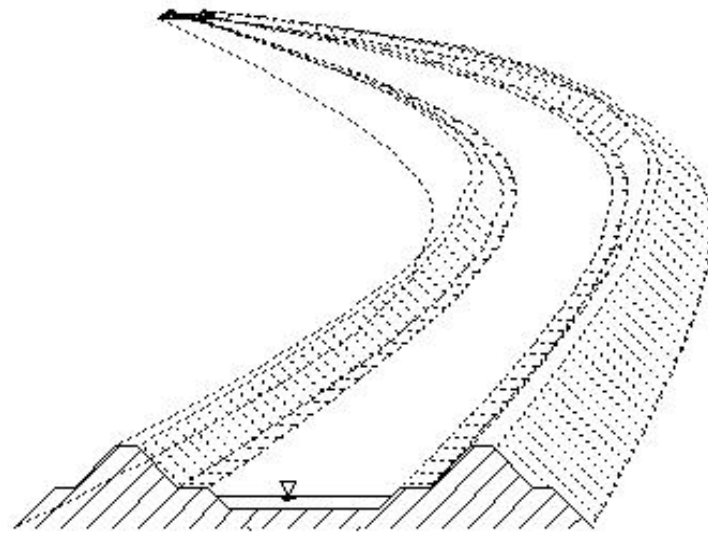


(R416)embankment

(R416)embankment

embankment

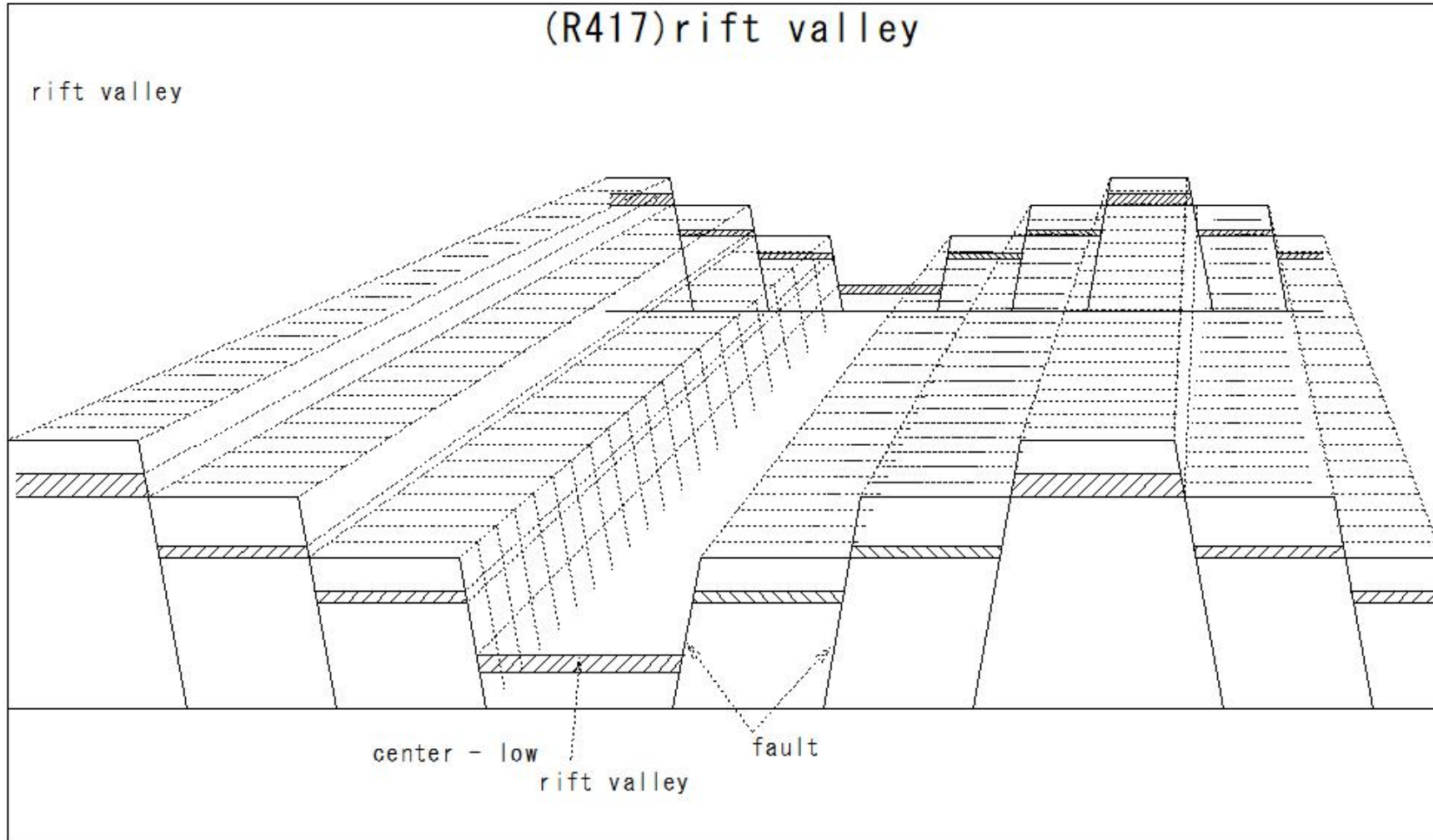
long and narrow embankment



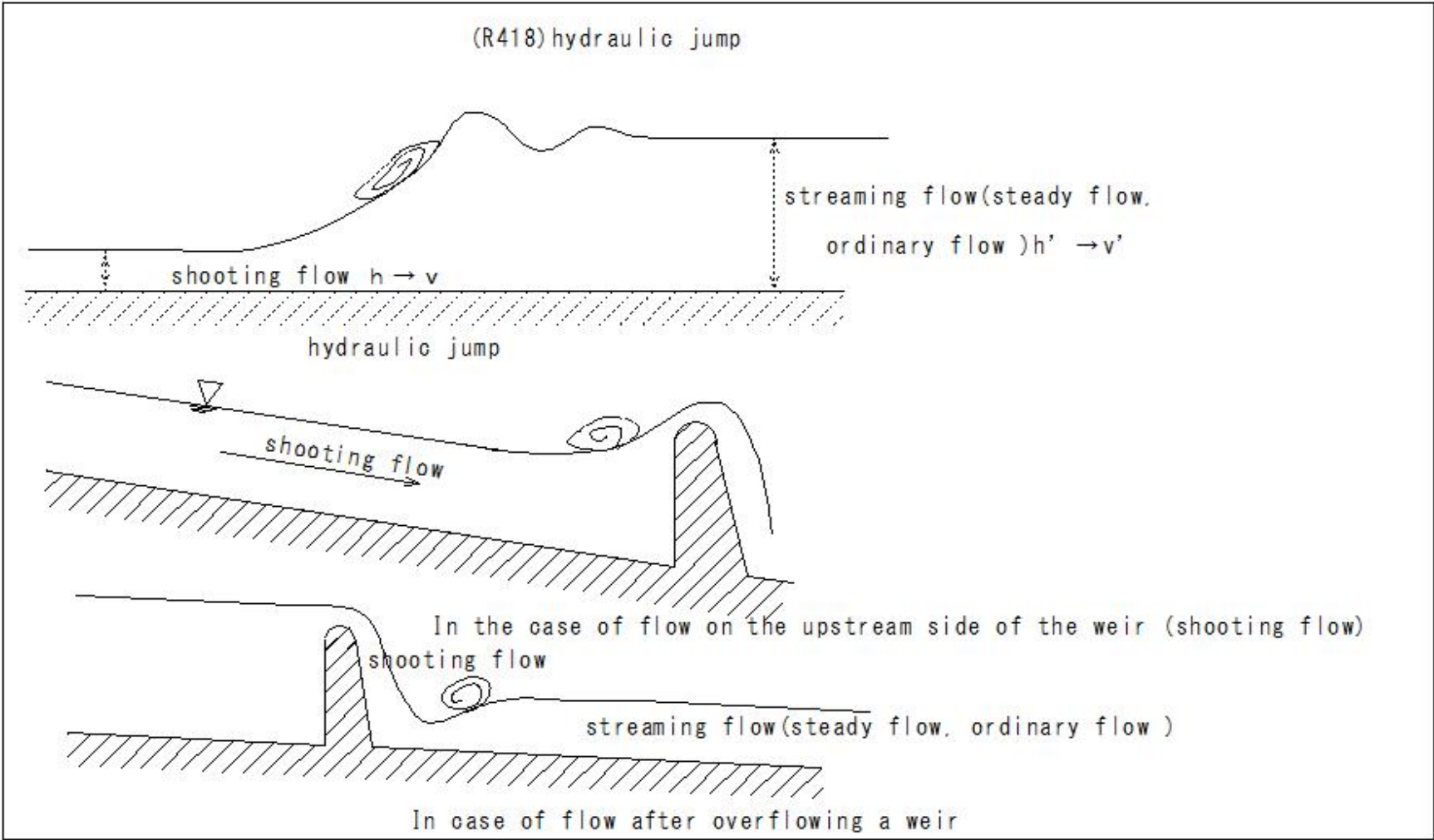
embankment

(R417)embankment

(R417)rift valley



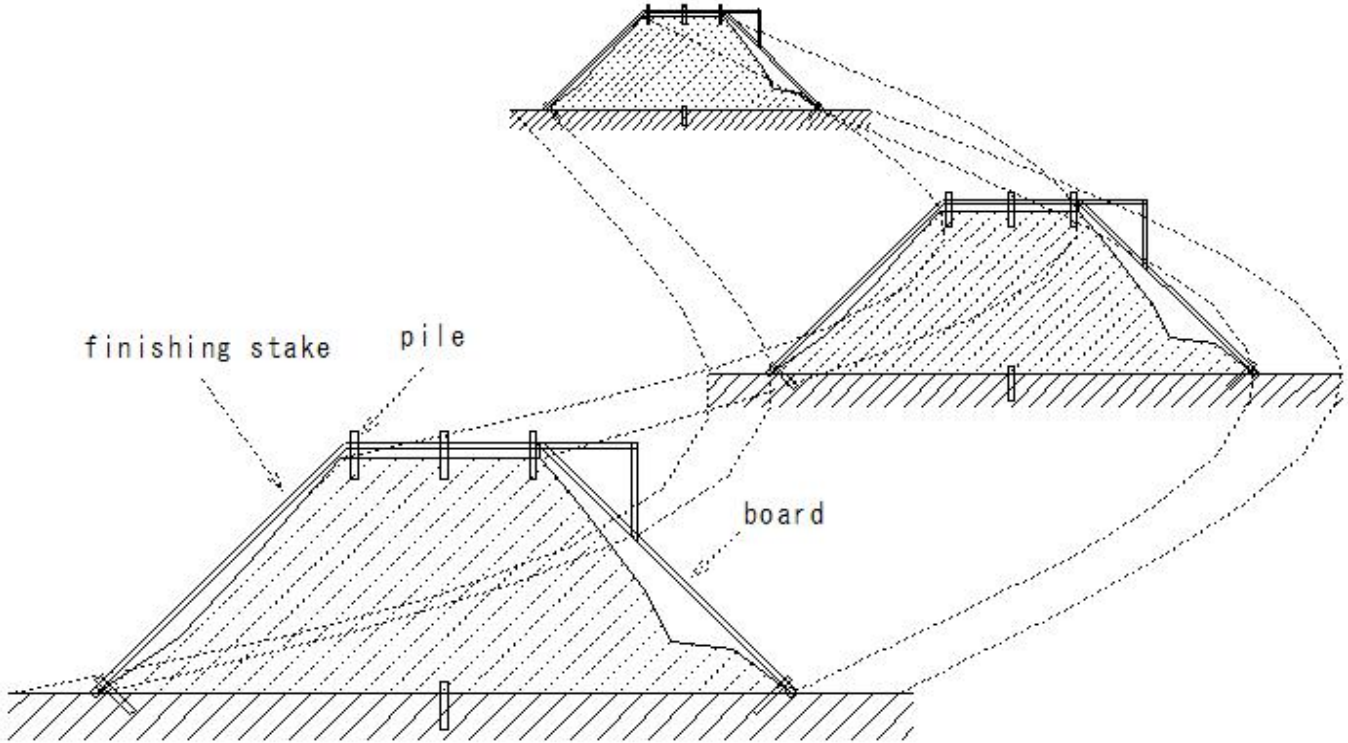
(R418)hydraulic jump



(R419)finishing stake

(R419) finishing stake

finishing stake
Earthwork standards

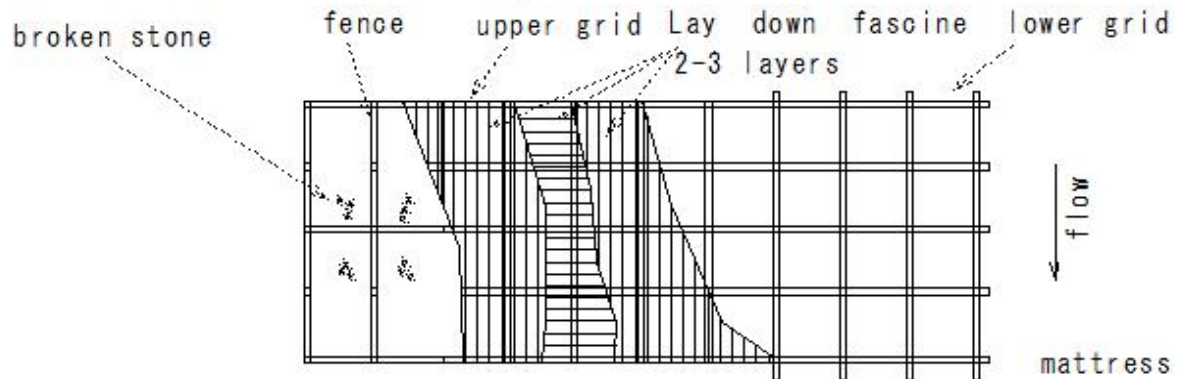
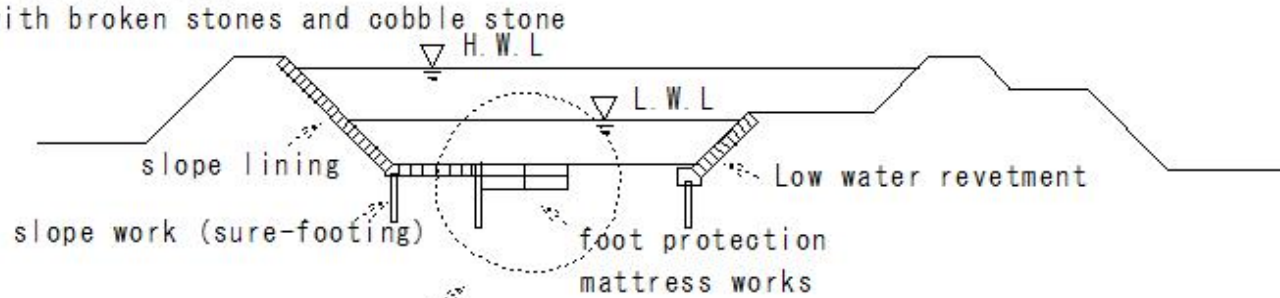


(R420)Bank protection(mattress)

(R420) 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



(R421)Bank protection(patch up method)

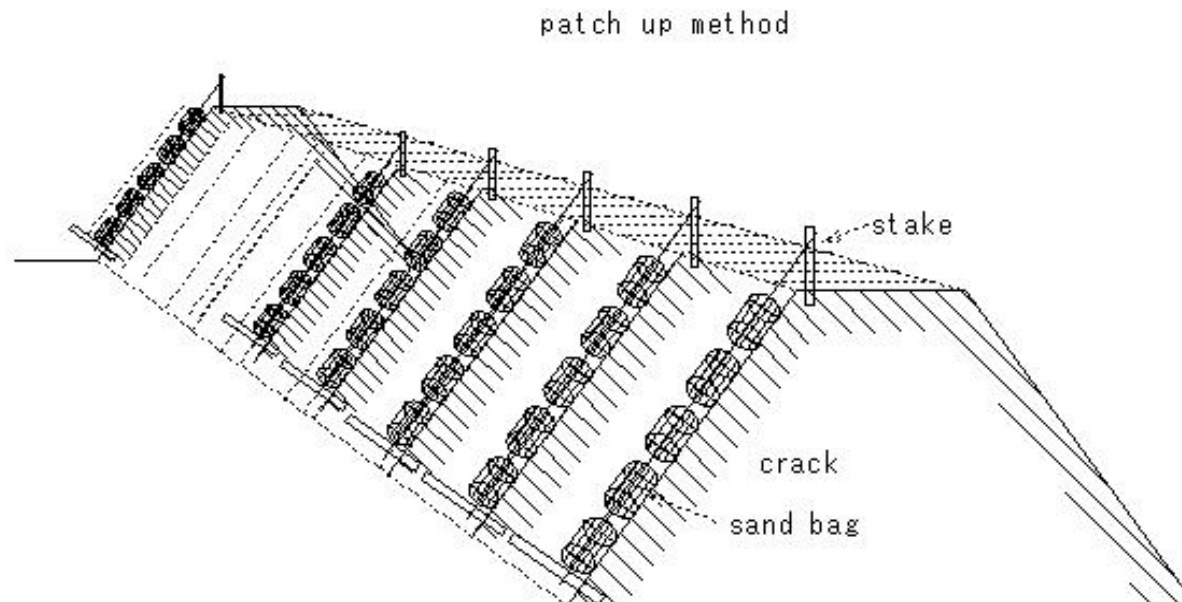
(R421)Bank protection(patch up method)

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

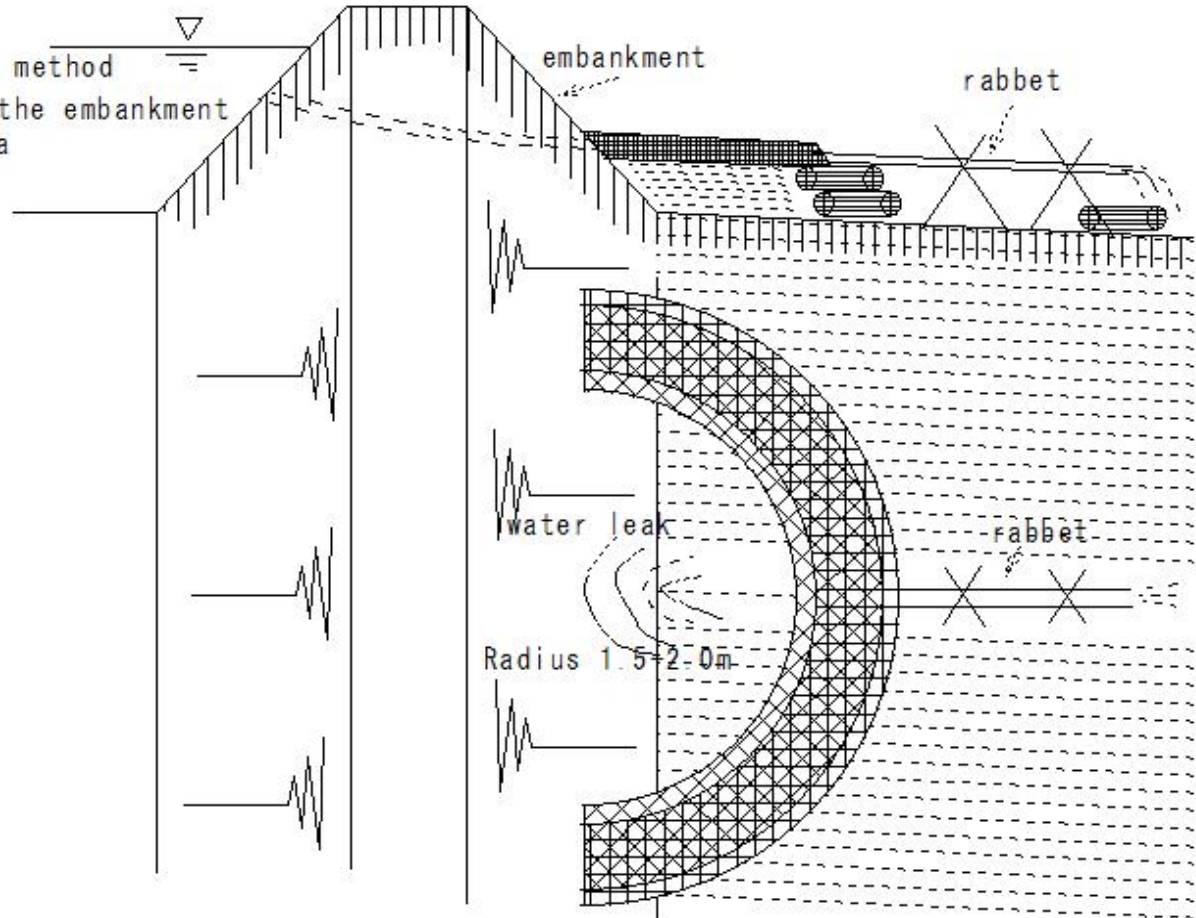


(R422)prevent water leakage(hooping)

(R422)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



(R423)Bank protection(back slope protection)

(R423)Bank protection(back slope protection)

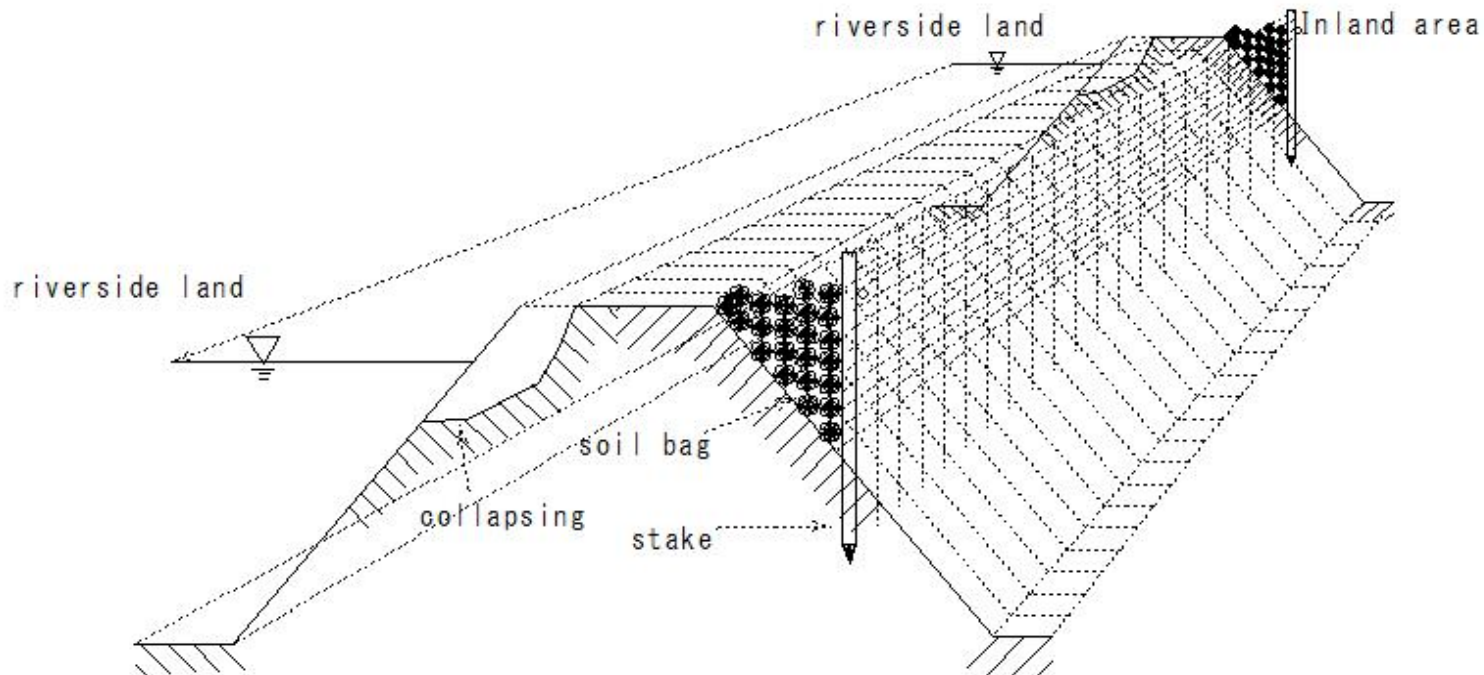
back slope protection

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



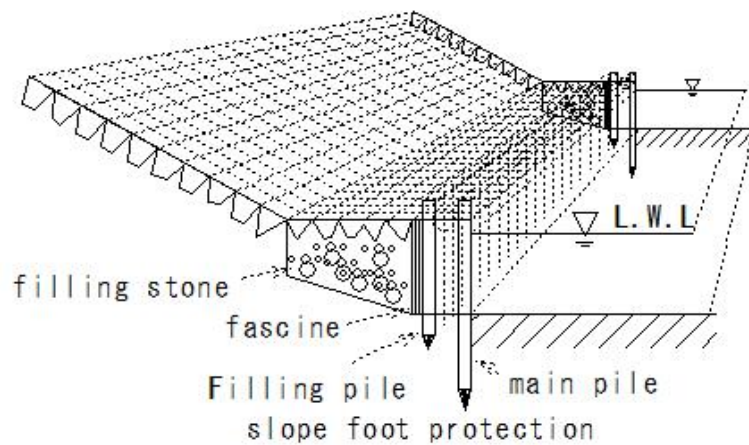
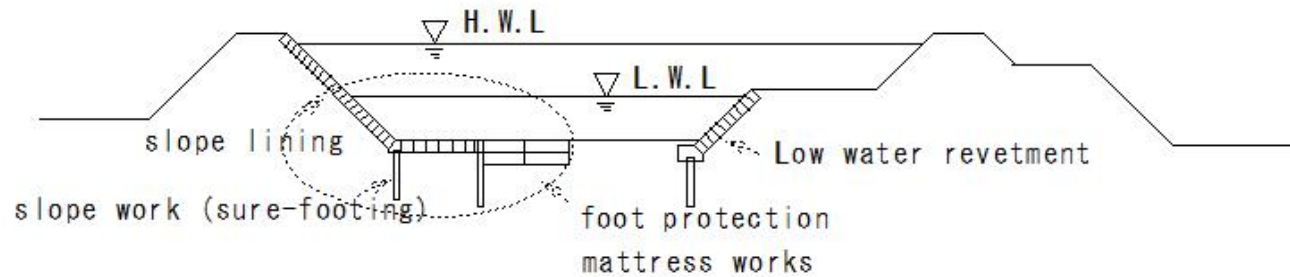
(R424)slope foot protection(Filling pile work)

(R424) slope foot protection(Filling pile work)

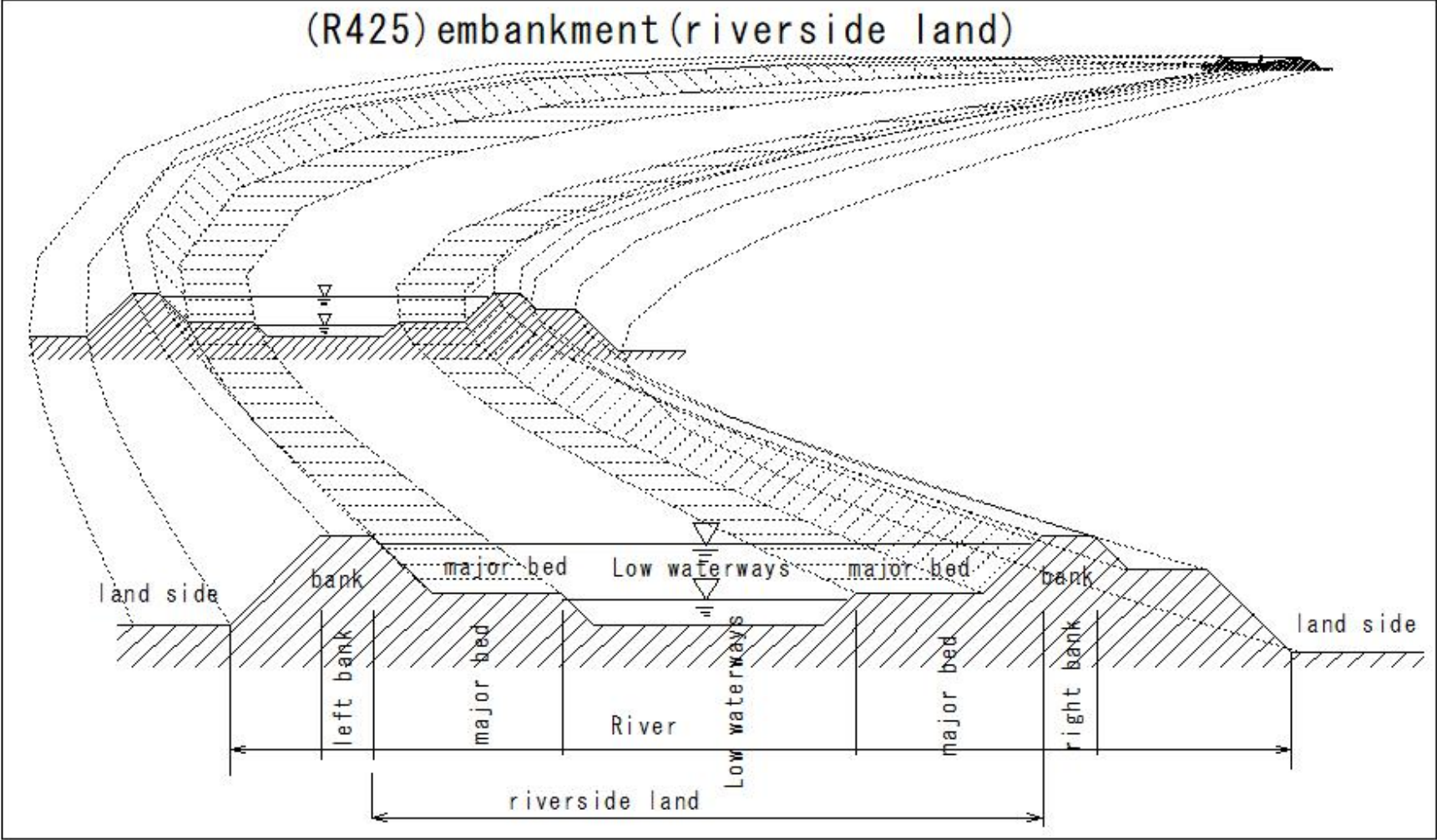
slope foot protection

Filling pile work

Foundation work for river embankments

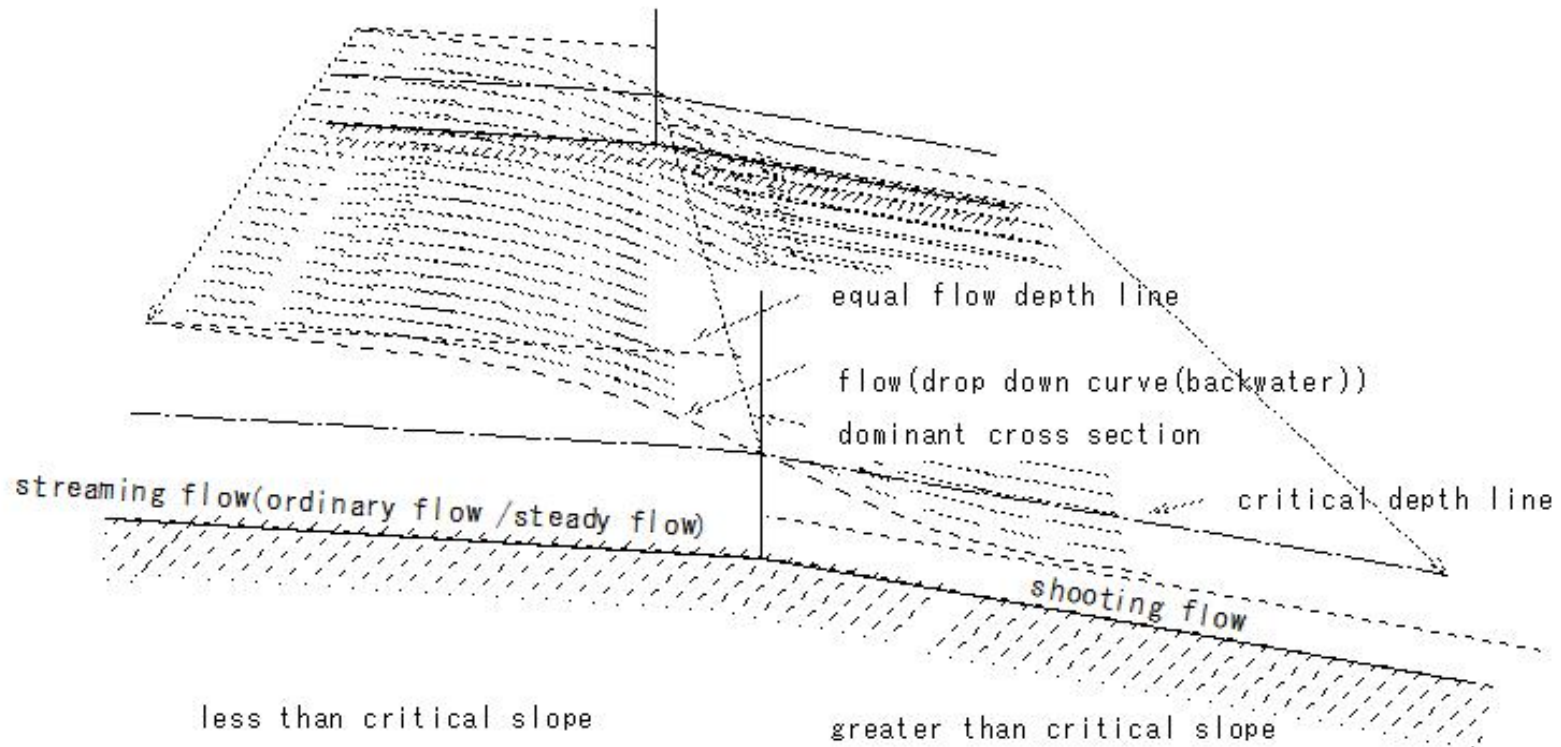


(R425)embankment(riverside land)



(R426)flow(drop down curve(backwater))

(R426)flow(drop down curve(backwater))

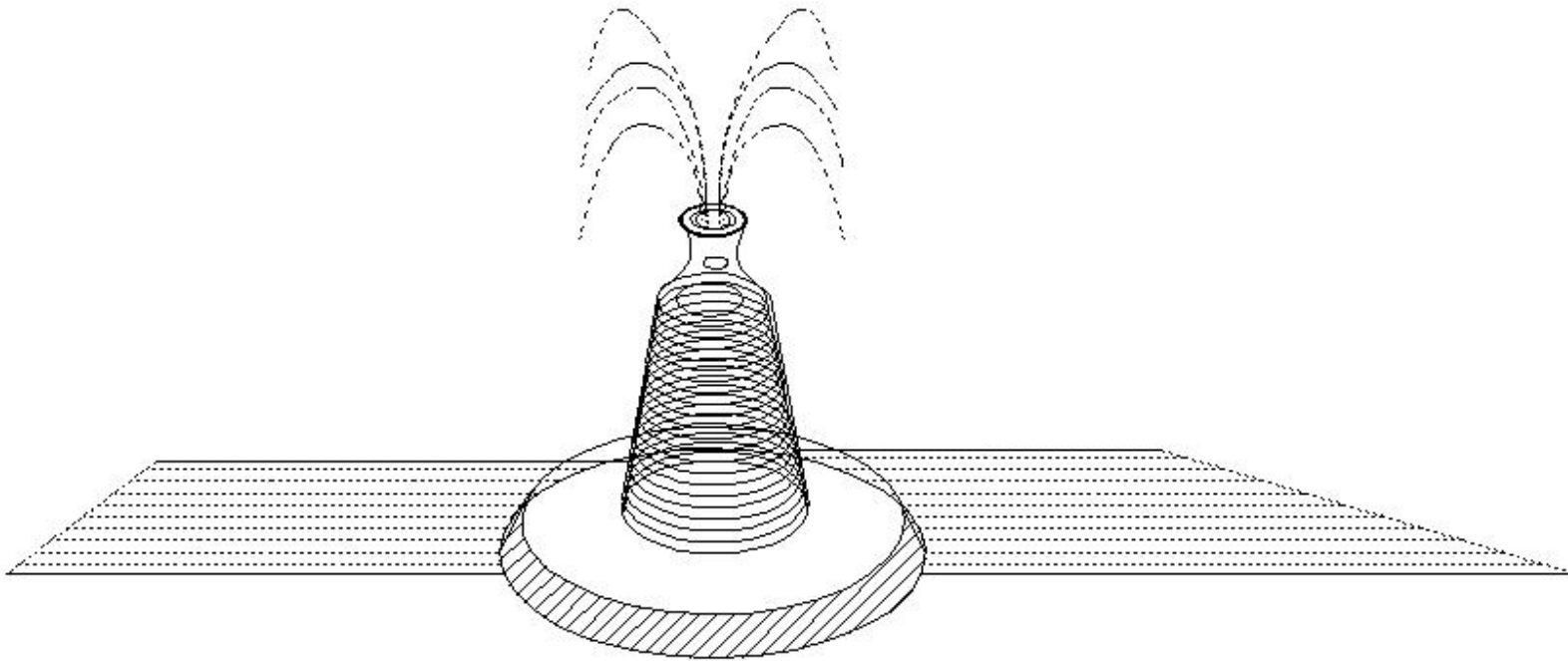


(R427)flow(steady flow)

(R427)flow(steady flow)

steady flow

discharge remains constant regardless of the passage of time



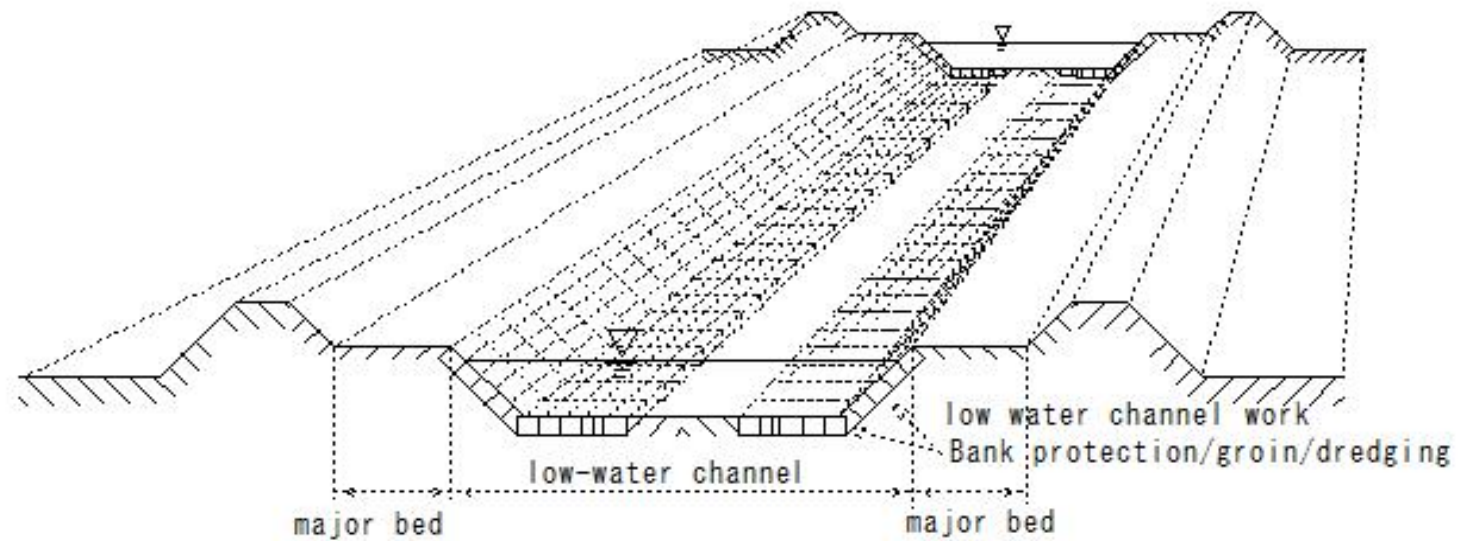
(R428)low water channel work

(R428)low water channel work

low water channel work

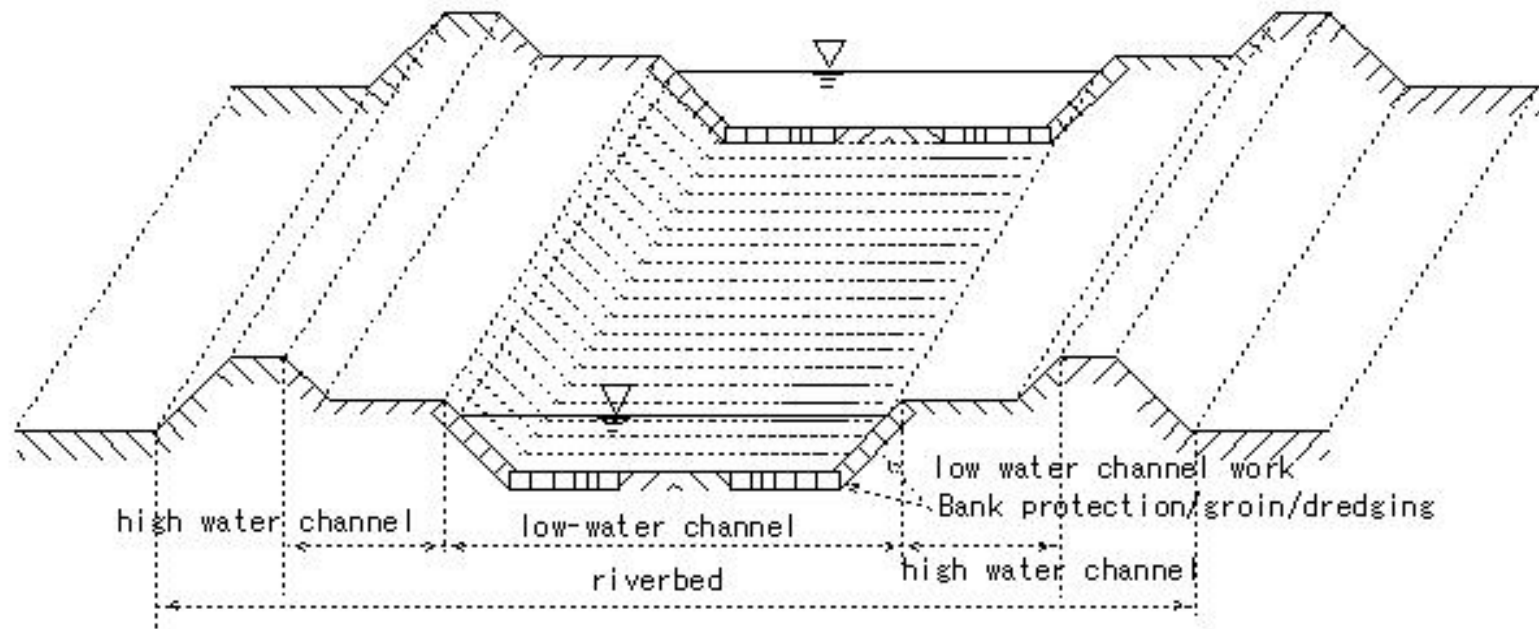
Work to organize and stabilize the flow path of low water channel work

low-water channel



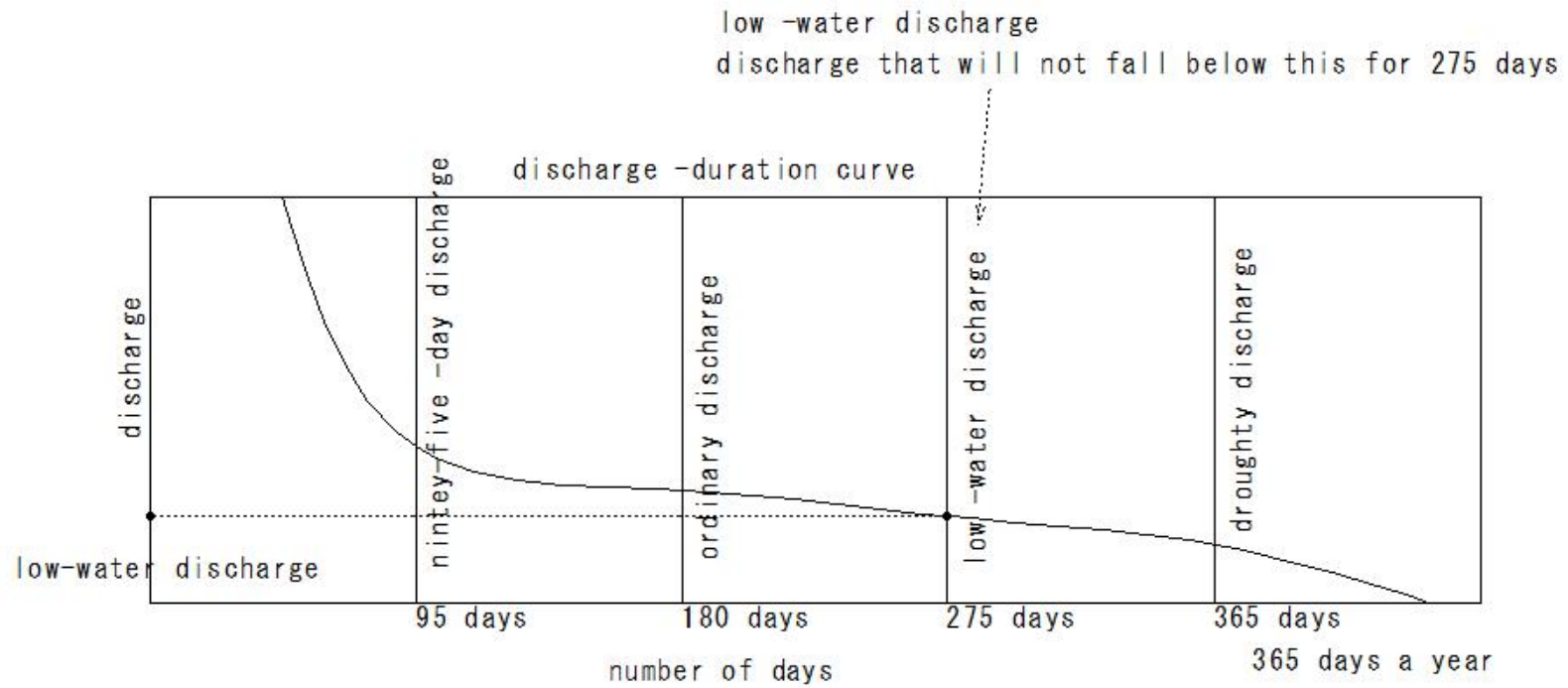
(R429)low water channel work

(R429) low water channel work



(R430)low -water discharge

(R430) low -water discharge



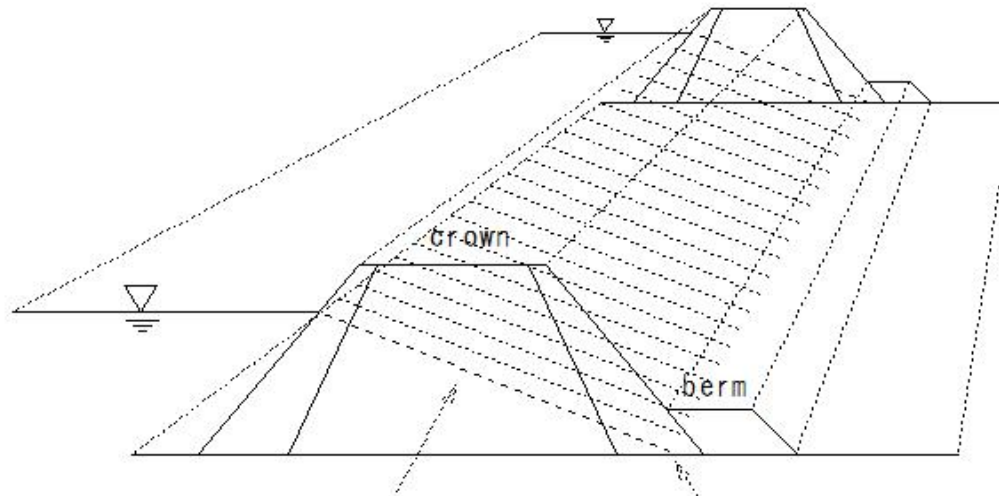
(R431)infiltration(percolation) of levee

(R431) infiltration(percolation) of levee

infiltration(percolation) of levee

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

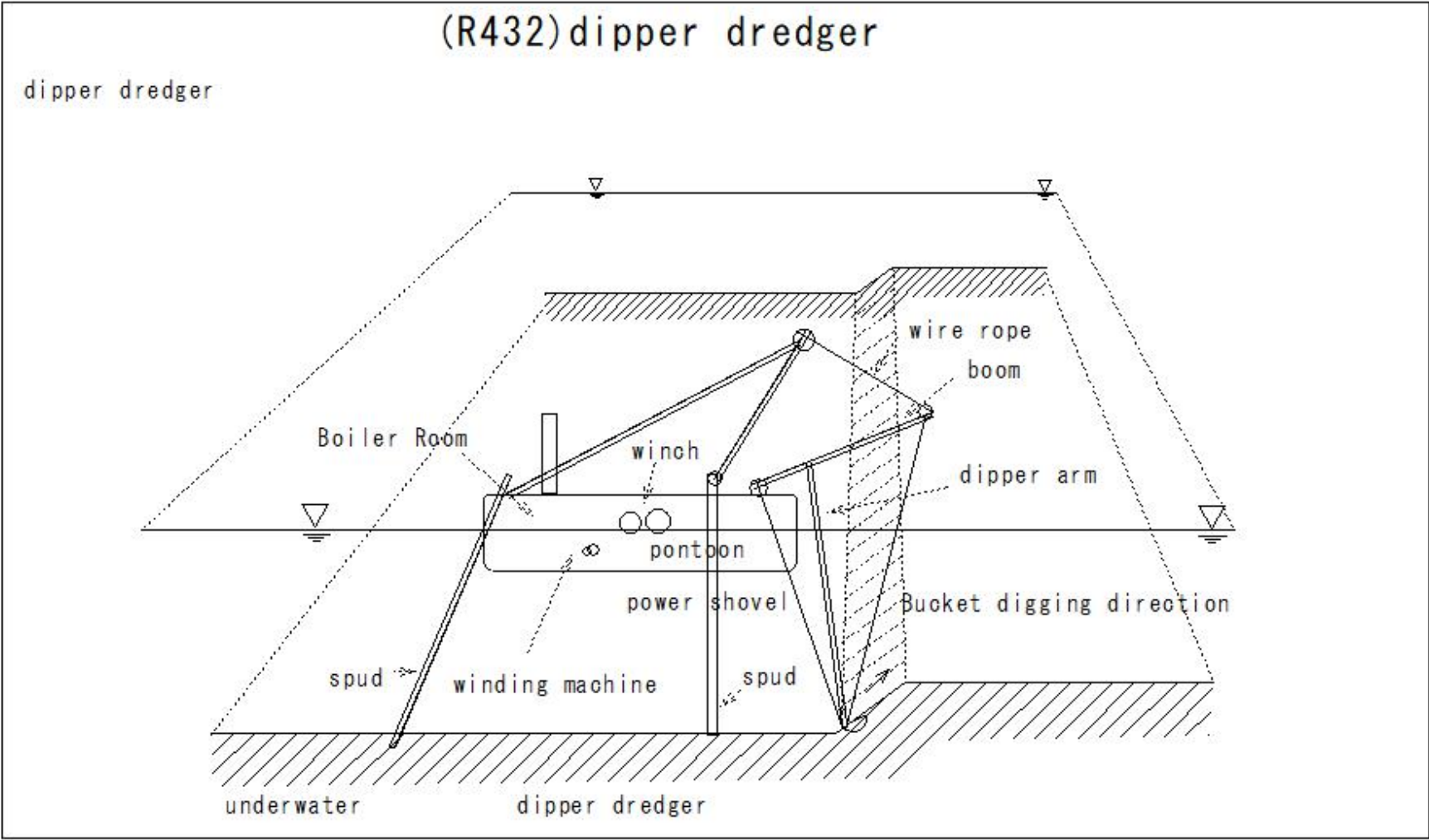
Make sure the back slope does not mix with the infiltration line.



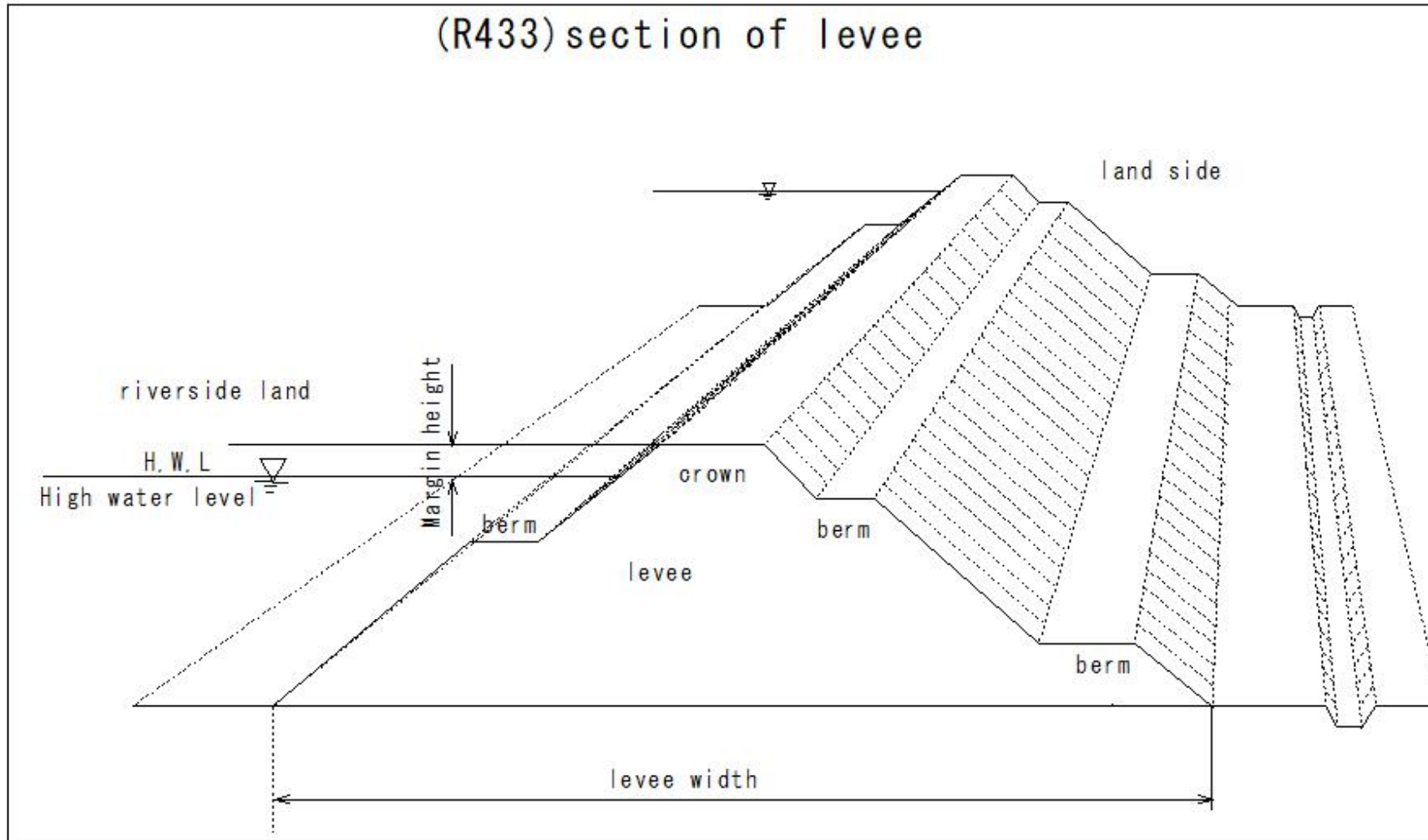
infiltration(seepage) line: about 1:3

Decide the crown width and back gradient

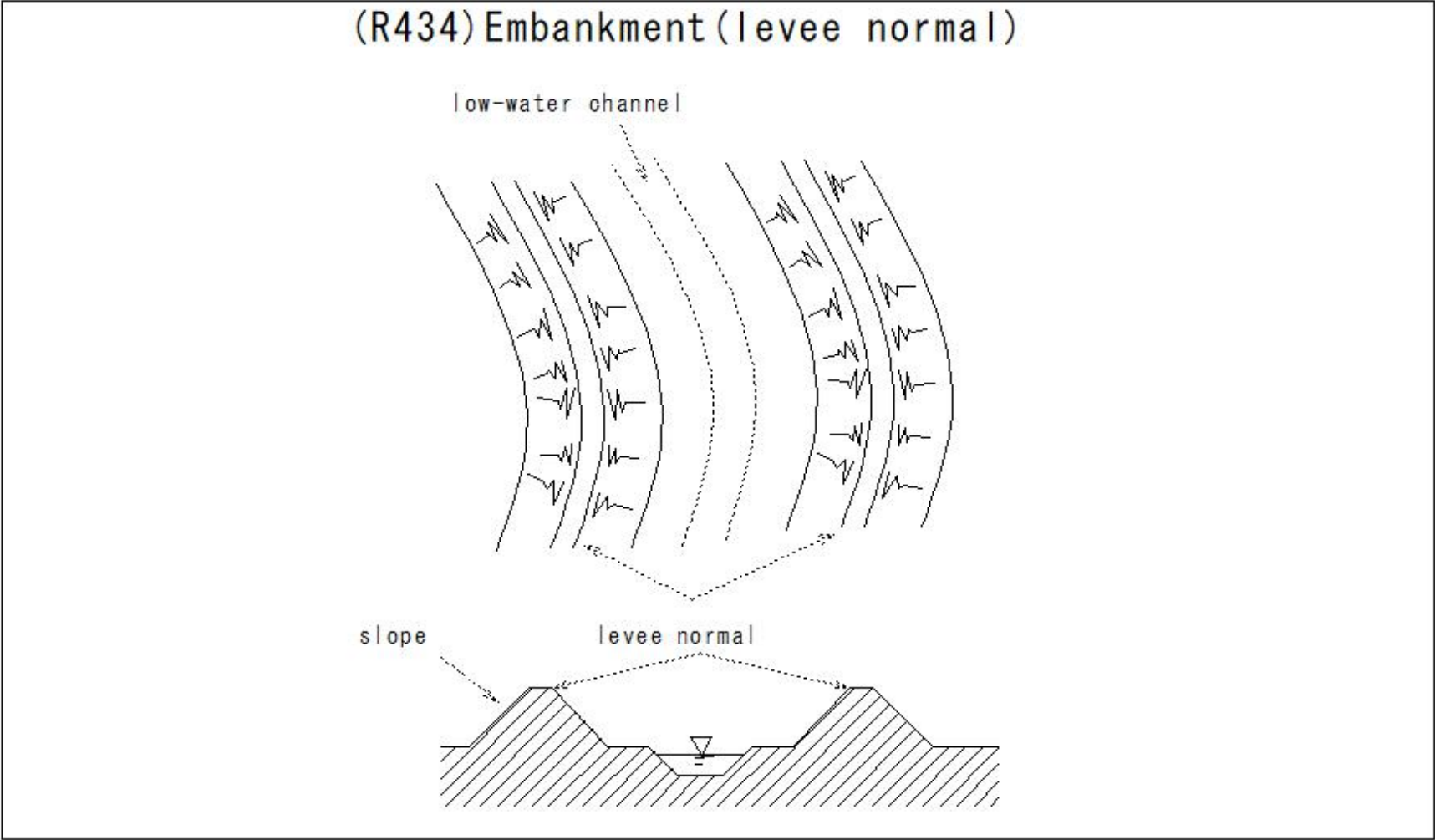
(R432)dipper dredger



(R433) section of levee



(R434) Embankment (levee normal)

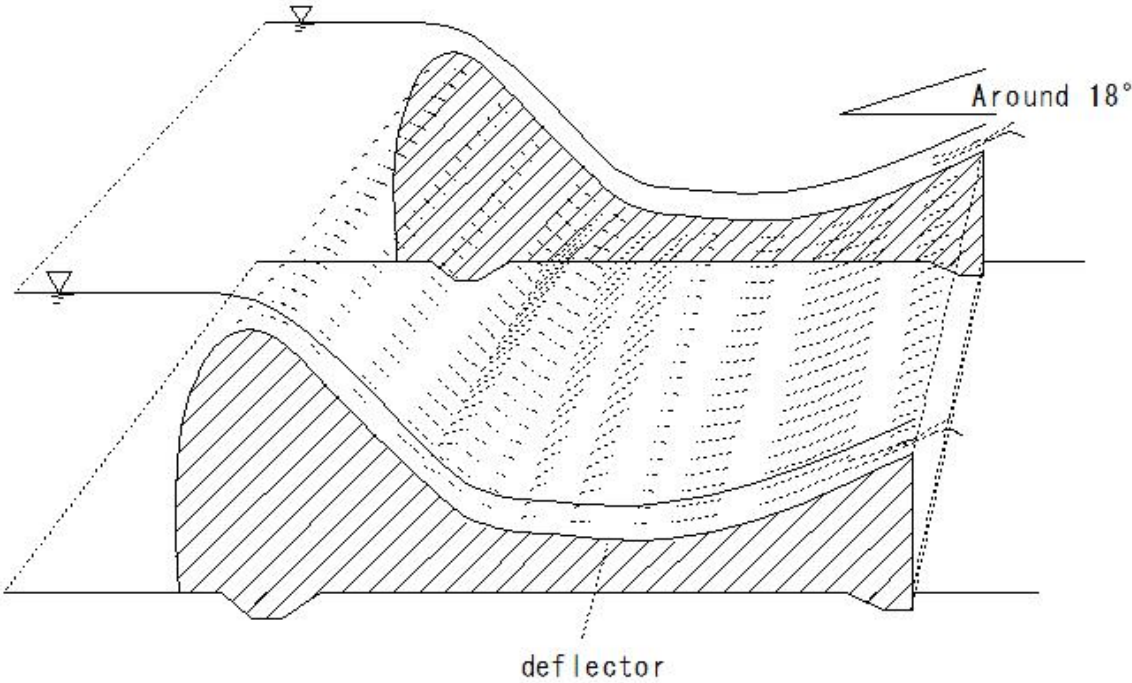


(R435)dam(deflector)

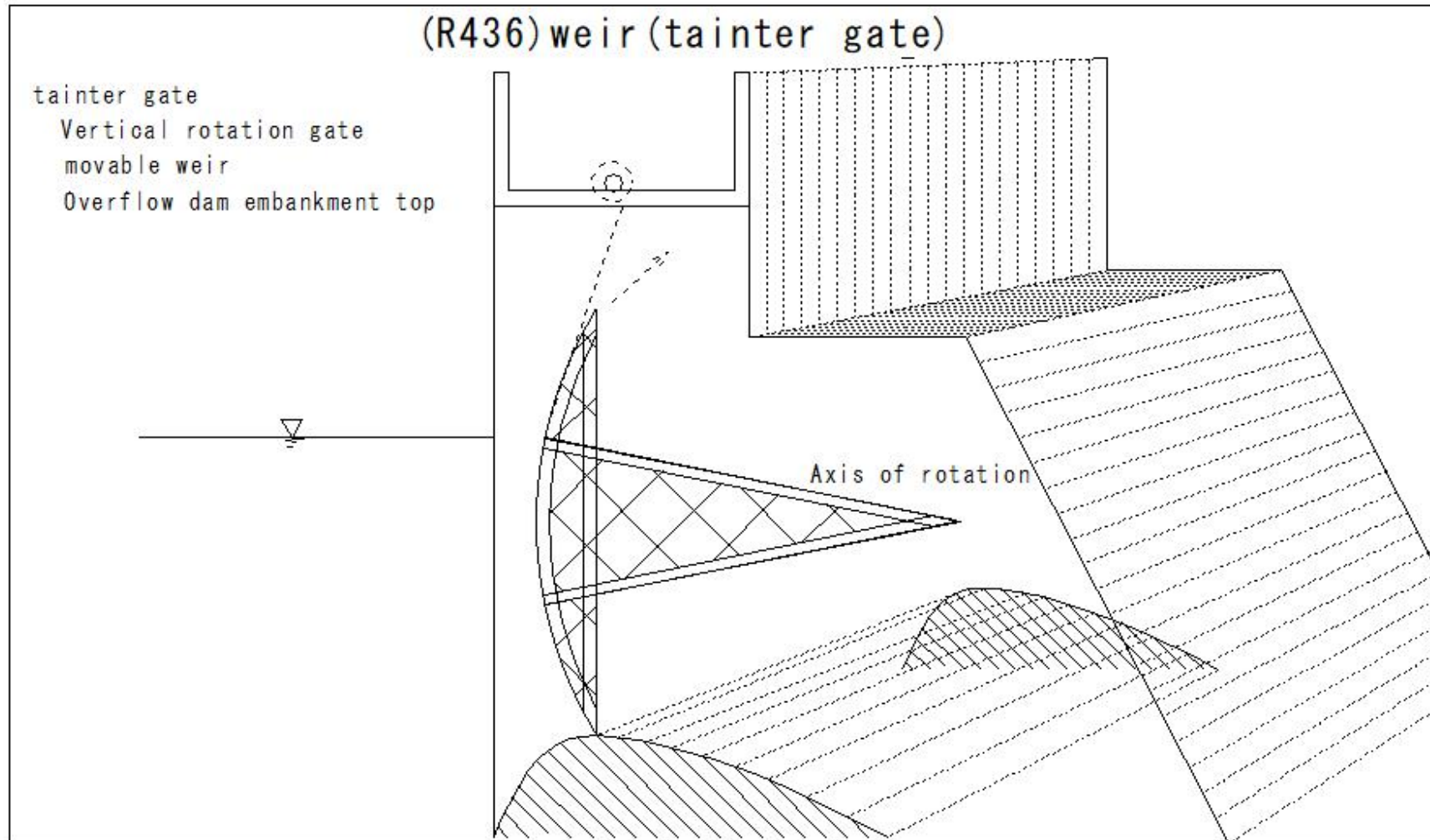
(R435) dam (deflector)

deflector

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

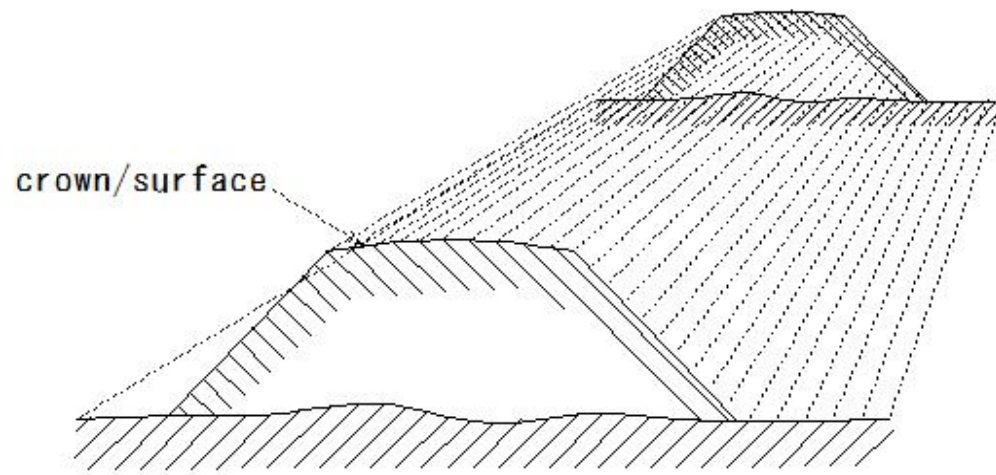


(R436)weir(tainter gate)



(R437)embankment(crown/surface)

(R437) embankment (crown/sur face)

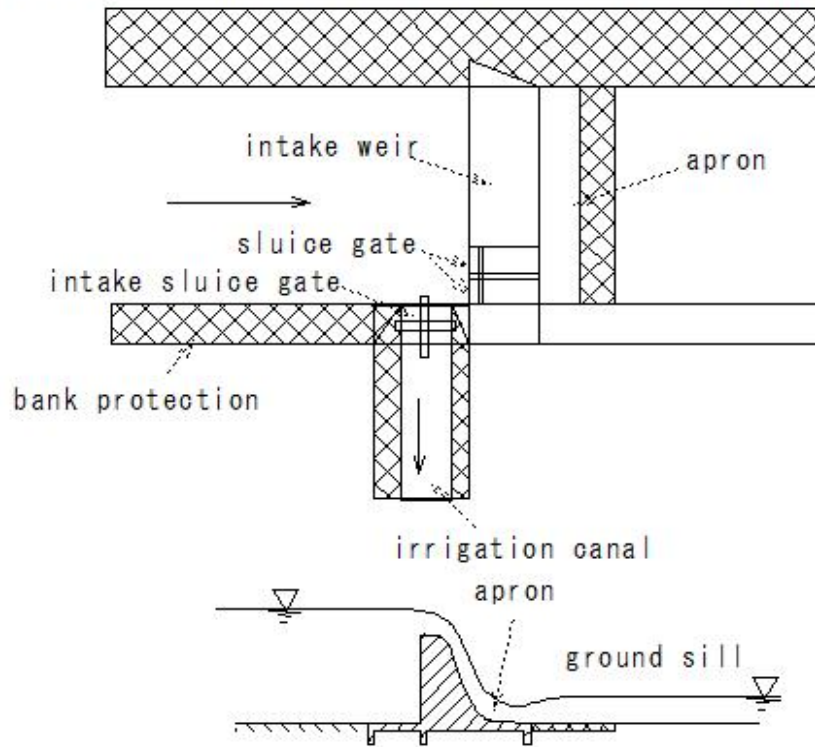


(R438)weir(head works)

(R438) weir (head works)

weir(head works)

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



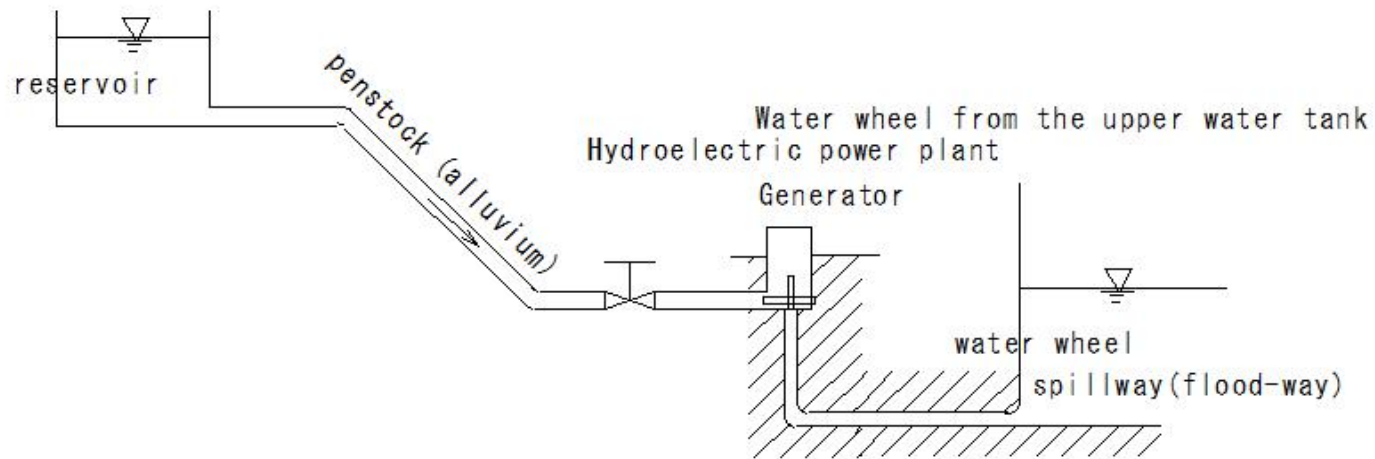
Weir cross section

(R439)penstock (alluvium)

(R439)penstock (alluvium)

penstock (alluvium)

High pressure water pipe that leads water

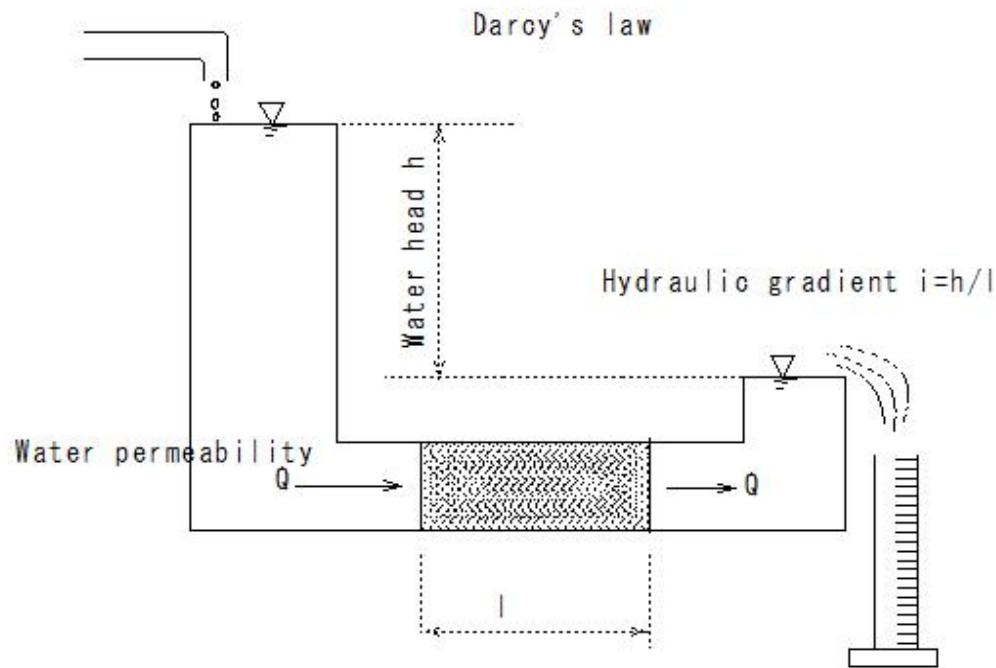


(R440)coefficient of permeability

(R440) coefficient of permeability

coefficient of permeability

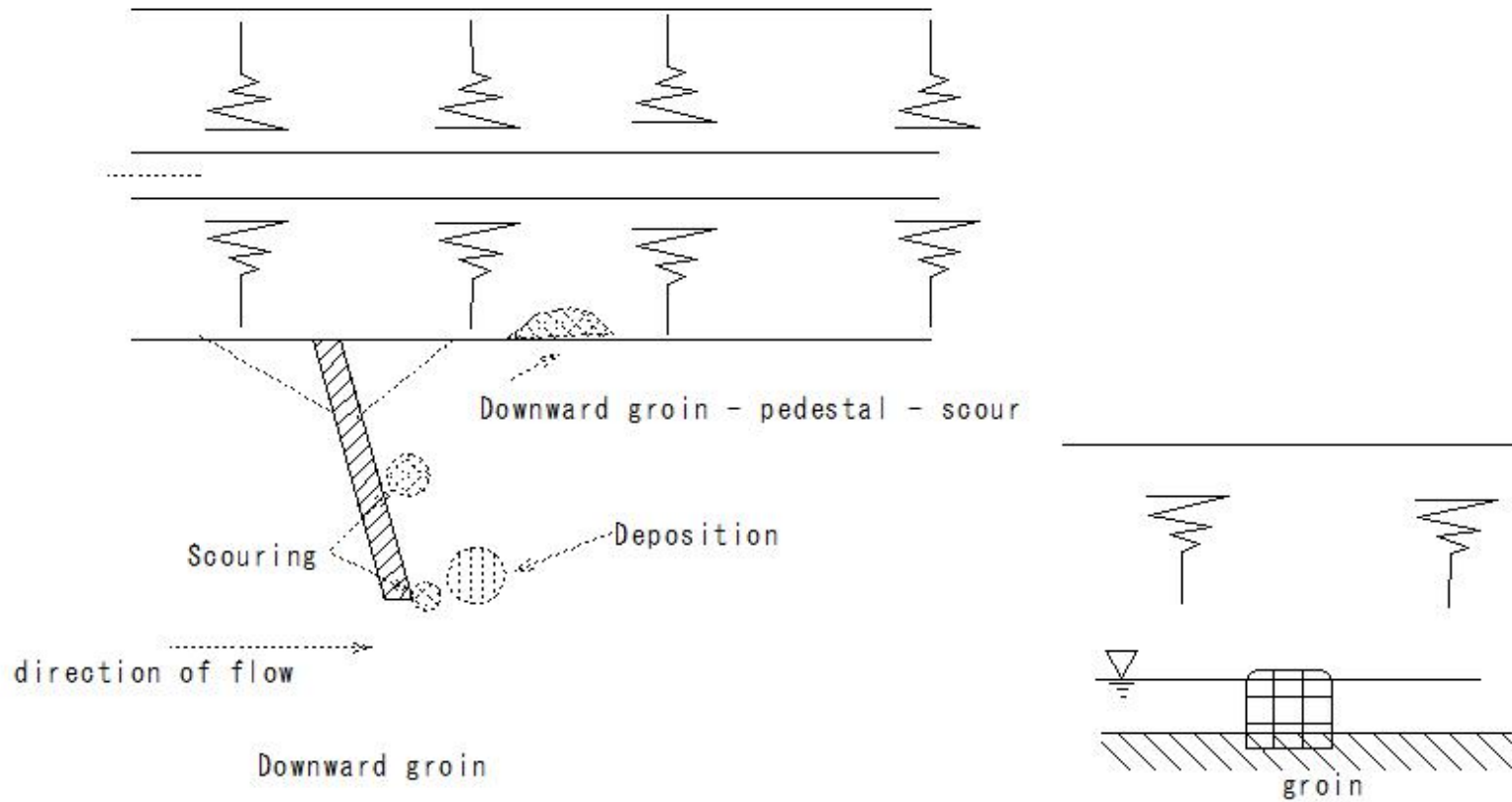
Amount of water flowing through a unit cross-sectional area of soil per unit time, unit: cm/s



coefficient of permeability K
Sample cross-sectional area A

(R441) Downward groin

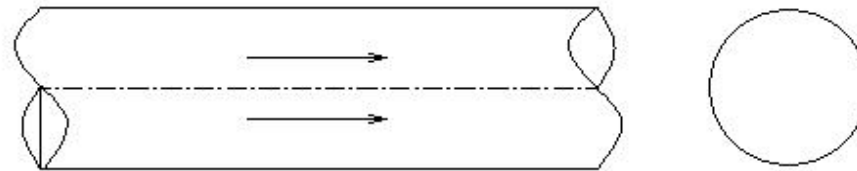
(R441) Downward groin



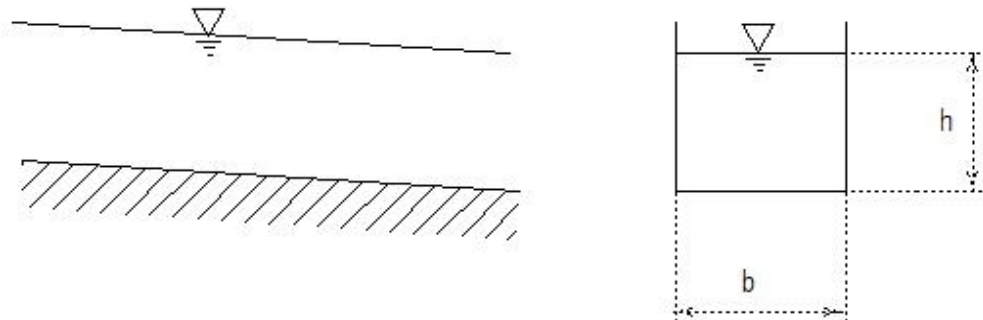
(R442)uniform flow

(R442) 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

(R443)training dyke

(R443)training dyke

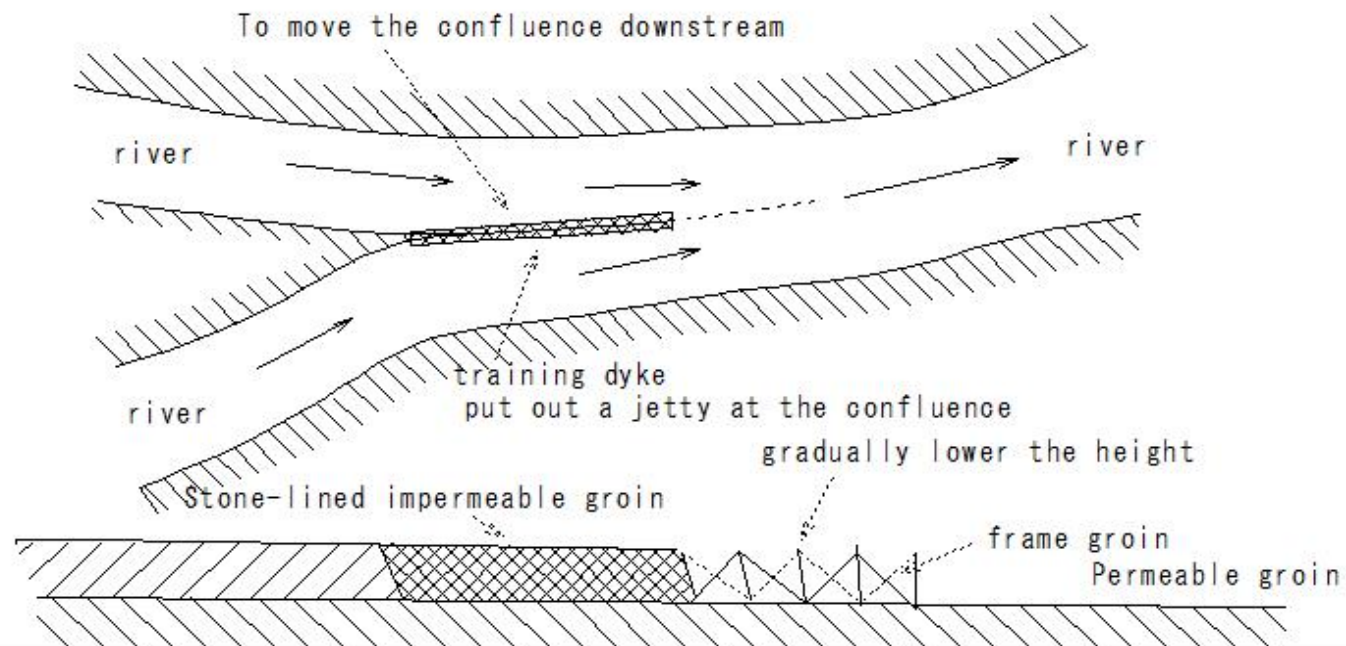
training dyke

river confluence

Running water - leads smoothly

Embankment groin

Preventing water from two rivers from interfering with each other

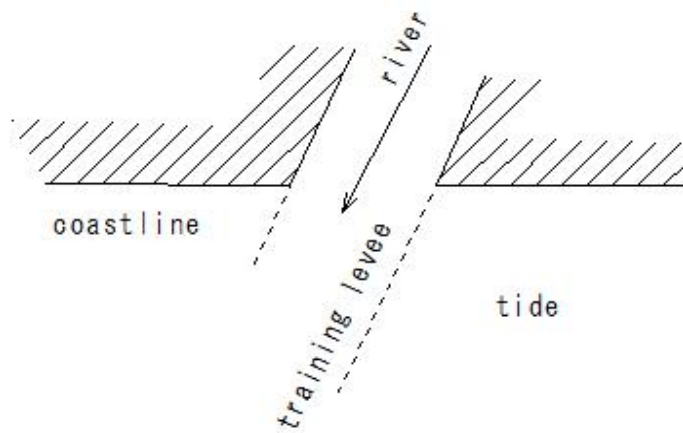
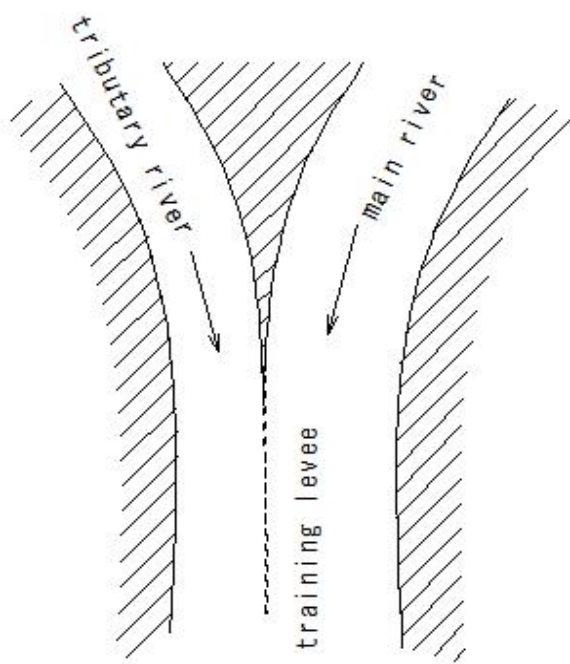


(R444)training levee

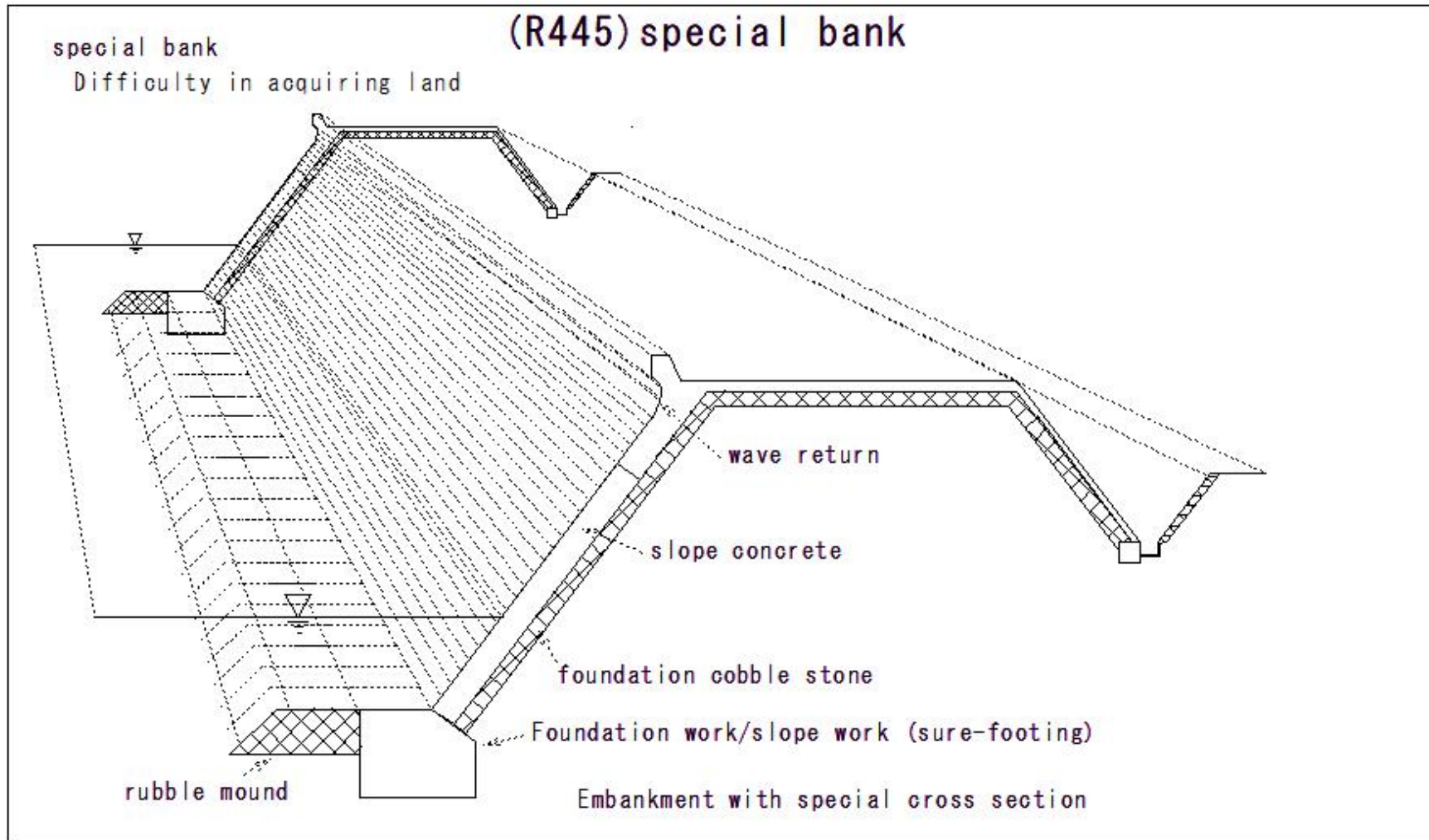
(R444)training levee

training levee

Maintain water flow direction

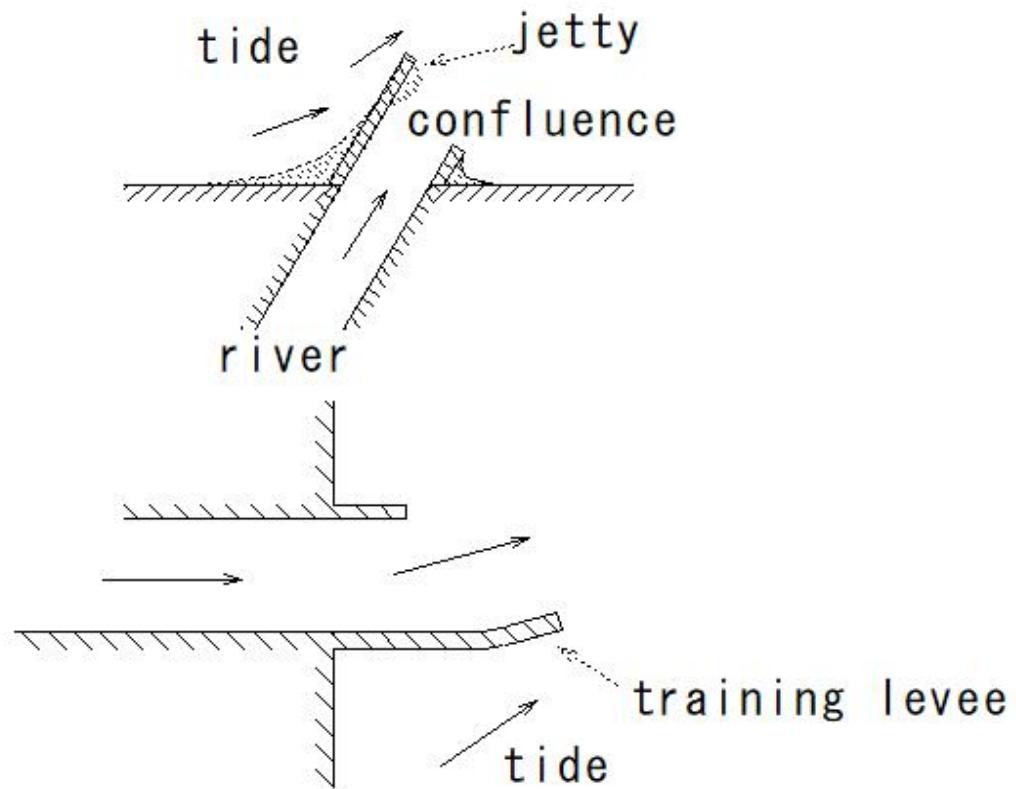


(R445)special bank



(R446)jetty

(R446) jetty



(R447)slope tamping

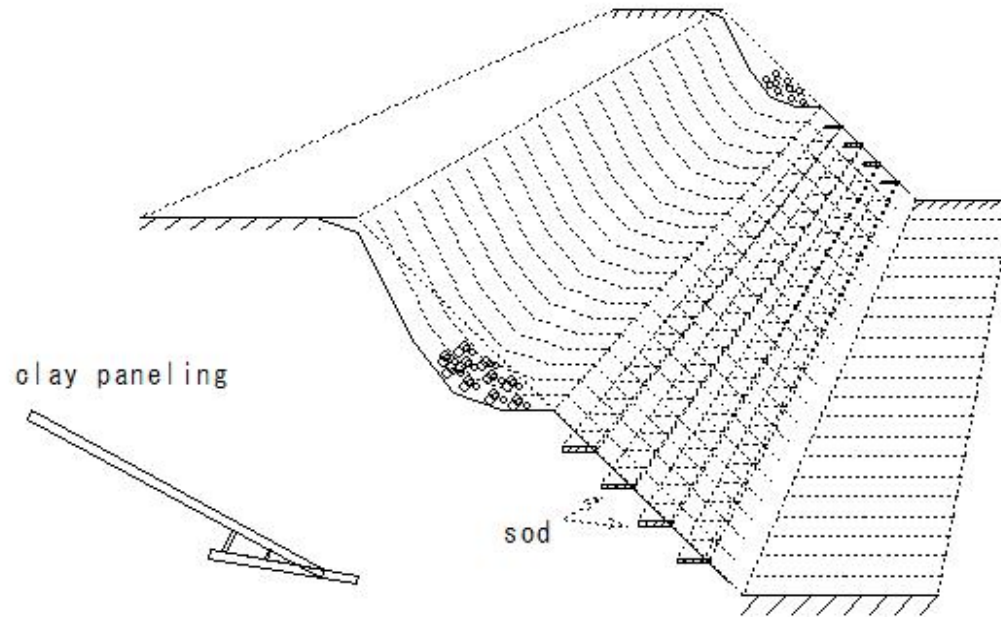
(R447) slope tamping

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.

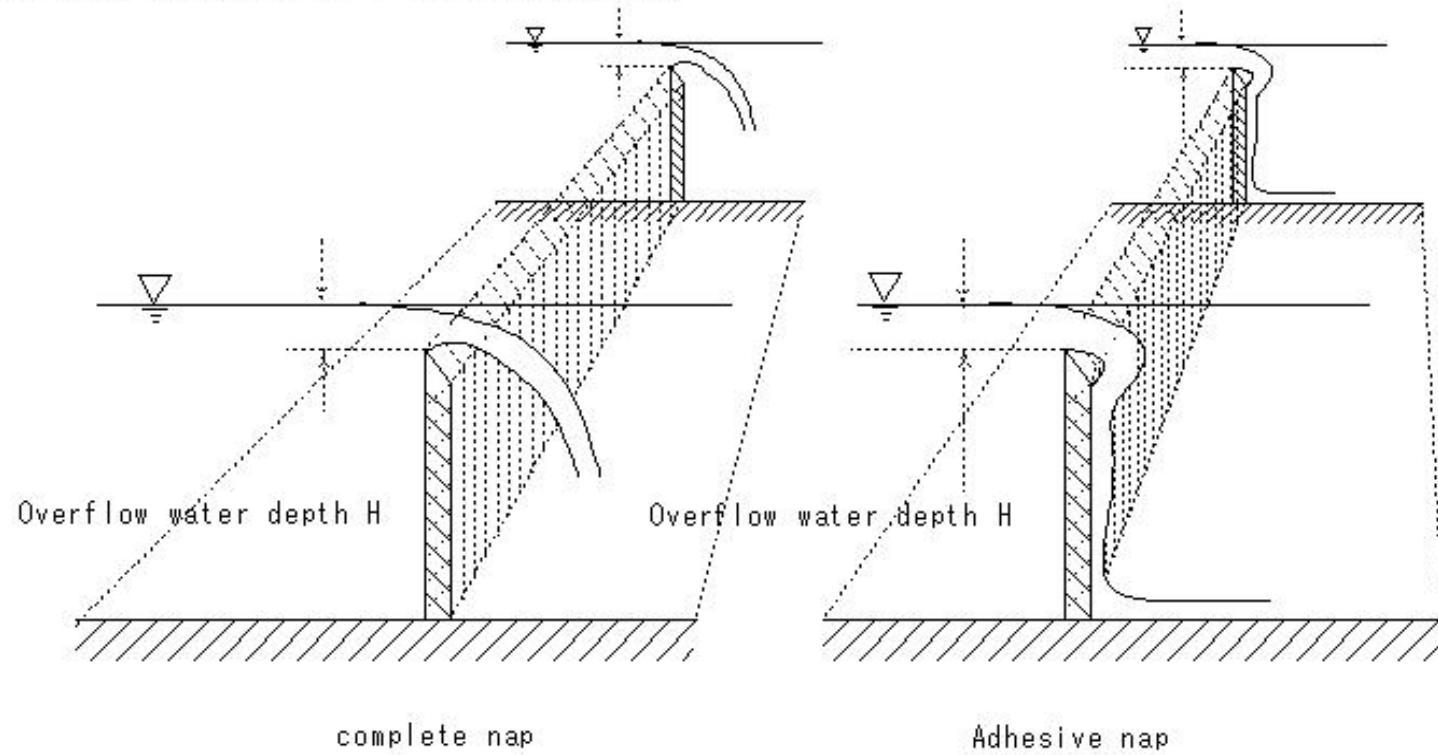


(R448)nappe

(R448)nappe

nappe

Shape of water falling over a tooth-shaped weir



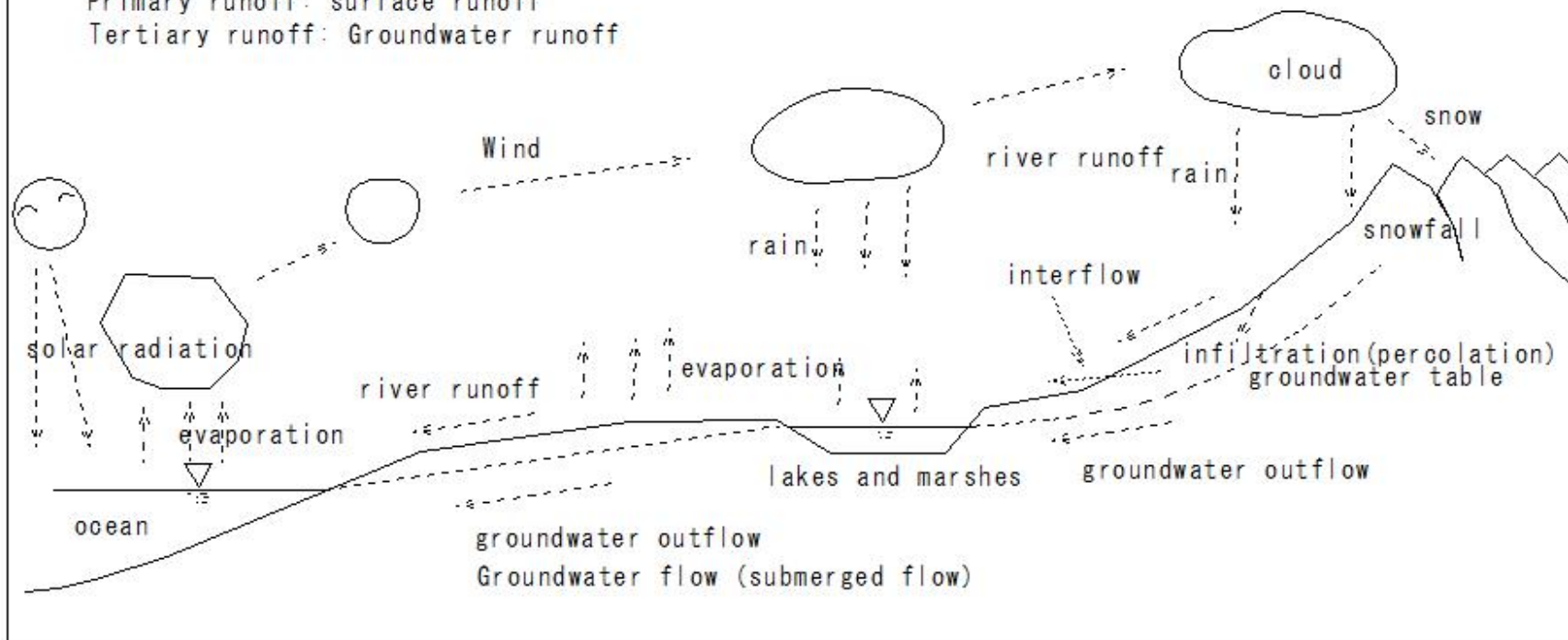
(R449)interflow

(R449) interflow

interflow

Precipitation infiltration(percolation) underground
Coming to the surface again
Phenomenon flowing into rivers

Primary runoff: surface runoff
Tertiary runoff: Groundwater runoff

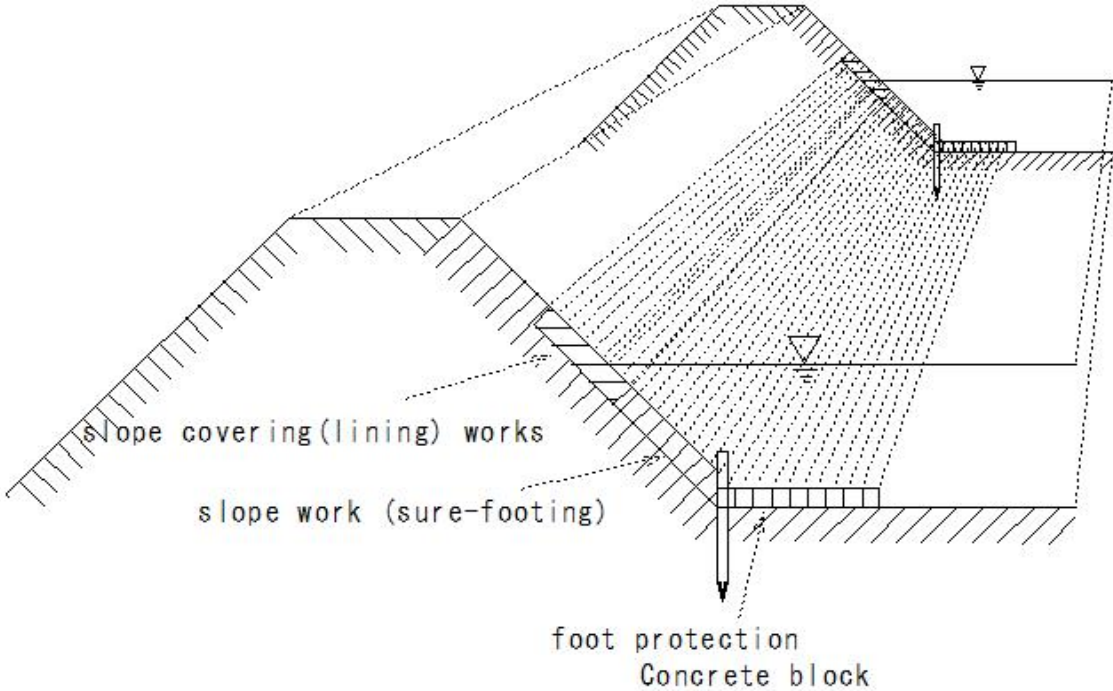


(R450)foot protection

(R450) foot protection

foot protection

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

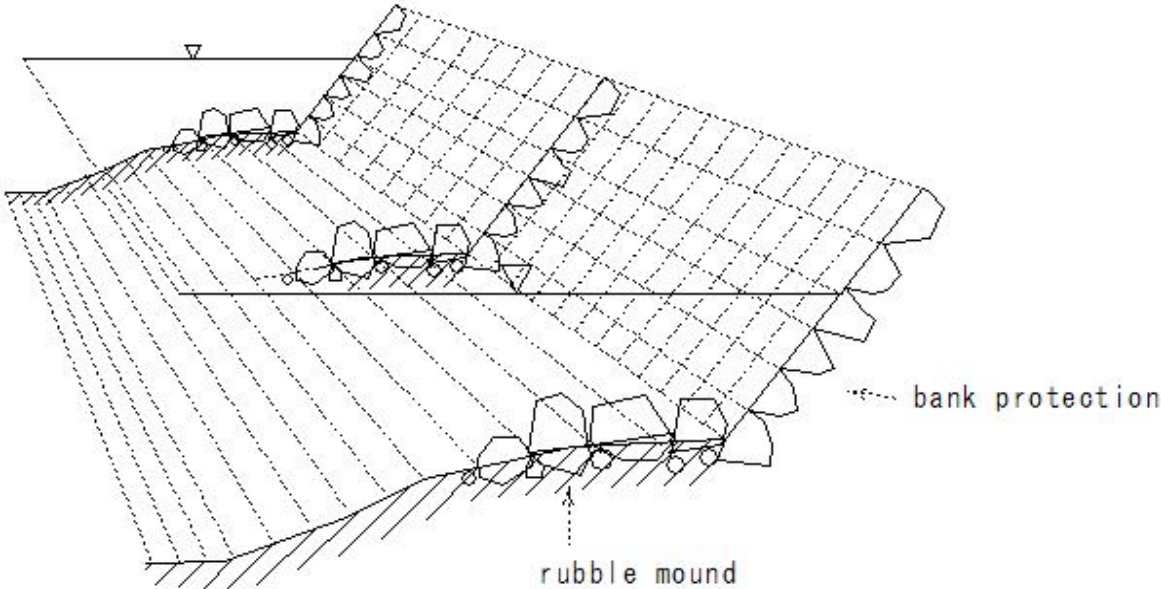


(R451)foot protection

(R451) foot protection

foot protection

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

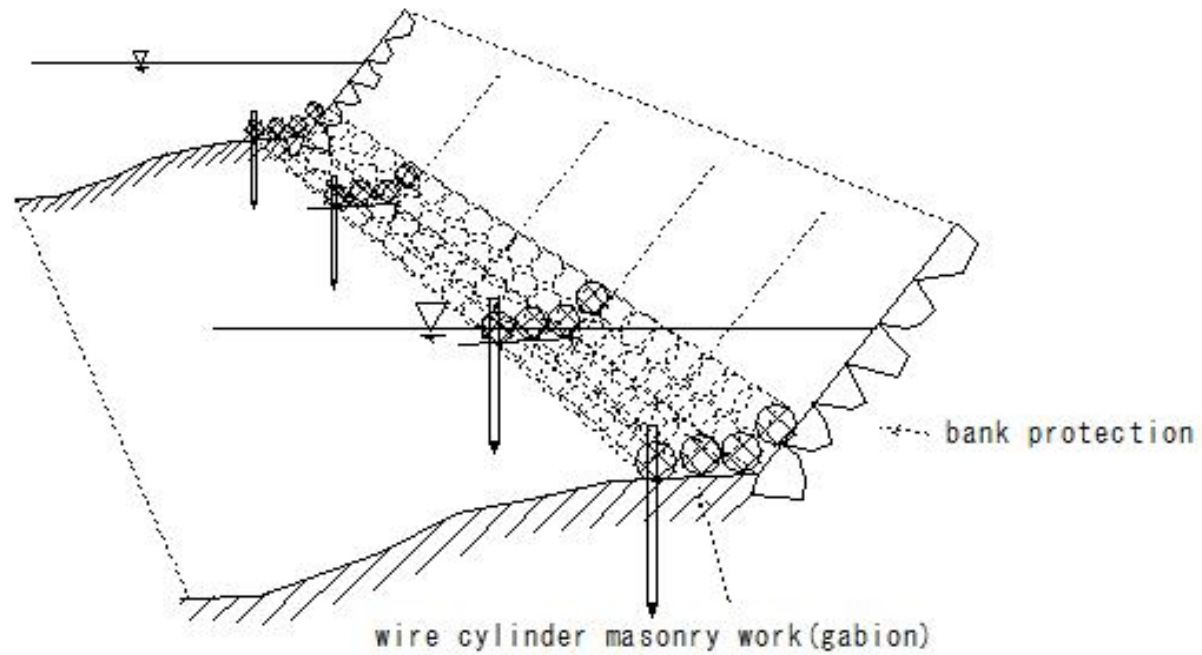


(R452)foot protection

(R452)foot protection

foot protection

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

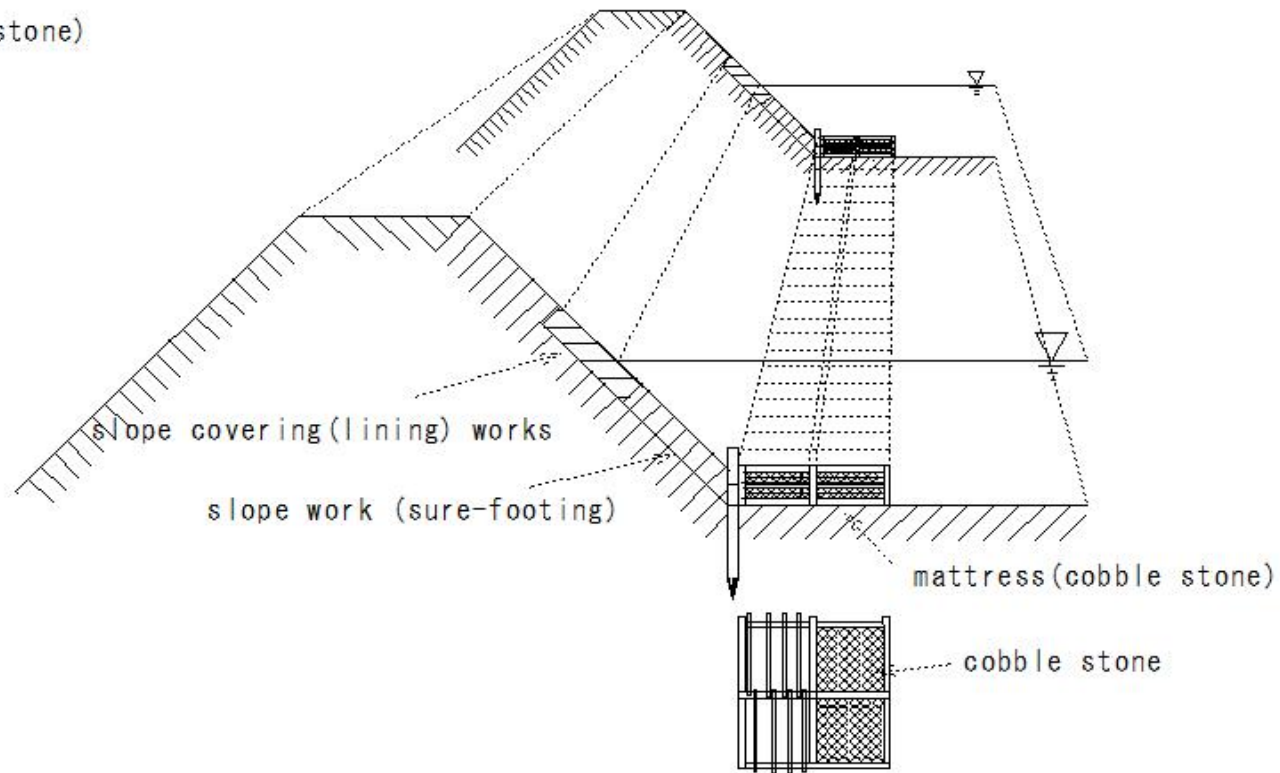


(R453)foot protection

(R453) foot protection

foot protection

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



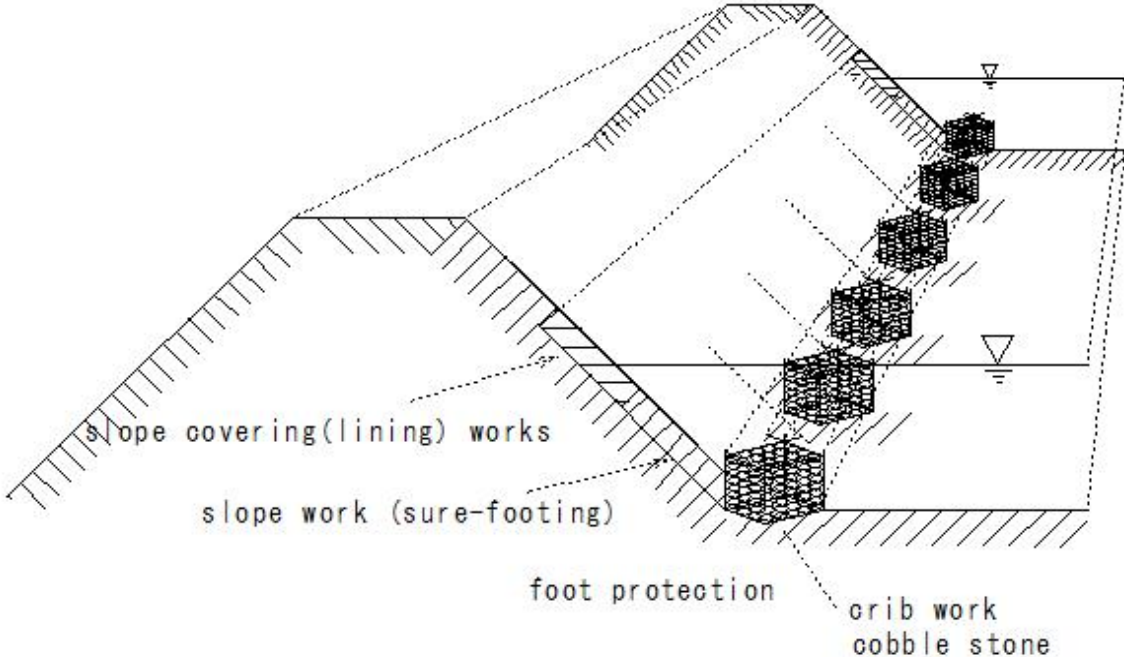
(R454)foot protection

(R454) foot protection

foot protection

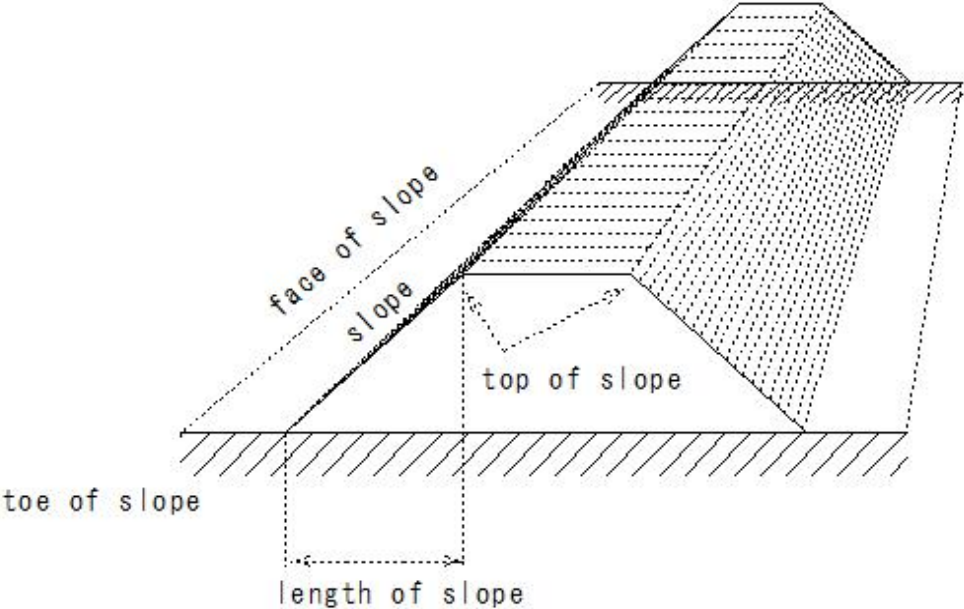
The toe of slope in front of the bank protection
Prevent from being destroyed by scouring

crib work



(R455)embankment(slope)

(R455) embankment (s lope)



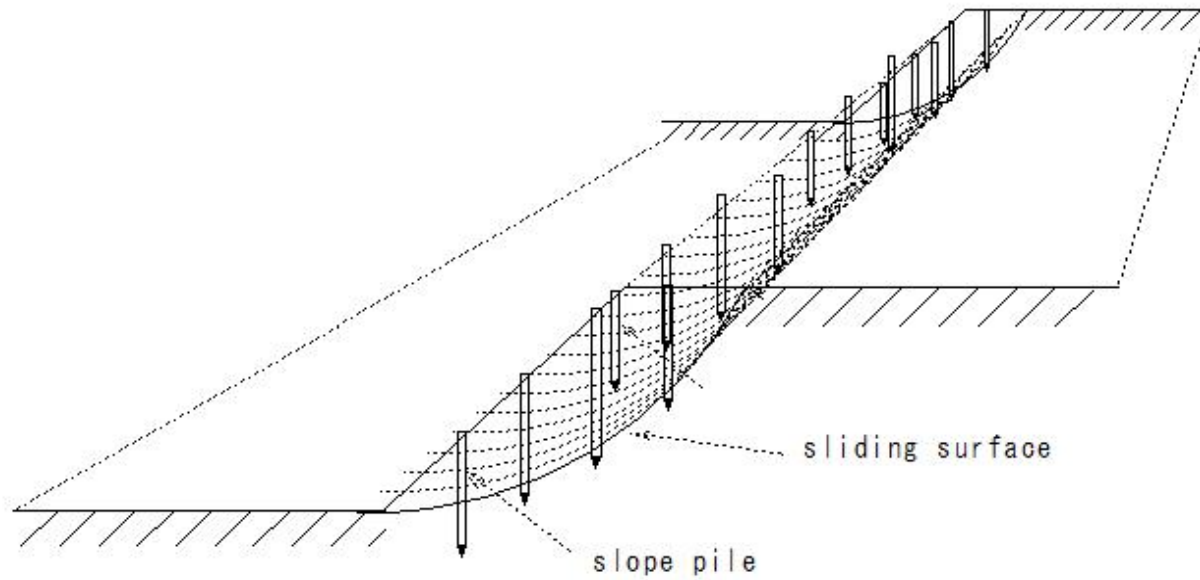
(R456)stability of the slope(slope pile)

(R456)stability of the slope(slope pile)

slope pile

Driving piles to strengthen the stability of the slope

Penetrate the sliding surface

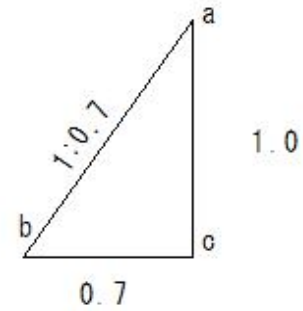
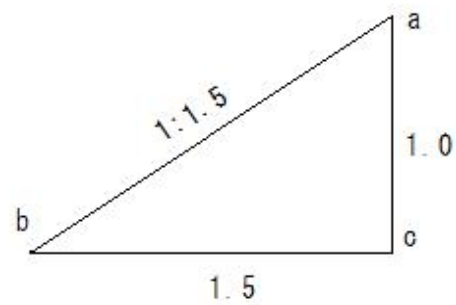
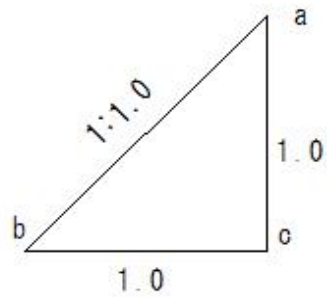


(R457)embankment(slope gradient)

(R457) embankment (slope gradient)

slope gradient (split)

Degree of inclination of the slope

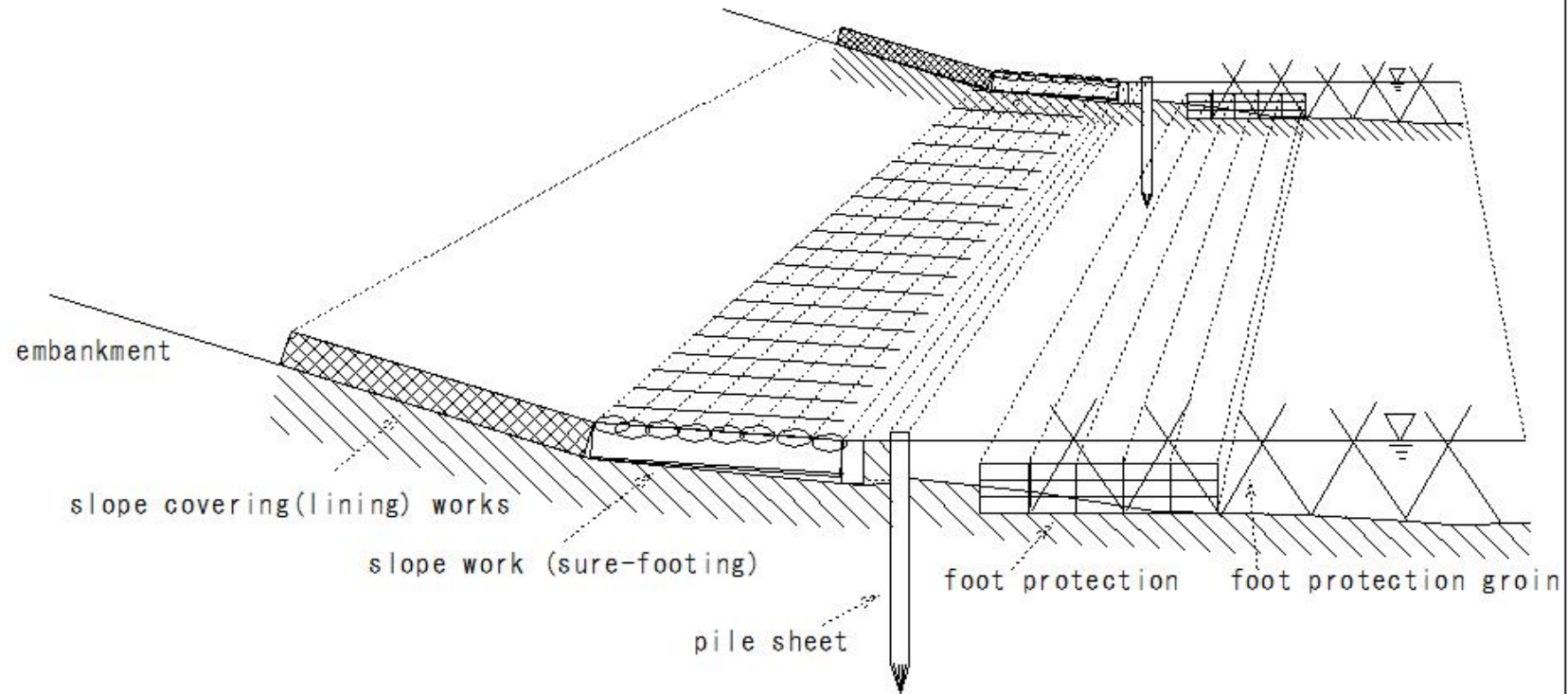


(R458)bank protection(sure-footing)

(R458)bank protection(sure-footing)

slope work (sure-footing)

Prevents scouring at the tip of the embankment or riverbank

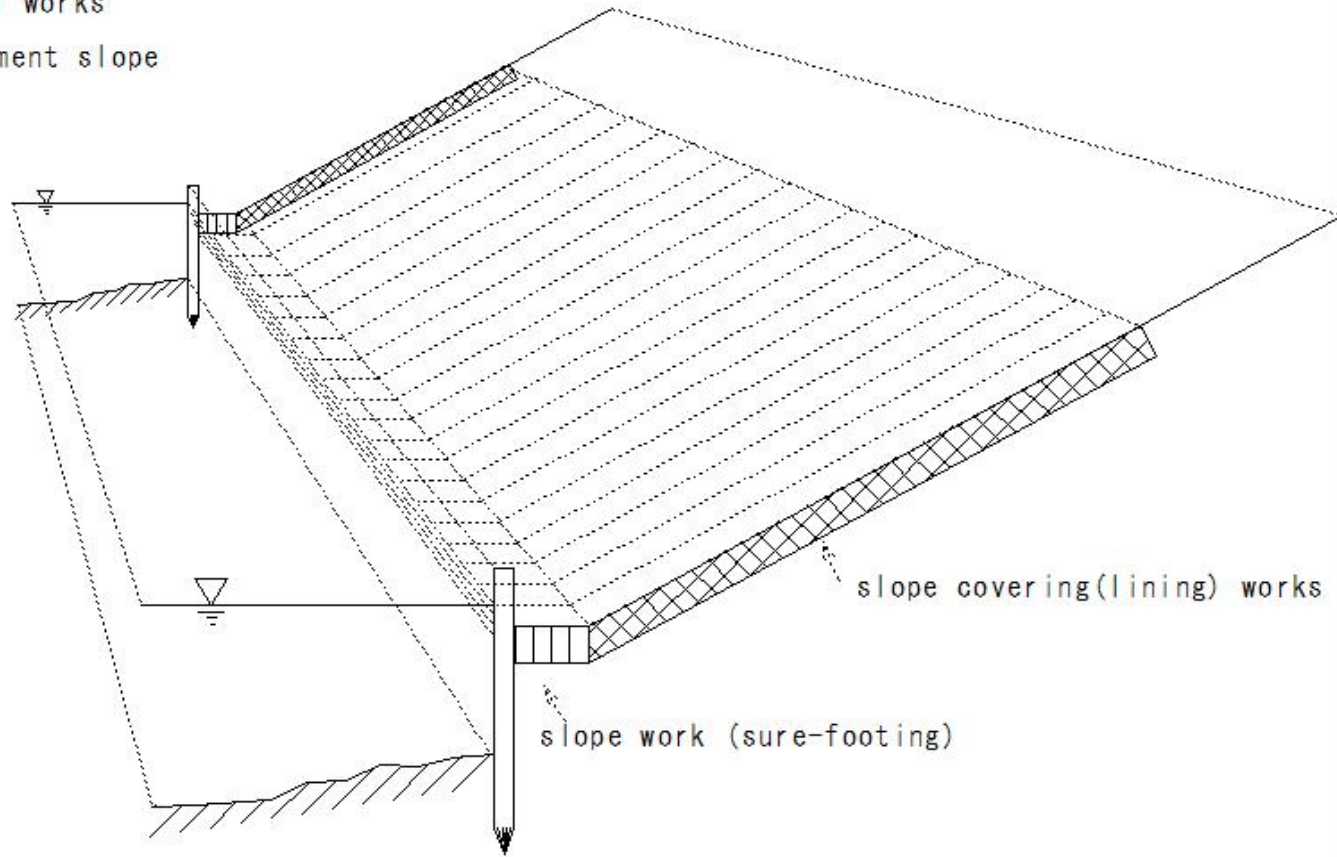


(R459)bank protection(slope covering(lining) works)

(R459)bank protection(slope covering(lining) works)

slope covering(lining) works

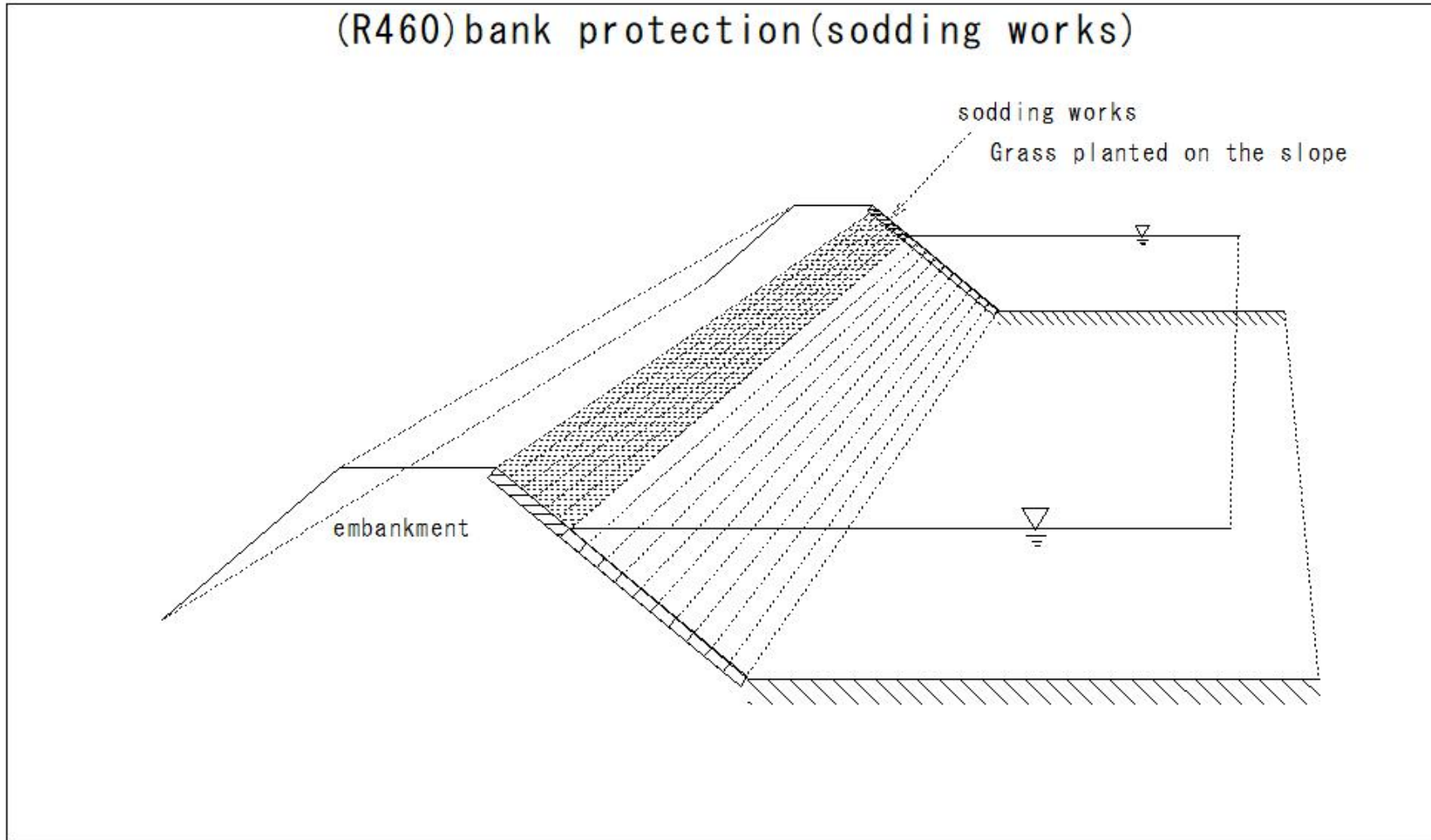
Covering the embankment slope



slope covering(lining) works

slope work (sure-footing)

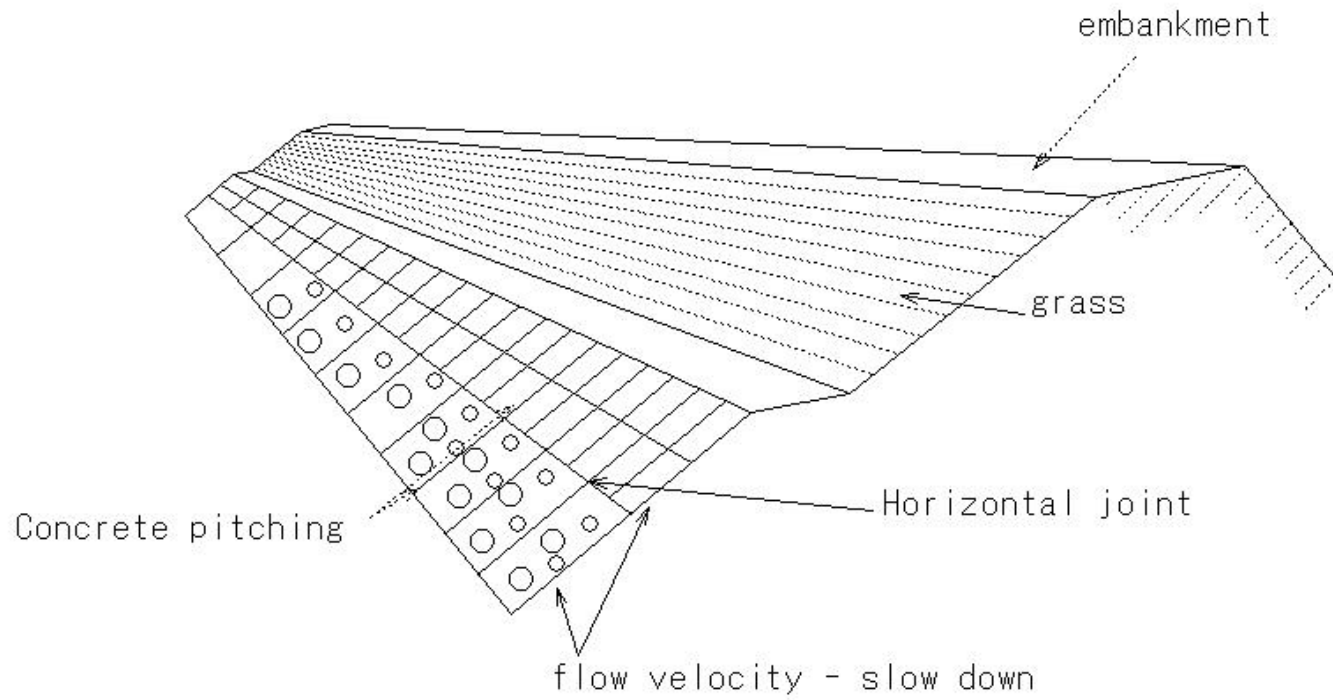
(R460)bank protection(sodding works)



(R461)bank protection(concrete pitching)

(R461)bank protection(concrete pitching)

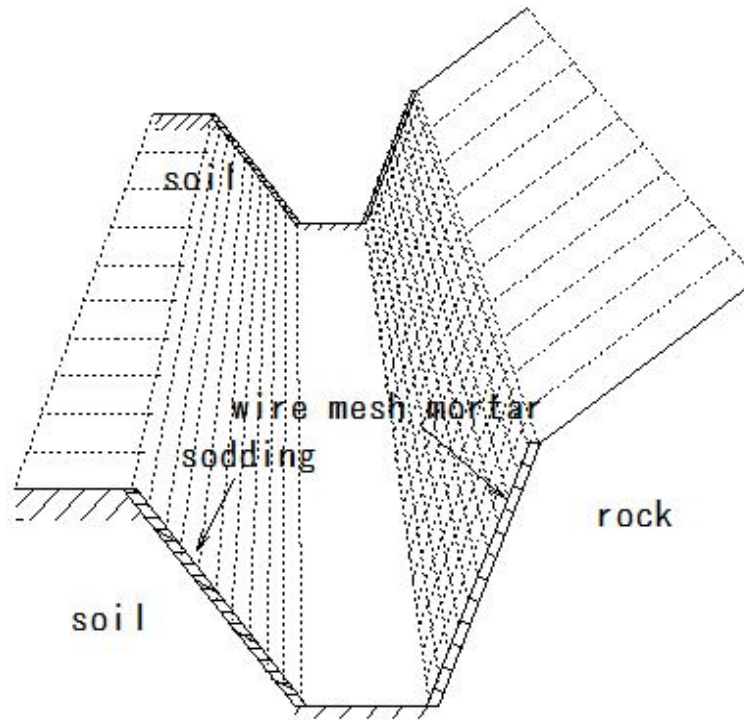
Concrete pitching



(R462)bank protection(slope protection)

(R462)bank protection(slope protection)

slope protection



(R463)weir(dentated sill)

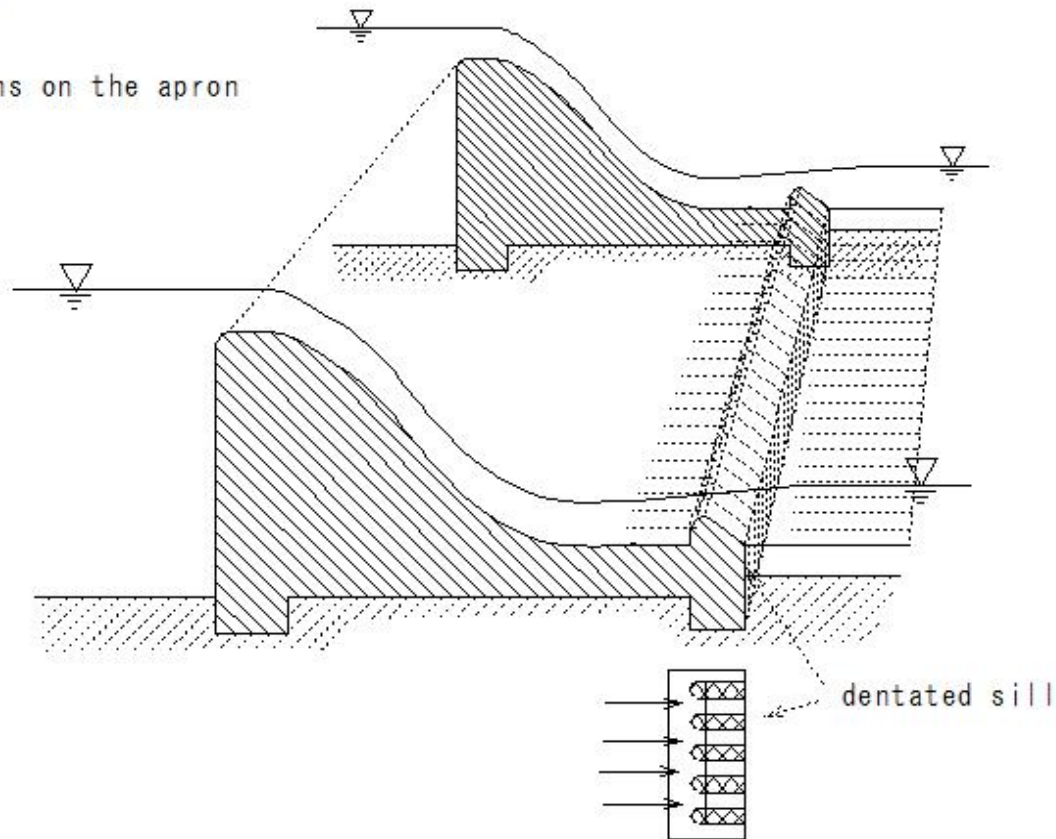
(R463)weir (dentated sill)

dentated sill

Overflowing a weir/dam

reduce water energy

Tooth-shaped protrusions on the apron



(R464)weir(sharp crested weir)

sharp crested weir

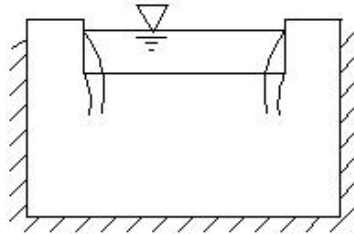
The overflow part is sharp.

blade shaped weir: Stable nap

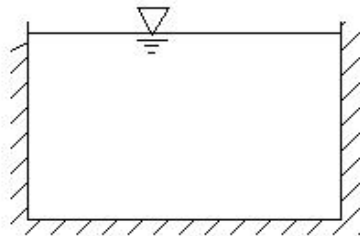
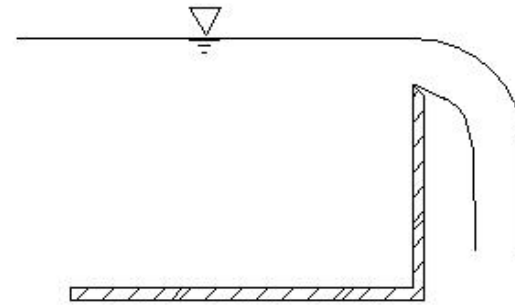
Easily measure overflow depth

Open channel flow measurement

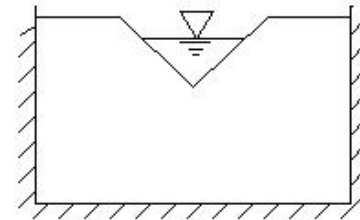
(R464) weir (sharp crested weir)



square cough

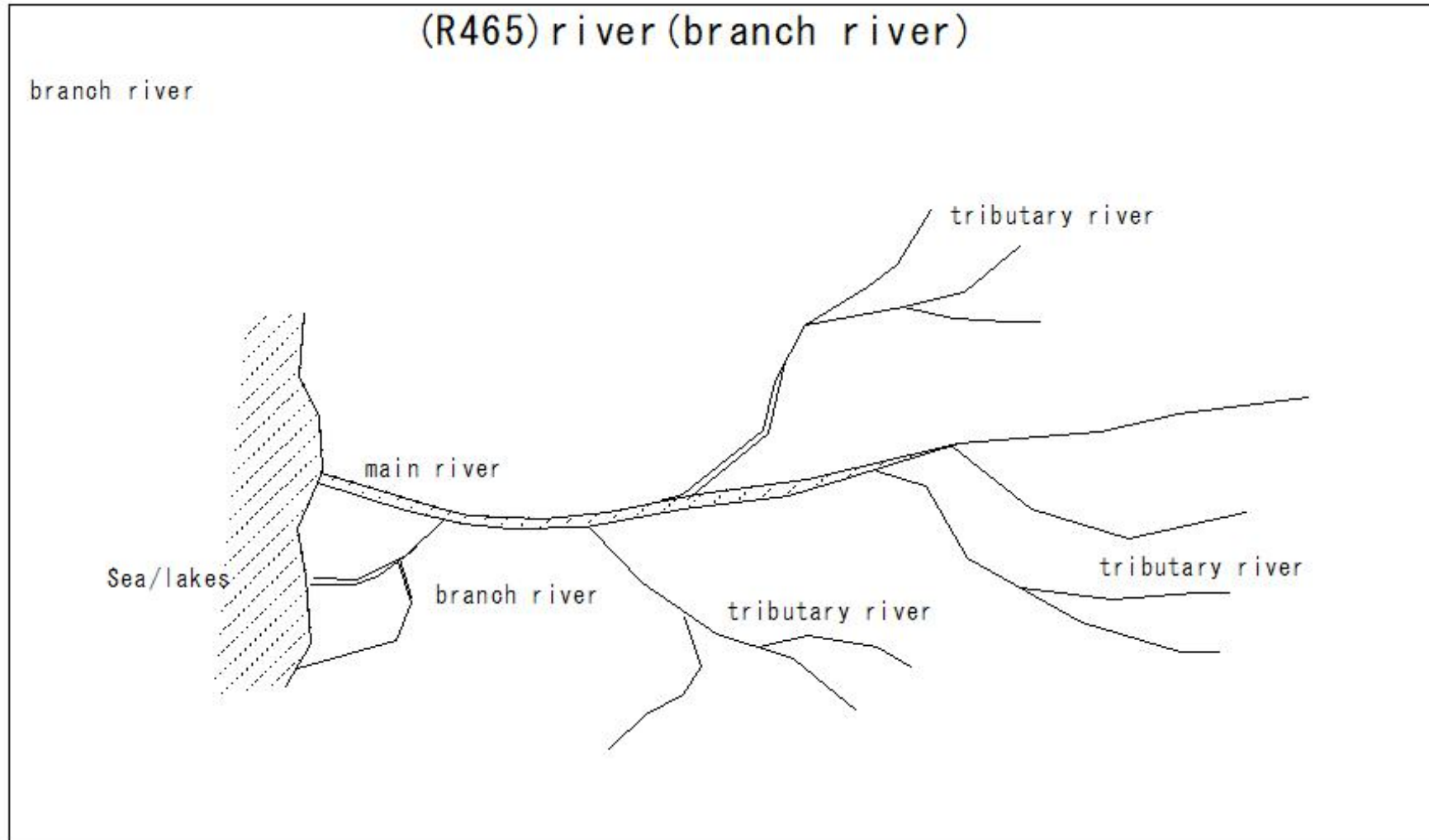


full width weir



triangular weir

(R465)river(branch river)



(R466)dam(baffle pier)

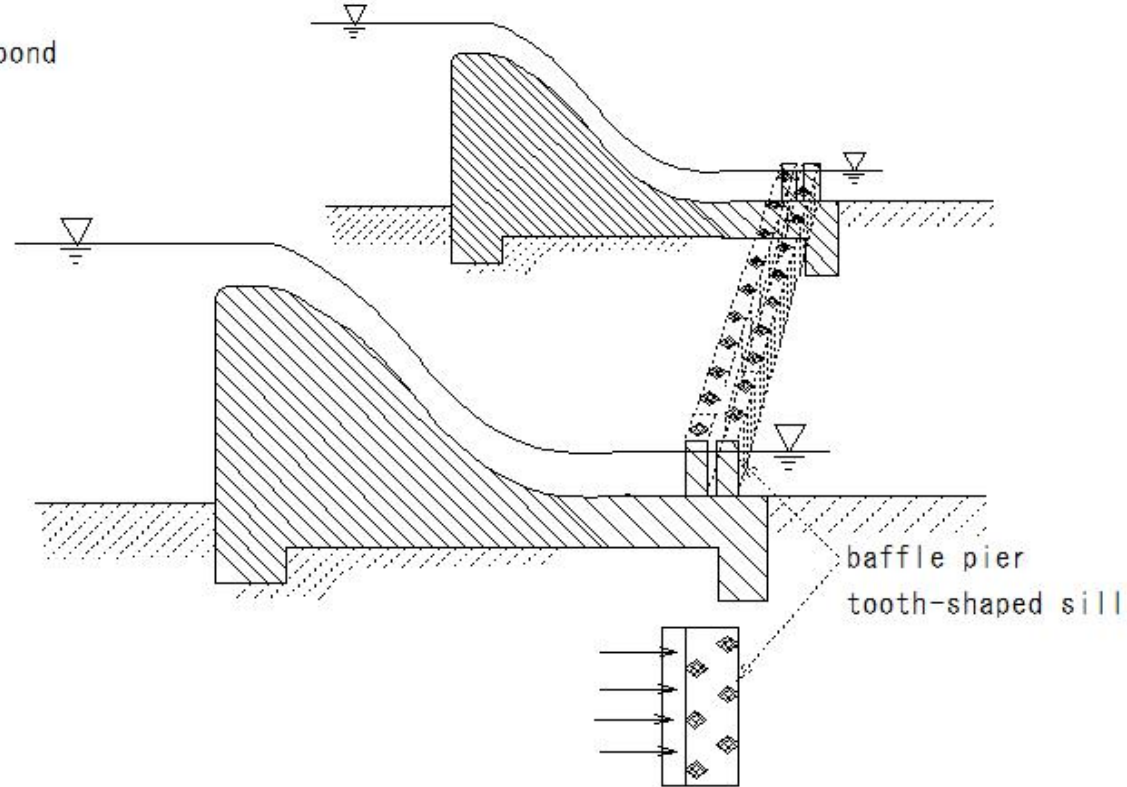
(R466) dam (baffle pier)

baffle pier

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

Energy reduction method

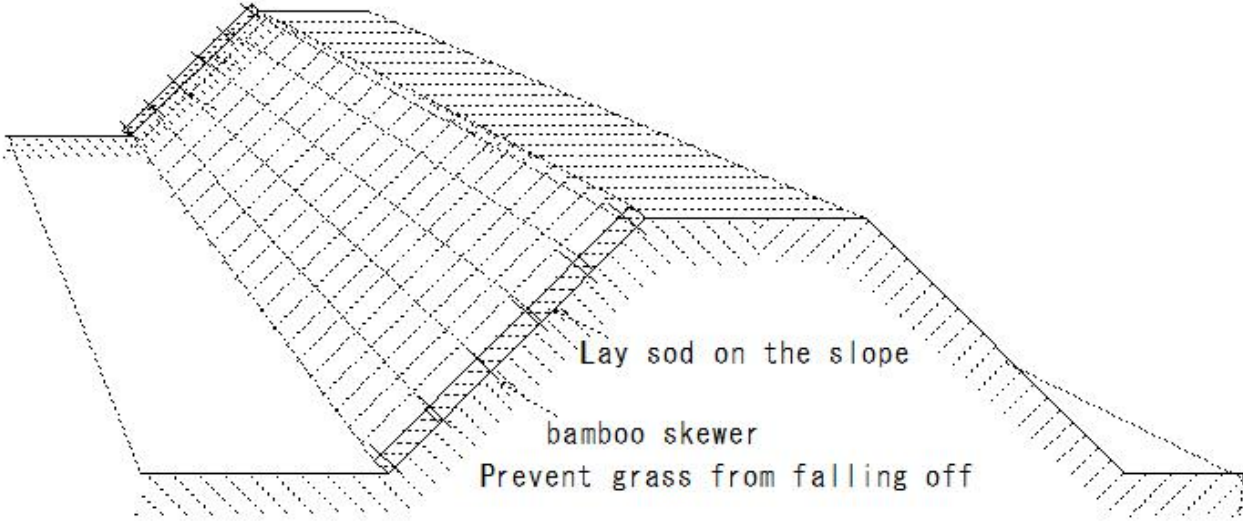
deflector
auxiliary dam



(R467)embankment(sodding)

(R467) embankment (sodding)

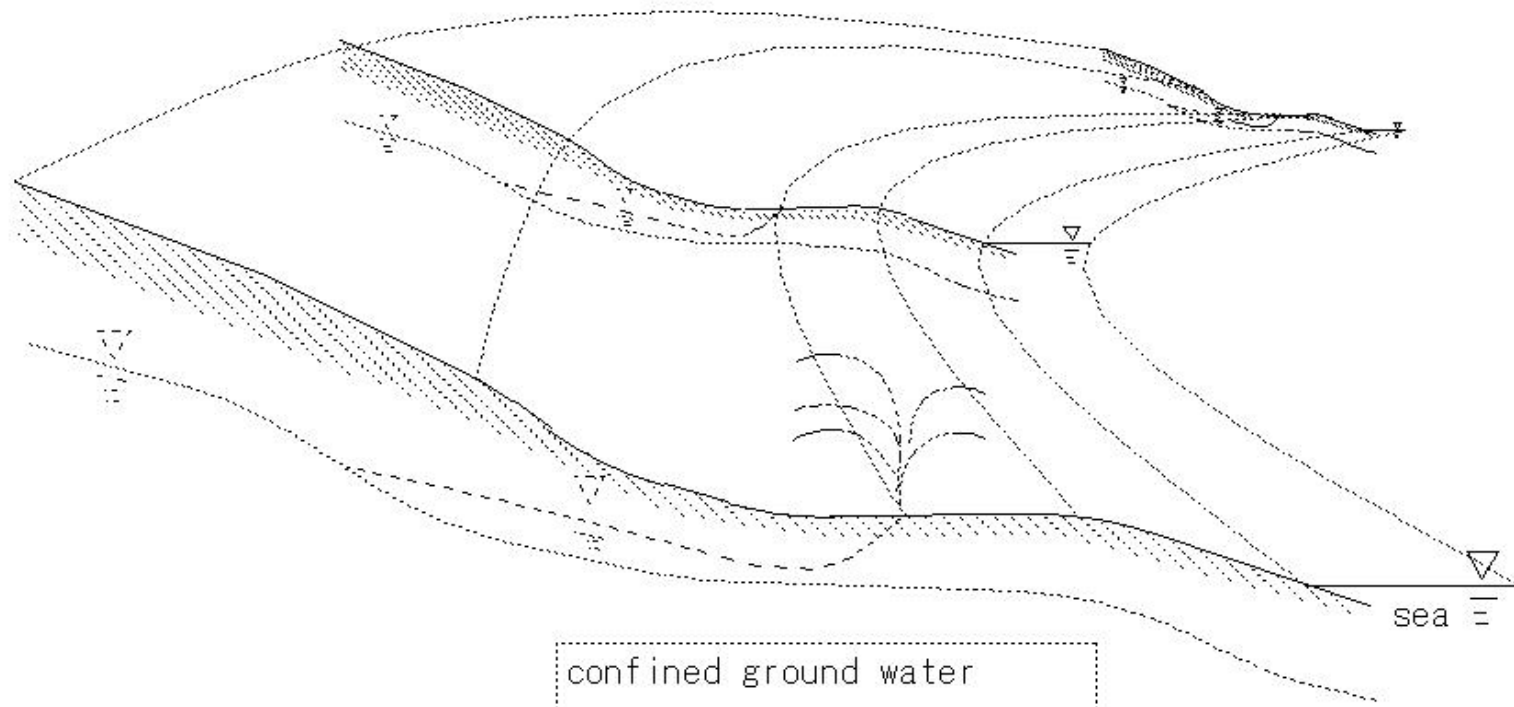
sodding



sodding

(R468)hydraulics(confined ground water)

(R468) hydraulics (confined ground water)



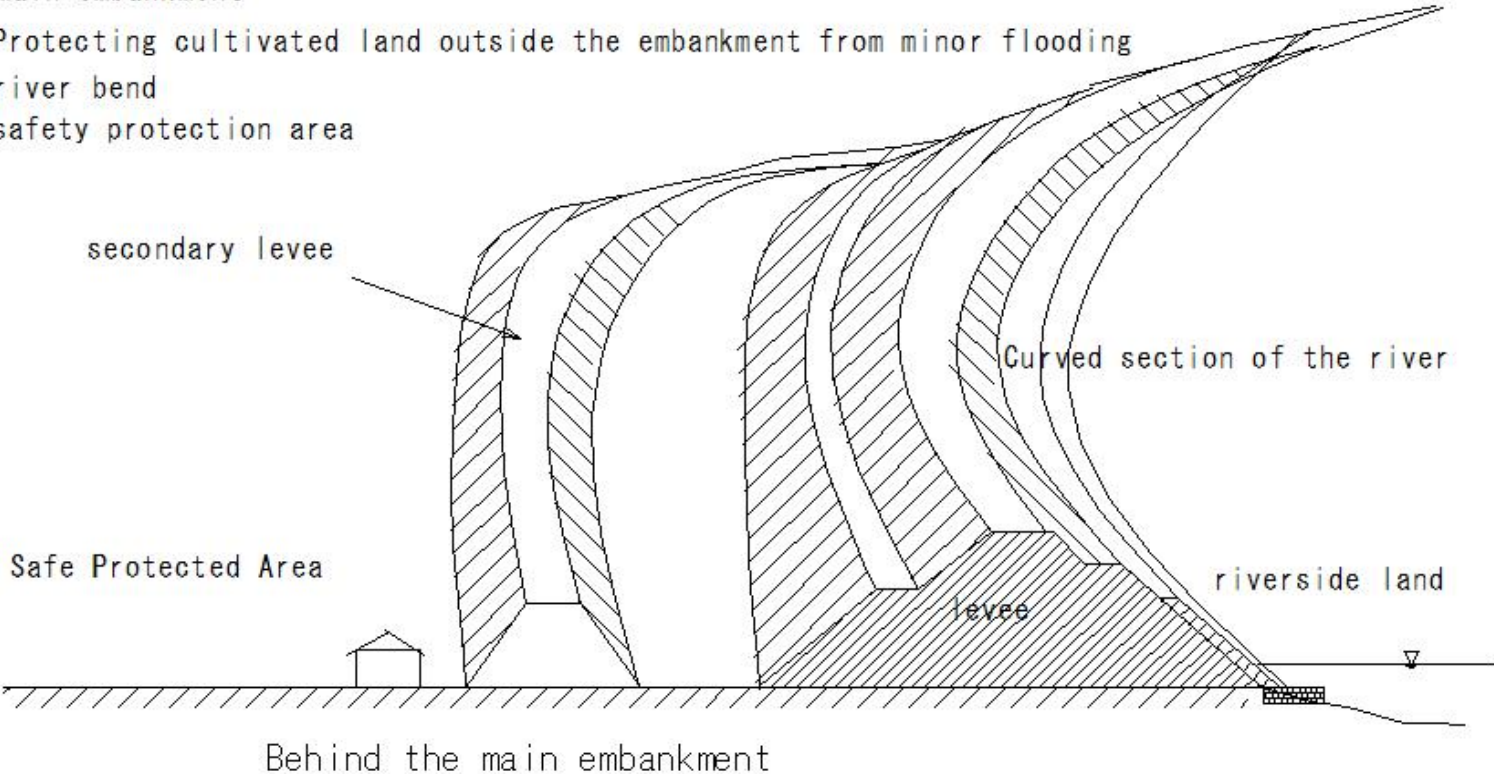
confined ground water
groundwater under pressure
artesian groundwater

(R469)embankment(secondary levee)

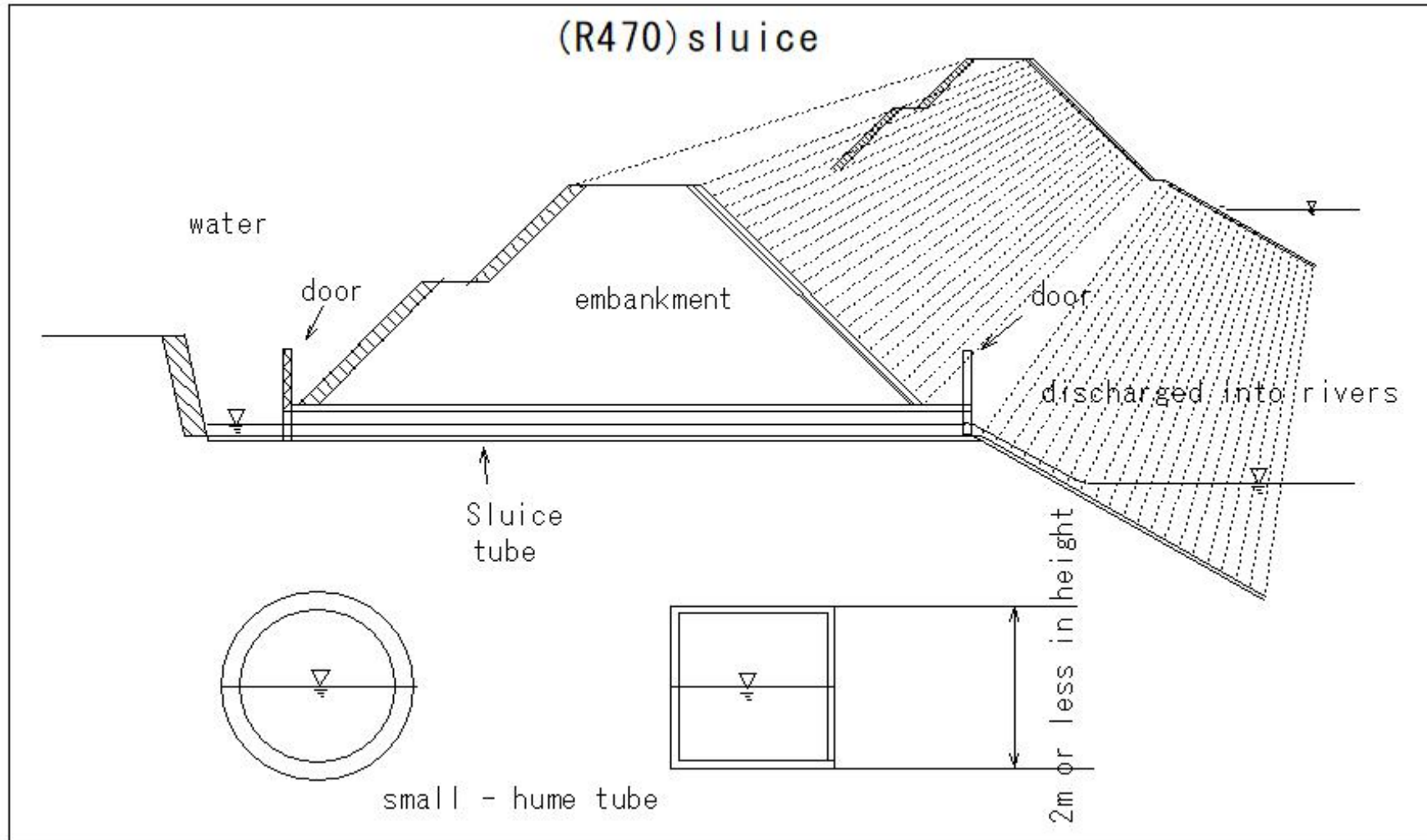
(R469) embankment (secondary levee)

secondary levee
Main embankment

Protecting cultivated land outside the embankment from minor flooding
river bend
safety protection area



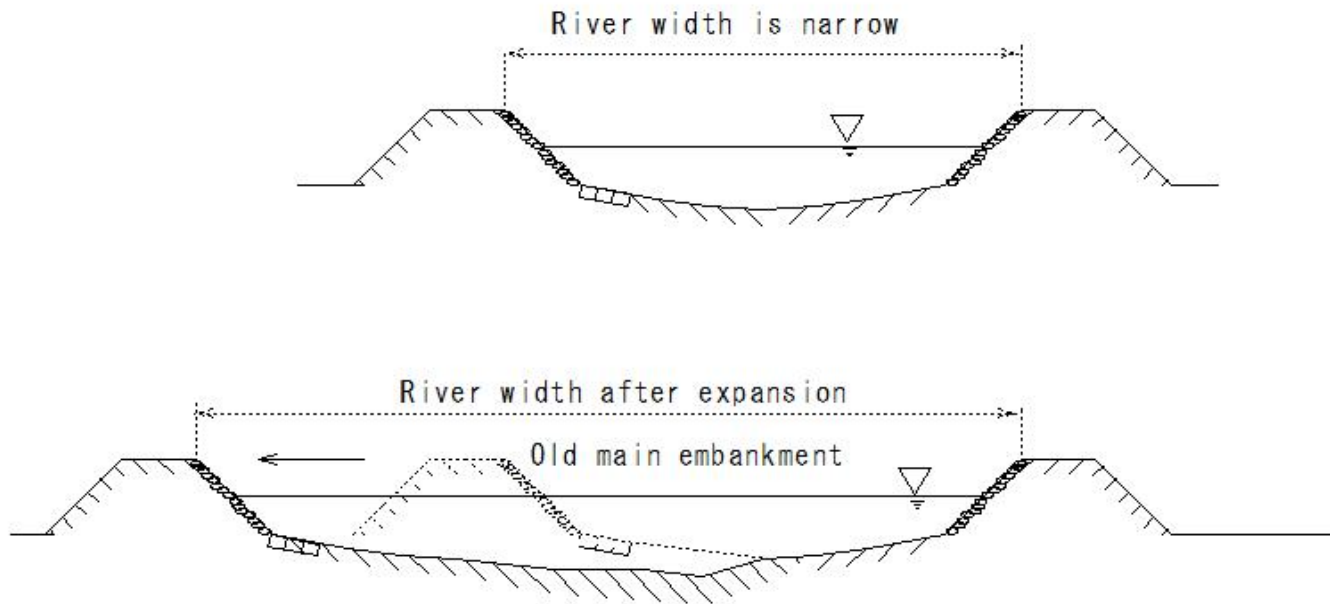
(R470)sluice



(R471)embankment(setting back of levee)

(R471) embankment(setting back of levee)

setting back of levee

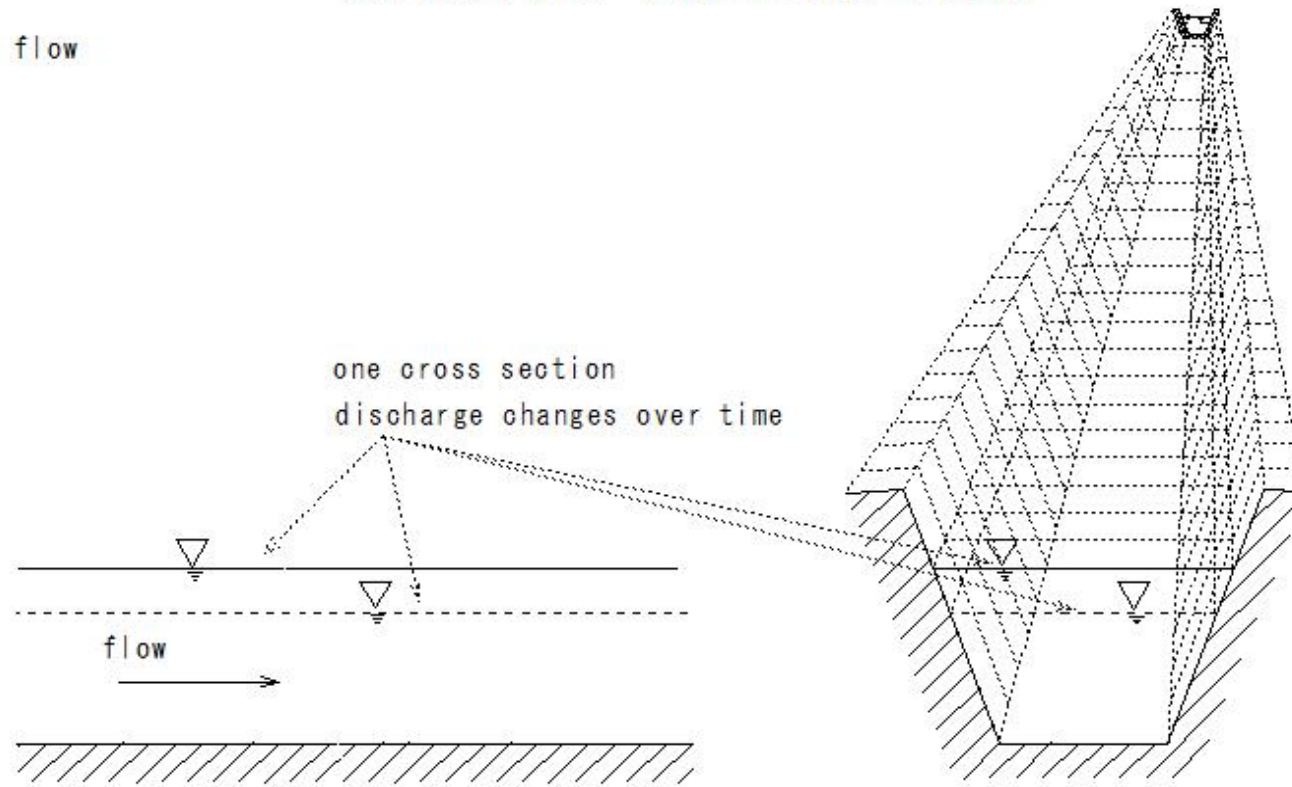


setting back of levee

(R472)flow (unsteady flow)

(R472)flow (unsteady flow)

unsteady flow



(R473)sluice

(R473) sluice

sluice

Water intake from rivers

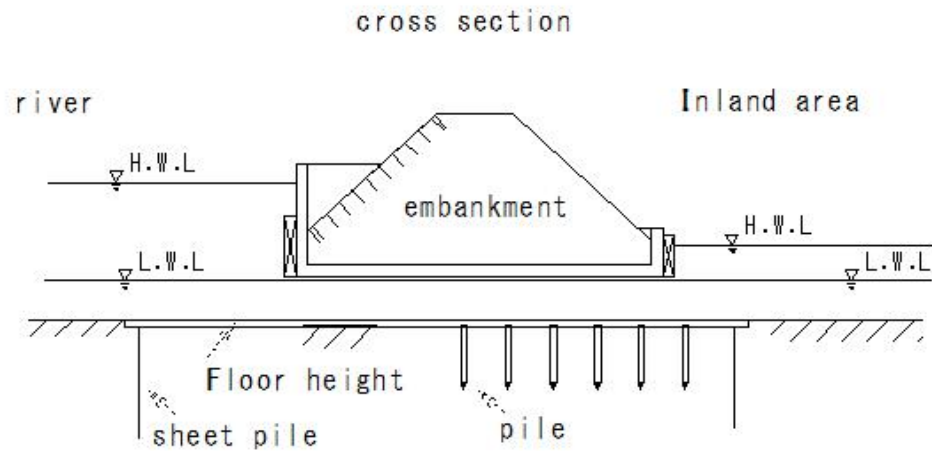
drainage to rivers

Embankment crossing - culvert

Small sluice pipe

2m or more - sluice

Higher than the embankment - sluice gate



(R474) surface impermeable wall

(R474) surface impermeable wall

surface impermeable wall

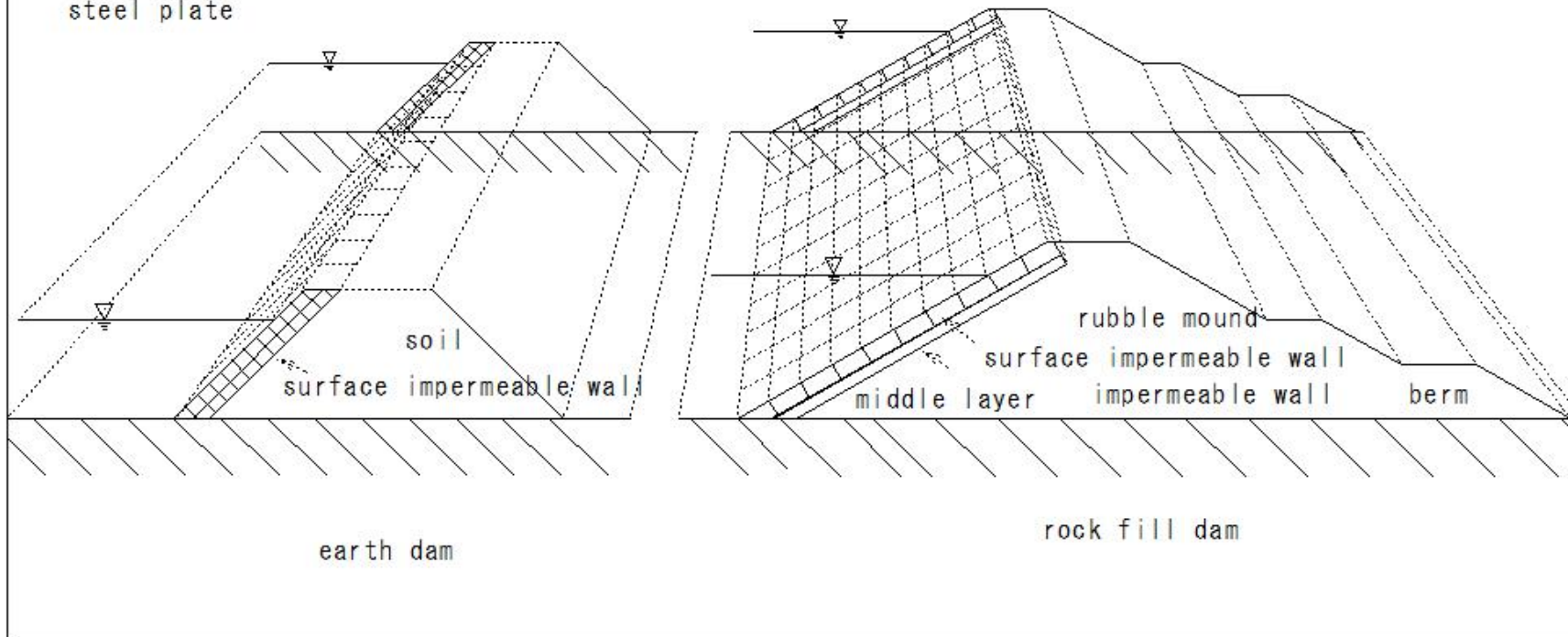
Impermeable wall on upstream surface

material

reinforced concrete

asphalt

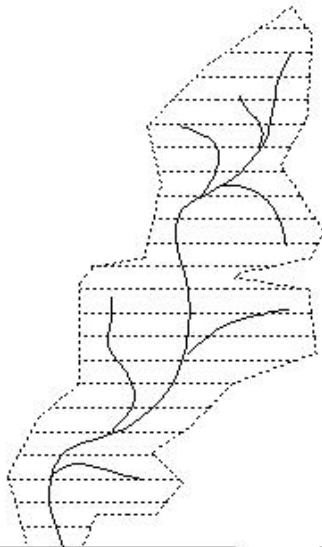
steel plate



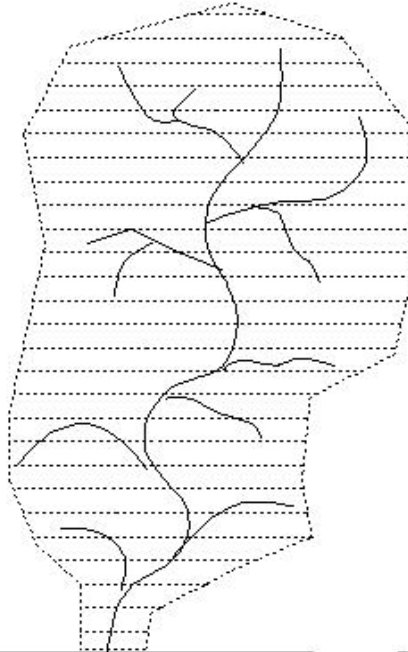
(R475) composite drainage basin

(R475) composite drainage basin

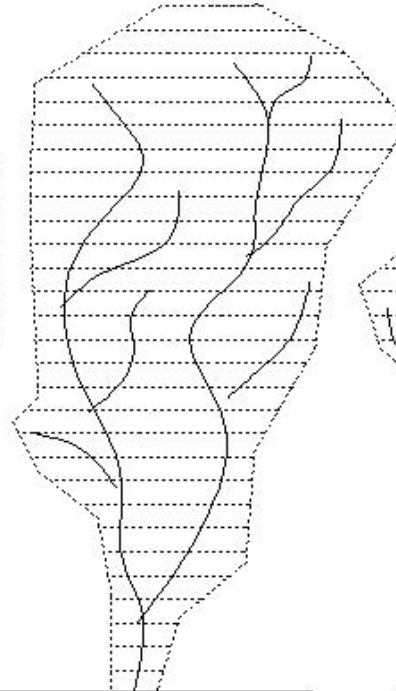
composite drainage basin



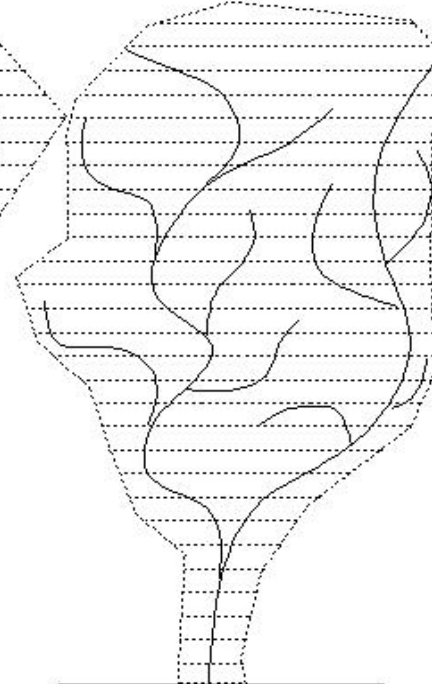
pinnate basin



radial basin



parallel basin



composite basin

(R476)auxiliary dam

(R476) auxiliary dam

auxiliary dam

Preventing scouring downstream of overflow dams

Installed at the apron of this dam

small overflow dam

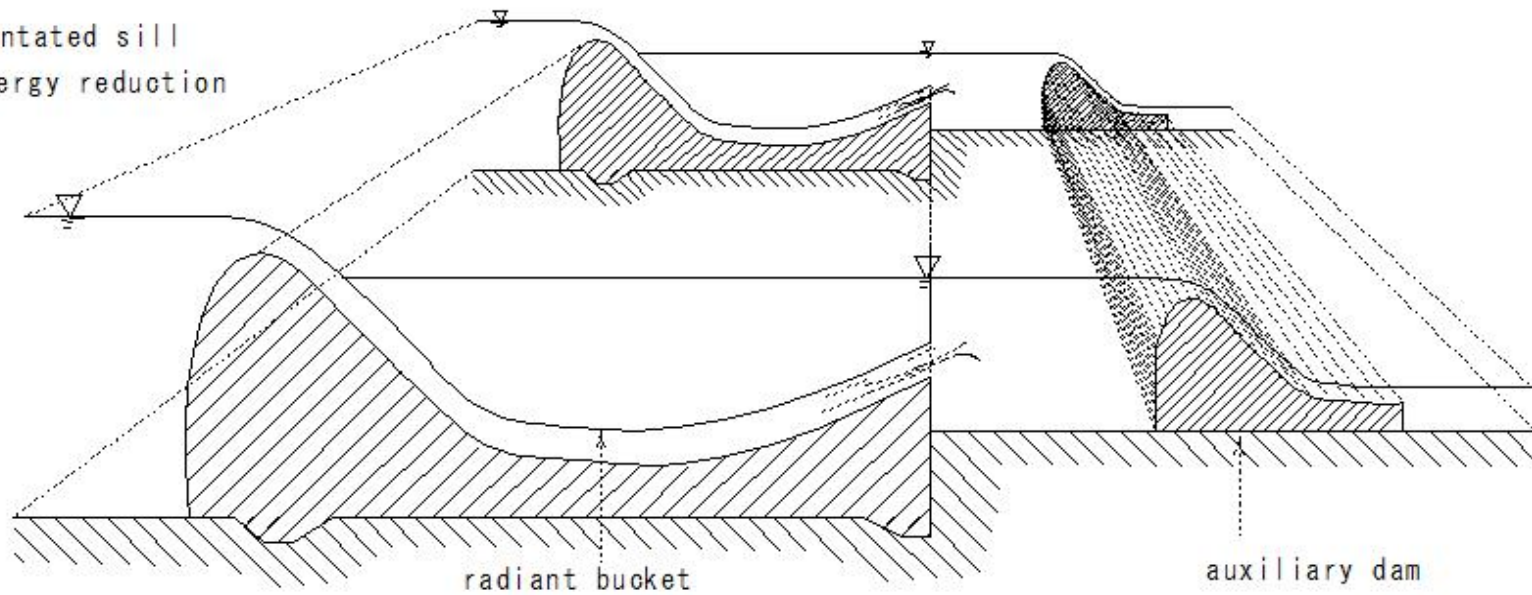
Rear end of apron

baffle pier

deflector

dentated sill

energy reduction

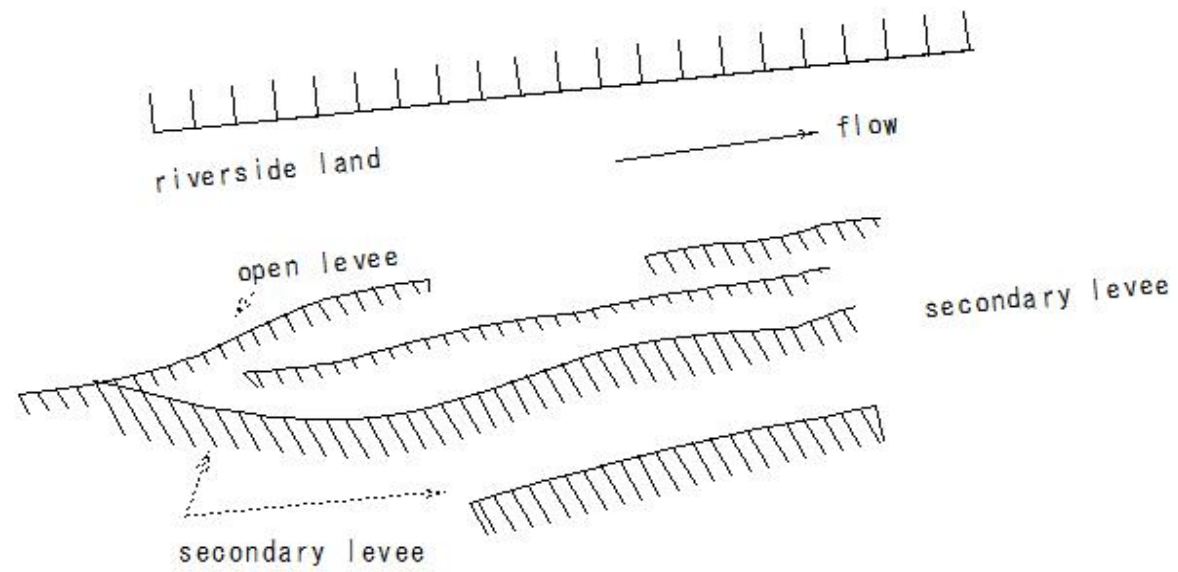


(R477)secondary levee

(R477) secondary levee

secondary levee

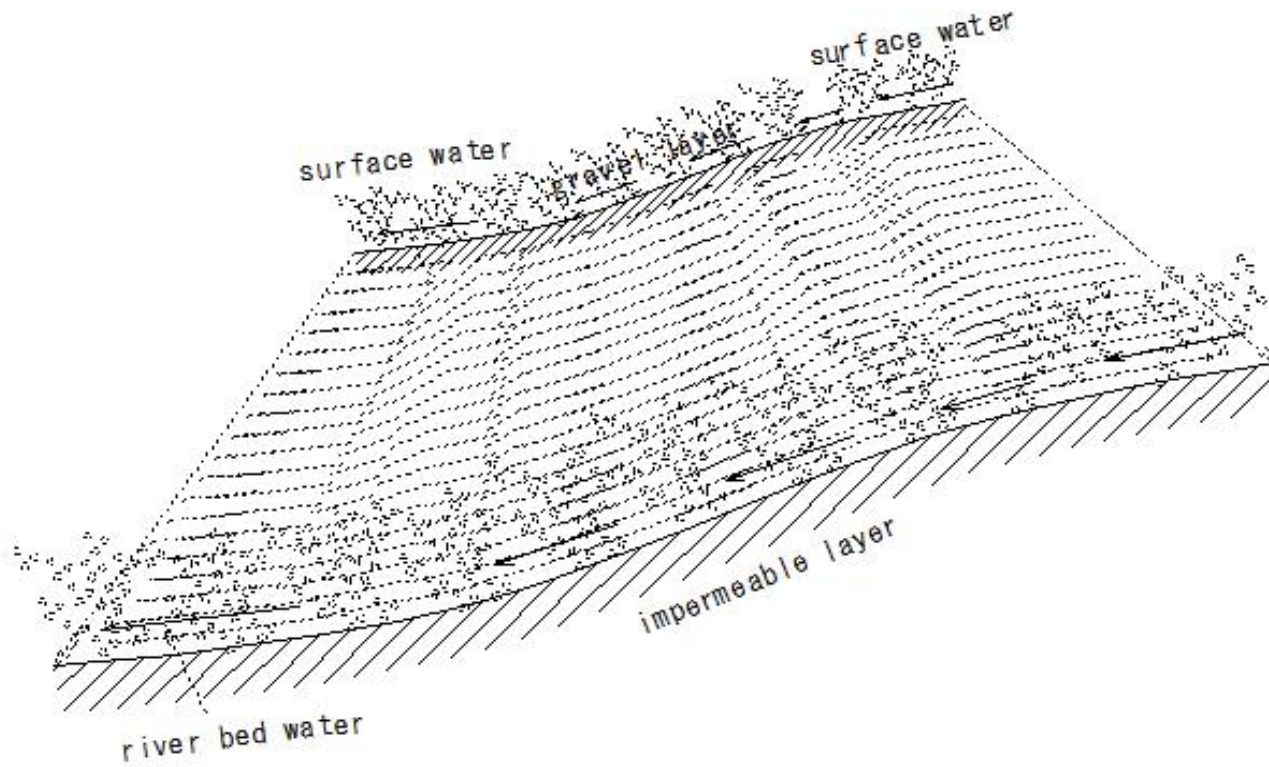
Embankment parallel to the main embankment



(R478)river bed water

(R478)river bed water

river bed water

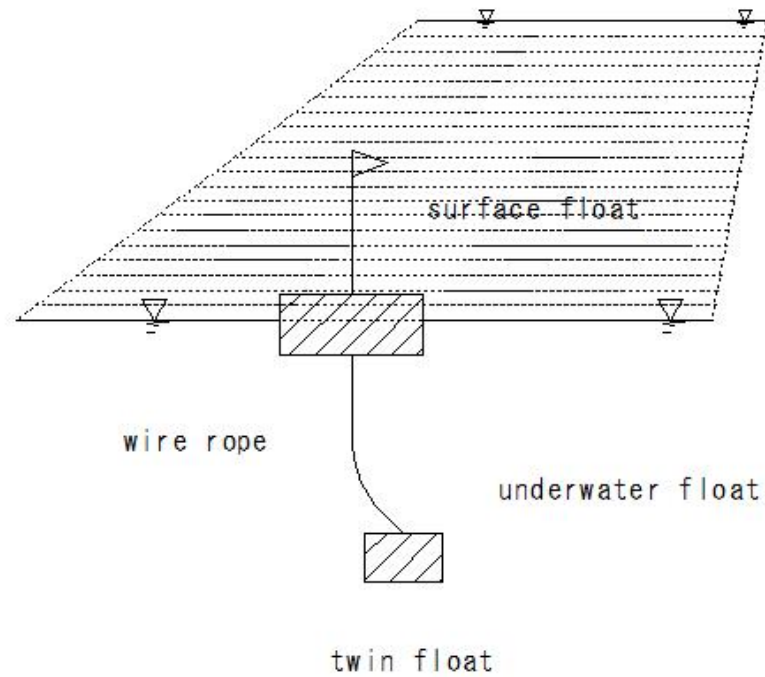


(R479)twin float

(R479) 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

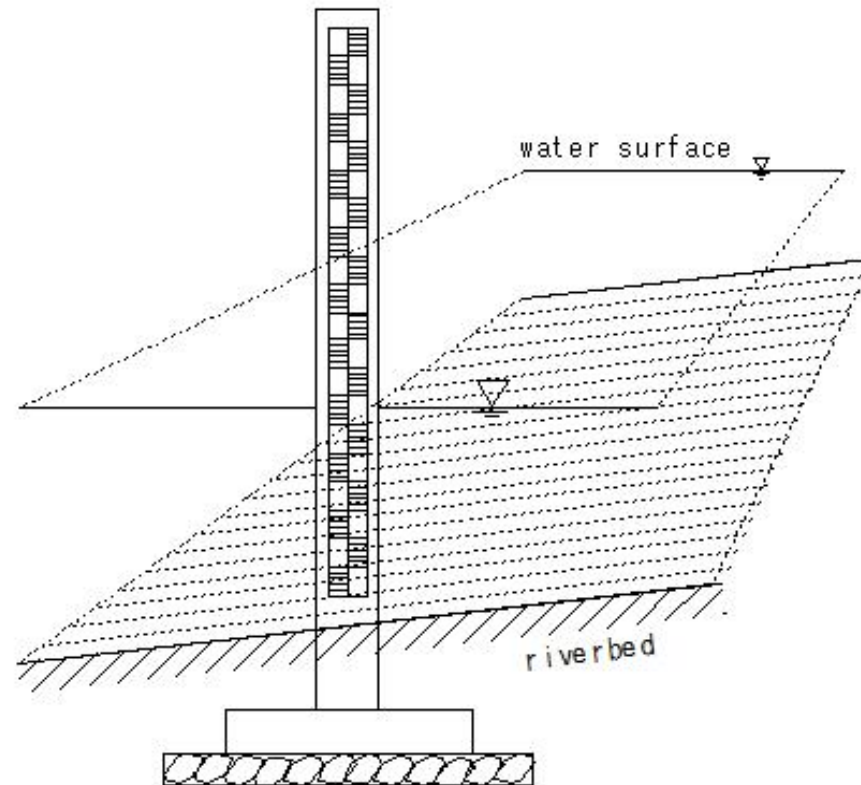


(R480)normal water gauge

(R480)normal water gauge

normal water gauge

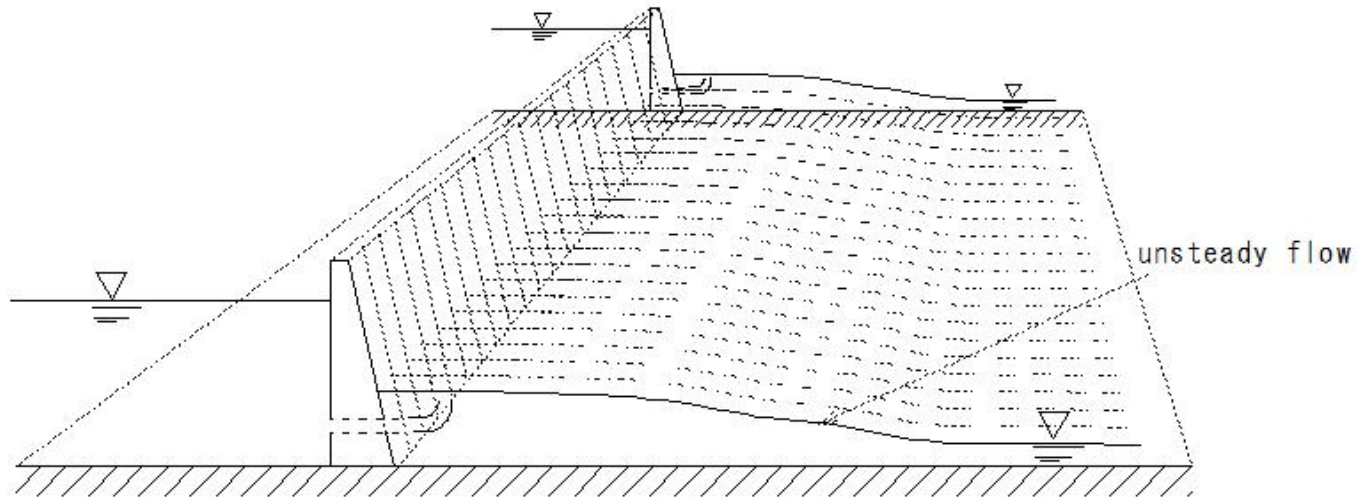
Read the river water level on the scale



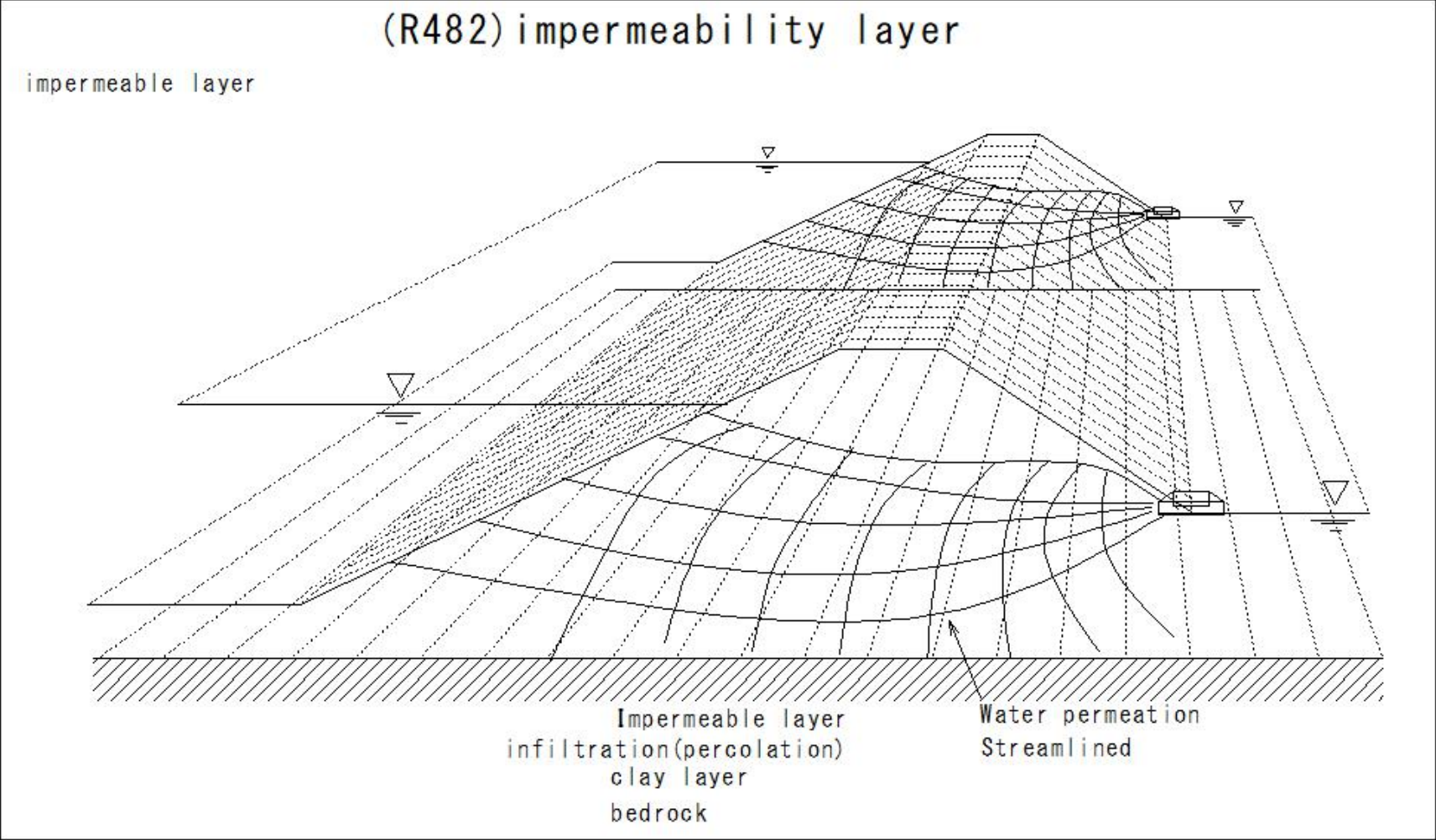
(R481)unsteady flow

(R481)unsteady flow

unsteady flow
waterway
flow: volume and velocity change over time
dam discharge



(R482)impermeability layer



(R483)non-uniform flow

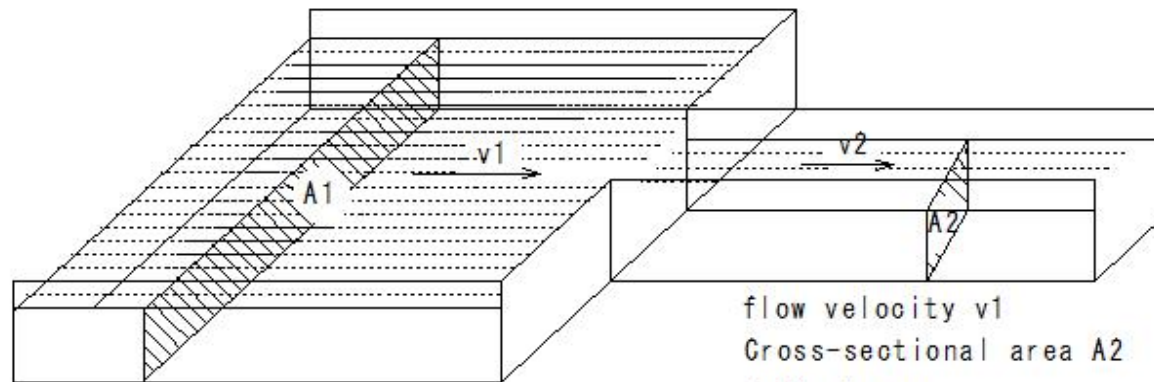
(R483)non-uniform flow

non-uniform flow

Constant discharge

waterway

flow with changing flow velocity and volume



flow velocity v_1

Cross-sectional area A_2

Q : discharge

$$Q = A_1 v_1 = A_2 v_2$$

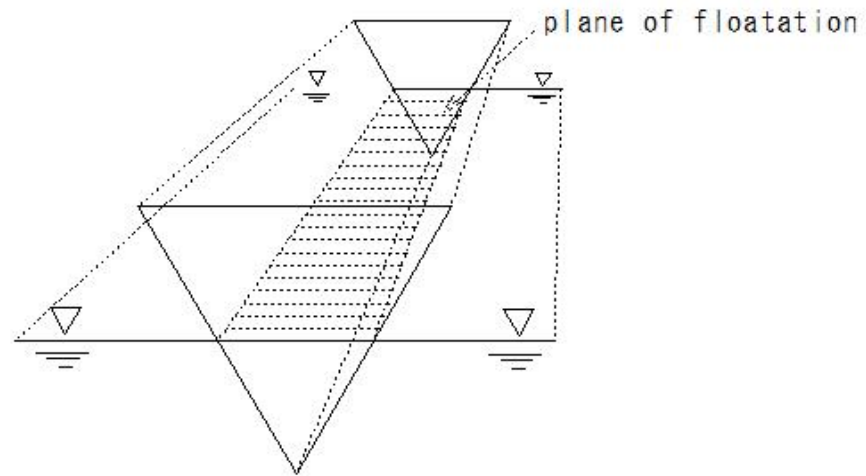
(R484)plane of floatation

(R484)plane of floatation

plane of floatation

objects floating in water

Virtual cross section : cut by the water surface



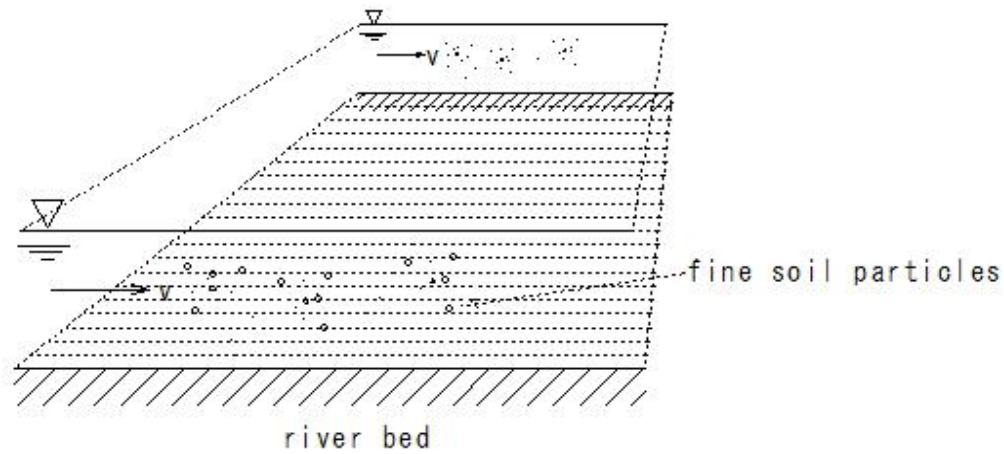
(R485)suspended load

(R485) 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.

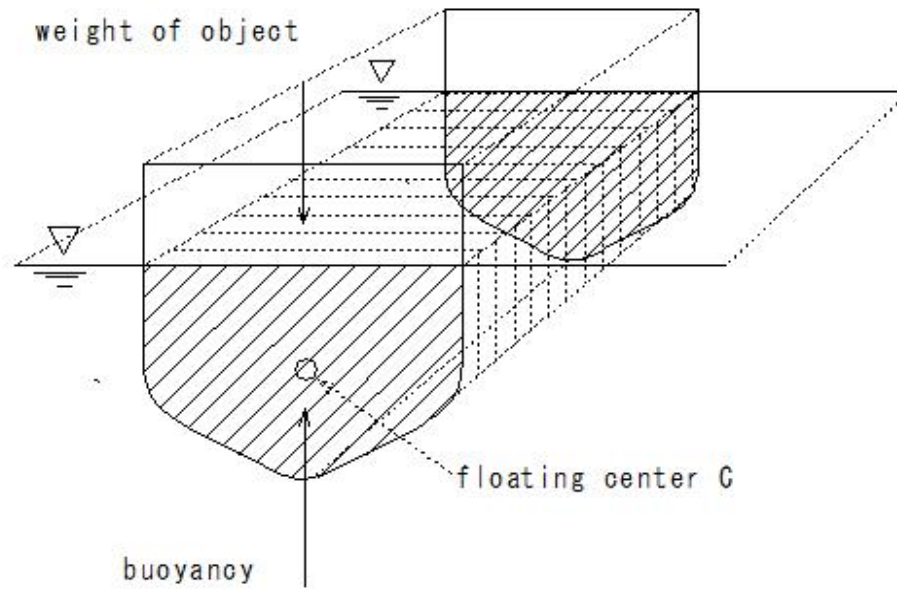


(R486)buoyancy

(R486) buoyancy

buoyancy

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



(R487)Froude number

(R487)Froude number

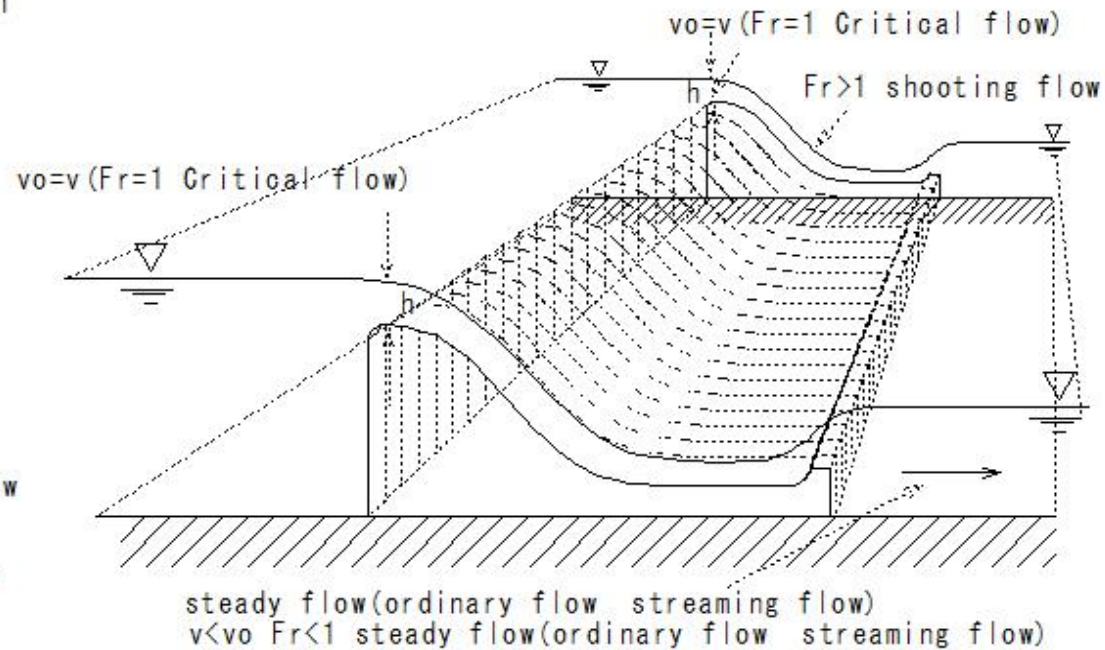
Froude number

open channel

Flow velocity v

Wave propagation speed $v_0(=\sqrt{gh})$

Froude number $Fr=v/v_0=v/\sqrt{gh}$



Fr > 1 shooting flow

Fr = 1 Critical flow

Fr < 1 steady flow (ordinary flow
streaming flow)

g : gravitational acceleration

h : water depth

steady flow (ordinary flow streaming flow)
 $v < v_0$ Fr < 1 steady flow (ordinary flow streaming flow)

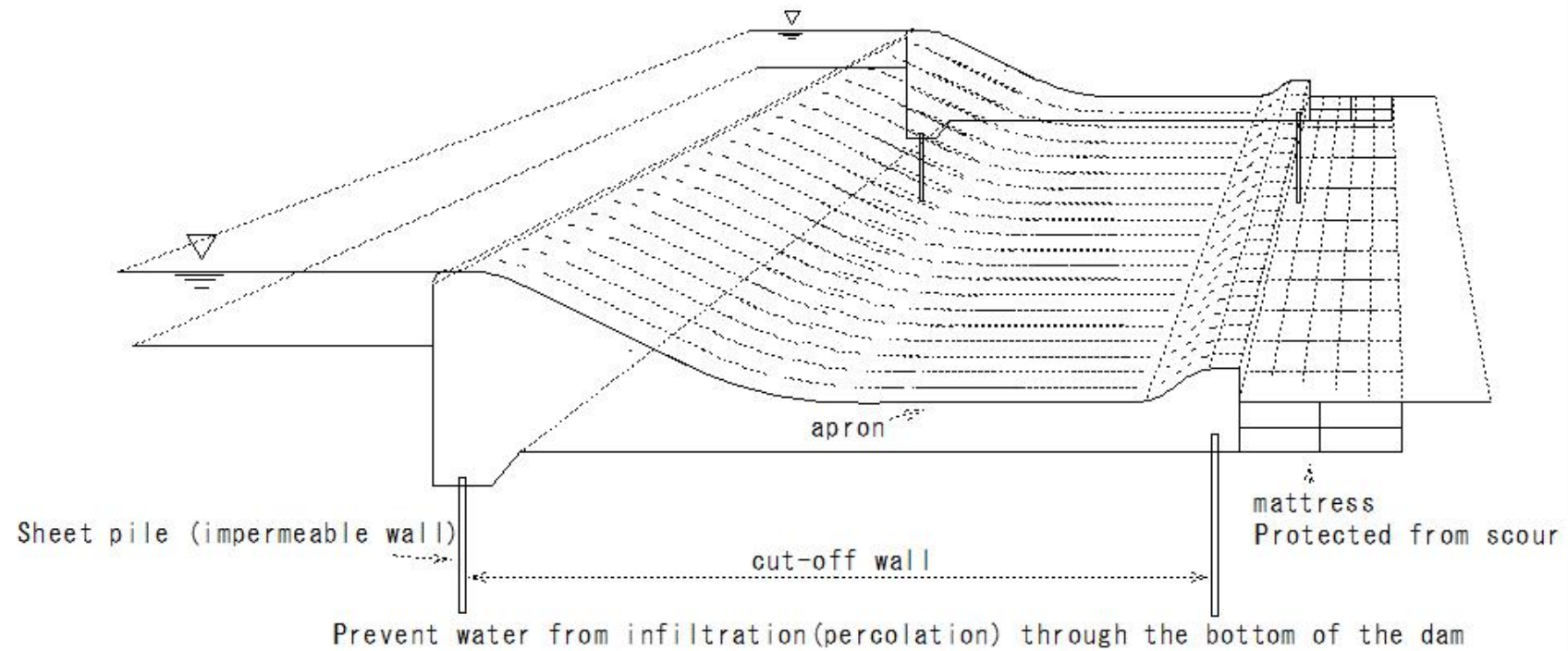
(R488)floating dam

(R488)floating dam

floating dam

A type of intake dam

Dams built on permeable foundations such as gravel layers



(R489)watershed

(R489)watershed

watershed

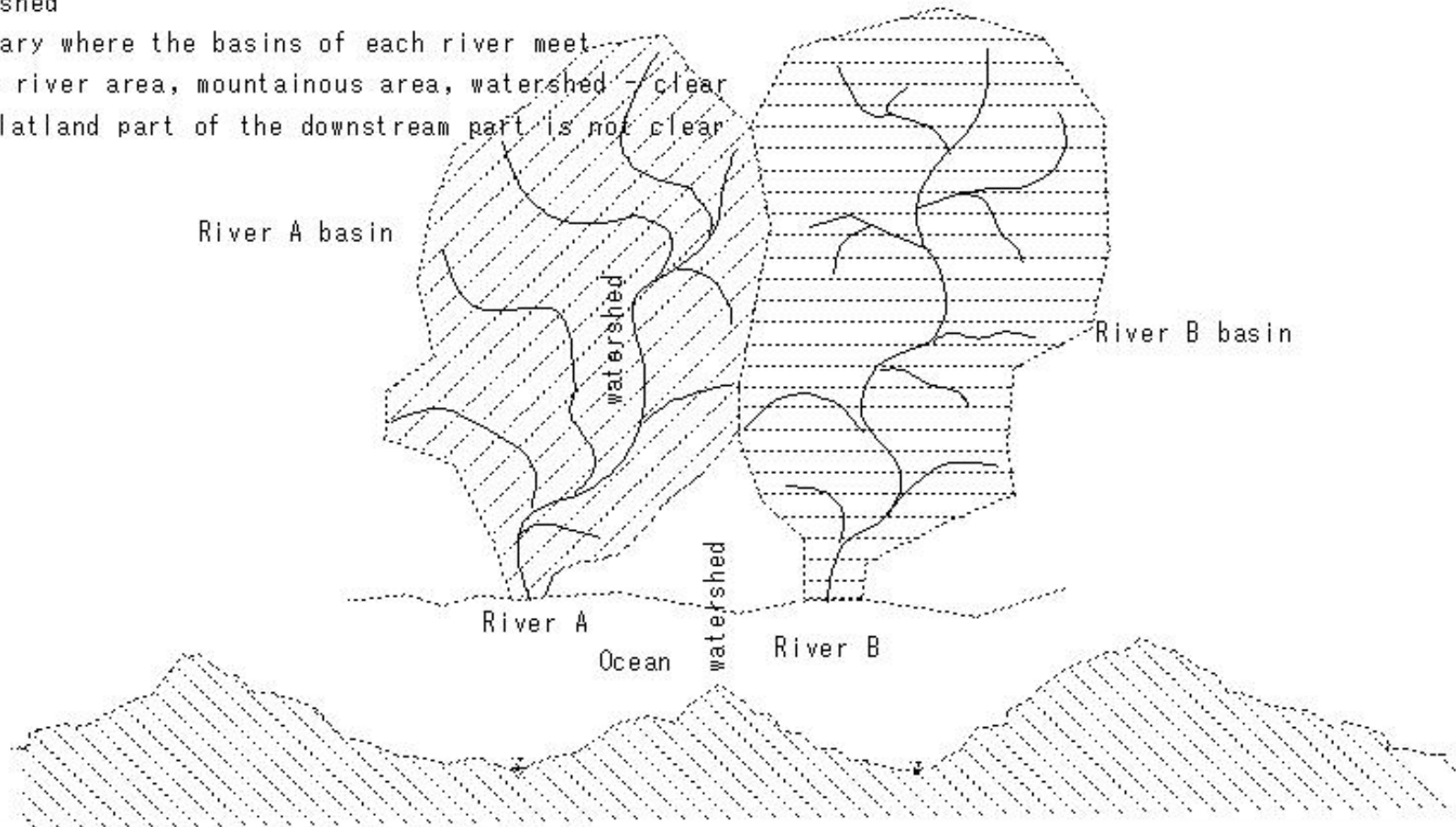
Boundary where the basins of each river meet

Upper river area, mountainous area, watershed - clear

The flatland part of the downstream part is not clear

River A basin

River B basin

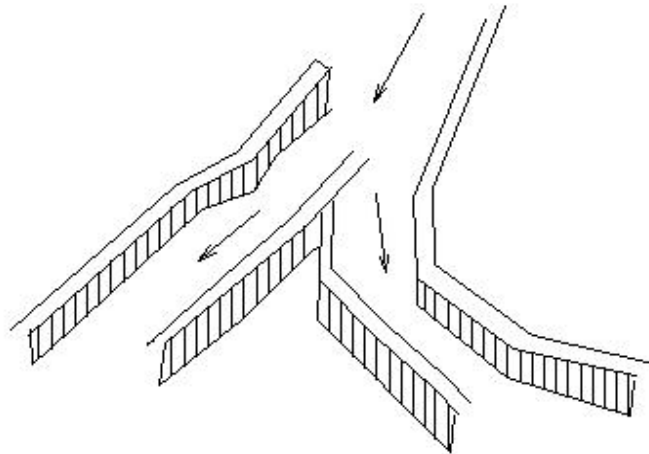


(R490)diversion works

(R490)diversion works

diversion works

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



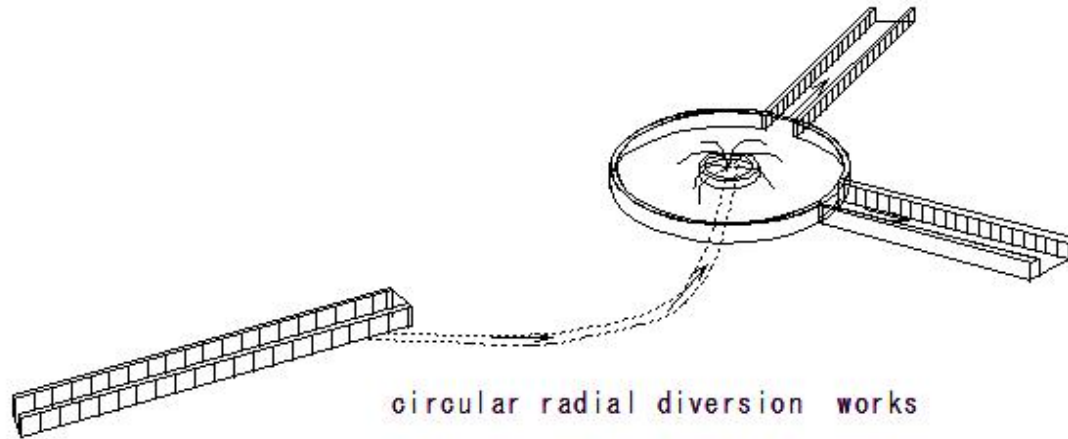
shooting flow diversion works

(R491)diversion works

(R491)diversion works

diversion works

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



(R492)mean velocity

(R492)mean velocity

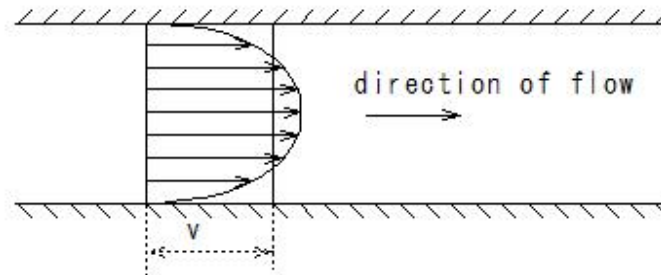
mean velocity

flow velocity v_1 v_2 v_3

mean velocity $V=Q/A$

Q: discharge

A: cross sectional area of stream

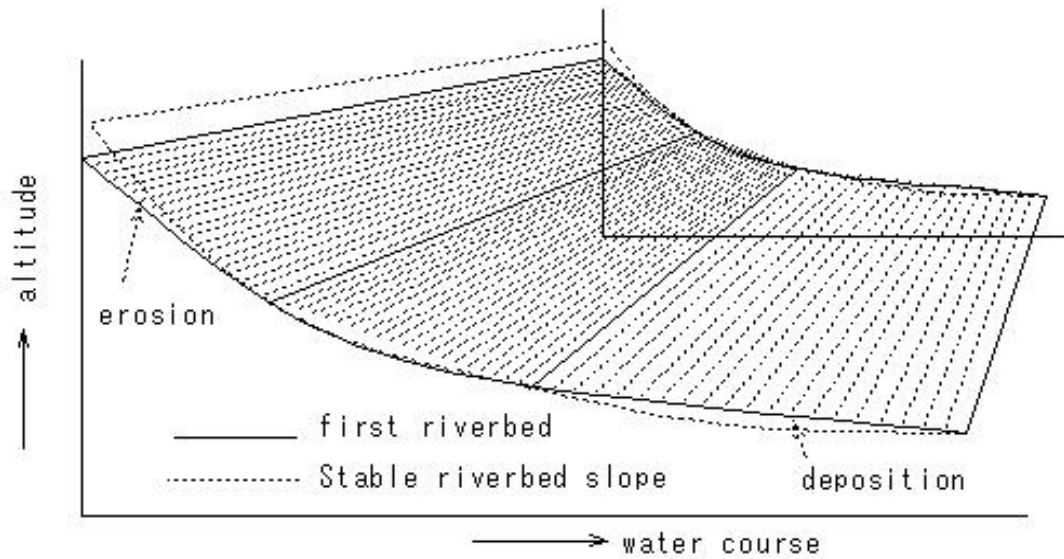


(R493)equilibrium slope

(R493)equilibrium slope

equilibrium slope

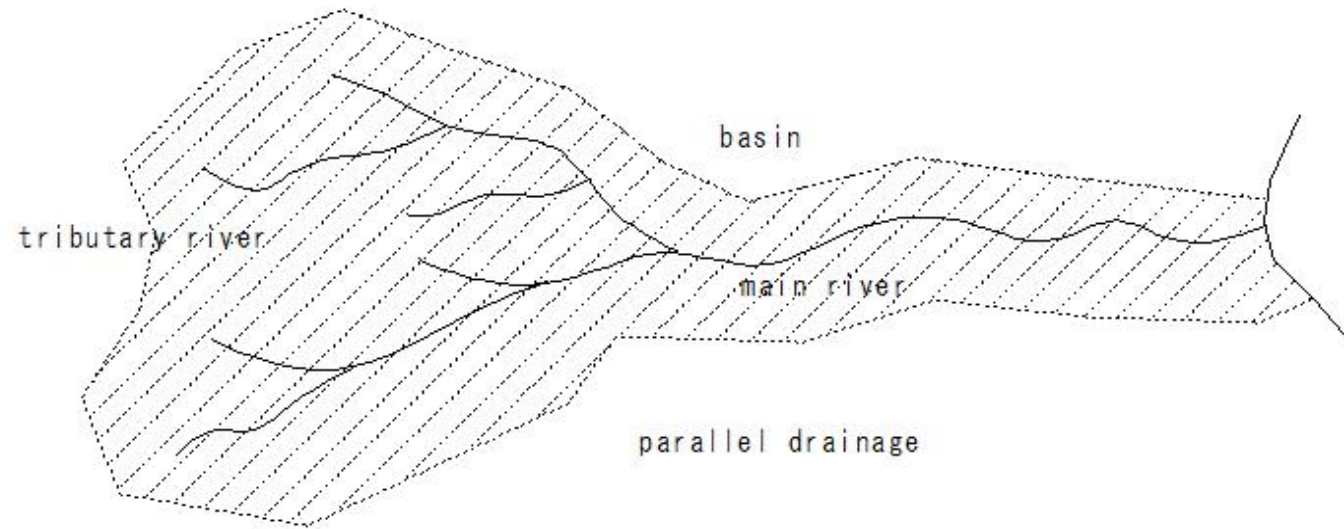
In a river with an equilibrium gradient, neither sedimentation nor scouring occurs.
River water flow, erosion, transportation, deposition



(R494)parallel drainage

(R494)parallel drainage

parallel drainage



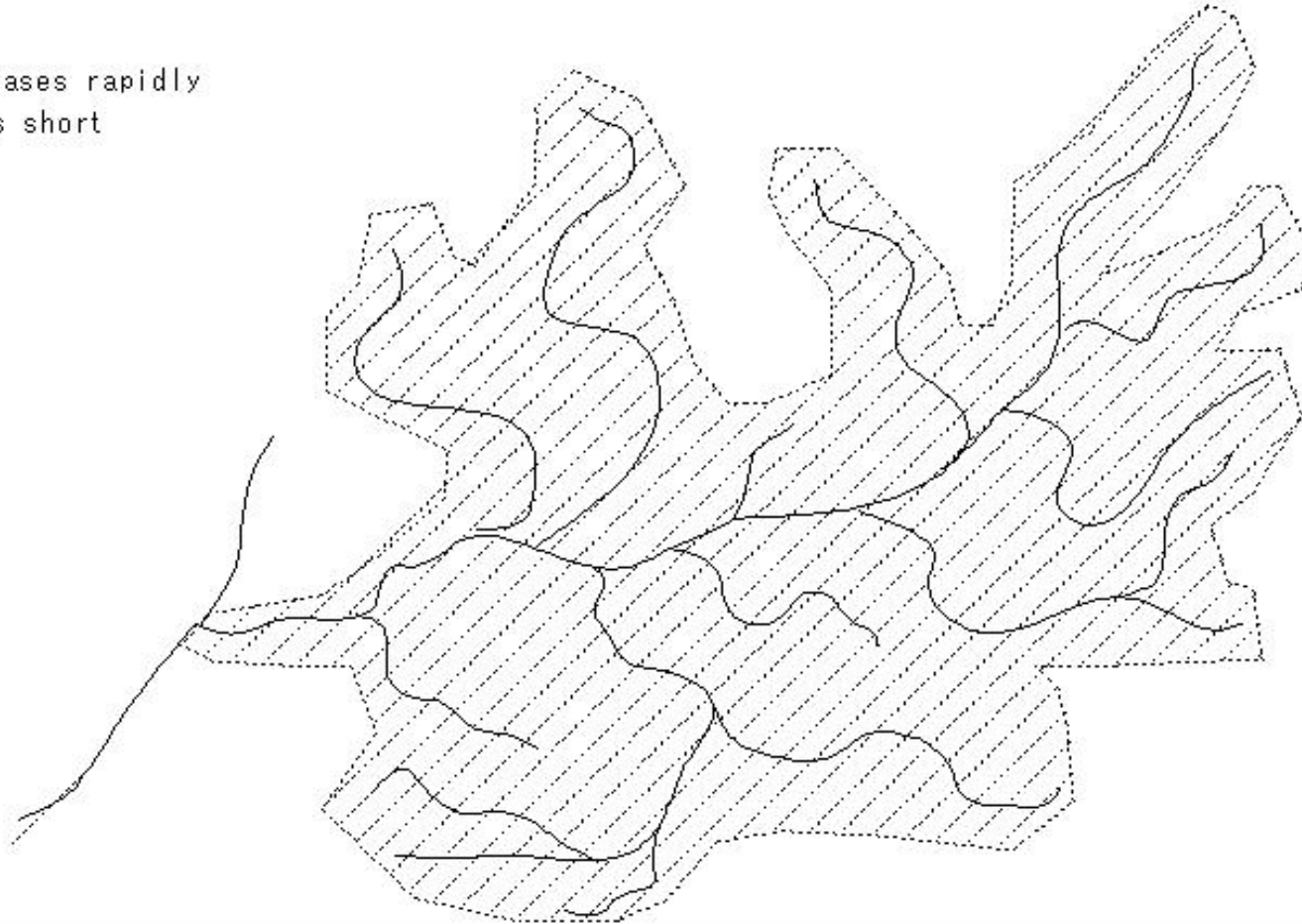
(R495)radial drainage

(R495)radial drainage

radial drainage

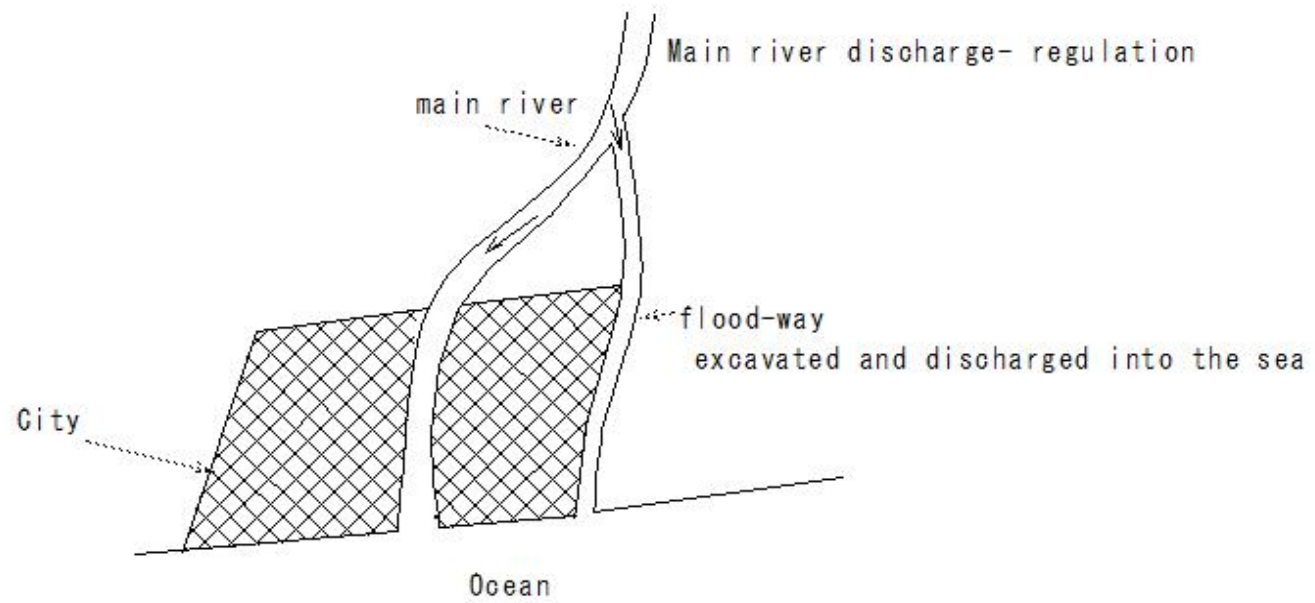
discharge increases rapidly

water season is short

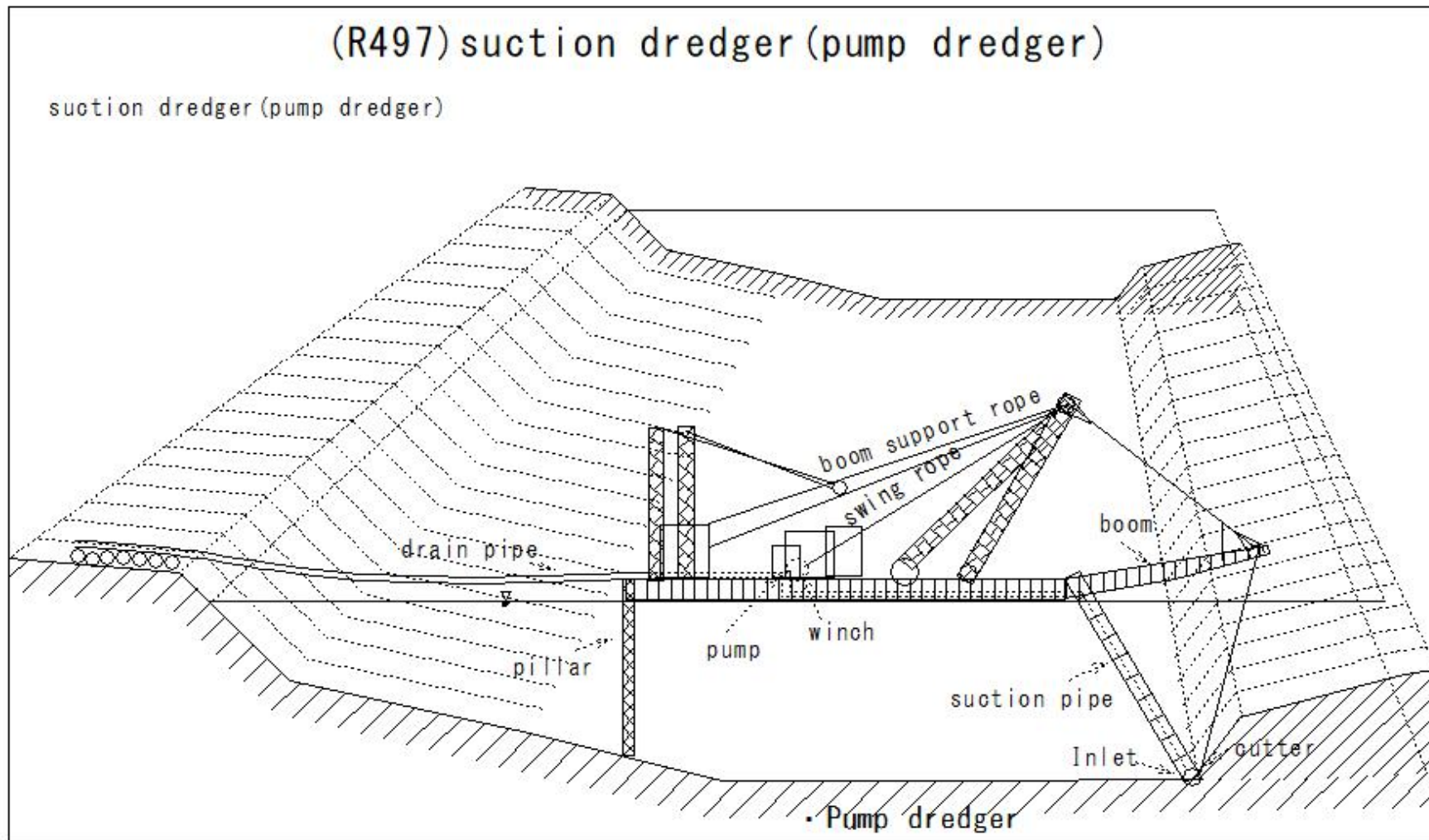


(R496)flood-way

(R496) flood-way



(R497)suction dredger(pump dredger)

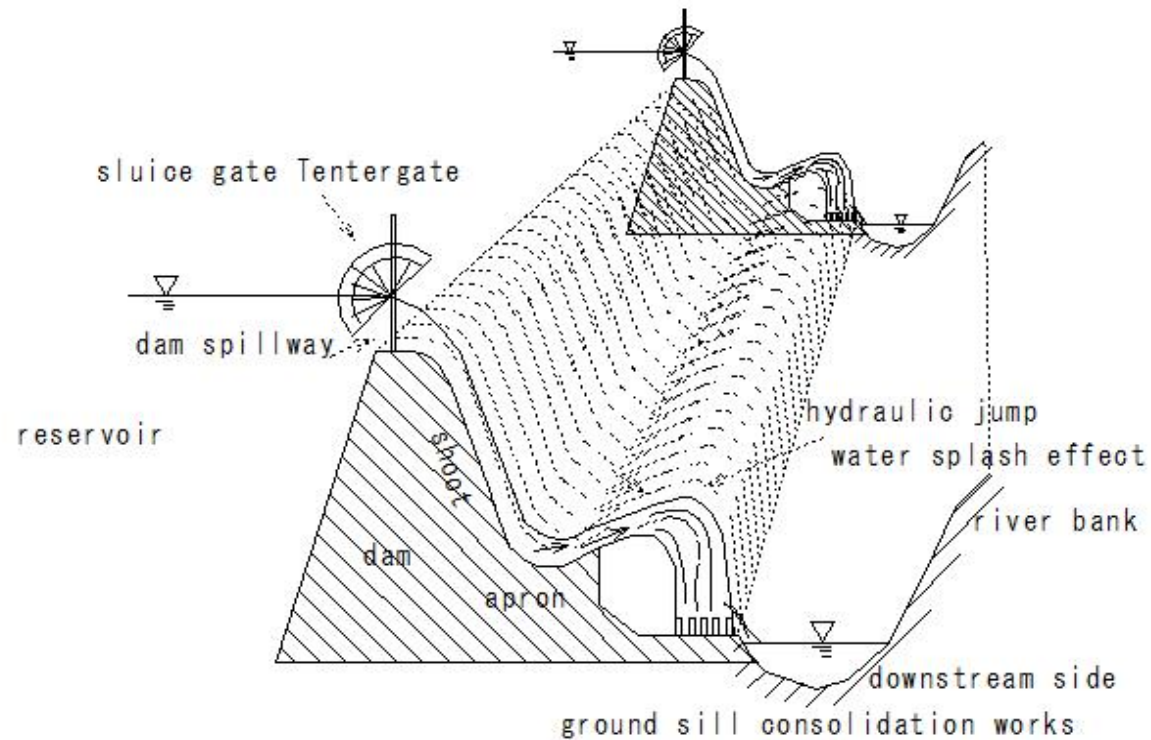


(R498)spatter's effect(water splash effect)

(R498) spatter ' s effect (water splash effect)

spatter's effect(water splash effect)

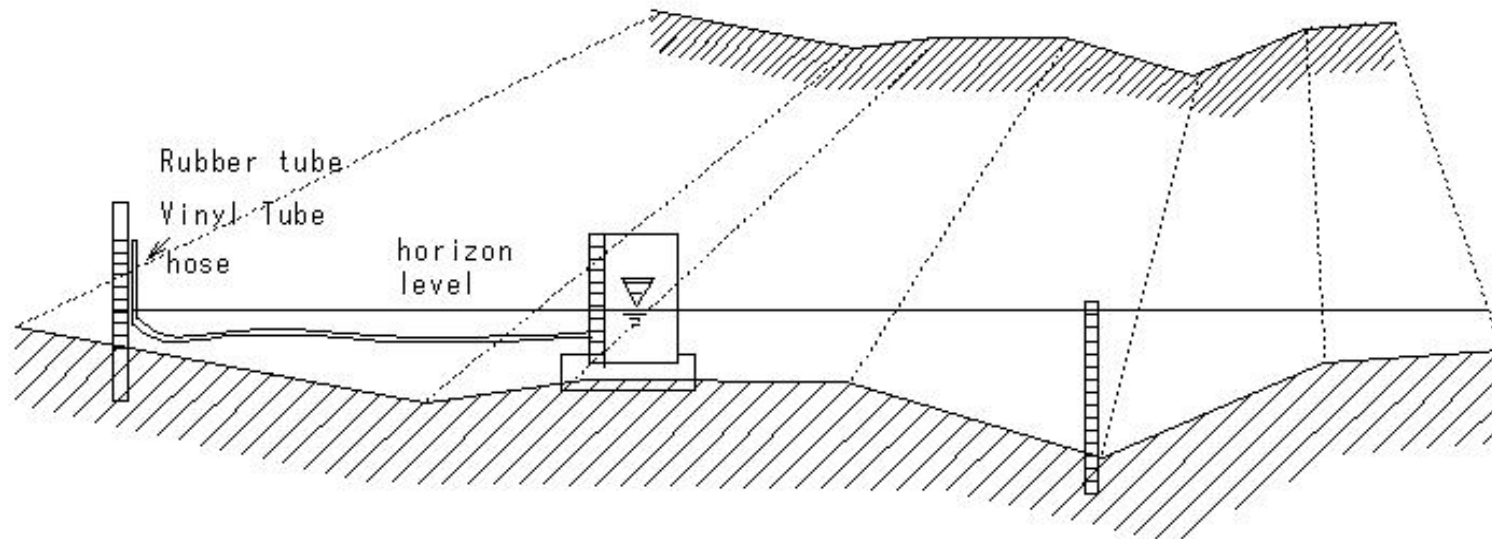
Diminishing effect



(R499)leveling

(R499) leveling

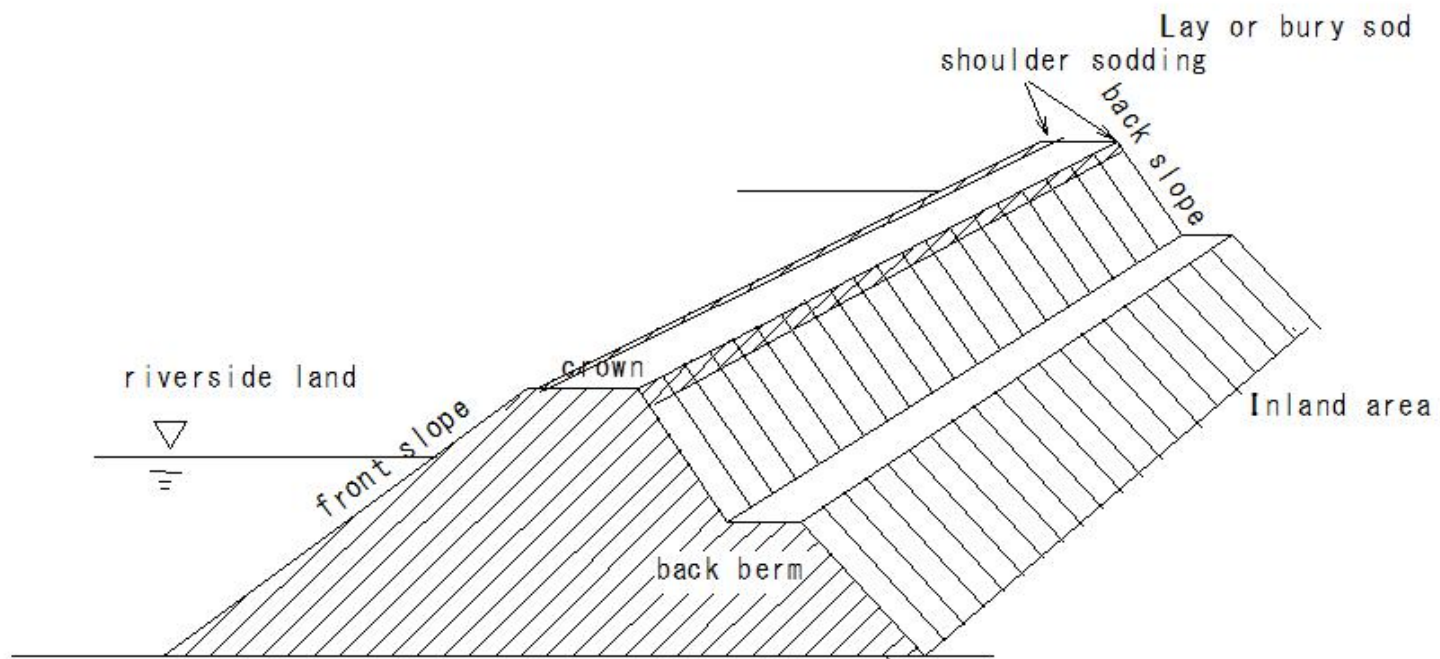
leveling
Decide on the level
Putting out a horizontal surface



(R500)shoulder sodding

(R500) shoulder sodding

Embankment-slope lining



Embankment cross-section

(R501)submerged orifice

(R501)submerged orifice

submerged orifice

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

a: Cross-sectional area of orifice

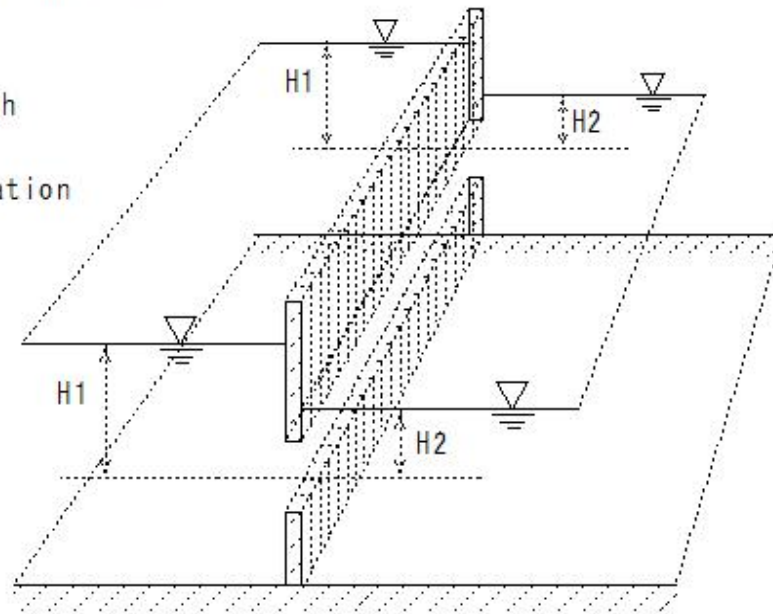
C: discharge coefficient

H₁: Upstream water depth

H₂: Downstream water depth

Q: discharge

g: gravitational acceleration



(R502)submerged discharge

(R502) 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

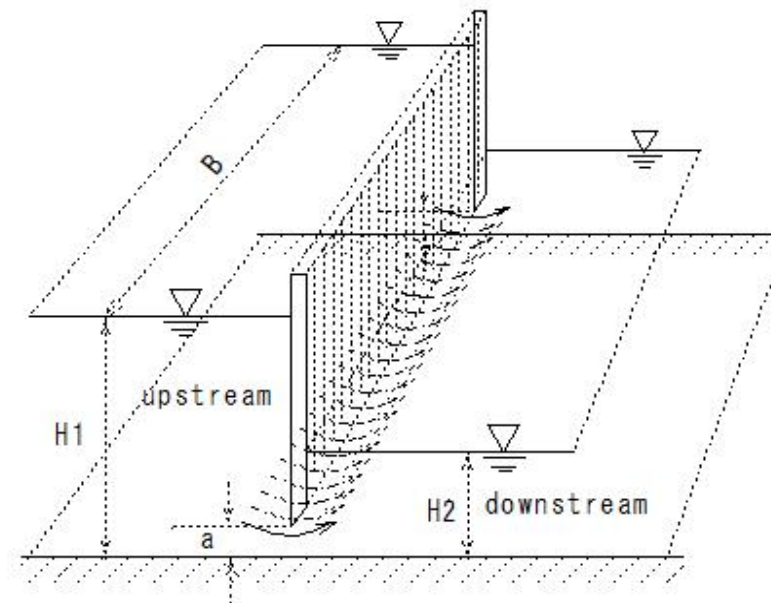
a: Gate opening

B: Channel width

H1: Upstream water depth

H2: Downstream water depth

g: gravitational acceleration



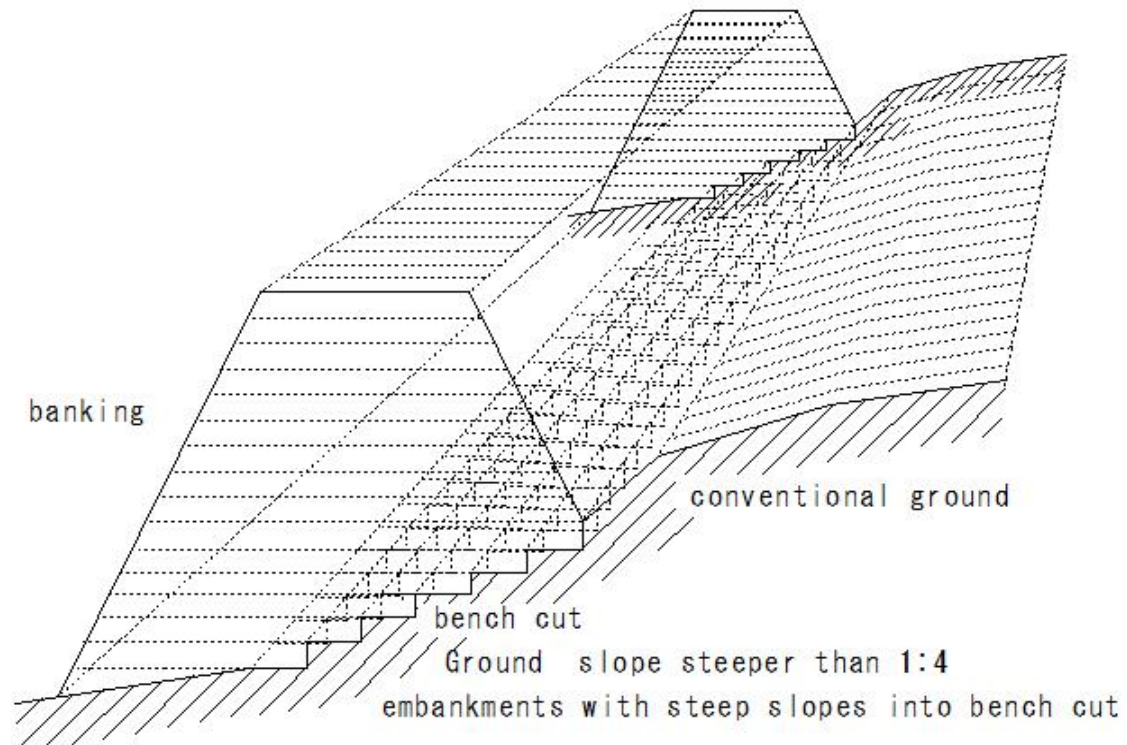
(R503)banking

(R503) banking

banking

put earth and sand on the ground

Embankment on sloped ground



(R504)retarding basin,flood storage basin

(R504)retarding basin,flood storage basin

retarding basin,flood storage basin

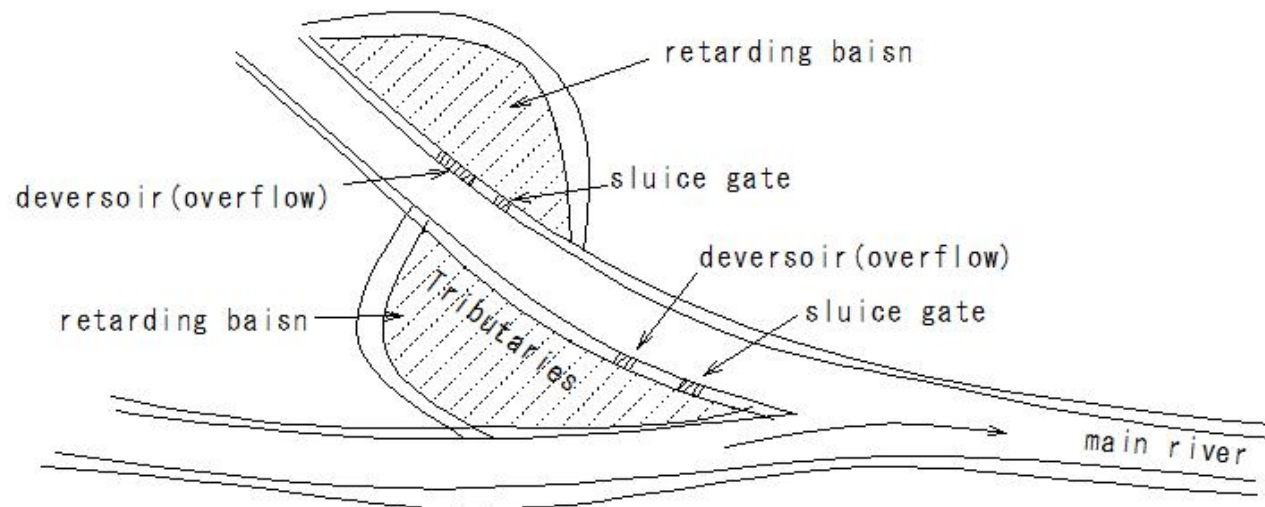
river confluence

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.



(R505)spillway

(R505) 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

spillway
sluice gate

spillway

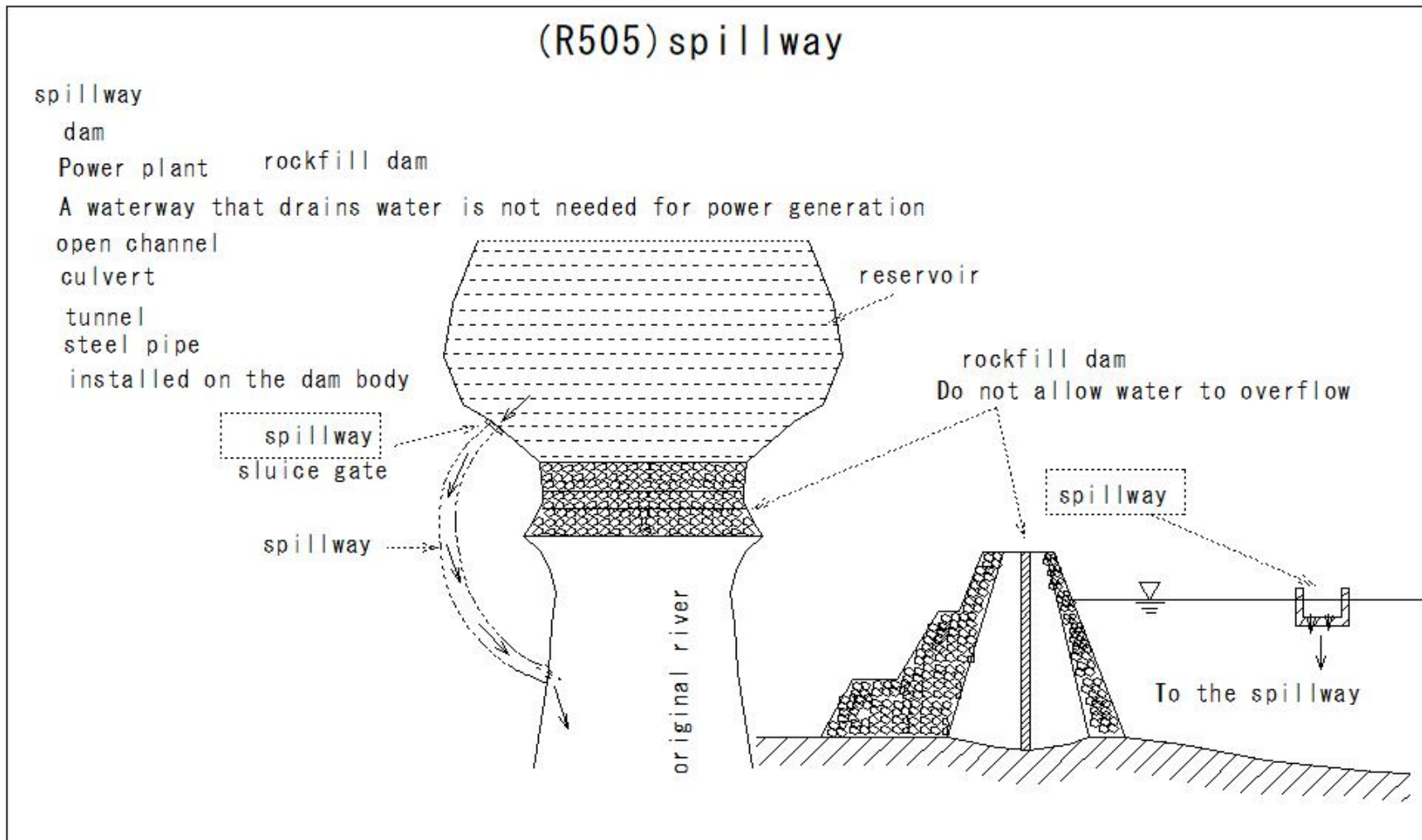
reservoir

rockfill dam
Do not allow water to overflow

spillway

To the spillway

original river

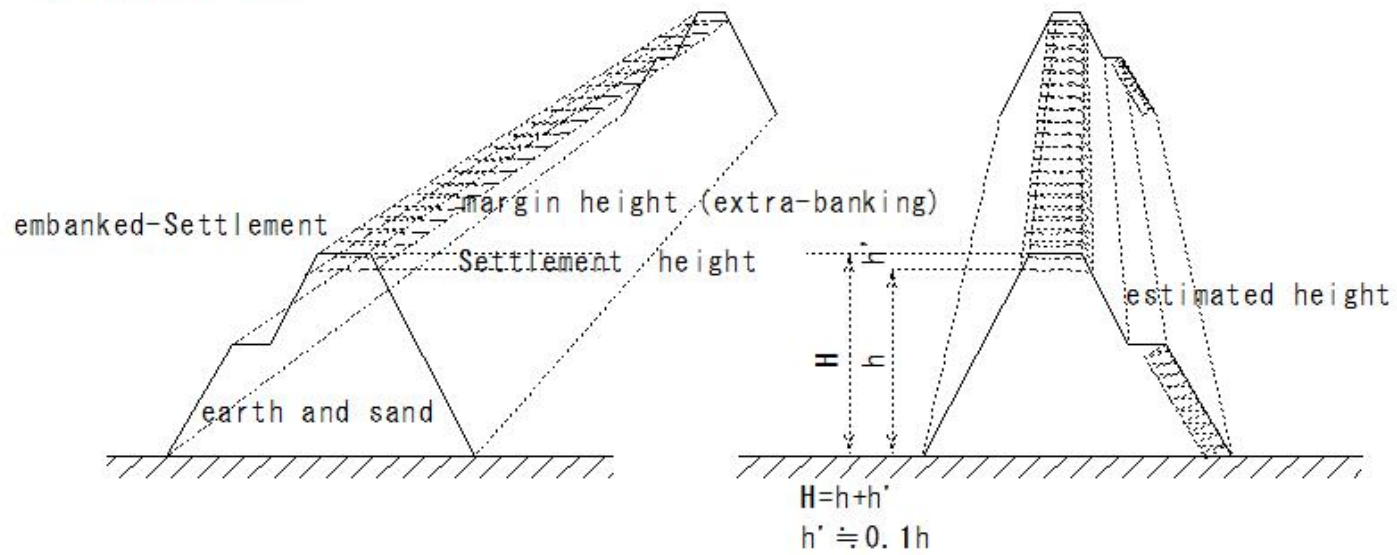


(R506)extra-banking

(R506) 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



(R507)freeboard-margin height (extra embankment)

(R507)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

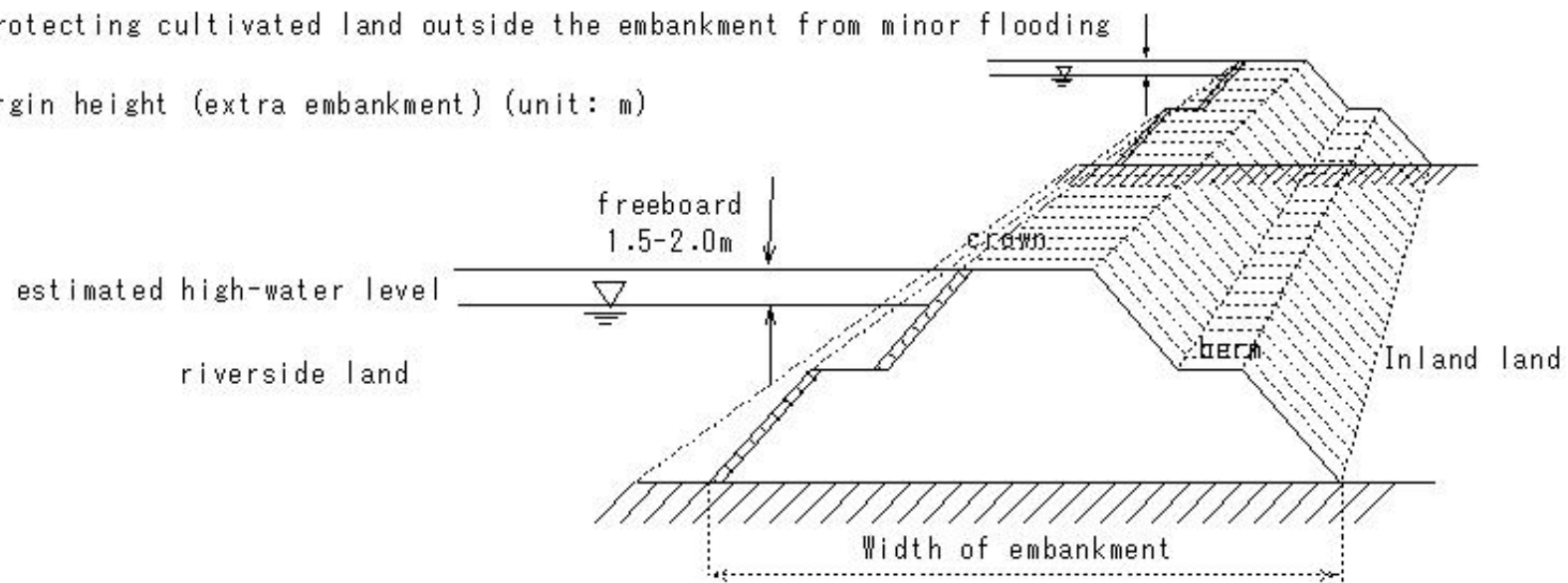
Large river 1.5-2.0m

Small and medium river 1.0m

estimated high-water level

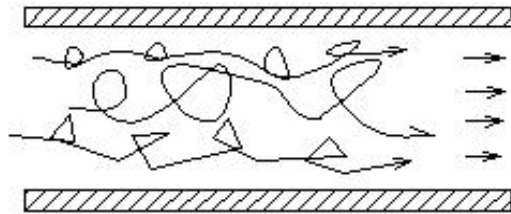
Protecting cultivated land outside the embankment from minor flooding

margin height (extra embankment) (unit: m)



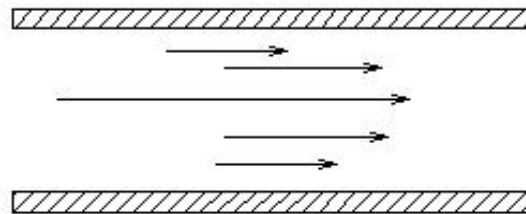
(R508)turbulent flow -Laminar flow

(R508)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

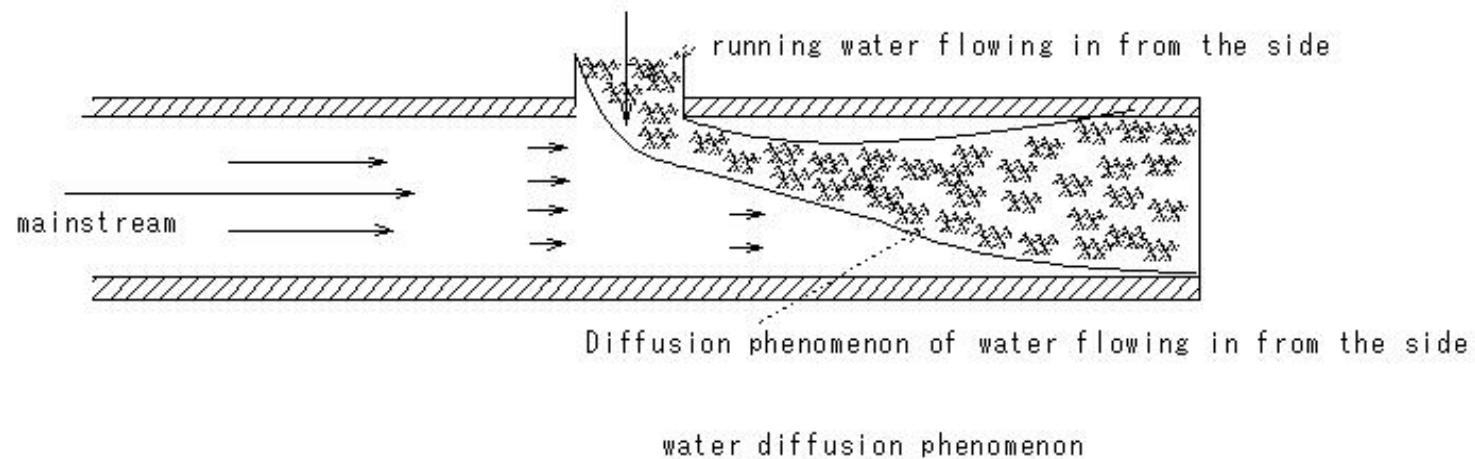
Expressing sexuality with Reynolds number

(R509)Diffusion effect of turbulent flow

(R509)Diffusion effect of turbulent flow

Diffusion effect of turbulent flow

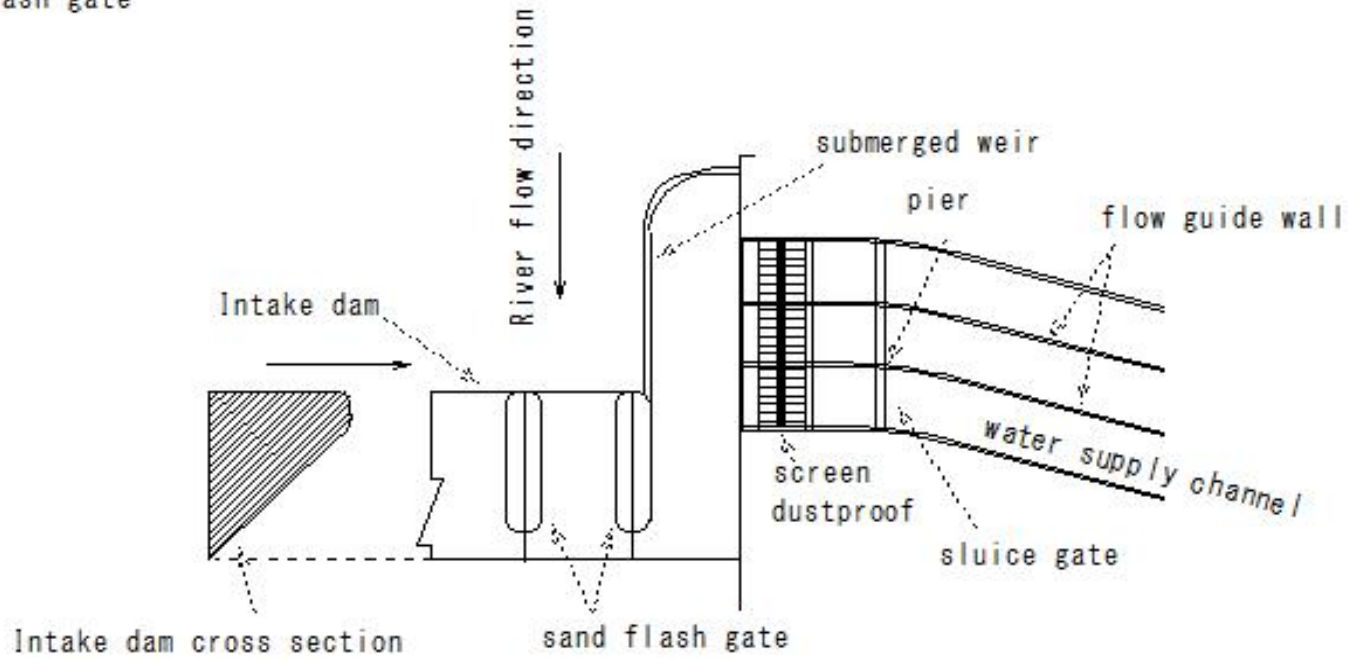
case of the flow changes from laminar to turbulent, the flows mix with each other and swirl.



(R510)sand flash gate

(R510)sand flash gate

sand flash gate



(R511)basin coefficient

(R511)basin coefficient

basin coefficient



Used to understand the shape and properties of rivers

$$F = A/L^2$$

F: basin coefficient

A: Basin area

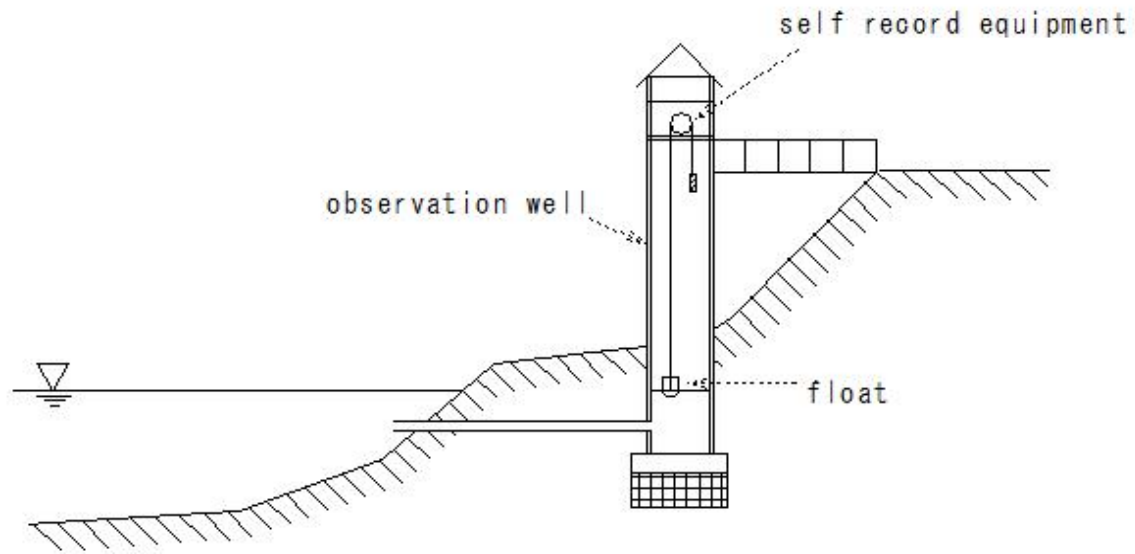
L: Extension of main water course

value of (F)	basin	Water flow time	Maximum discharge	Shape example
Big	wide range	short	Big	
small	long	long	small	

(R512) automatic water gauge

(R512) automatic water gauge

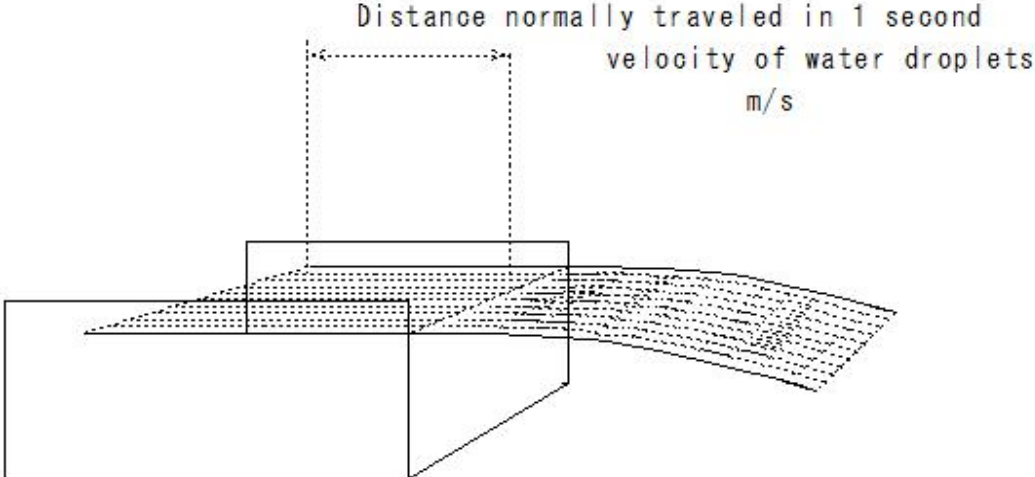
automatic water gauge



(R513)velocity of flow

(R513)velocity of flow

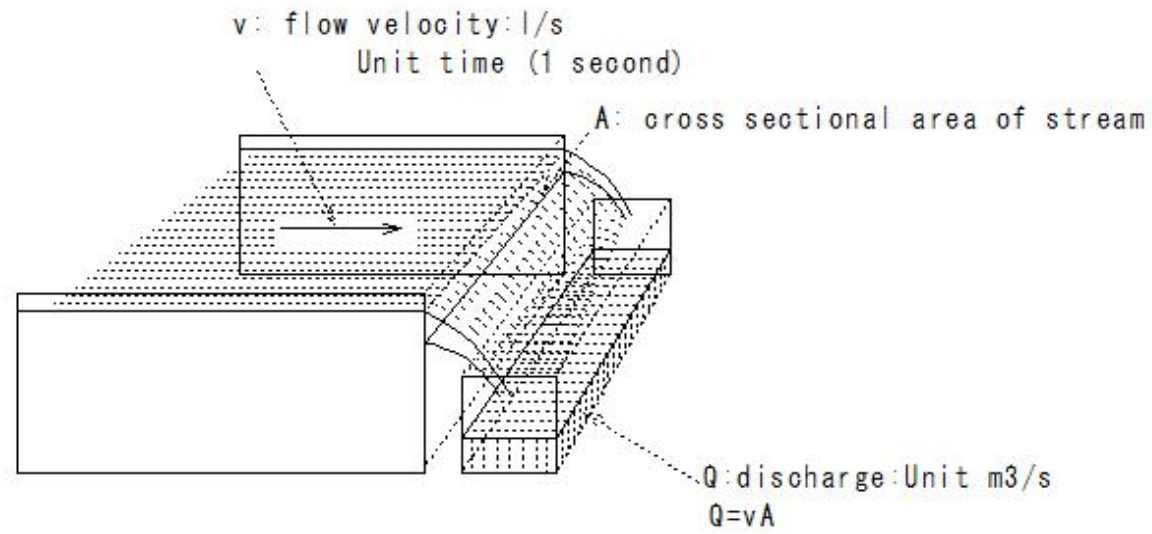
velocity of flow



(R514)discharge

(R514) discharge

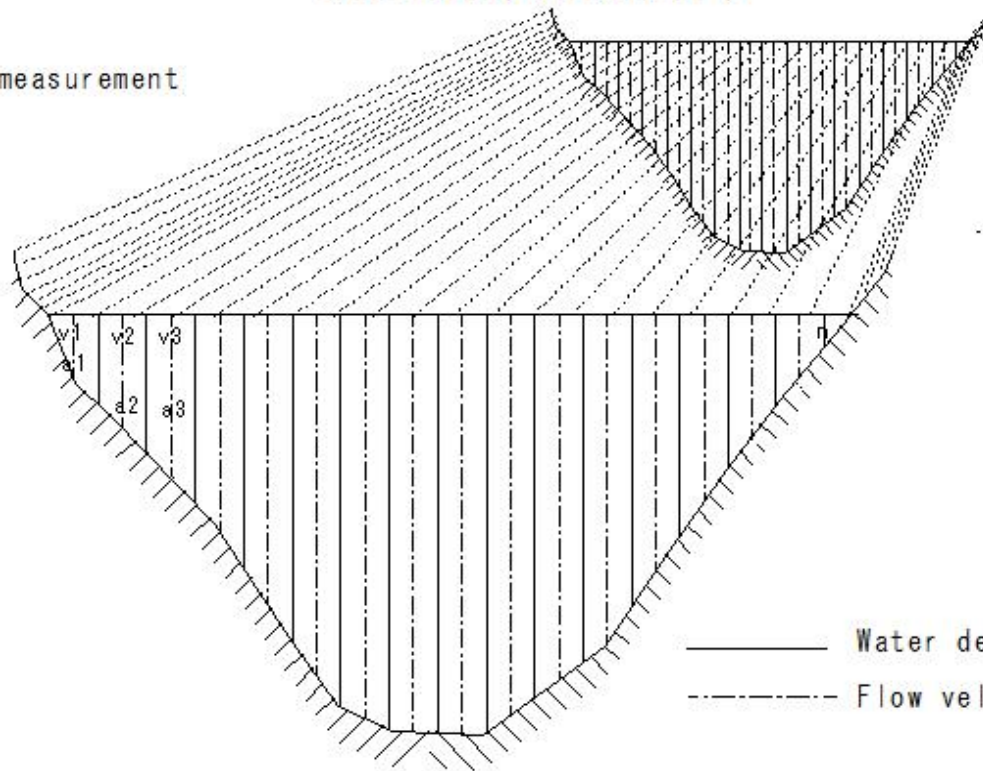
discharge



(R515)hydrometry

(R515)hydrometry

hydrometry
discharge measurement



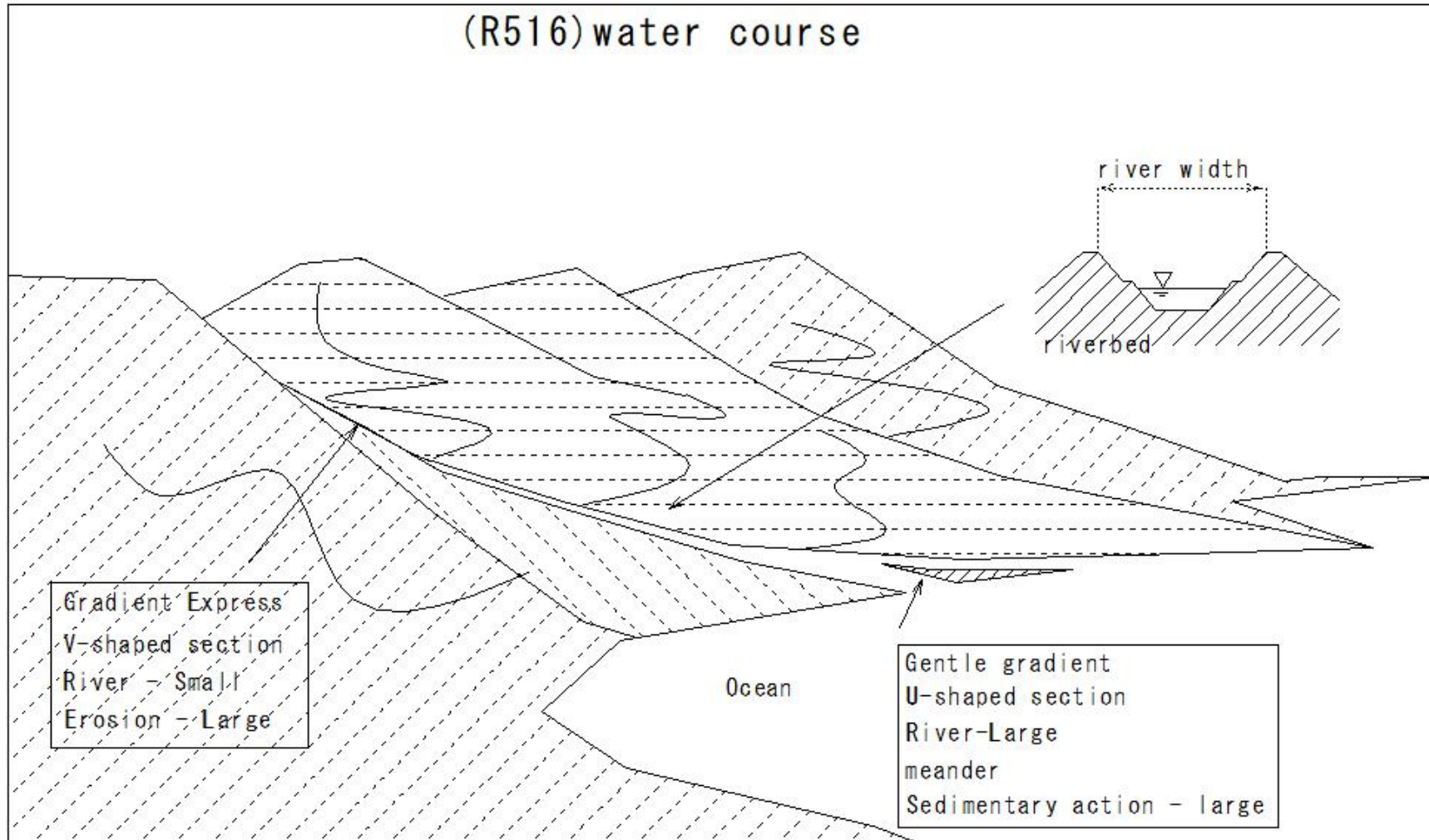
——— Water depth measurement
- - - - - Flow velocity measurement

discharge measurement

$$Q = v_1 a_1 + v_2 a_2 + \dots + v_n a_n = \sum v_i a_i$$

(R516)water course

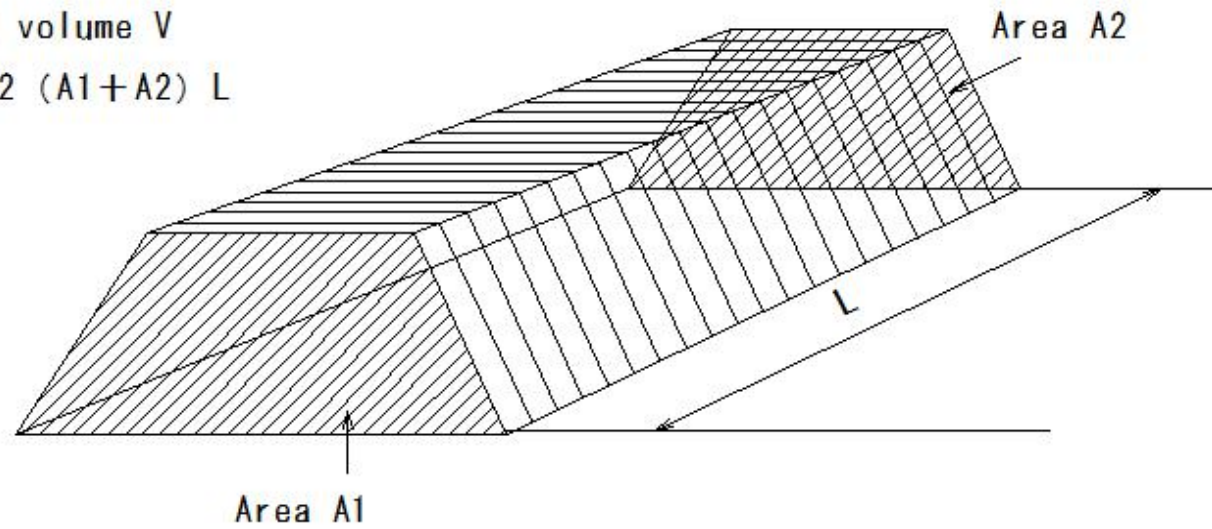
(R516)water course



(R517)method of average end areas

(R517)method of average end areas

Soil volume V
 $V = 1/2 (A1 + A2) L$



(R518) Reynoldsnumber

(R518) Reynoldsnumber

Reynoldsnumber

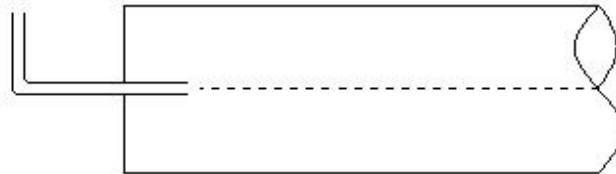
Determine whether fluid flow is laminar or turbulent

v1: flow velocity

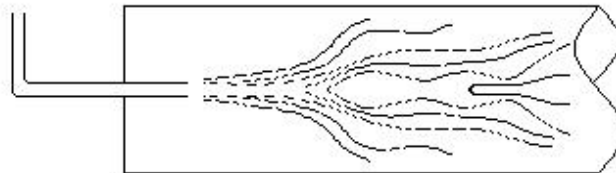
d: Pipe inner diameter

v2: Kinematic viscosity coefficient

$$Re = v1d/v2$$



laminar flow
 $Re \leq 2320$



turbulence
 $Re > 2320$

(R519)sounding lead

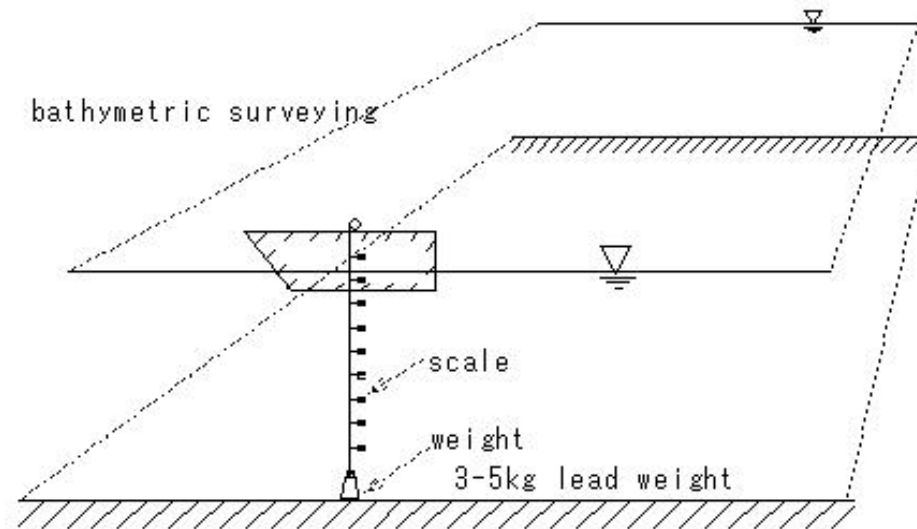
(R519)sounding lead

sounding lead

deep water

Flow velocity - small

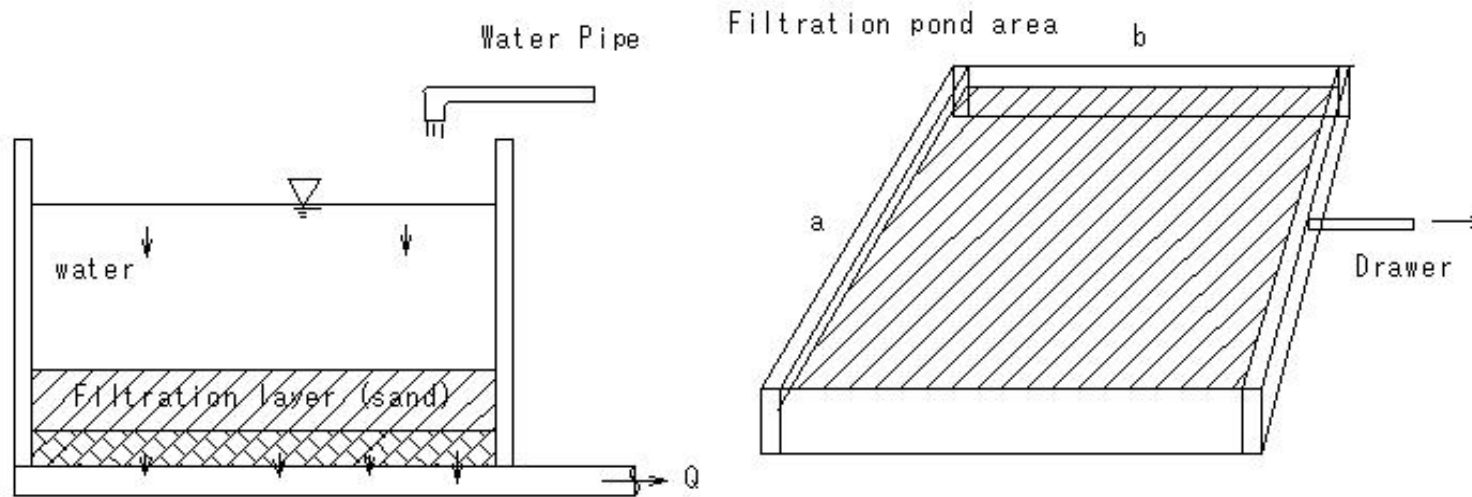
Read the river water level on the scale



(R520)rate of filtration

(R520)rate of filtration

rate of filtration



Filtered water volume

rate of filtration(Q)

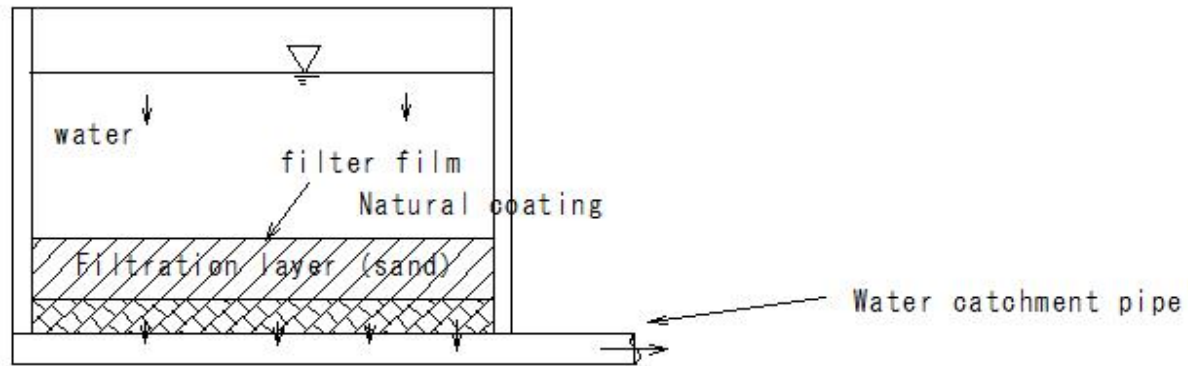
Unit: m³/day

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

(R521)filter film

(R521)filter film

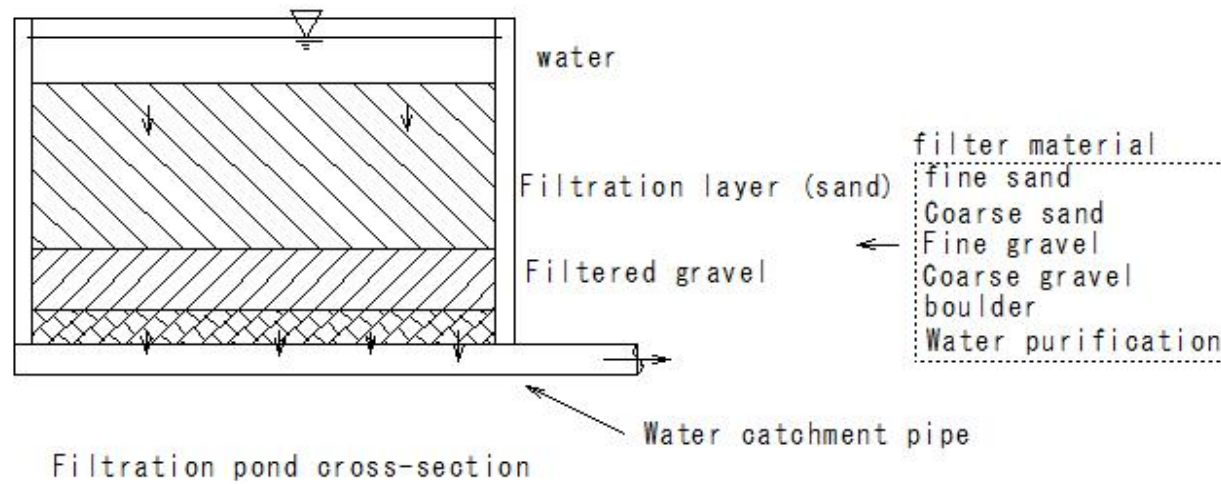
filter film



Filtration pond cross-section

(R522)filter material

(R522) filter material



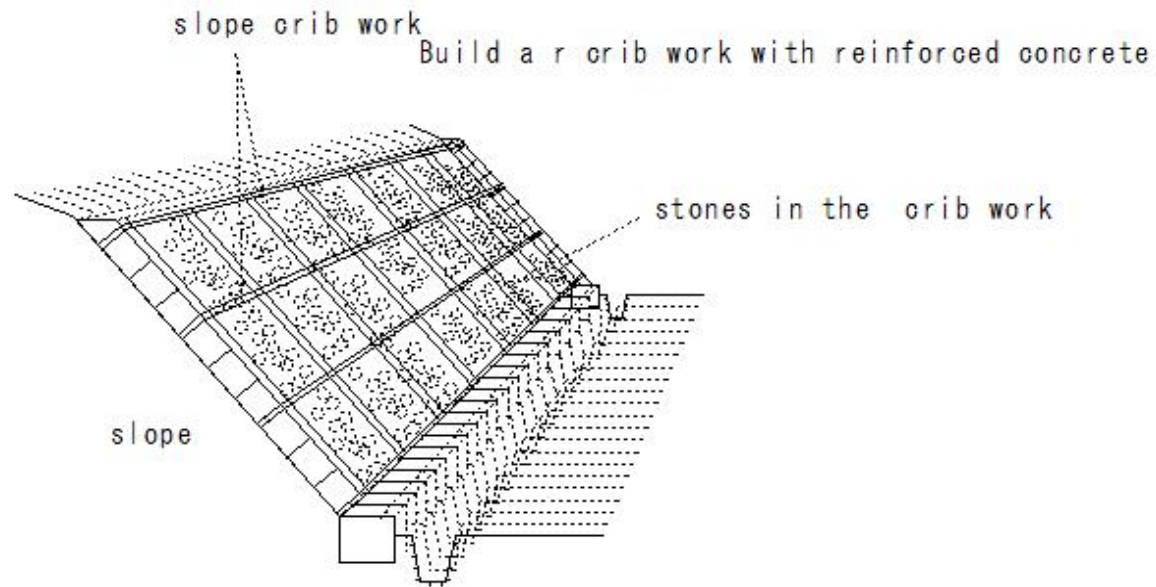
(R523)cribwork

(R523) cribwork

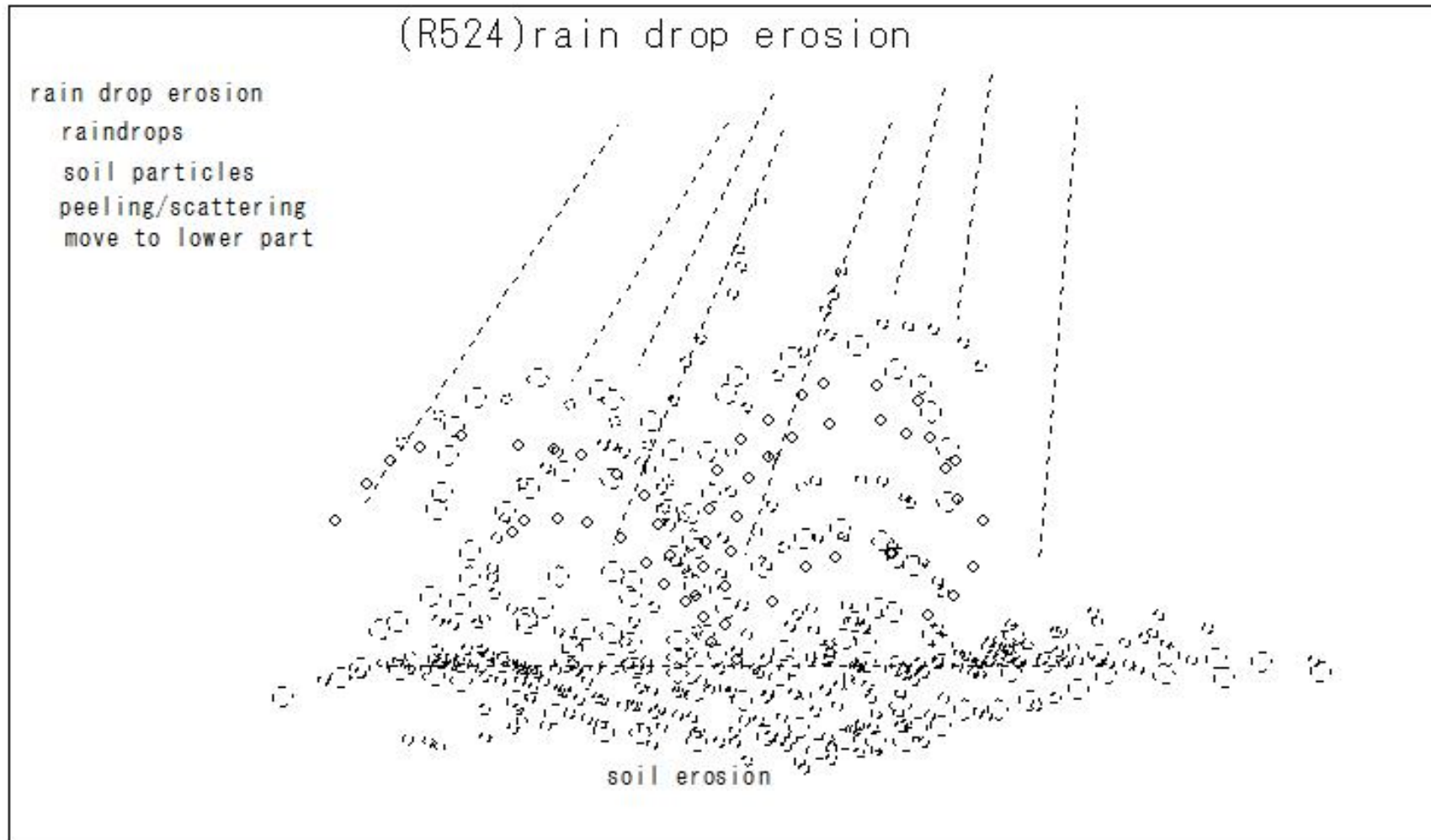
cribwork

Embankment - slope reinforcement

Slope - crib work



(R524)rain drop erosion

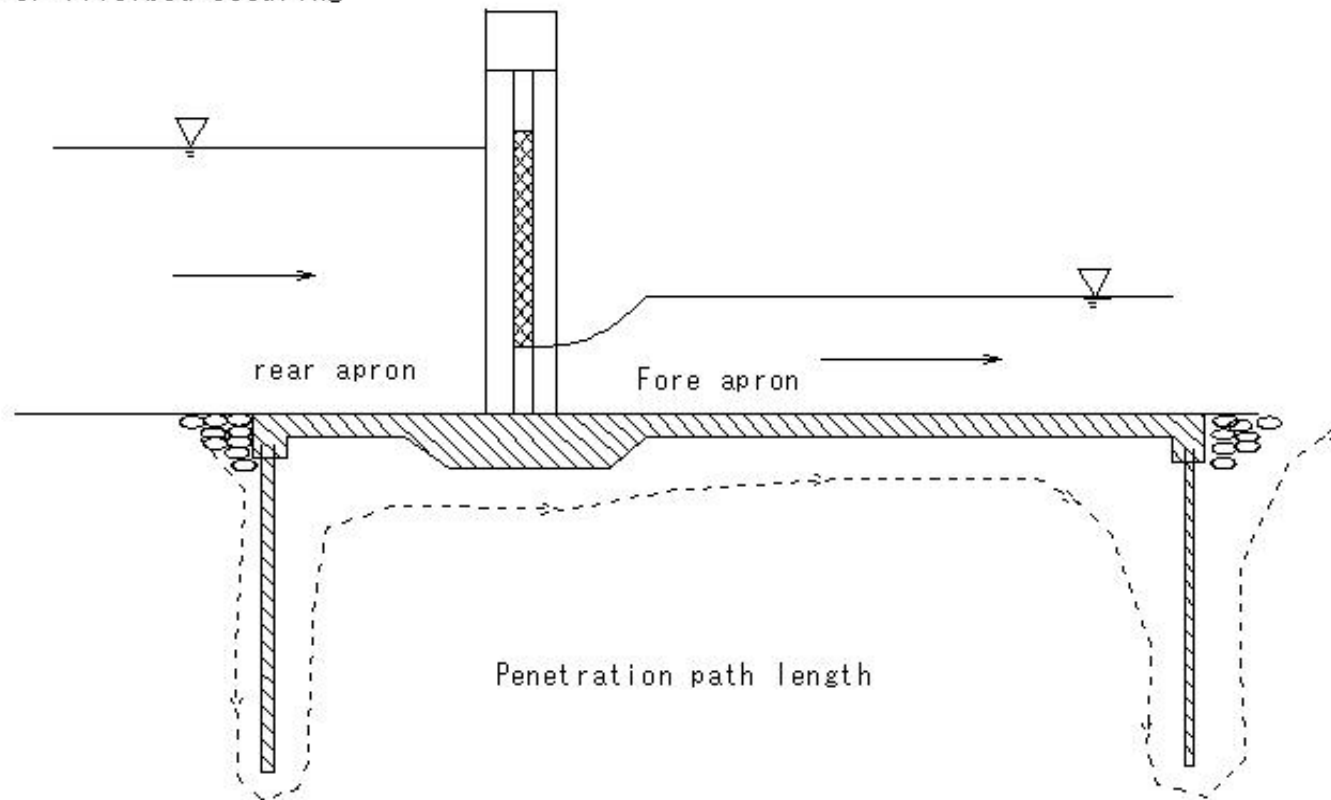


(R525)apron

(R525)apron

apron

Prevention of riverbed scouring



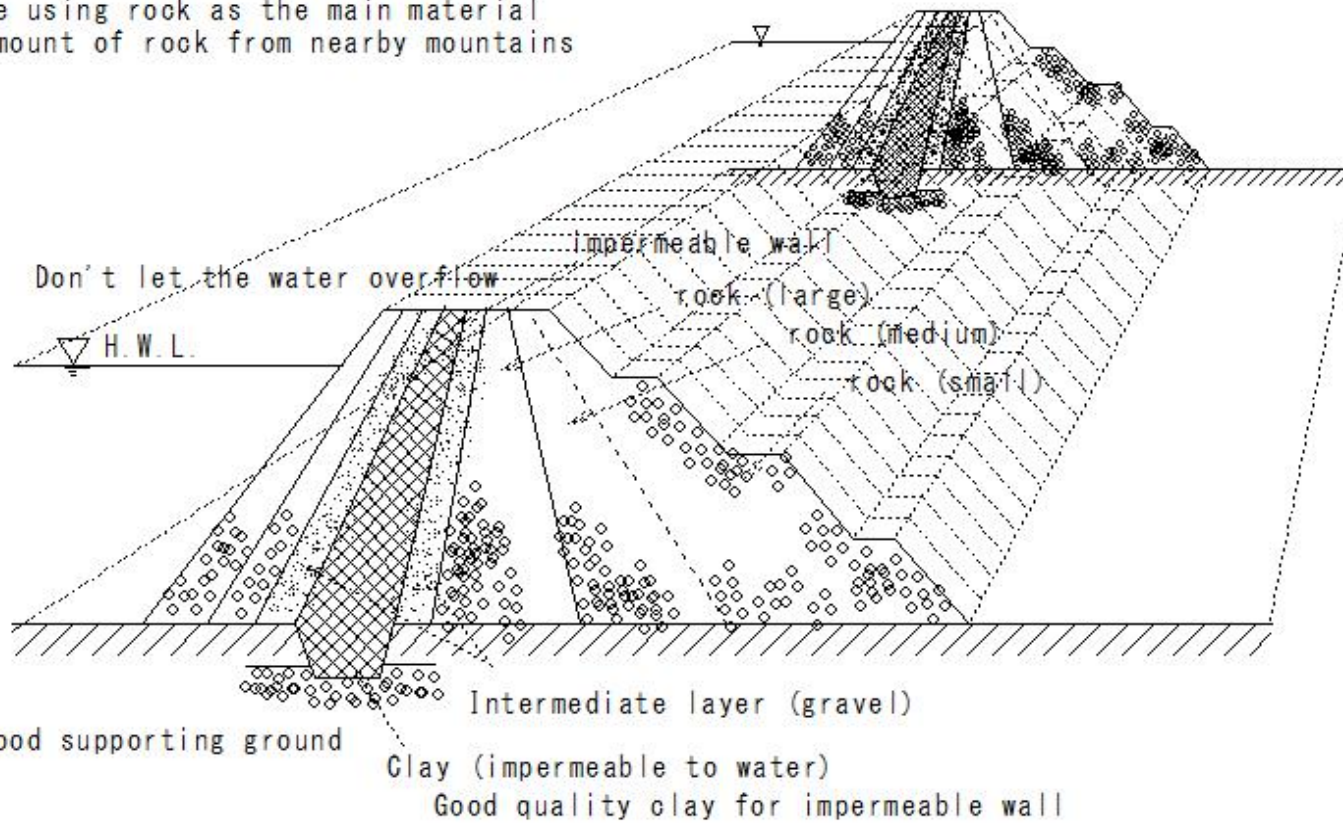
Penetration path length

(R526)rock fill dam

(R526)rock fill dam

rock fill dam

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



(R527)water warming facilities

(R527)water warming facilities

water warming facilities

Water temperature-low

Limit water temperature 18°C

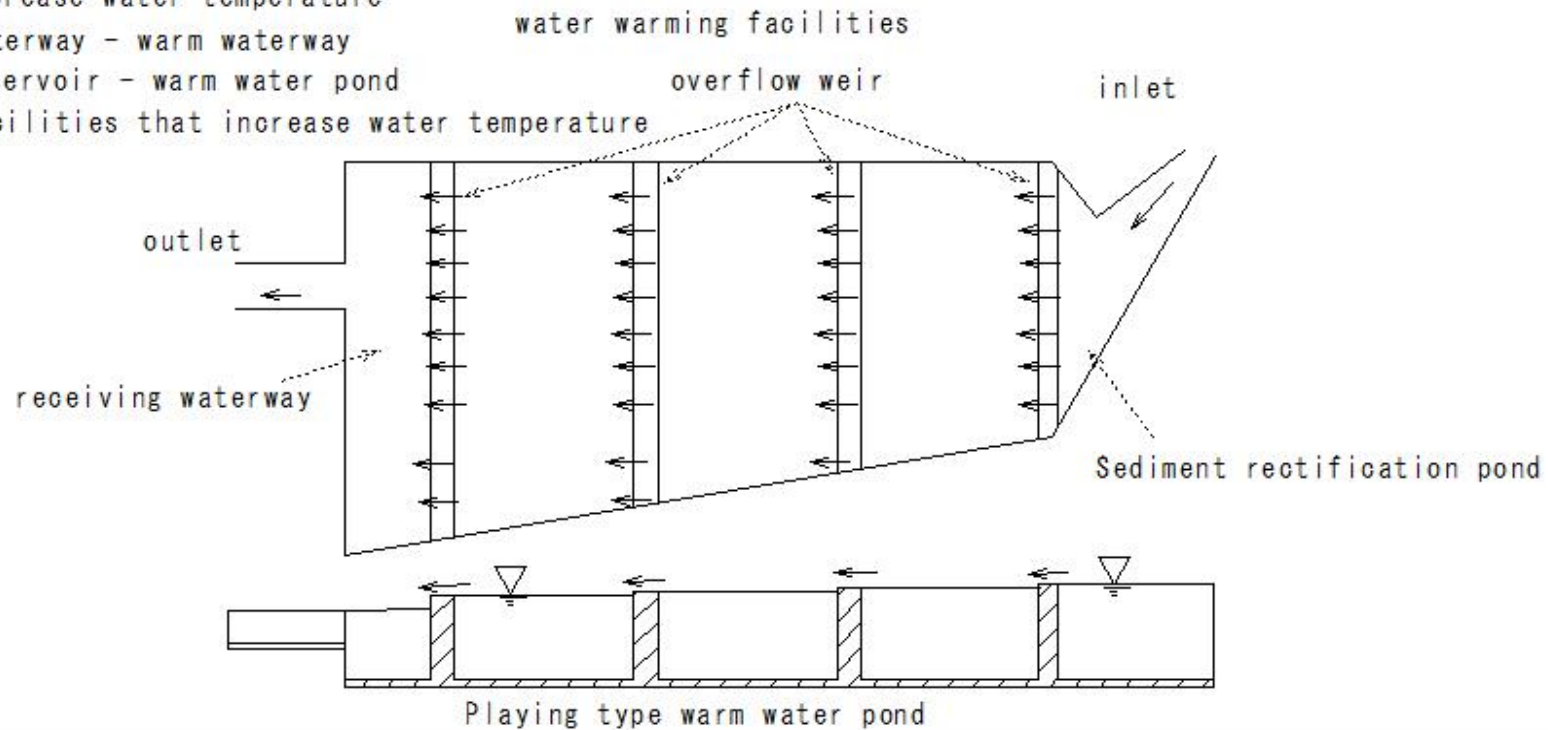
cold water failure

increase water temperature

Waterway - warm waterway

Reservoir - warm water pond

Facilities that increase water temperature



(R528)water warming facilities

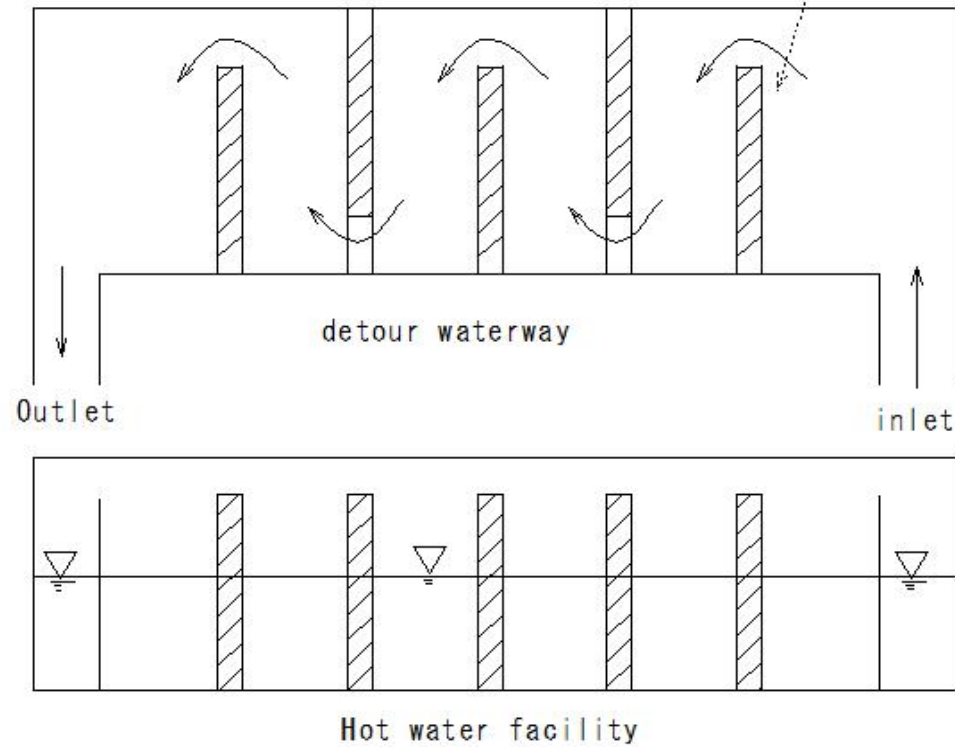
(R528)water warming facilities

water warming facilities

Water temperature

Hot water facility

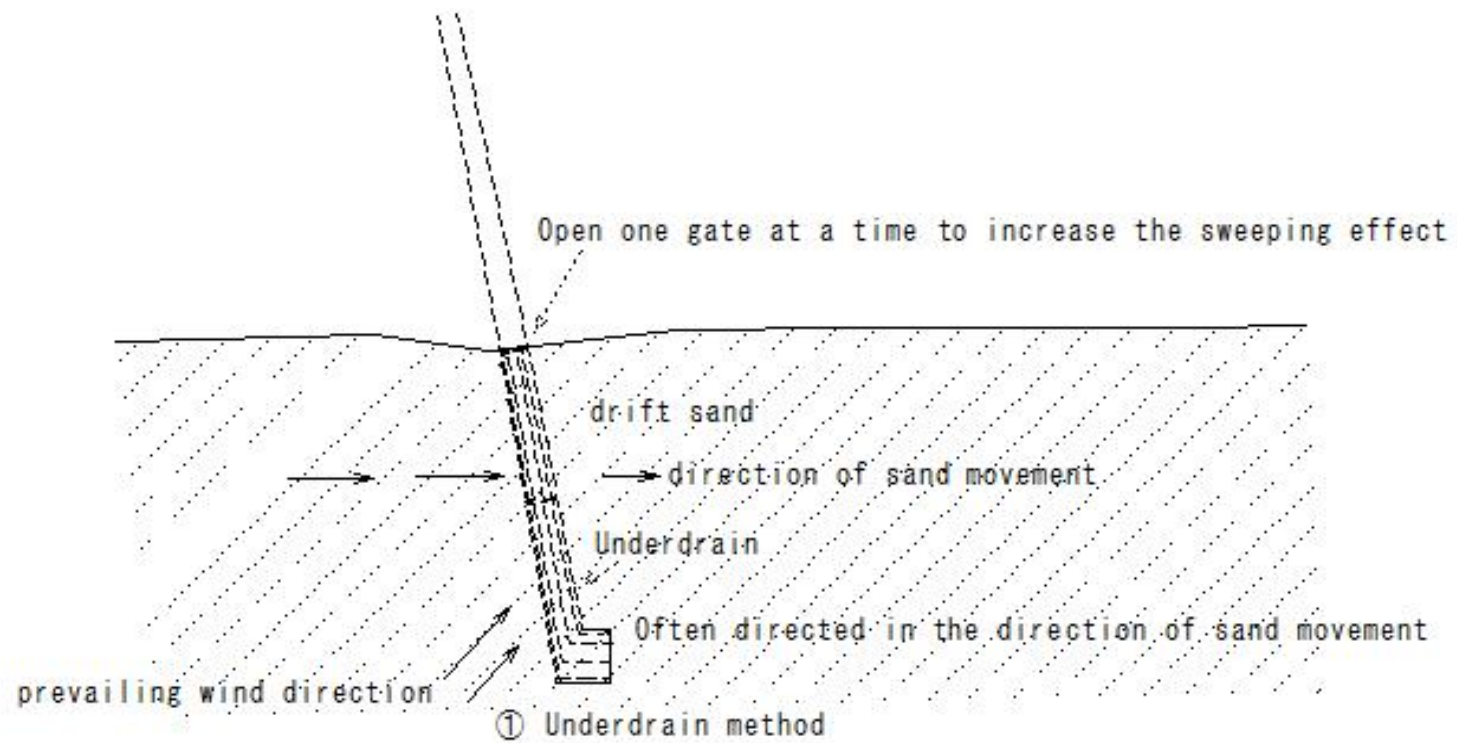
soil embankment



(R529)river mouth improvement

(R529)river mouth improvement

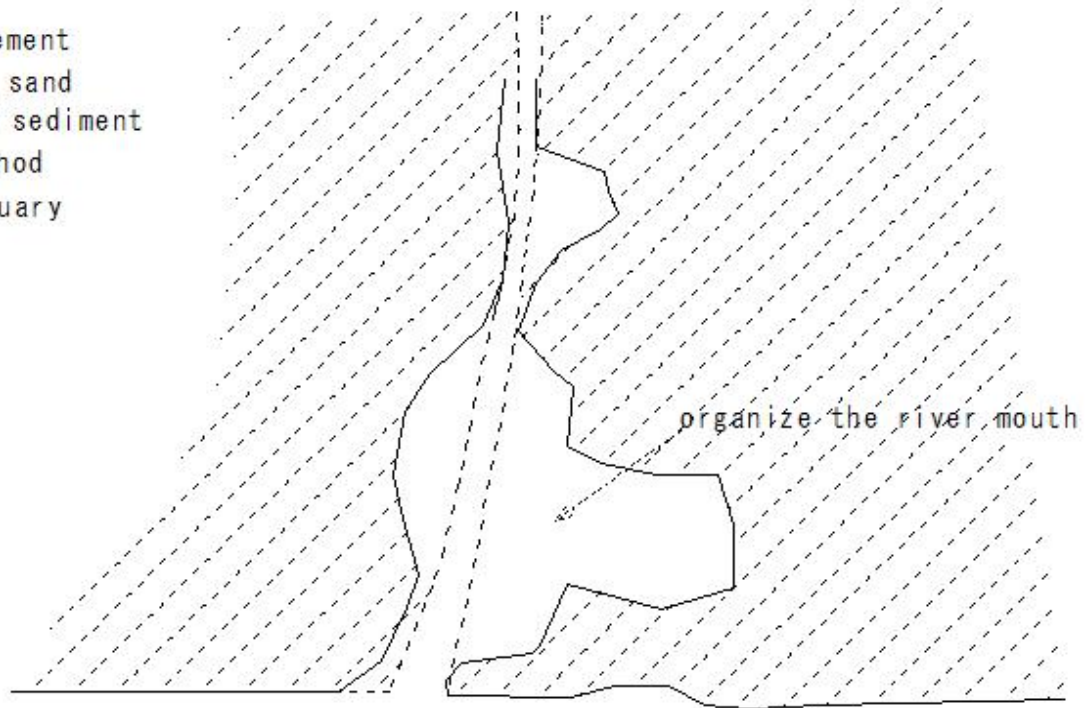
river mouth improvement
drift sand -beach sand
Excludes estuary sediment



(R530)river mouth improvement

(R530)river mouth improvement

river mouth improvement
beach sand-drift sand
Excludes estuary sediment
②Open drain method
organize the estuary



②Open drain method

(R531)river mouth improvement

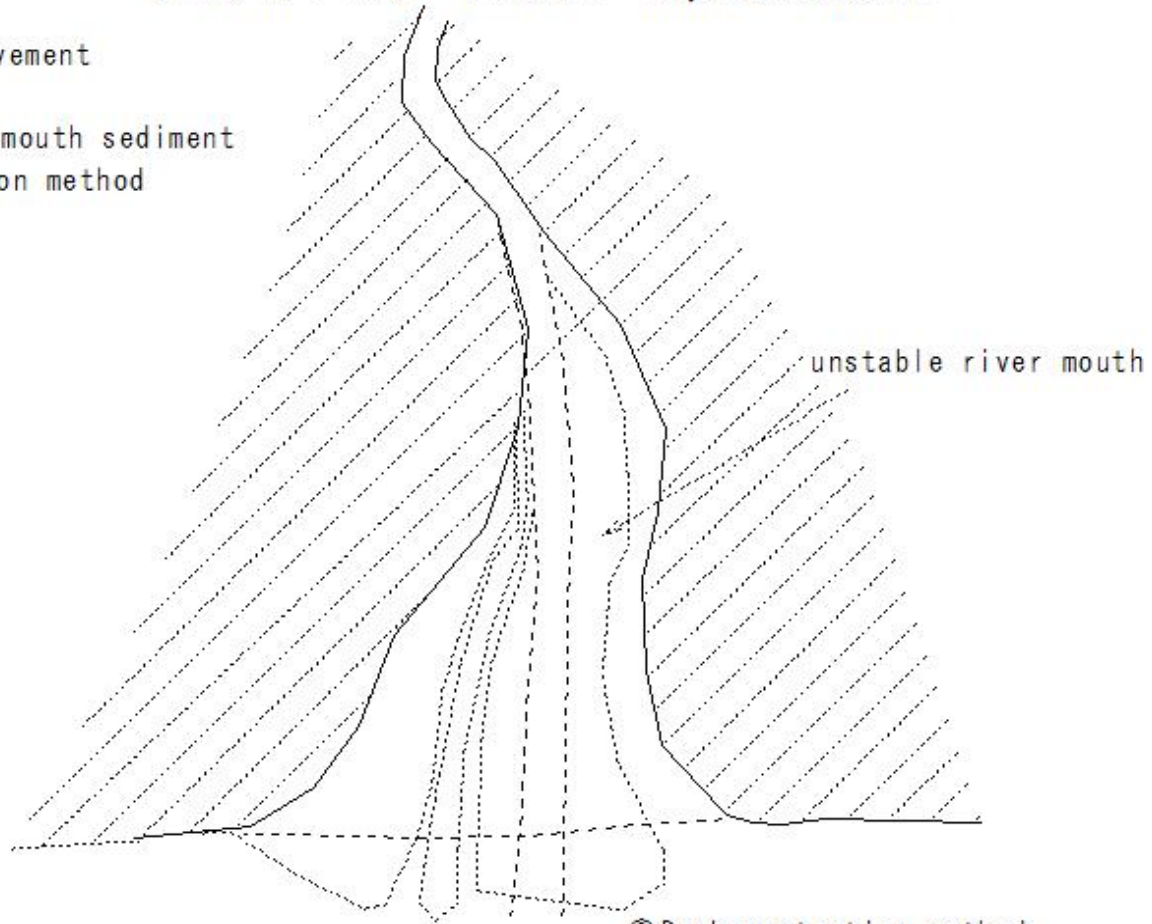
(R531)river mouth improvement

river mouth improvement

drift sand

Excludes river mouth sediment

③ Bank protection method

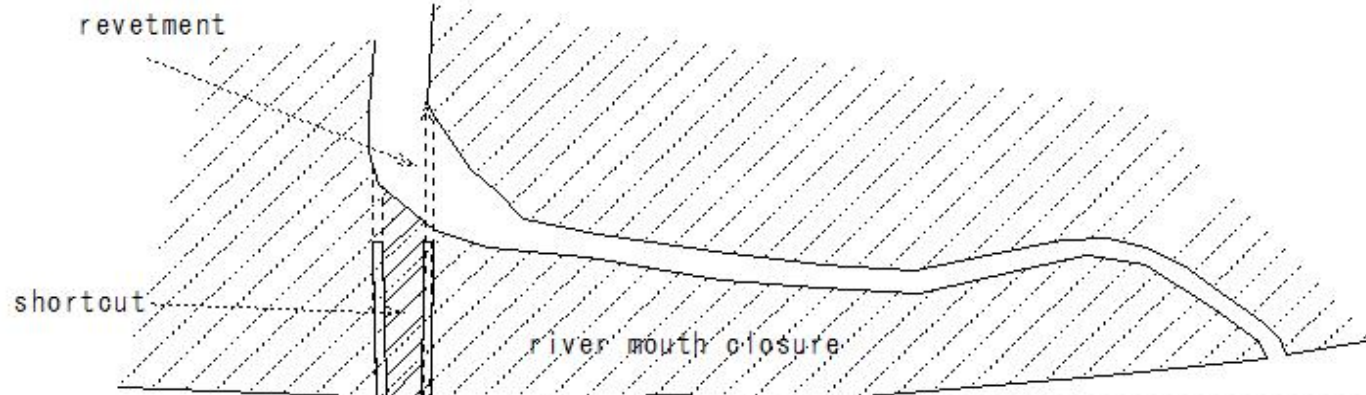


③ Bank protection method

(R532)river mouth improvement

(R532)river mouth improvement

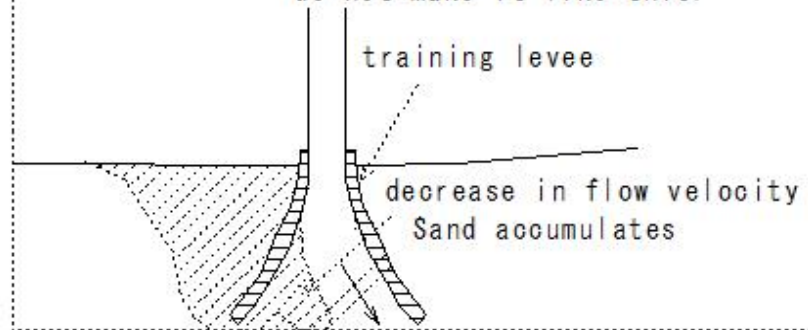
river mouth improvement
training levee



to increase the flow
Reduce to a level that does not impede outflow

④training levee
river mouth improvement

In the case of estuary closure measures,
do not make it like this.



(R533)stream order

(R533) stream order

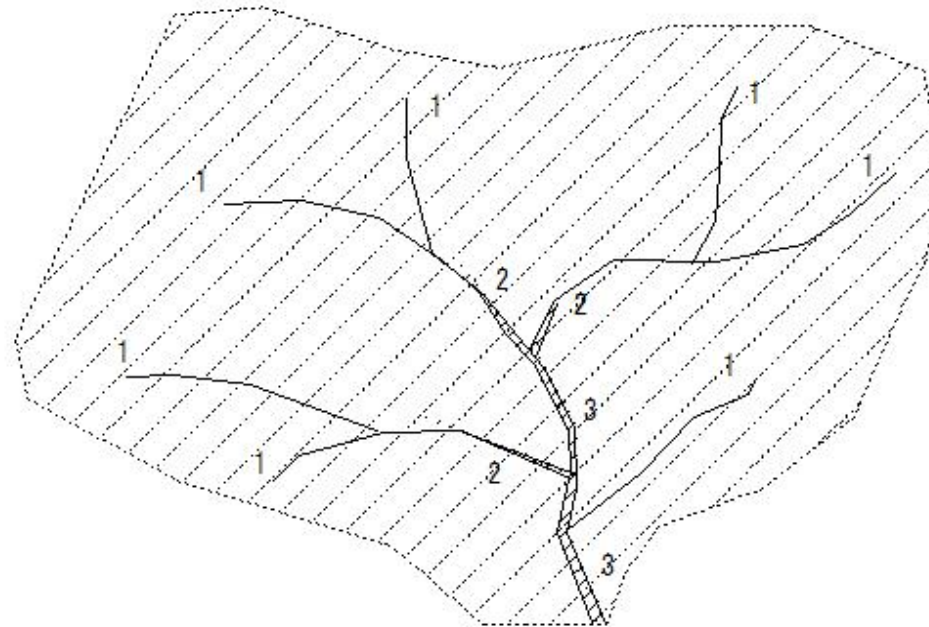
river order

Horton (R.E.Horton)

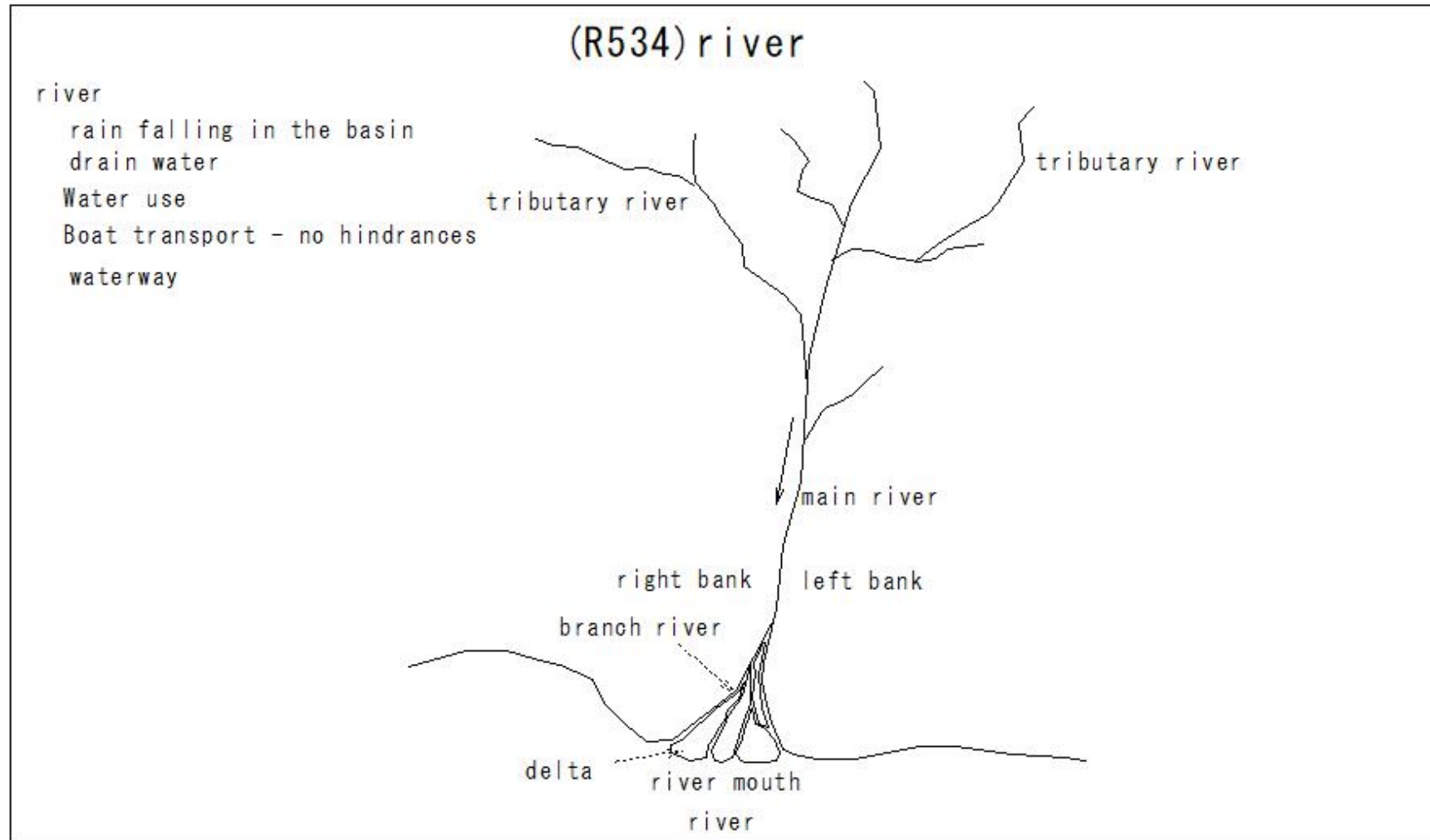
Trivial stream with no branches at the uppermost stream - primary river

Confluence of primary rivers - secondary rivers

Confluence of secondary rivers - Tertiary rivers



(R534)river



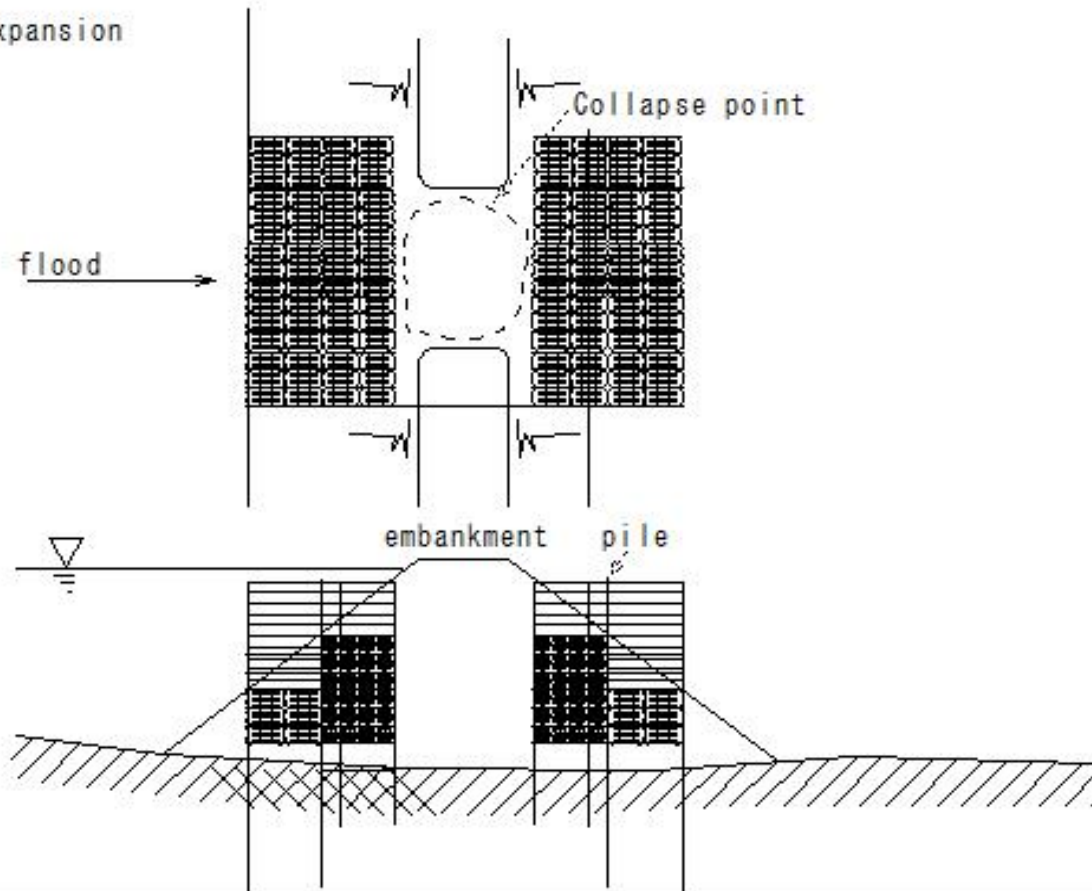
(R535)levee burst prevention (hurdle work)

(R535)levee burst prevention (hurdle work)

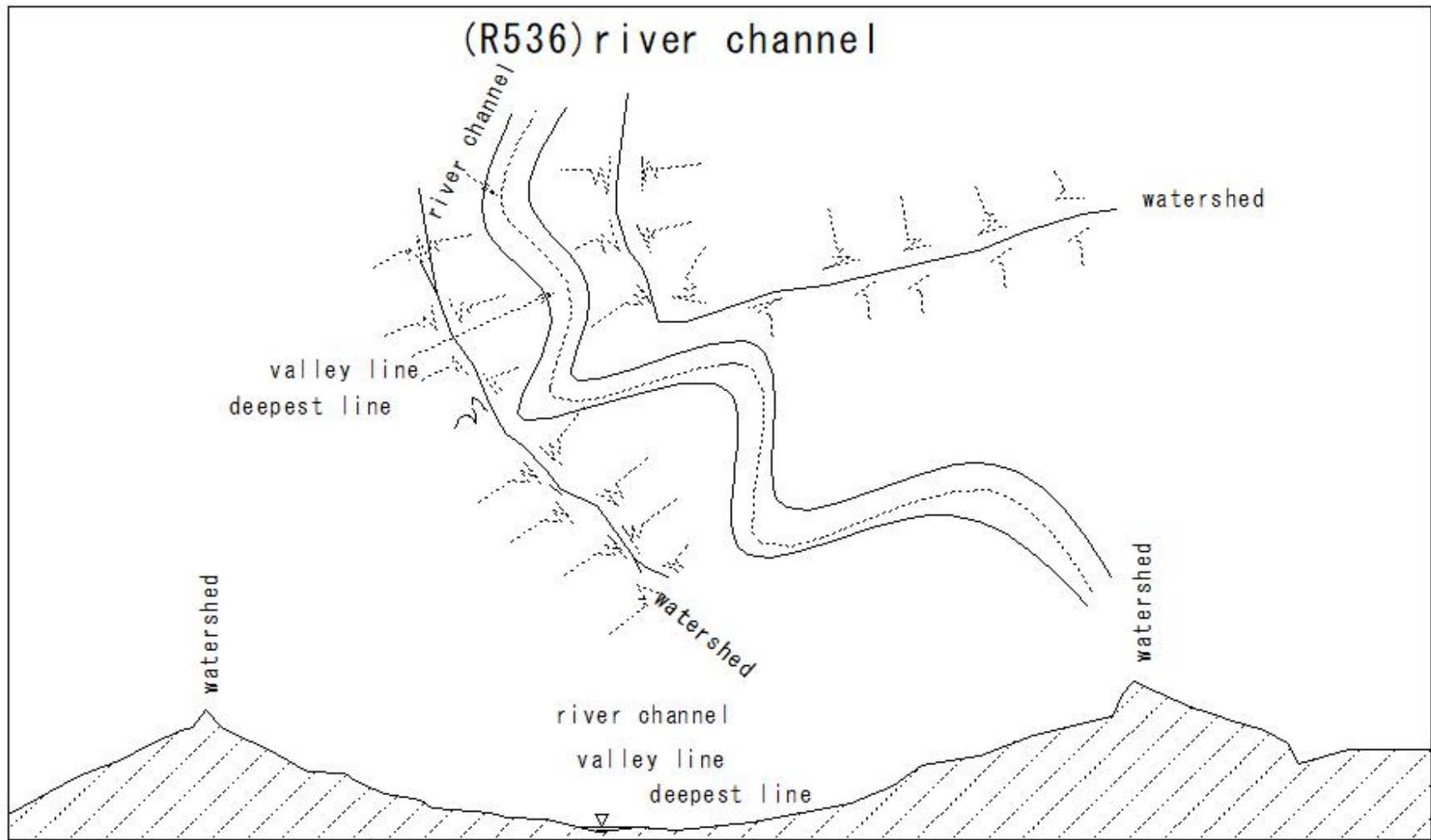
hurdle work(soil bag)

Levee burst - prevention of expansion

Emergency measure



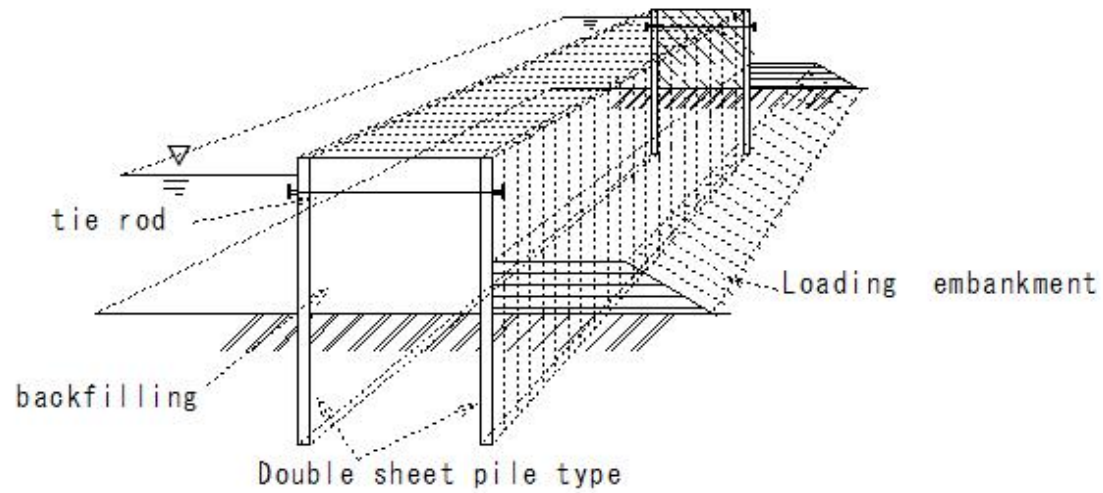
(R536)river channel



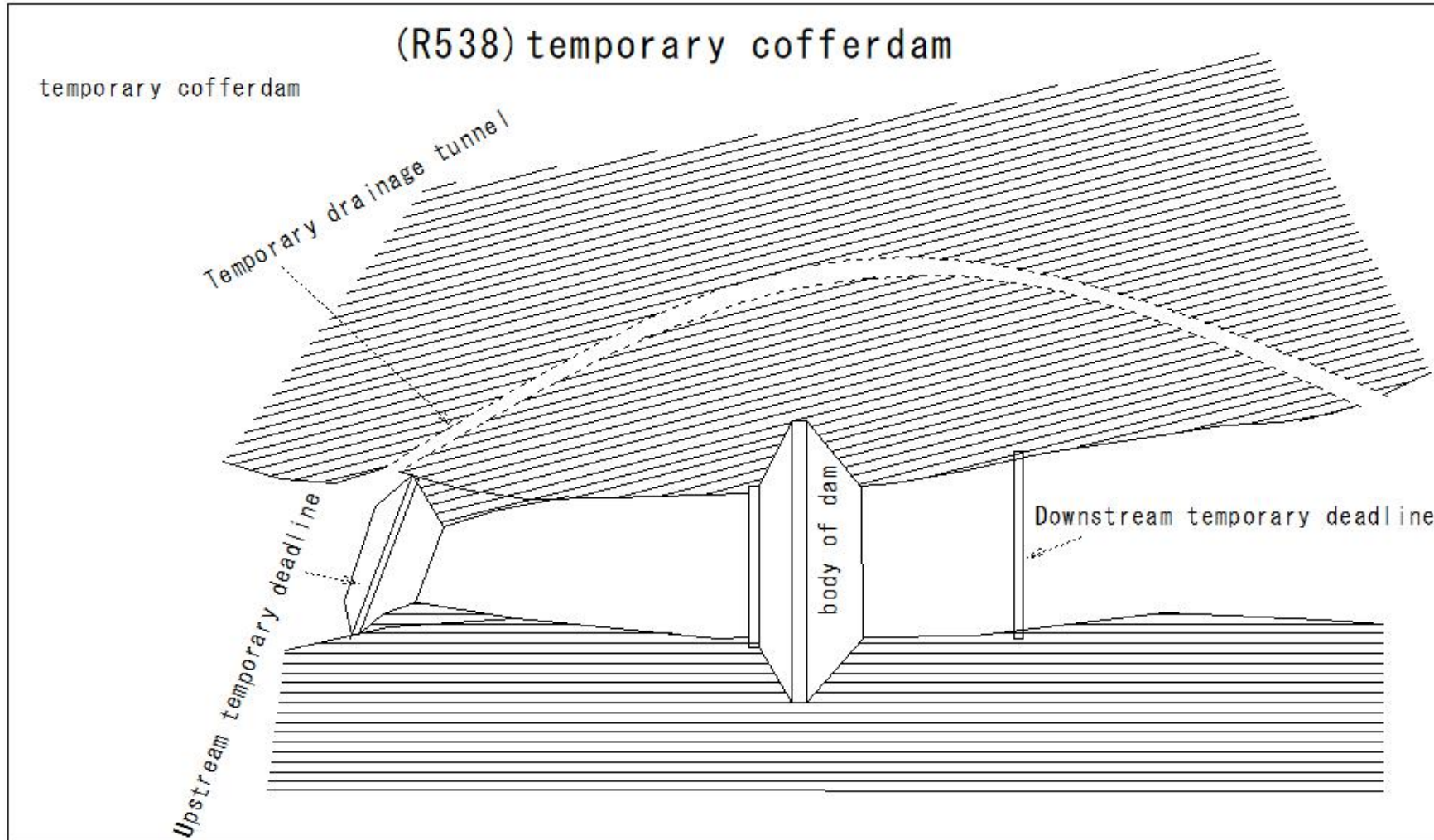
(R537)temporary cofferdam

(R537)temporary cofferdam

temporary cofferdam
steel sheet pile



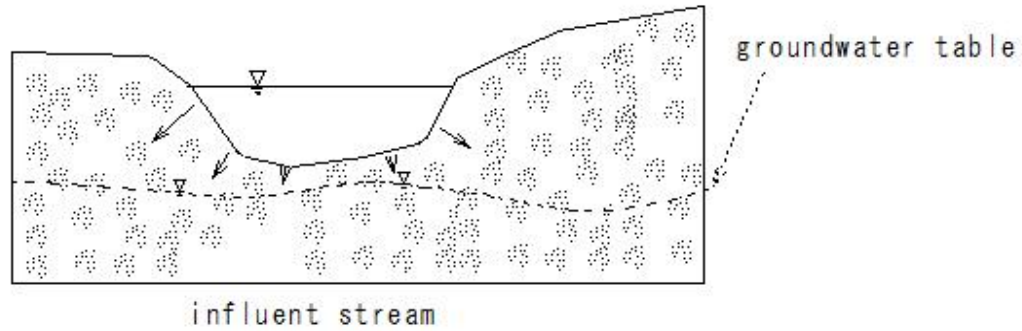
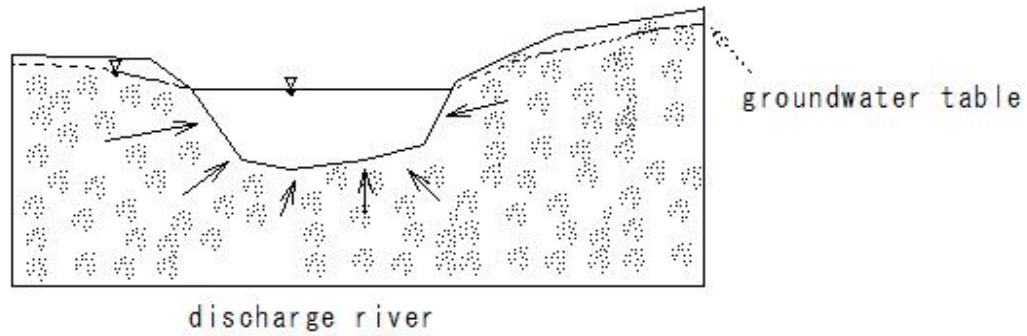
(R538)temporary cofferdam



(R539)temporary cofferdam

(R539) temporary cofferdam

influent stream



(R540)flood control

(R540) flood control

flood control

discharge

discharge changes over time

A portion of flood runoff is stored in reservoirs, etc. for flood control and disaster prevention purposes.

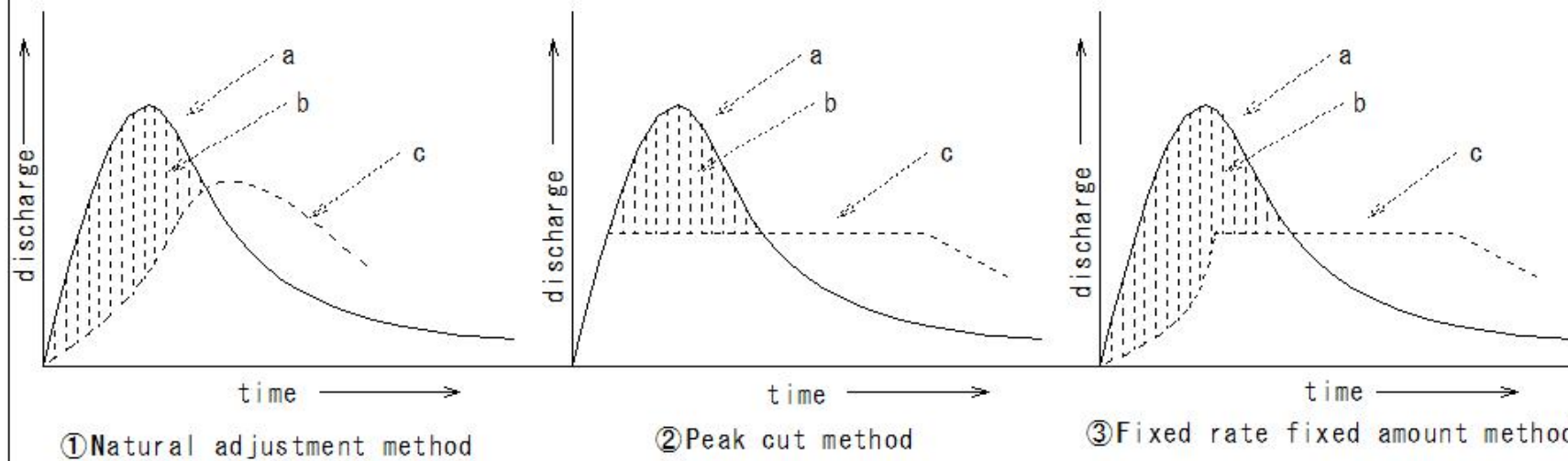
change flow time

Reduce downstream flood peak flows

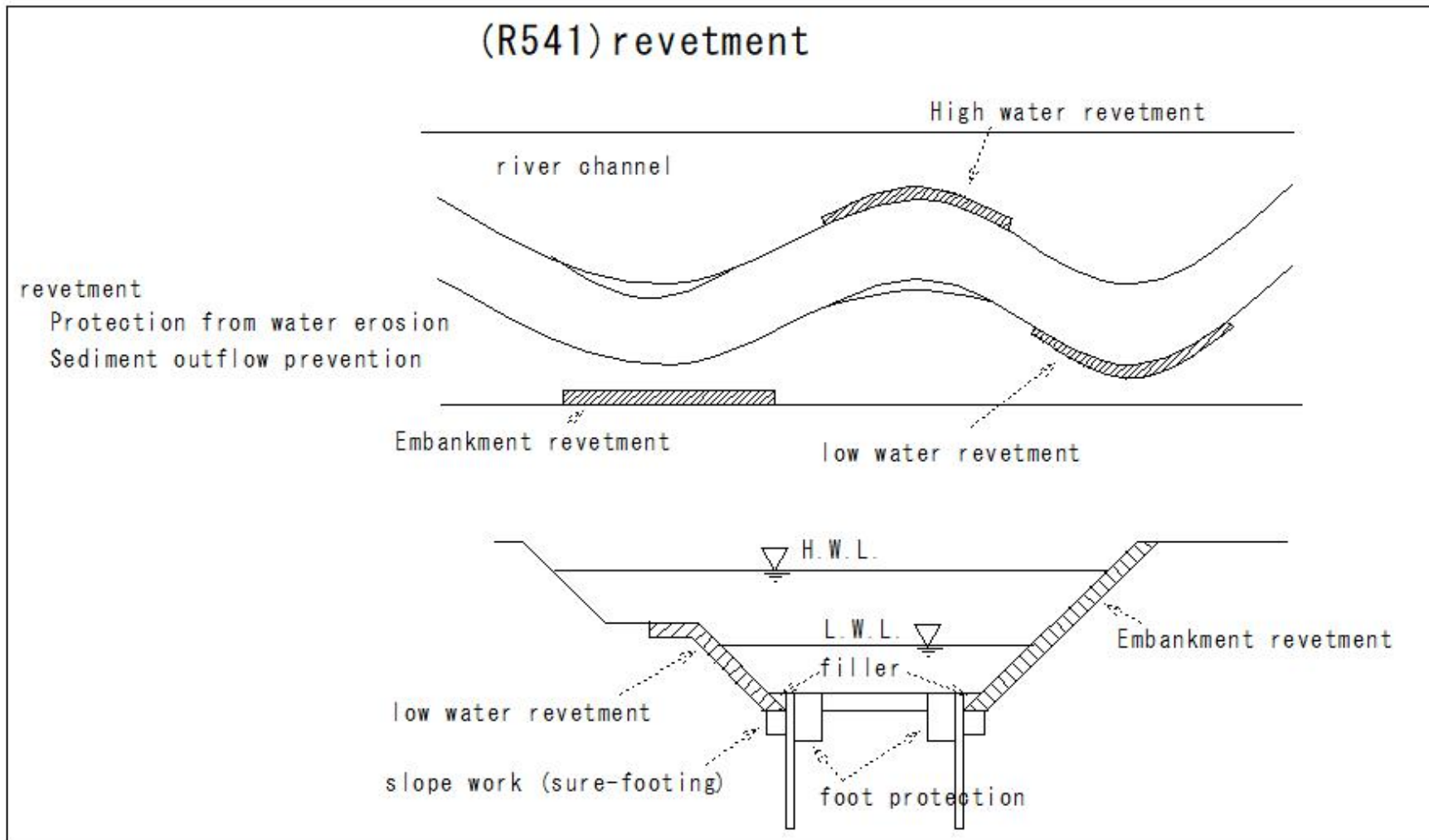
a:flood discharge

b:discharge after flood control

c:flood control amount



(R541)revetment

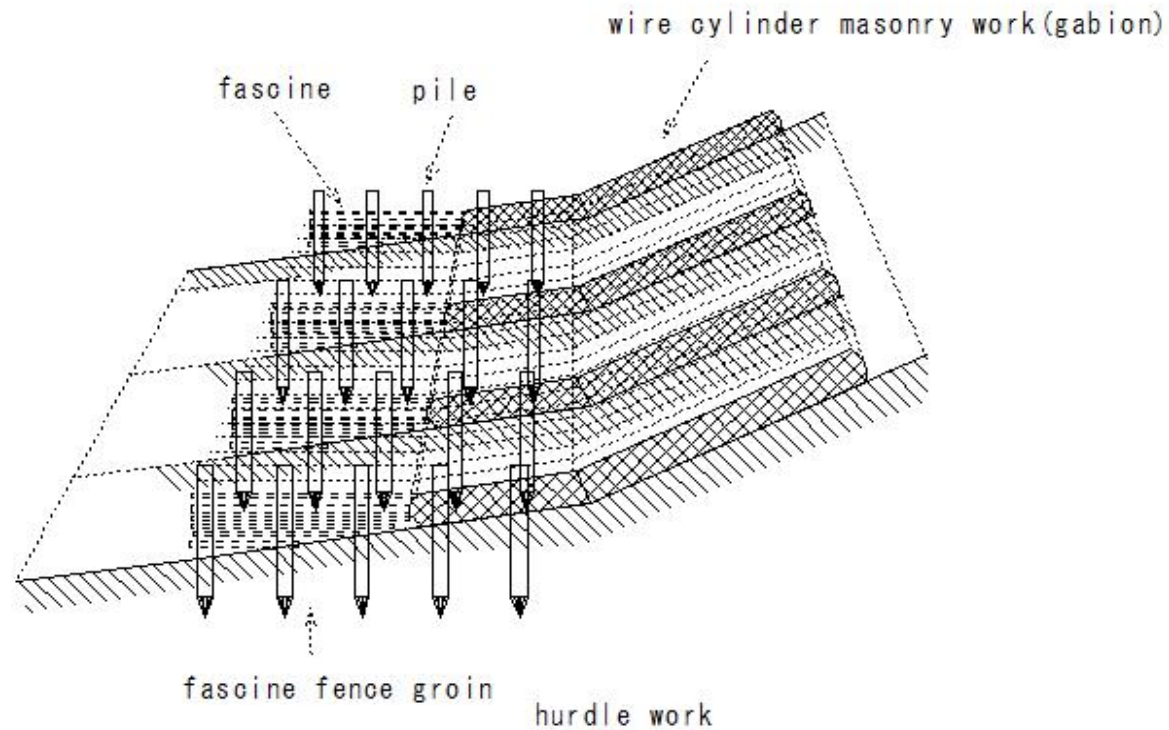


(R542)hurdle work(bank protection work)

(R542) hurdle work (bank protection work)

hurdle work(bank protection work)

- Weaken the flow
- Prevention of scouring



(R543)retarding basin

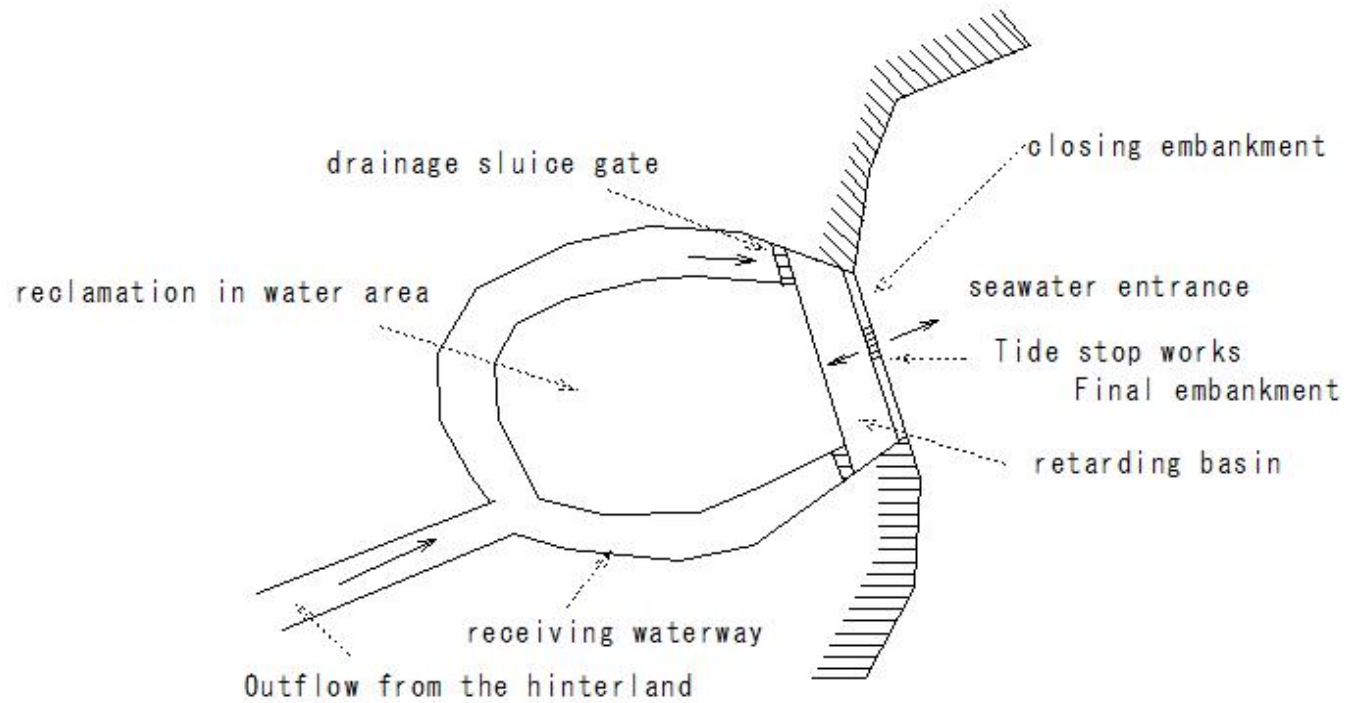
(R543)retarding basin

retarding basin

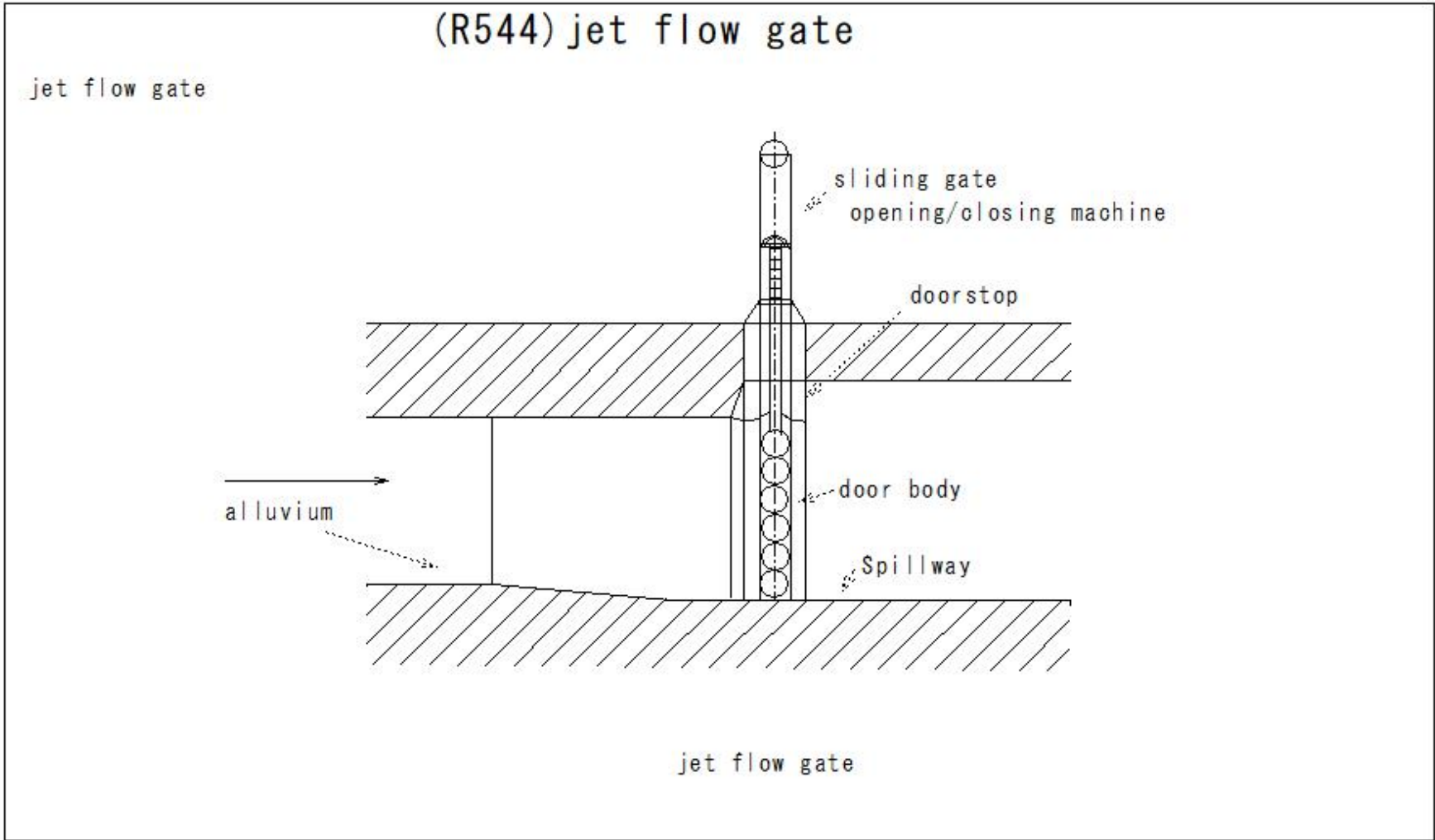
Invading seawater

Excludes water from the basin (inland water) to the outside

Reservoir for temporary retention within the area

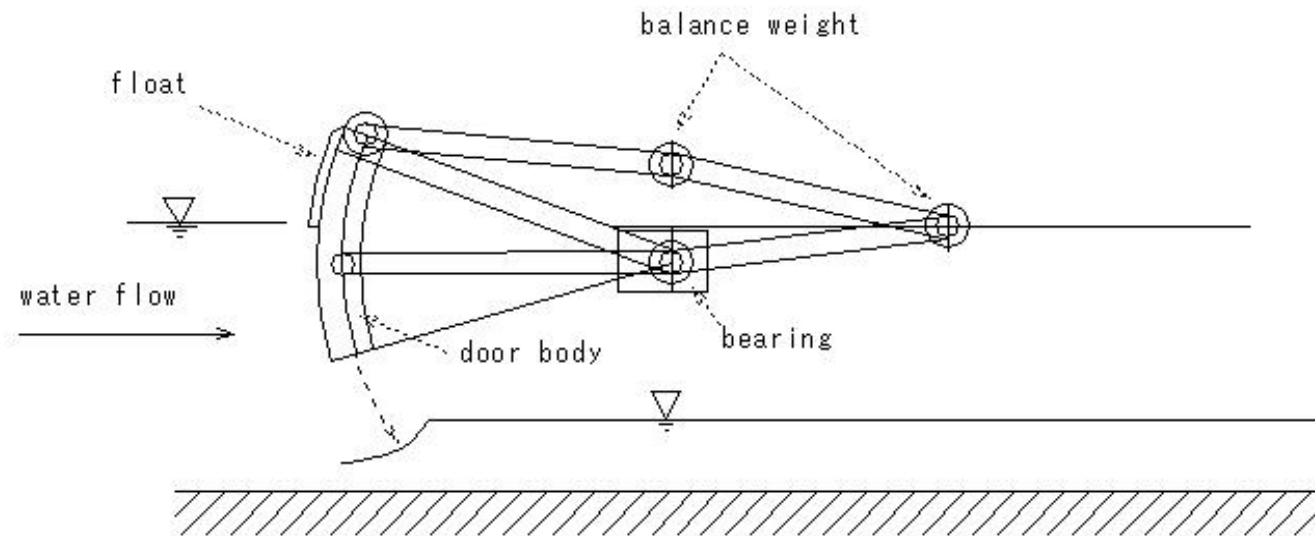


(R544)jet flow gate



(R545)automatic cross regulator

(R545)automatic cross regulator

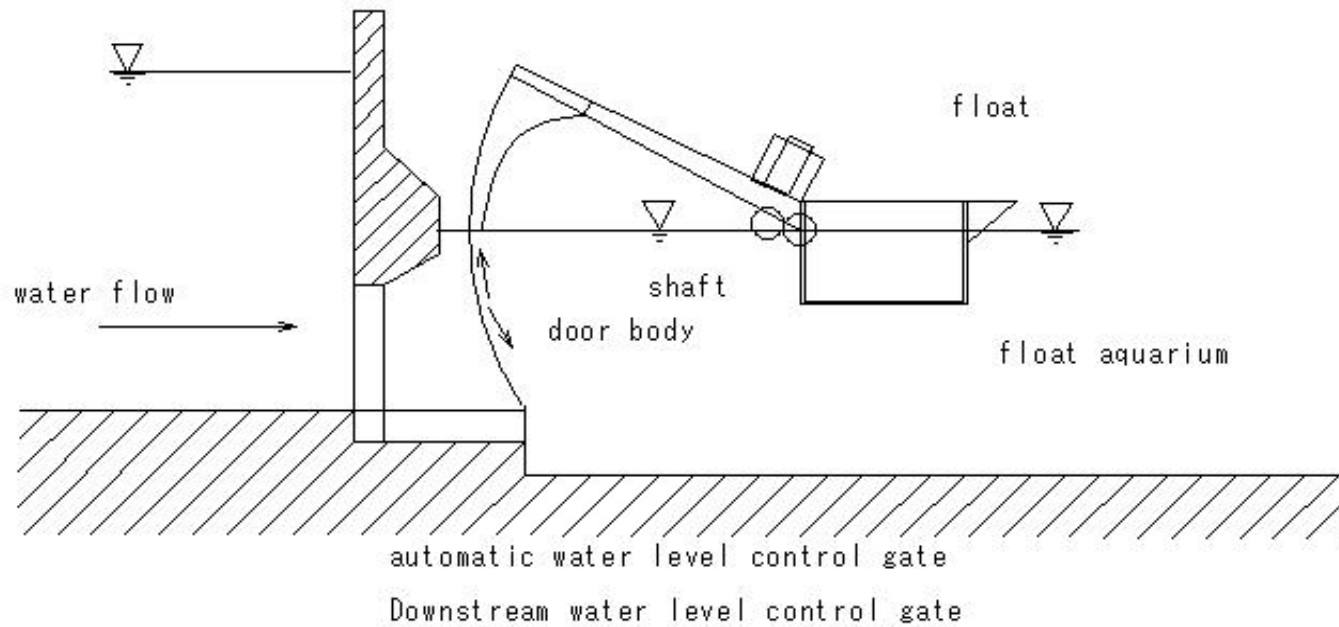


automatic water level control gate
automatic cross regulator

(R546)automatic cross regulator

(R546)automatic cross regulator

automatic cross regulator



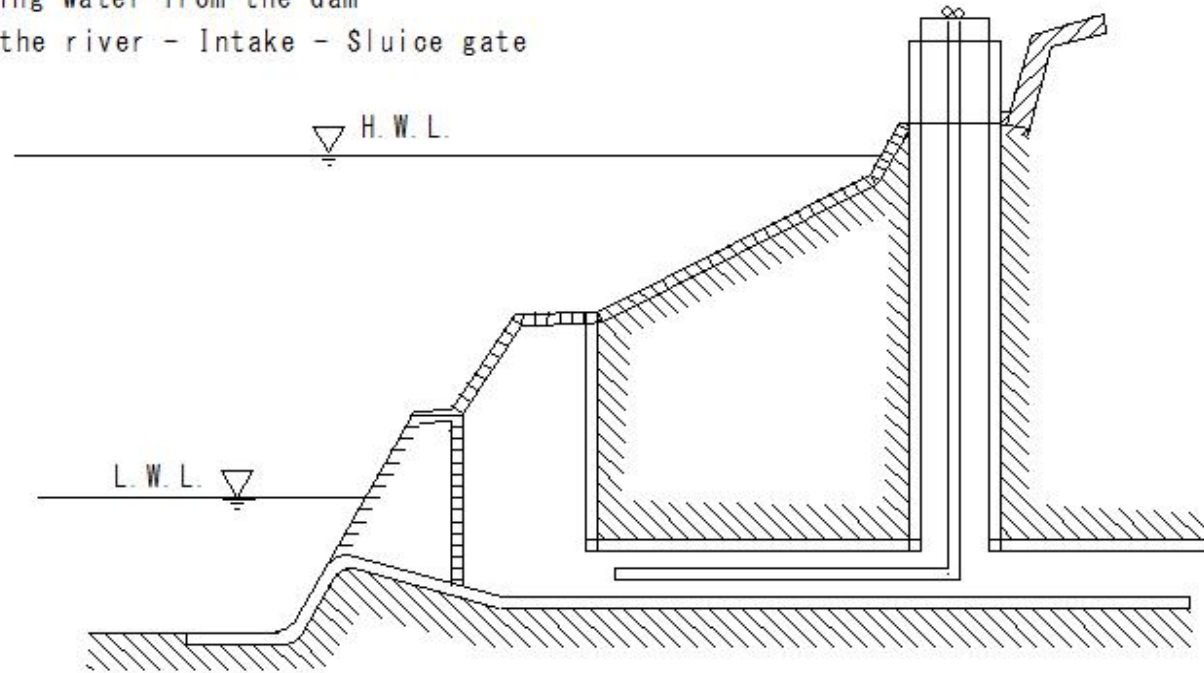
(R547)inlet works(water intake facility)

(R547) inlet works(water intake facility)

inlet works(water intake facility)

Facilities for taking water from the dam

Water intake from the river - Intake - Sluice gate



inlet works(water intake facility)

(R548)groin(groyne • spur dike)

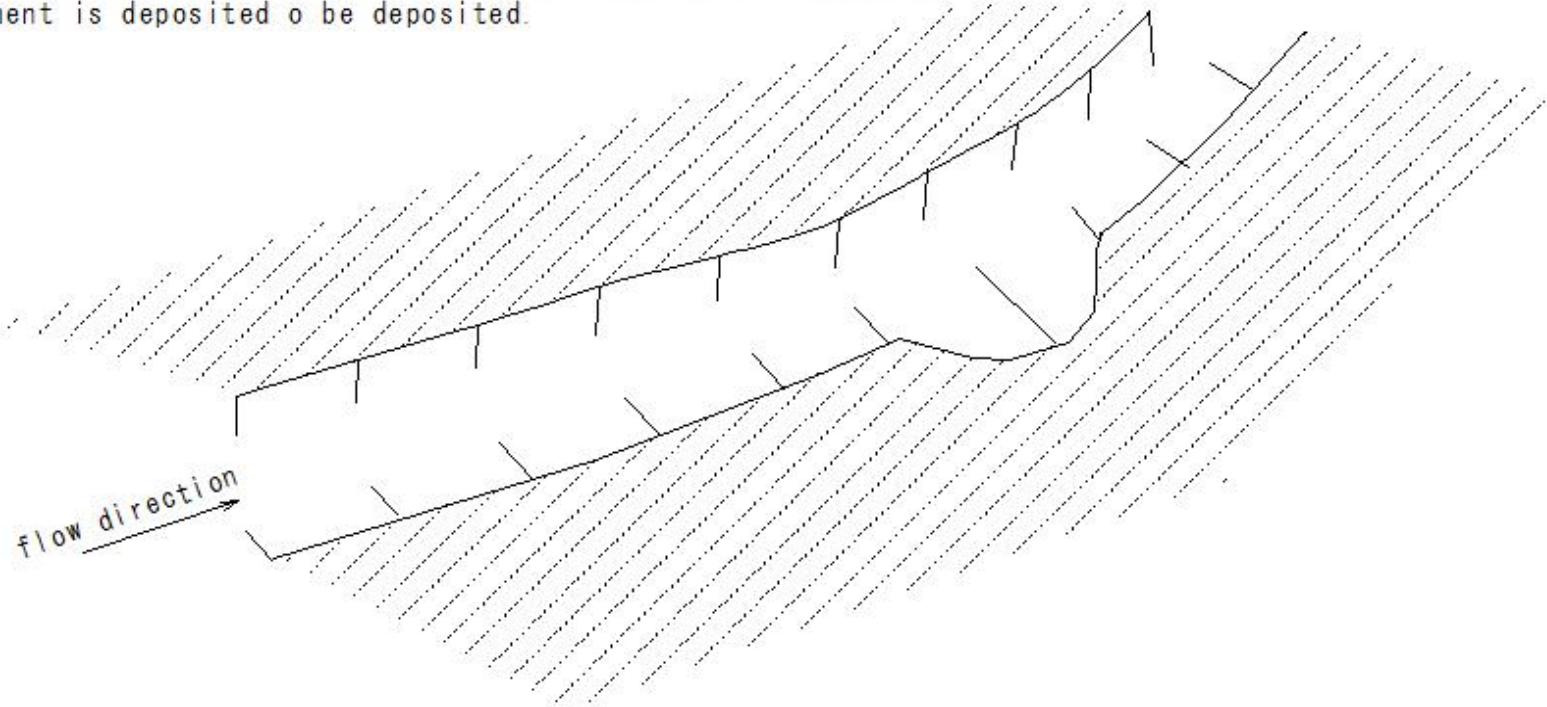
(R548) groin(groyne • spur dike)

groin(groyne • spur dike)

Allowing water to flow safely down river channels

Stabilize the center of the flow in the center of the riverbed

Sediment is deposited o be deposited.



(R549)groin(groyne • spur dike)

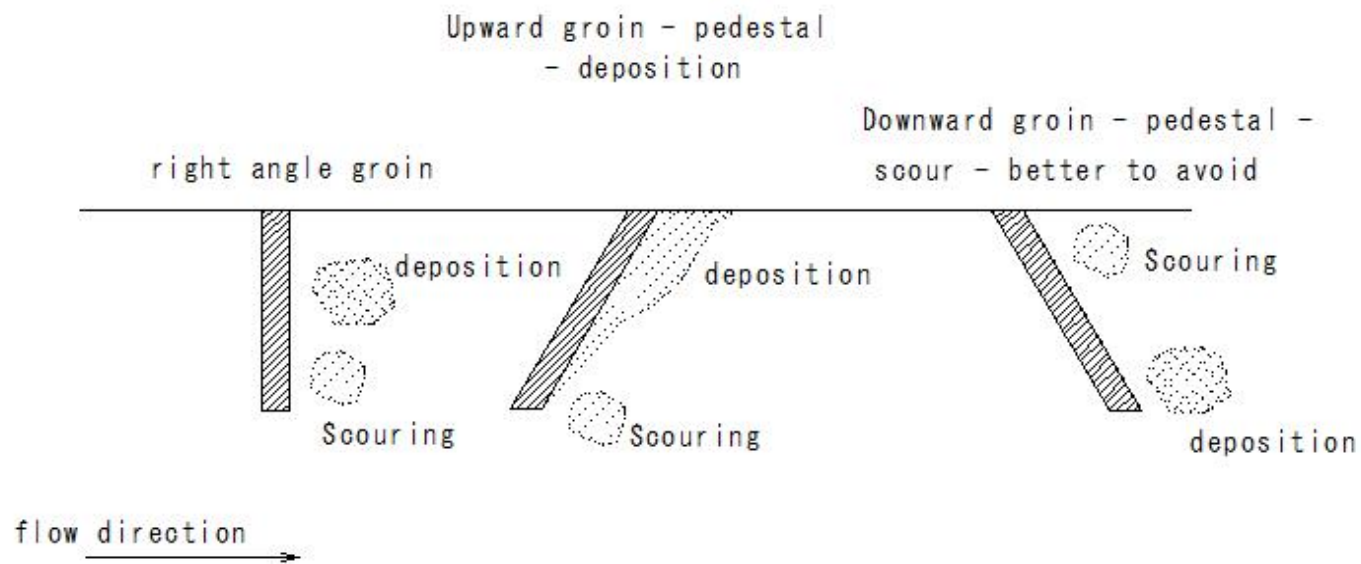
(R549) groin(groyne • spur dike)

groin(groyne • spur dike)

Allowing water to flow safely down river channels

Stabilize the center of the flow in the center of the riverbed

Sediment is deposited o be deposited.



(R550)groin(groyne • spur dike)

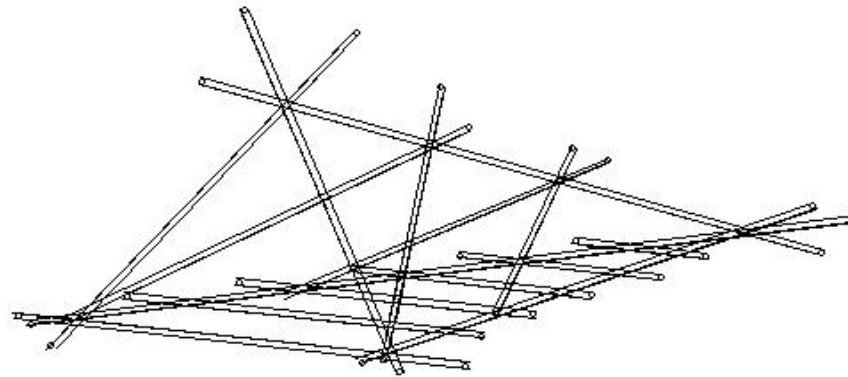
(R550) groin(groyne • spur dike)

groin(groyne • spur dike)

Allowing water to flow safely down river channels

Stabilize the center of the flow in the center of the riverbed

Sediment is deposited o be deposited.



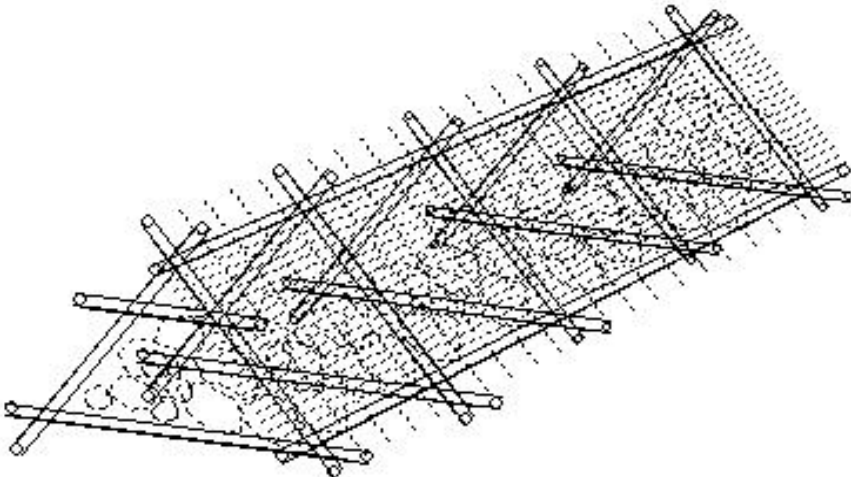
groin-crib work

(R551)groin(groyne · spur dike)

(R551)groin(groyne · spur dike)

groin(groyne · spur dike)

Allowing water to flow safely down river channels
Stabilize the center of the flow in the center of the riverbed
Sediment is deposited o be deposited.



)groin(groyne · spur dike)
crib work

(R552)groin(groyne • spur dike)

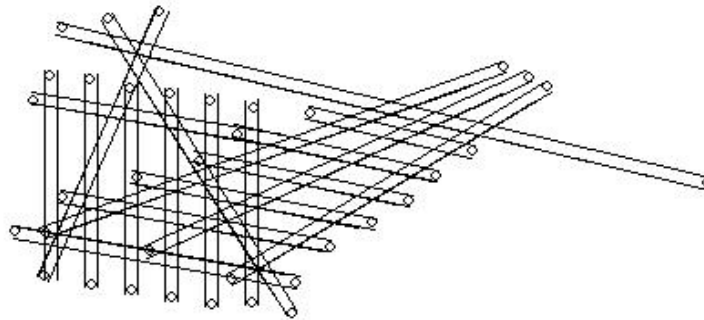
(R552) groin(groyne • spur dike)

groin(groyne • spur dike)

Allowing water to flow safely down river channels

Stabilize the center of the flow in the center of the riverbed

Sediment is deposited o be deposited.



(R553)groin(groyne · spur dike)

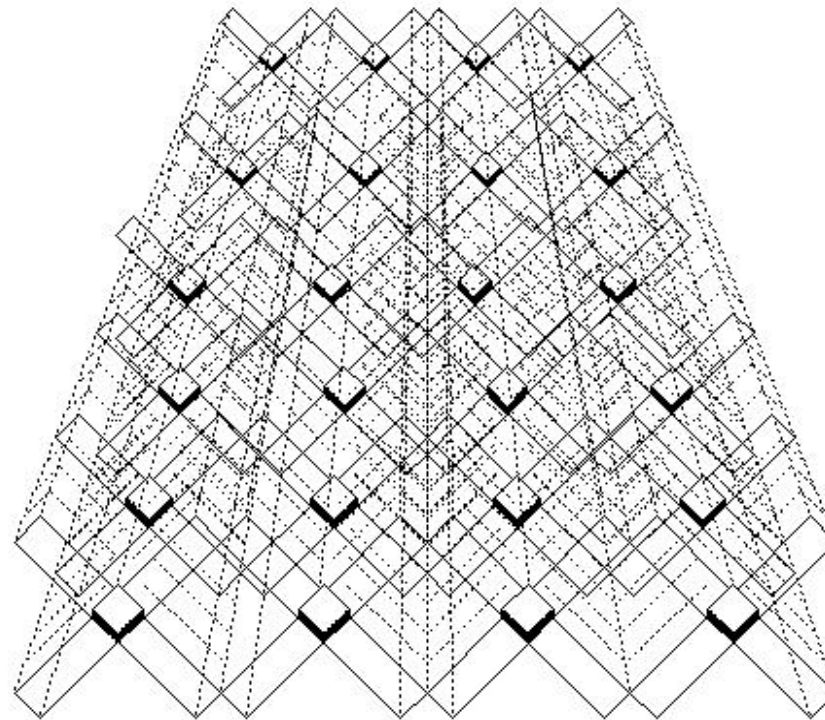
(R553) groin(groyne · spur dike)

groin(groyne · spur dike)

Allowing water to flow safely down river channels

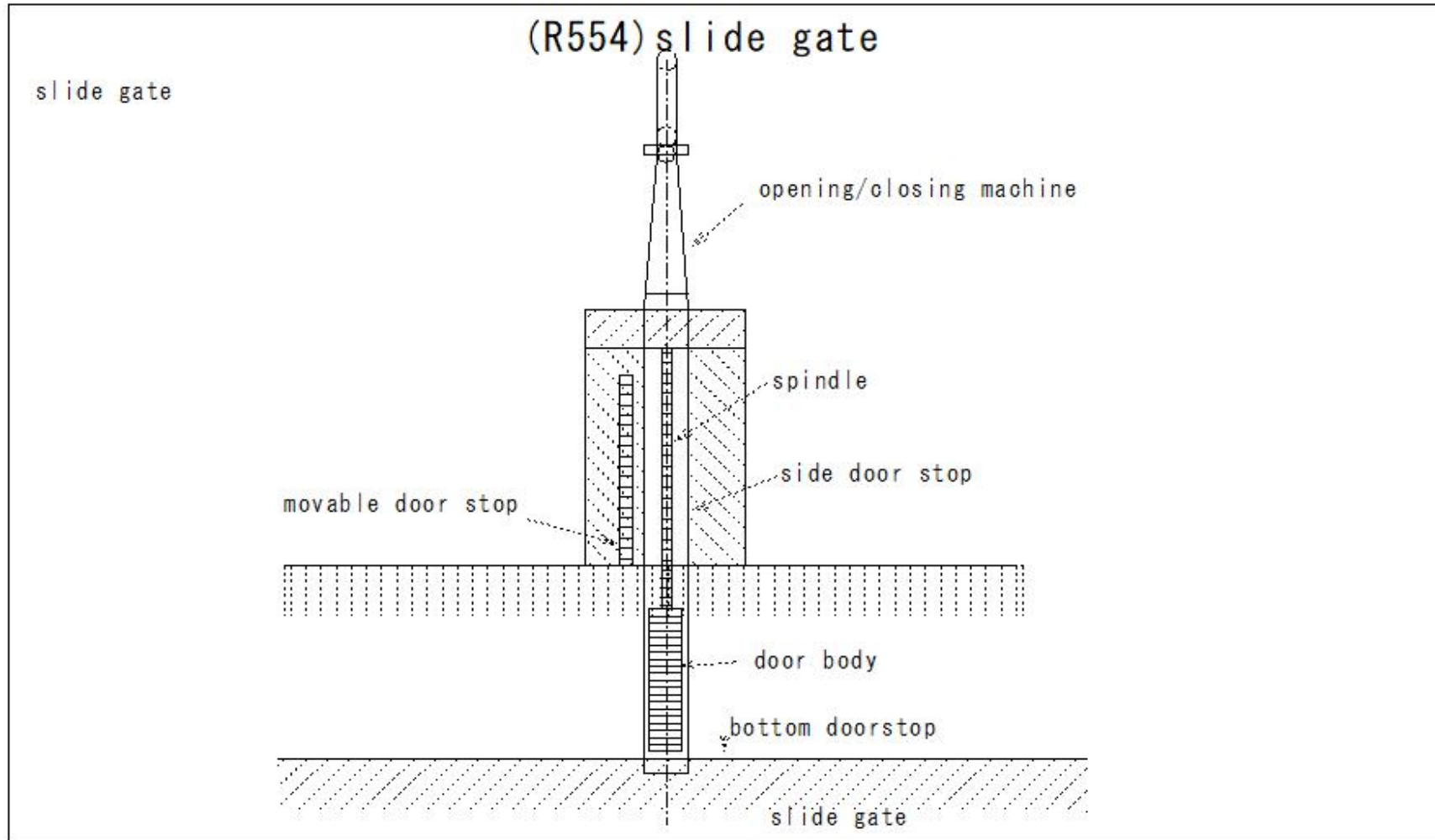
Stabilize the center of the flow in the center of the riverbed

Sediment is deposited o be deposited.



groin : using irregularly shaped blocks

(R554)slide gate



(R555)laminar flow • laminar flow

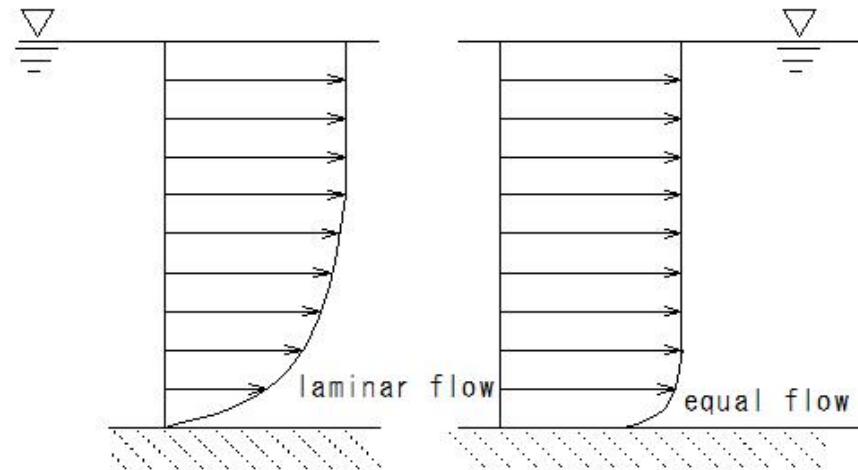
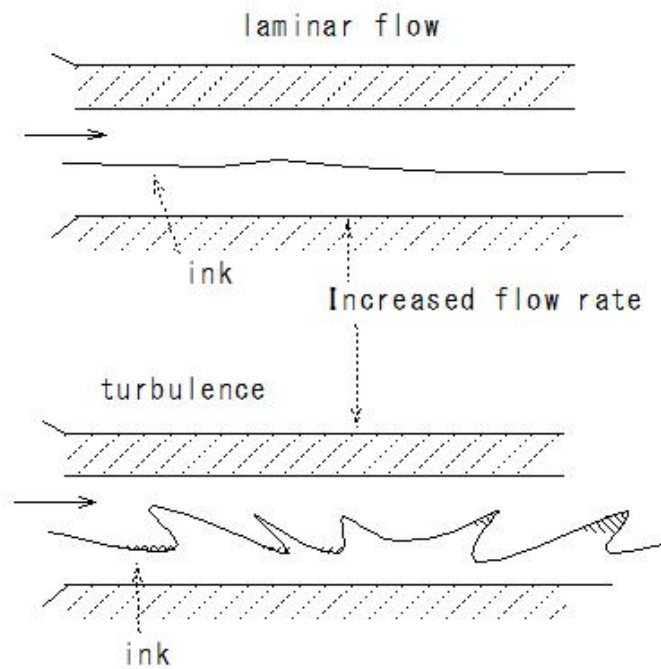
(R555)laminar flow • laminar flow

laminar flow • laminar flow

Fluid particles: move only in the direction of flow

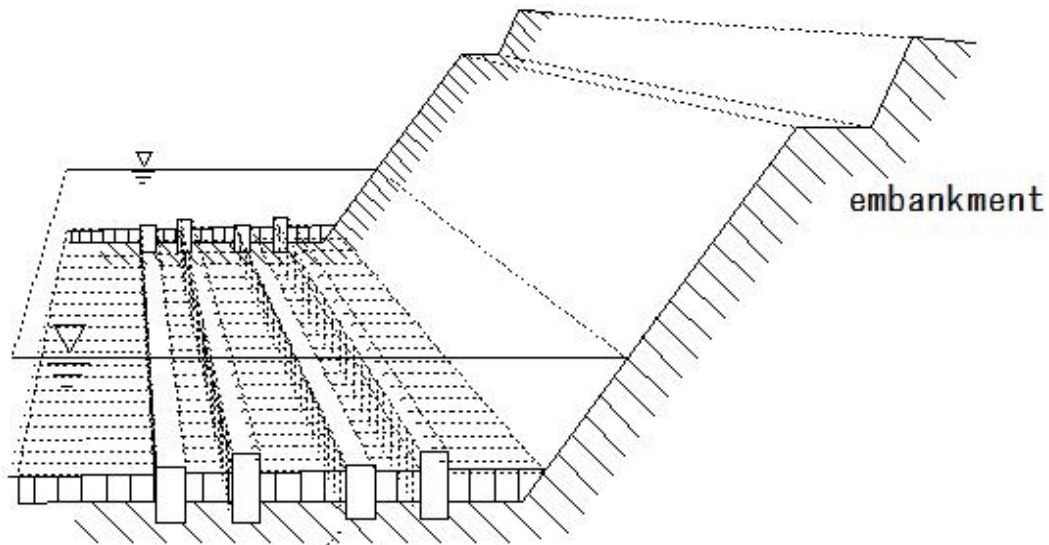
Open channel: Reynolds number 500 or less

Laminar flow within the pipeline, approx. 2000 or less



(R556)Concrete block groin (water control)

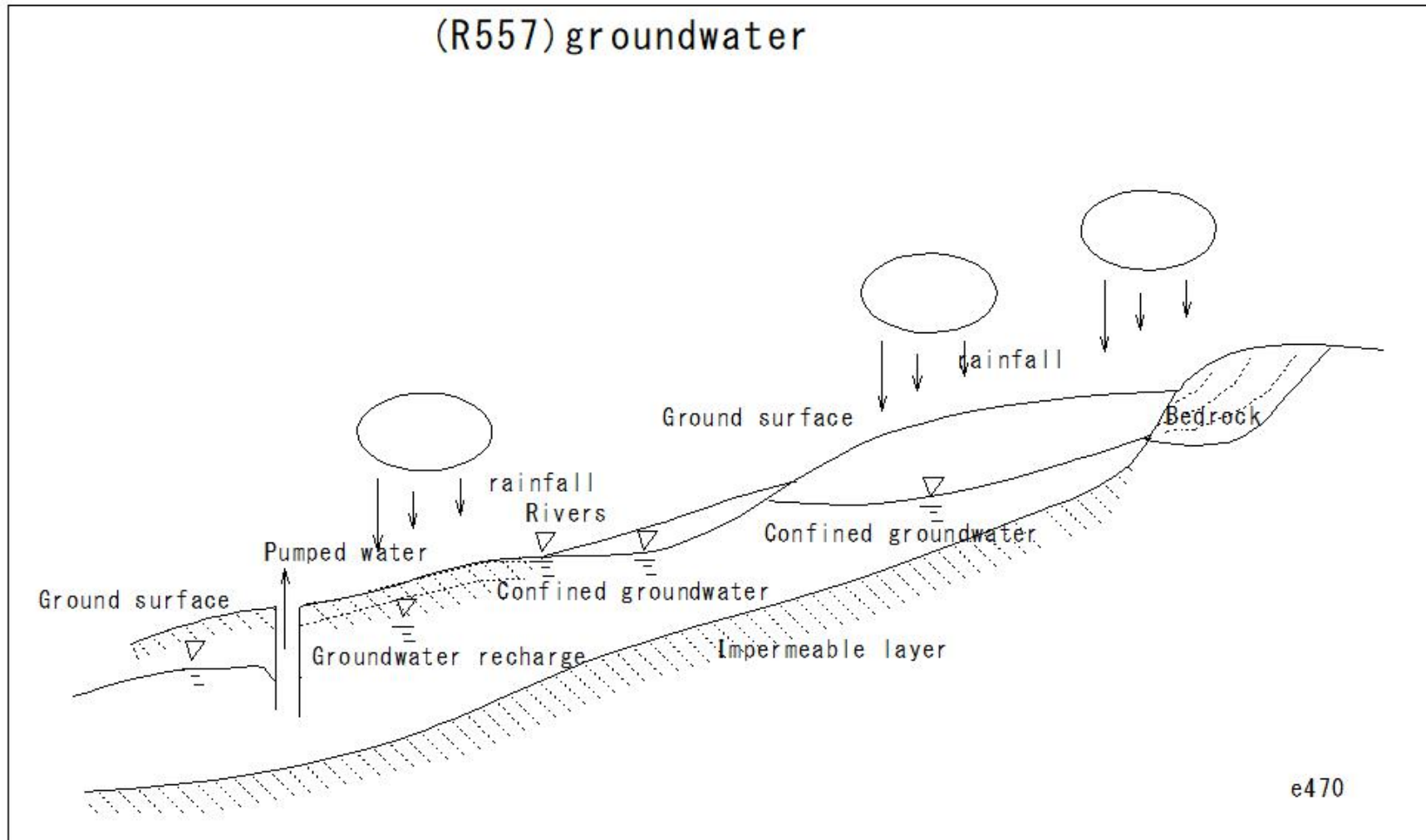
(R556) Concrete block groin (water control)



- ① Impermeability/Permeability
- ② Foot protection to prevent falls and washouts
- ③ Rectangular concrete sluice

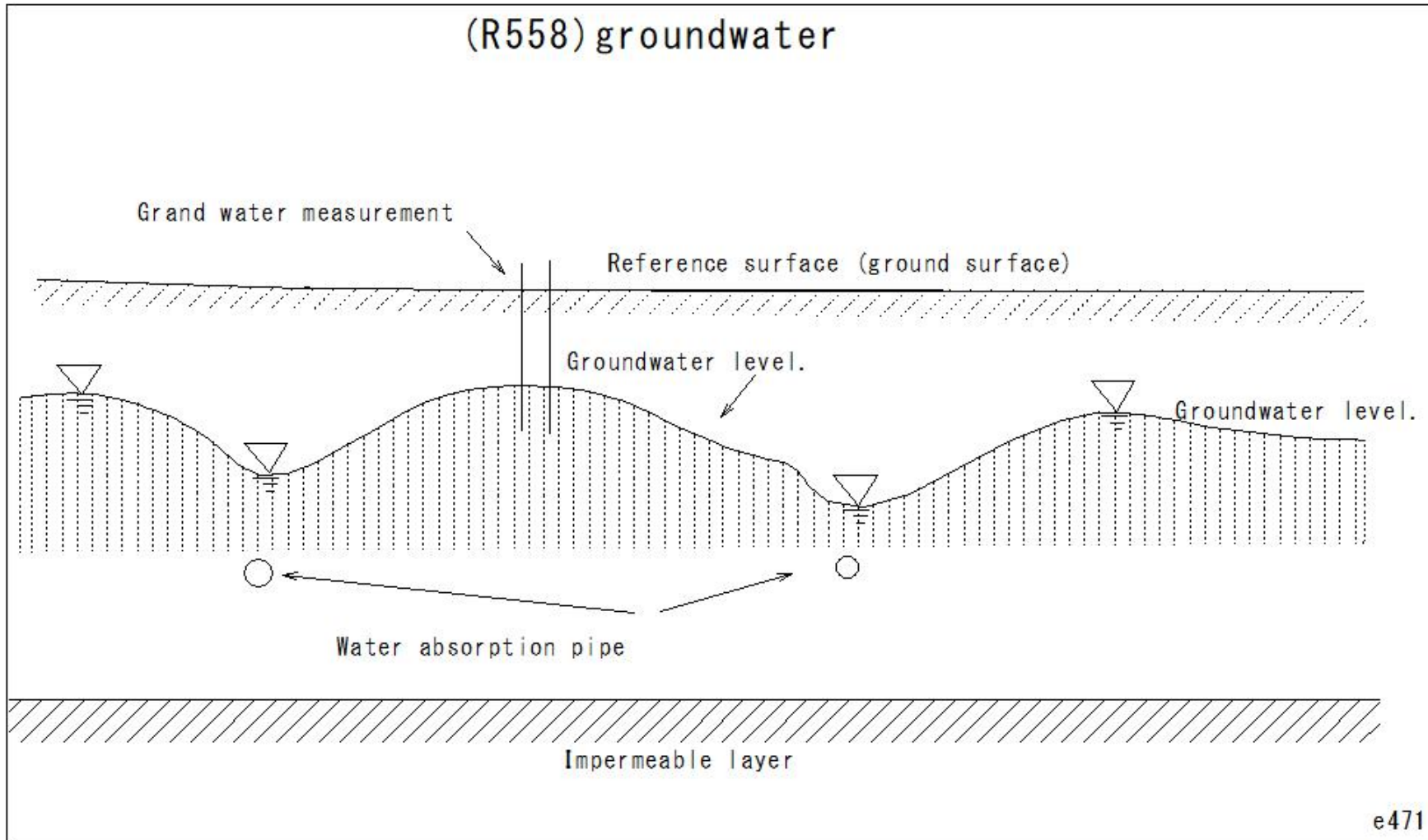
Concrete block groin (water control)

(R557)groundwater



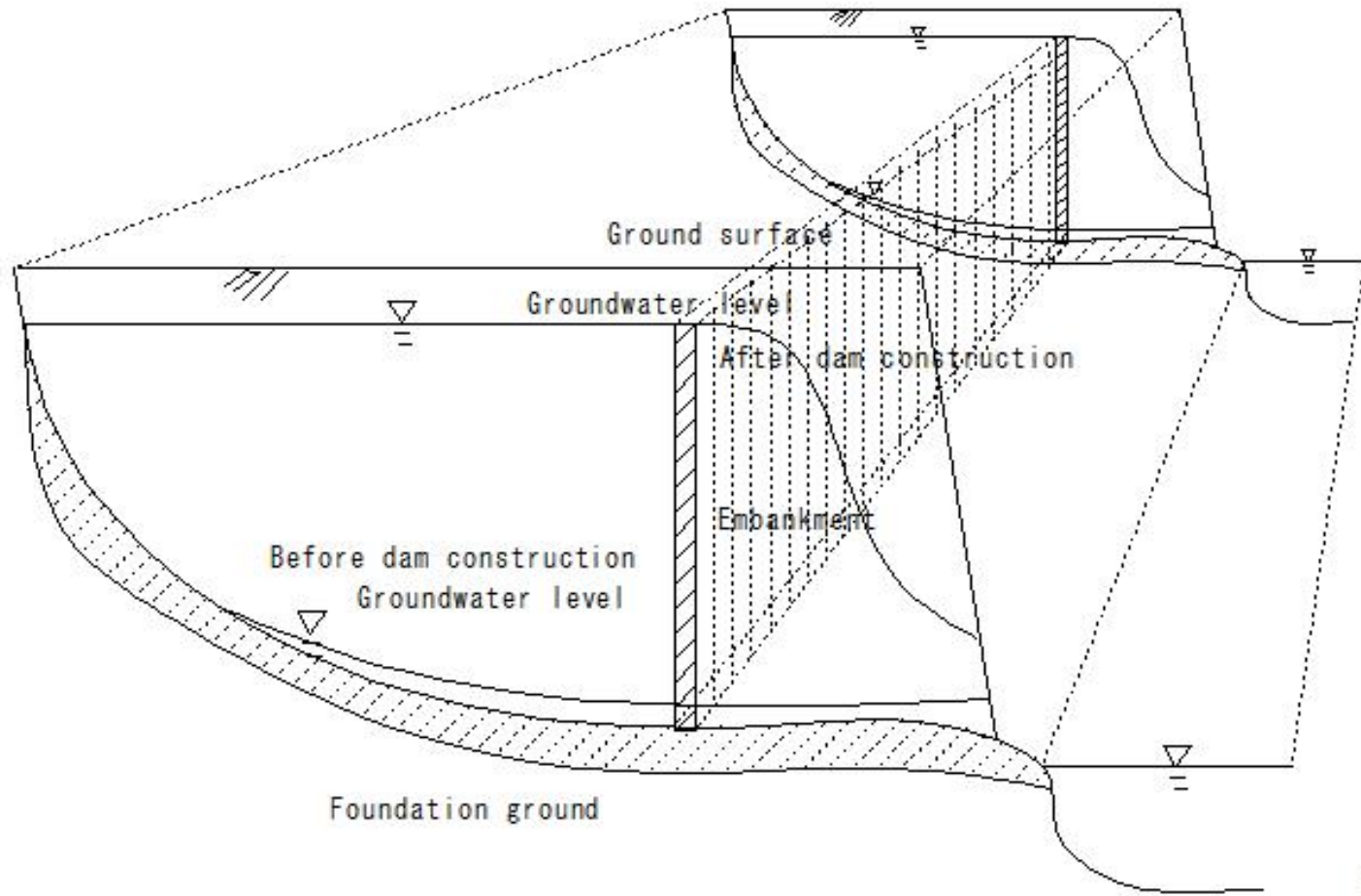
(R558)groundwater

(R558) groundwater



(R559)subsurface dam

(R559)subsurface dam



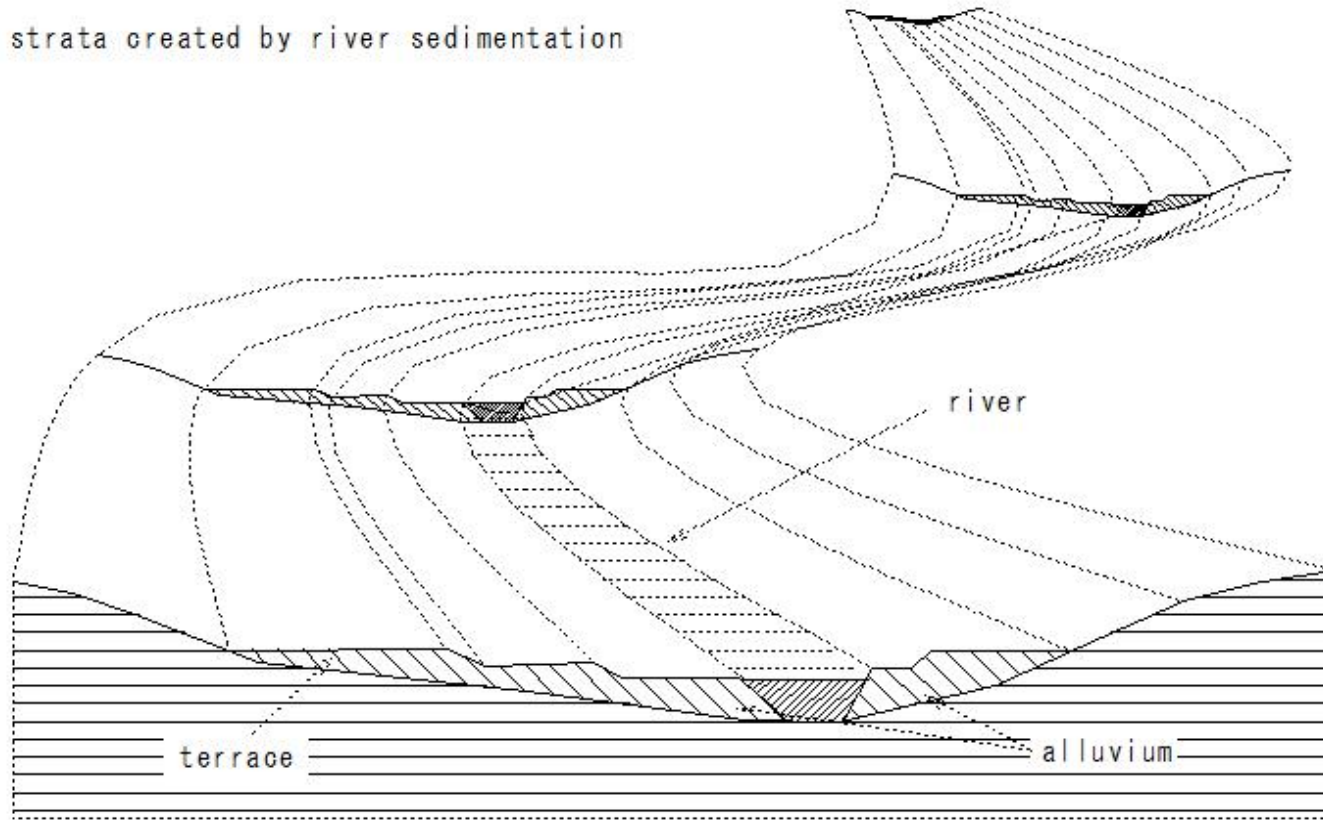
e472

(R560)alluvium

(R560) alluvium

alluvium

Geological strata created by river sedimentation



(R561)mattress

(R561) mattress

mattress

River bank, coast, before and after the sluice gate

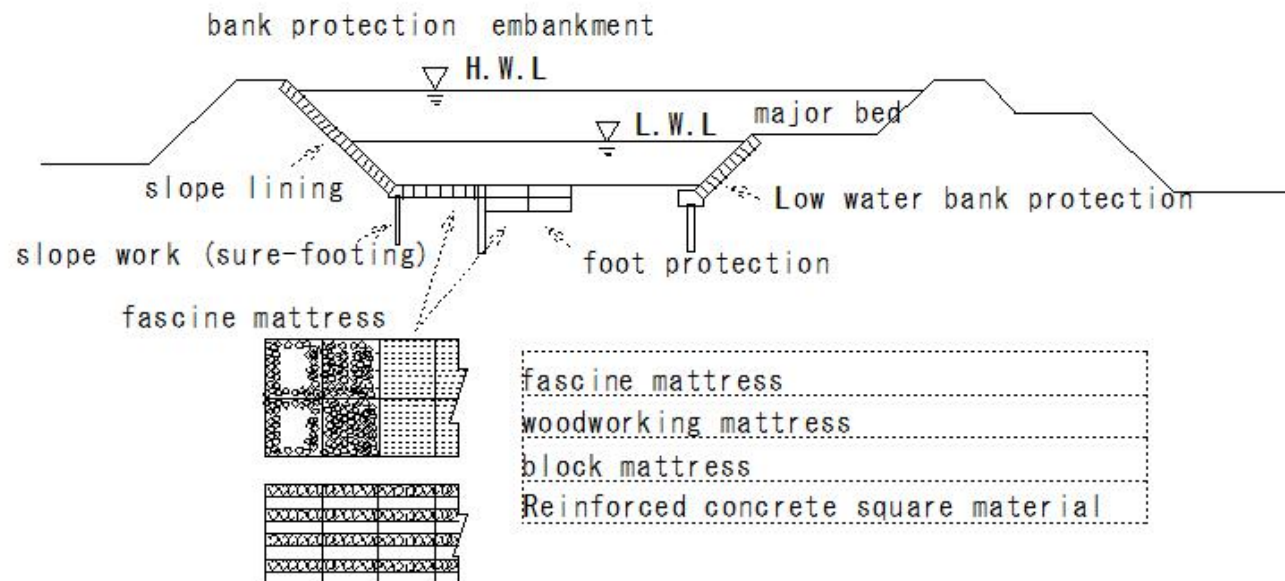
Maintains river bottom shape

foot protection

Construction of embankment sand and rubble mound on soft ground

A synthetic fiber mattress that distributes the load evenly

Function to prevent settlement of the superstructure



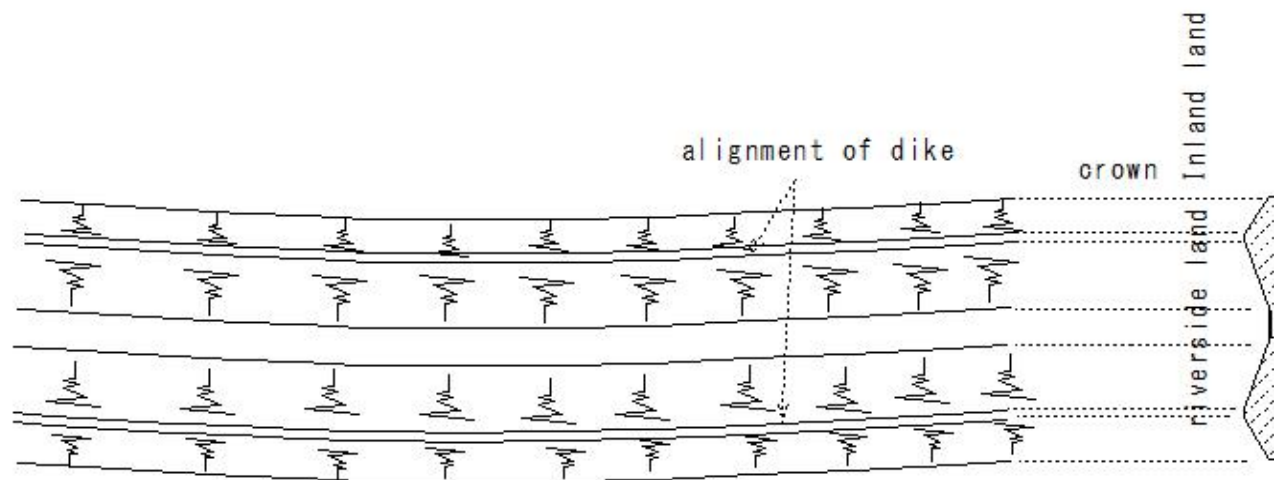
(R562)alignment of dike

(R562)alignment of dike

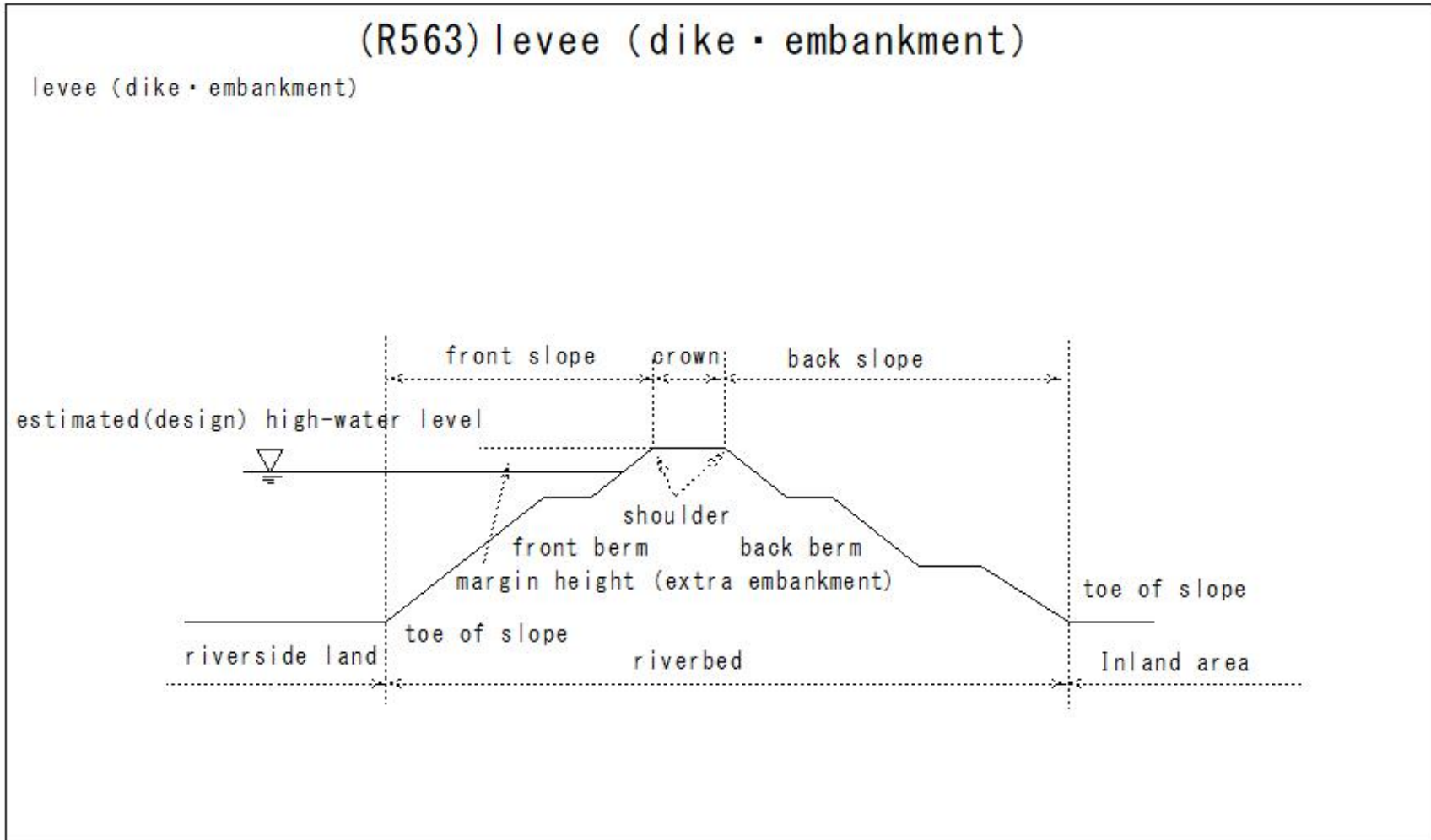
alignment of dike

Plane shape of the inner shoulder of the embankment crown

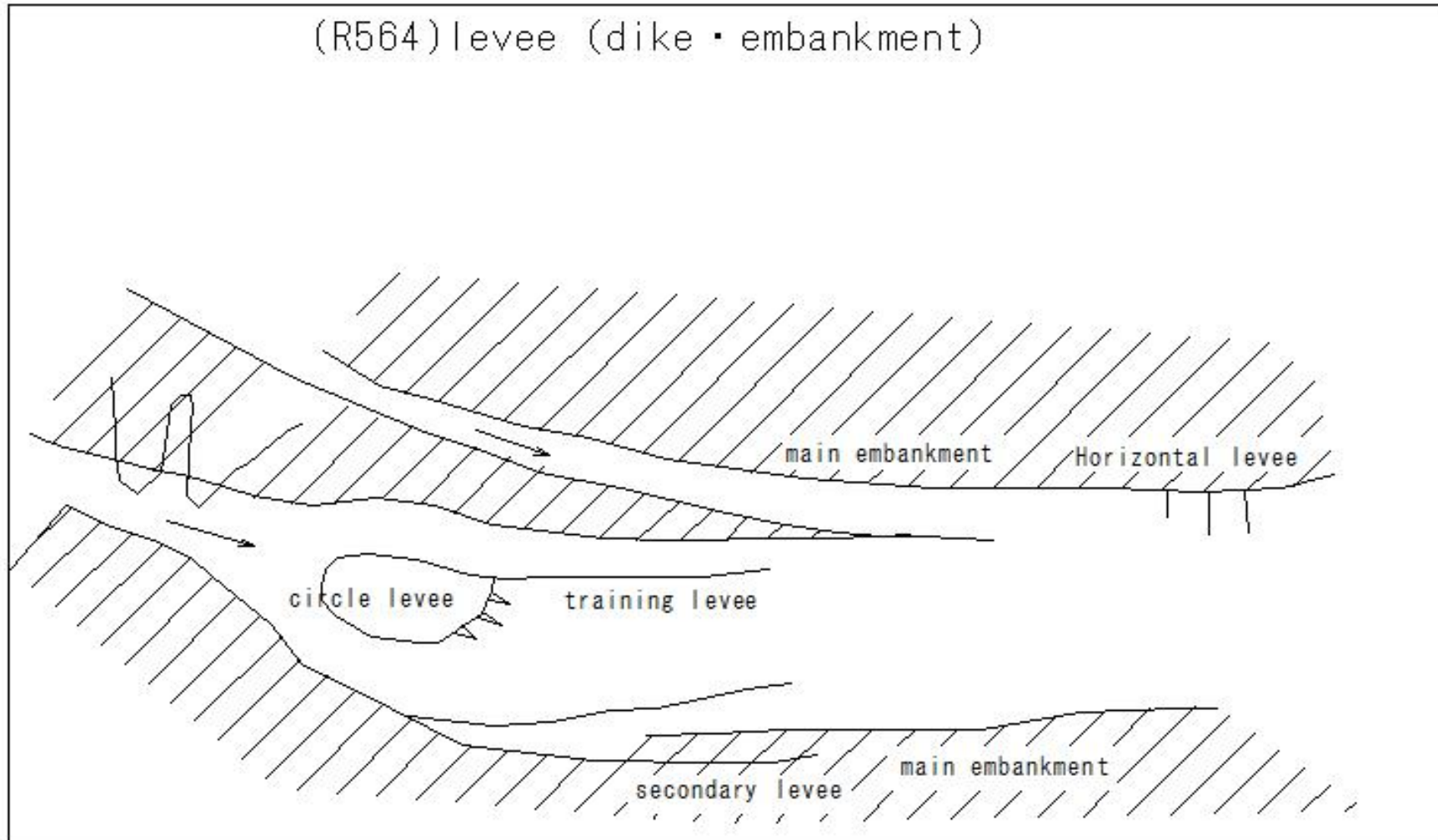
Protecting cultivated land outside the embankment from minor flooding



(R563)levee(dike · embankment)



(R564)levee(dike • embankment)



(R565)isohyetal method

(R565)isohyetal method

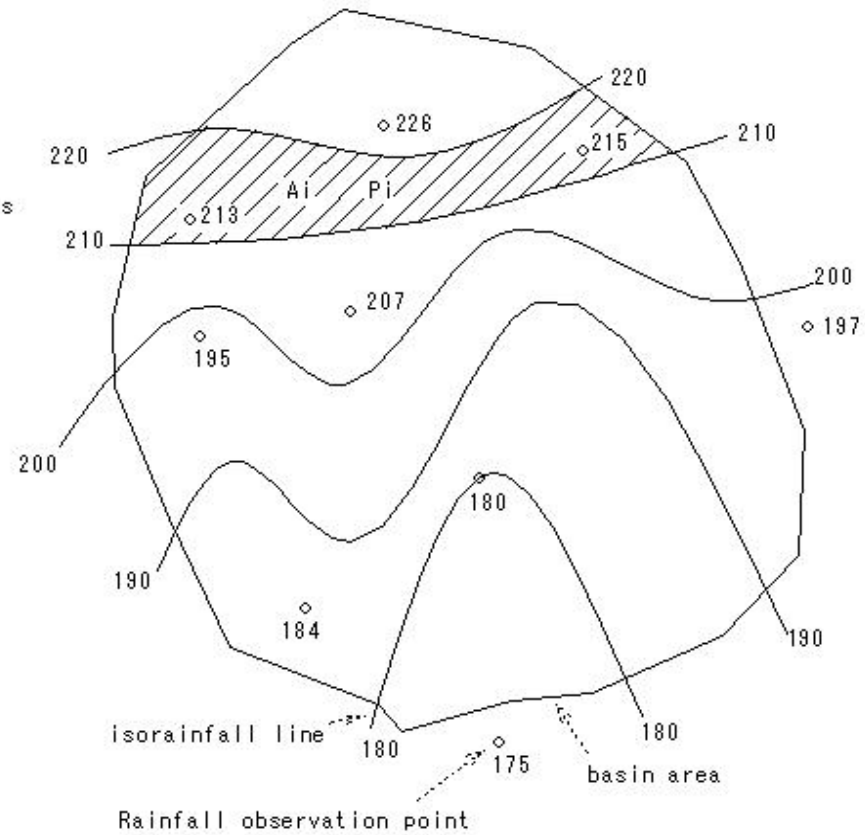
isohyetal method

$$P = \frac{\sum A_i \times P_i}{\sum A_i}$$

P: Area rainfall

A: Area between iso-rainfall lines

P_i: Average rainfall between iso-rainfall lines

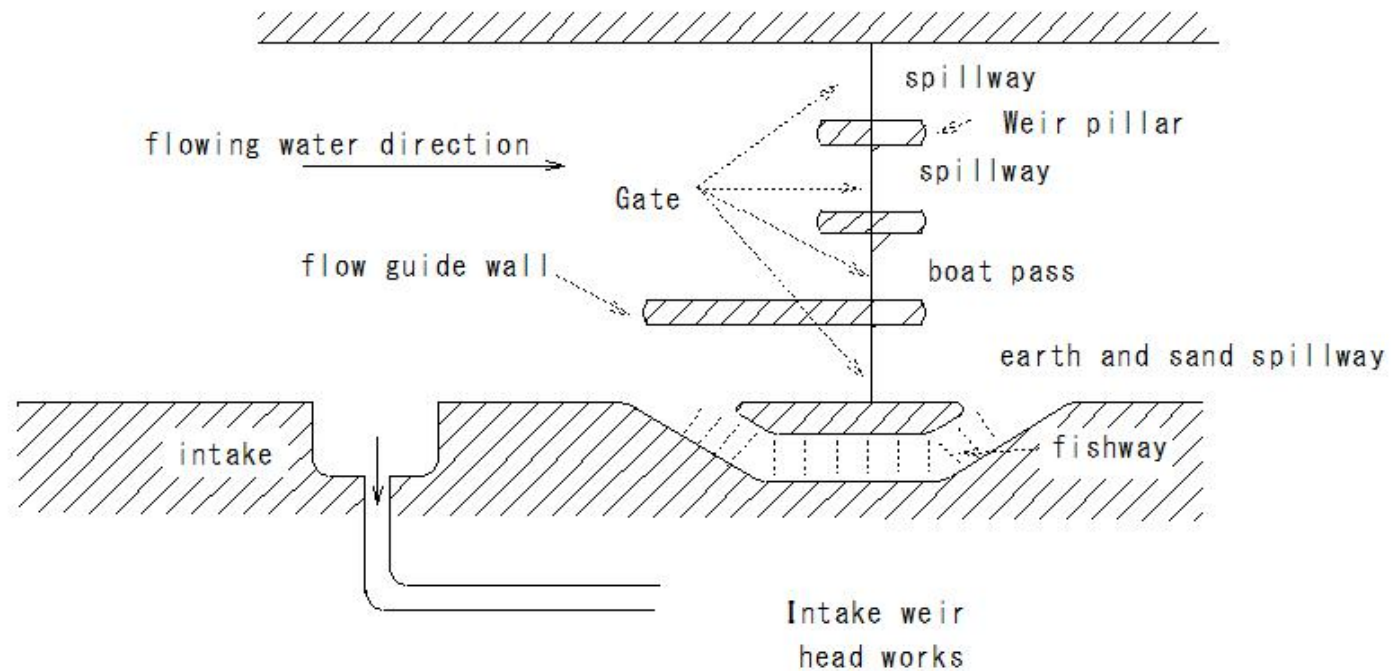


(R566)head works

(R566) head works

Headworker

Rivers, lakes and marshes
intake irrigation water into the irrigation canal
dam raising structure



(R567)head works(Intake weir)

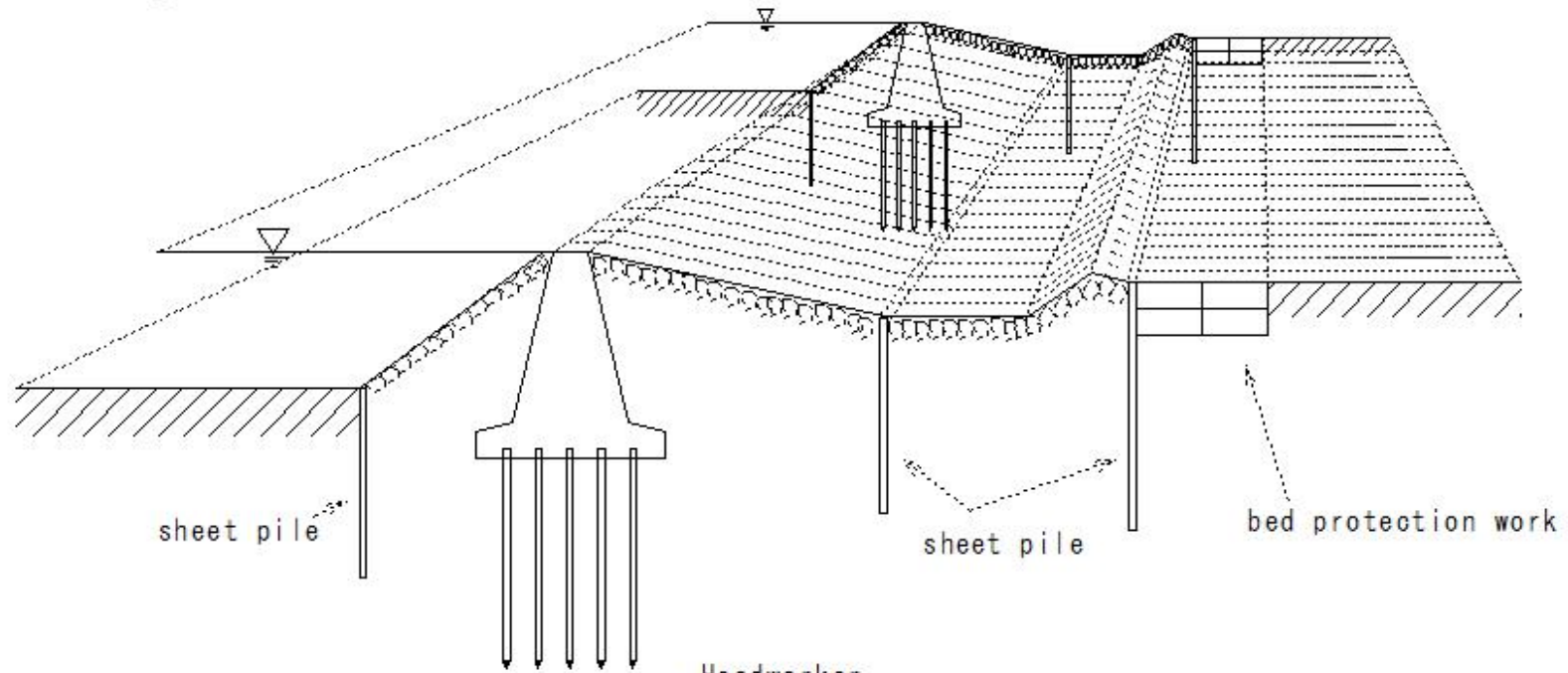
(R567)head works(Intake weir)

Headworker

Rivers, lakes and marshes

intake irrigation water into the irrigation canal

dam raising structure



Headworker
Intake weir

(R568)head works(Intake weir)

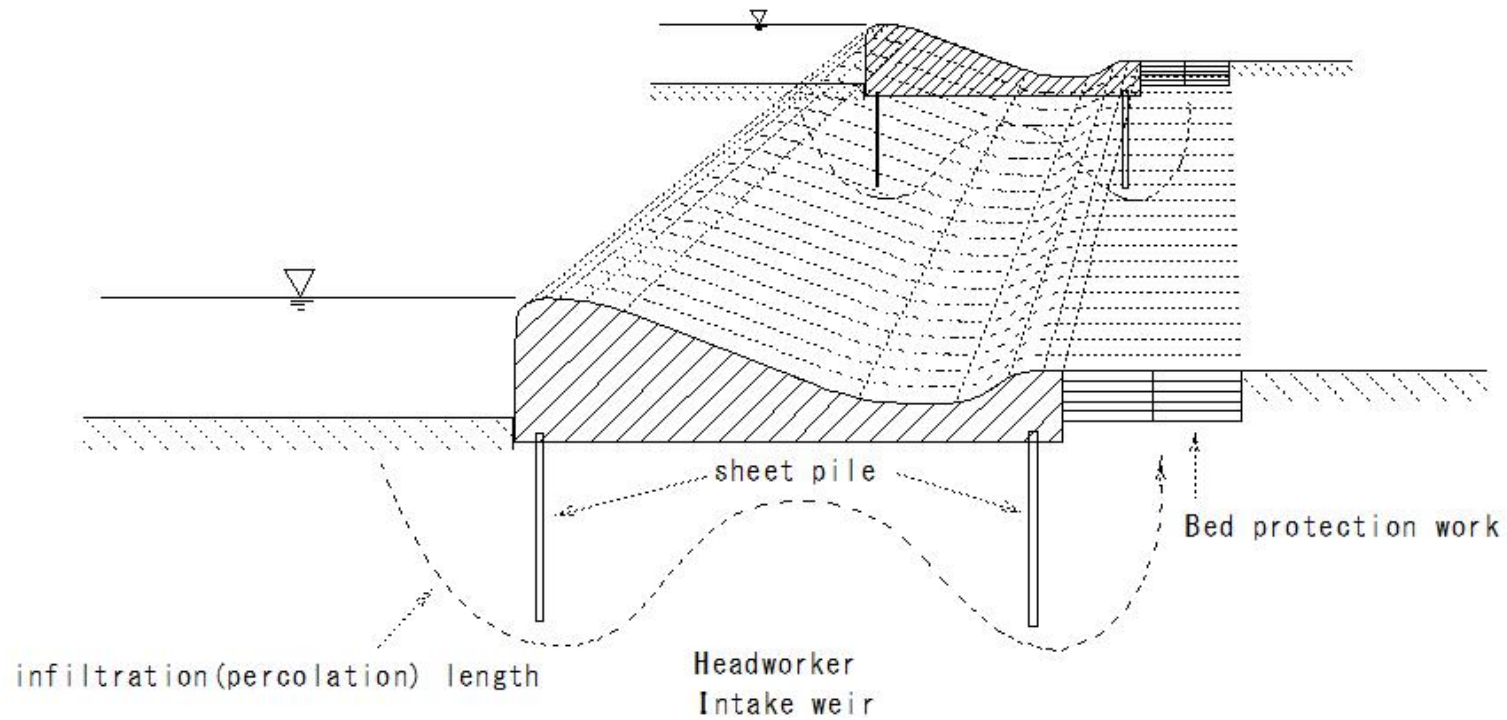
(R568)head works(Intake weir)

Headworker

Rivers, lakes and marshes

intake irrigation water into the irrigation canal

dam raising structure



(R569)ground sill consolidation works

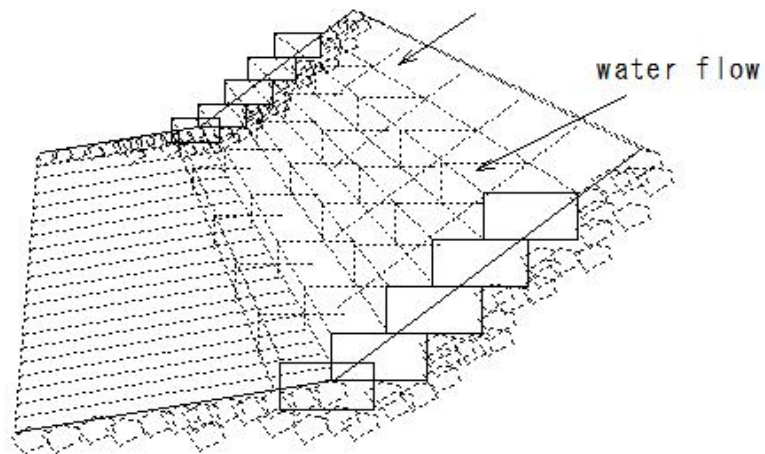
(R569)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

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



ground sill consolidation works

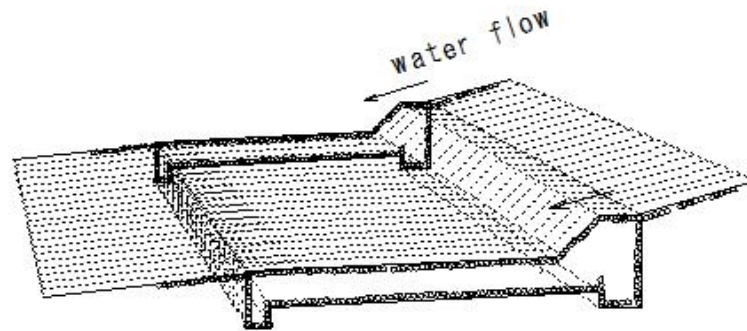
(R570)ground sill consolidation works

(R570)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed
cross the river

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



ground sill consolidation works

(R571)ground sill consolidation works

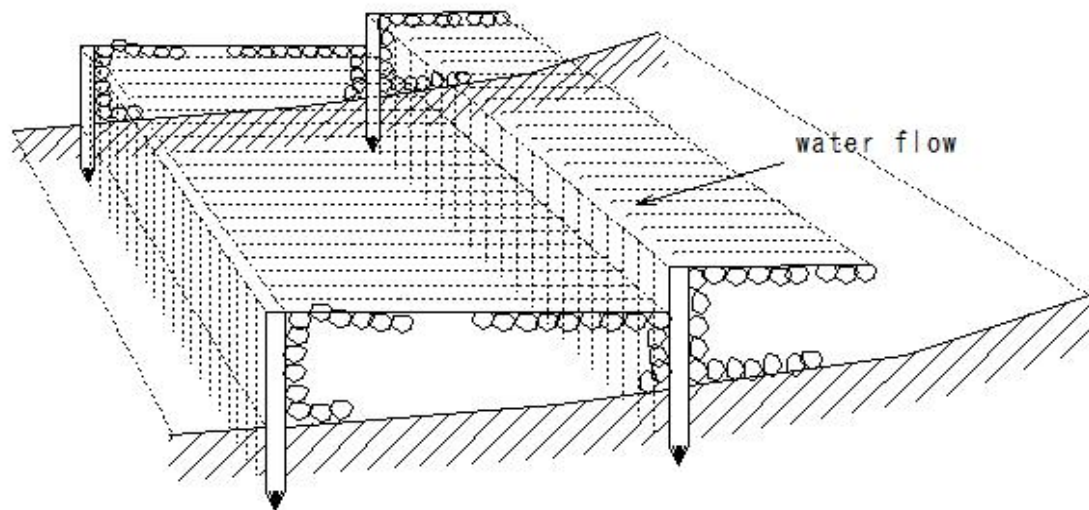
(R571)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

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



ground sill consolidation works

(R572)ground sill consolidation works

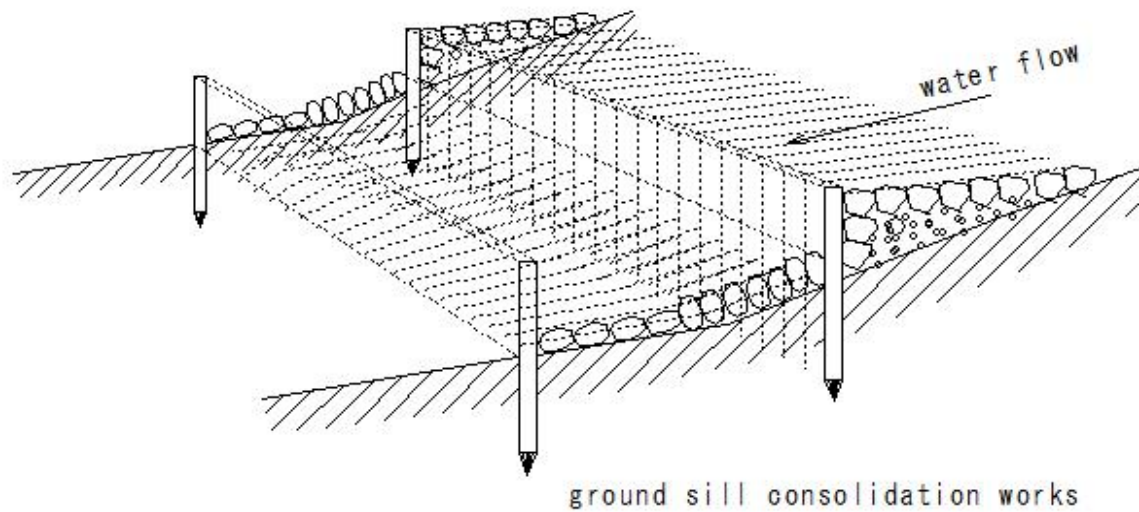
(R572)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

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



(R573)ground sill consolidation works

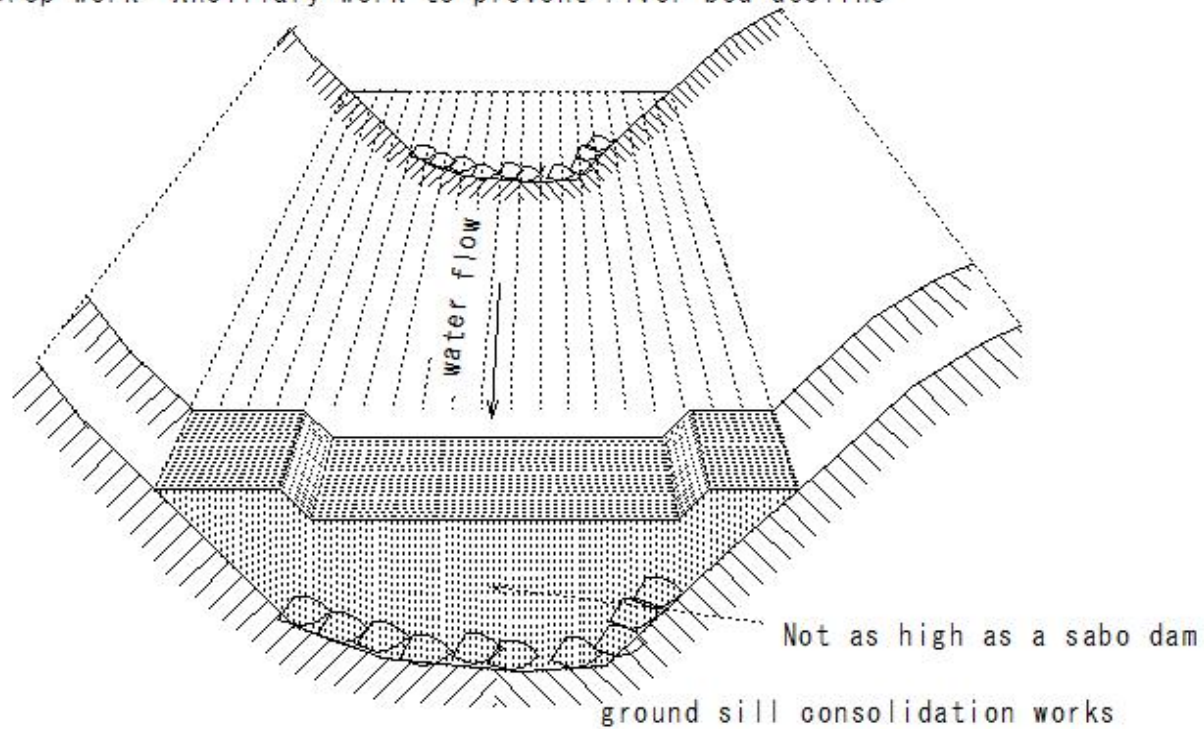
(R573)ground sill consolidation works

ground sill consolidation works

Stabilizes riverbeds and major bed

cross the river

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



(R574)soil stabilization

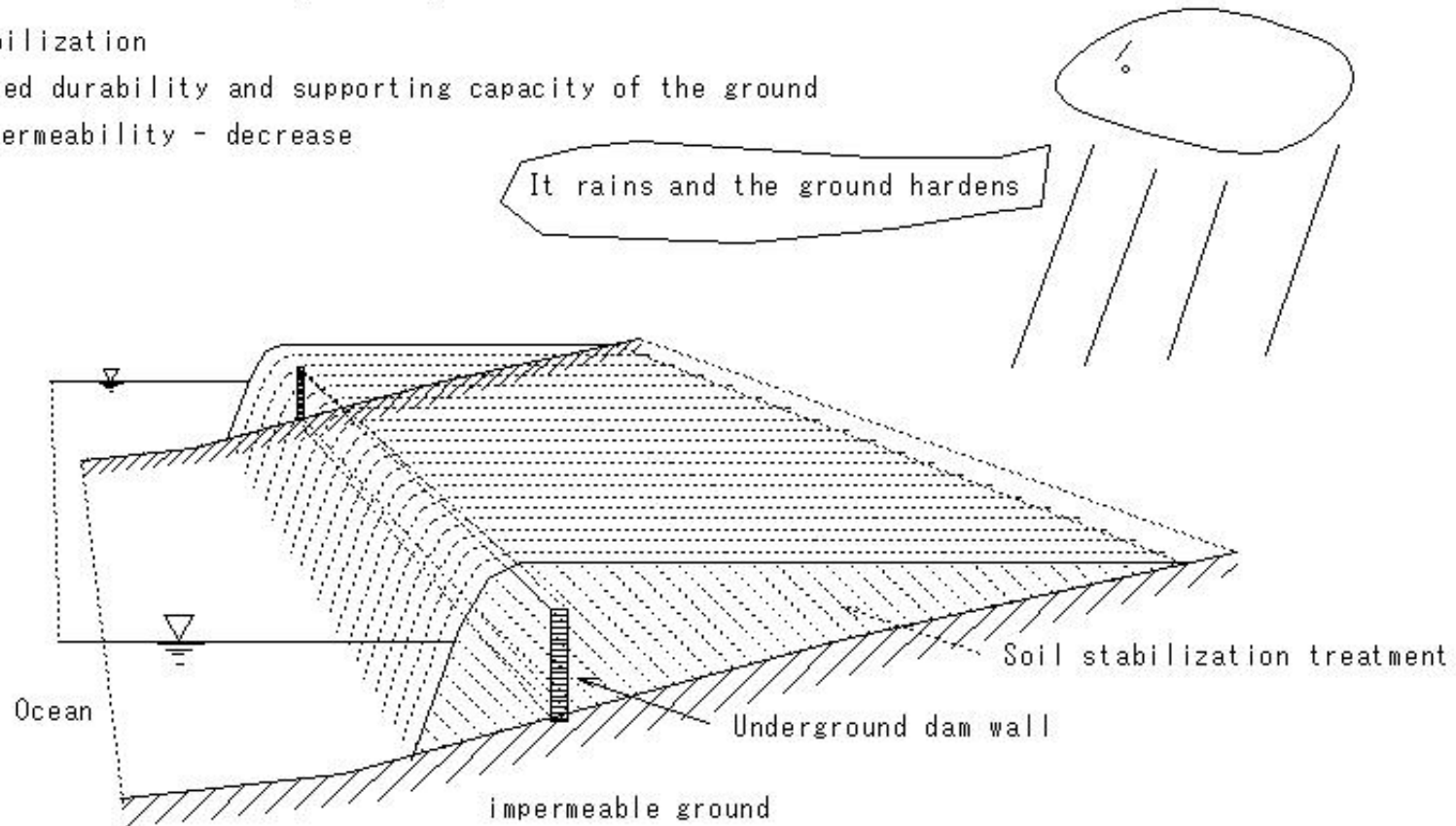
(R574)soil stabilization

soil stabilization

Increased durability and supporting capacity of the ground

Water permeability - decrease

It rains and the ground hardens

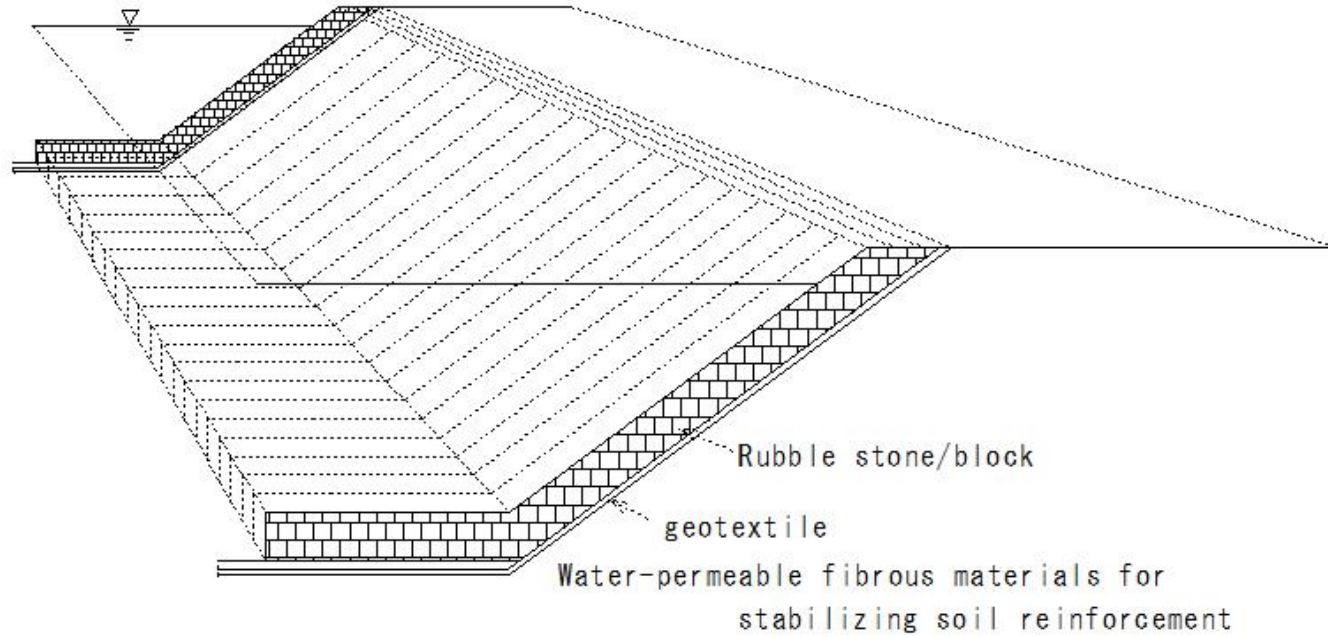


(R575)soil stabilization

(R575) soil stabilization

Soil stabilization treatment

Preventing soil and sand from being sucked out



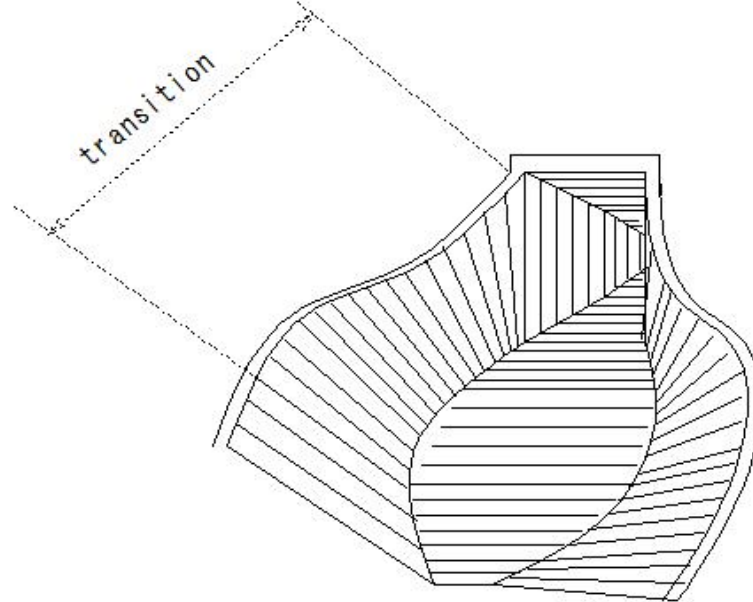
(R576)transition

(R576) transition

transition

Attachment part that connects two water channels

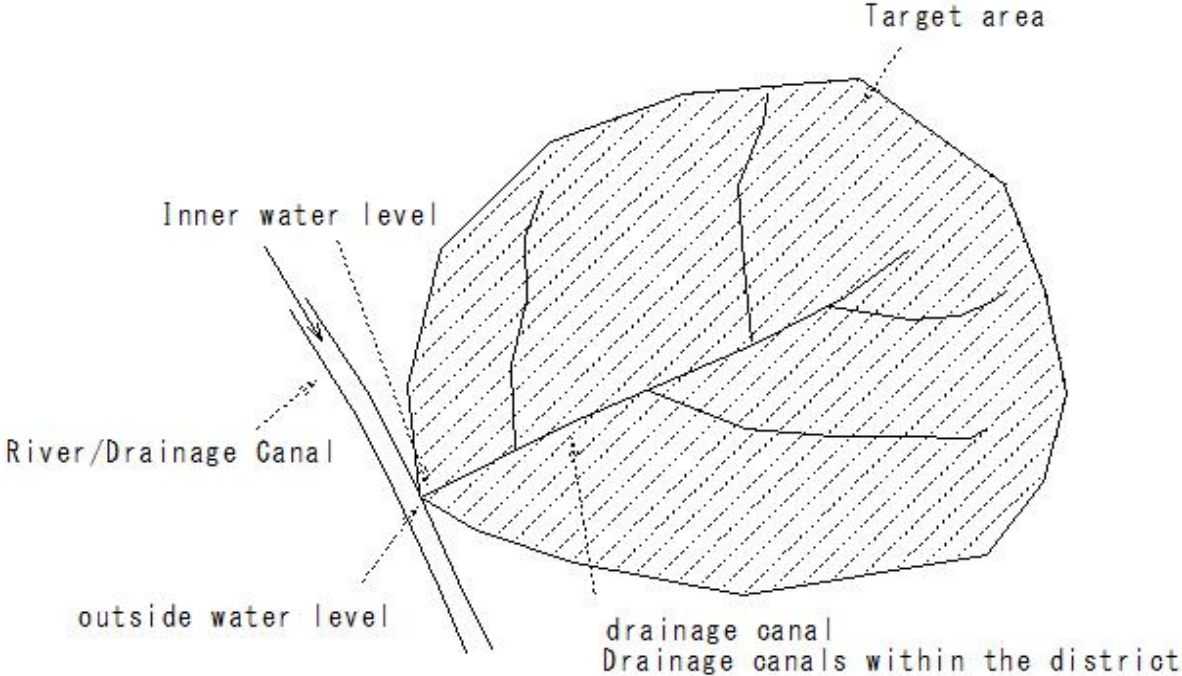
- Gradual change in shape and dimensions
- Less water head loss
- Flow water safely and smoothly



(R577)inside water level

(R577) inside water level

inside water level
Drainage canals within the district
Deciding on natural drainage or mechanical drainage

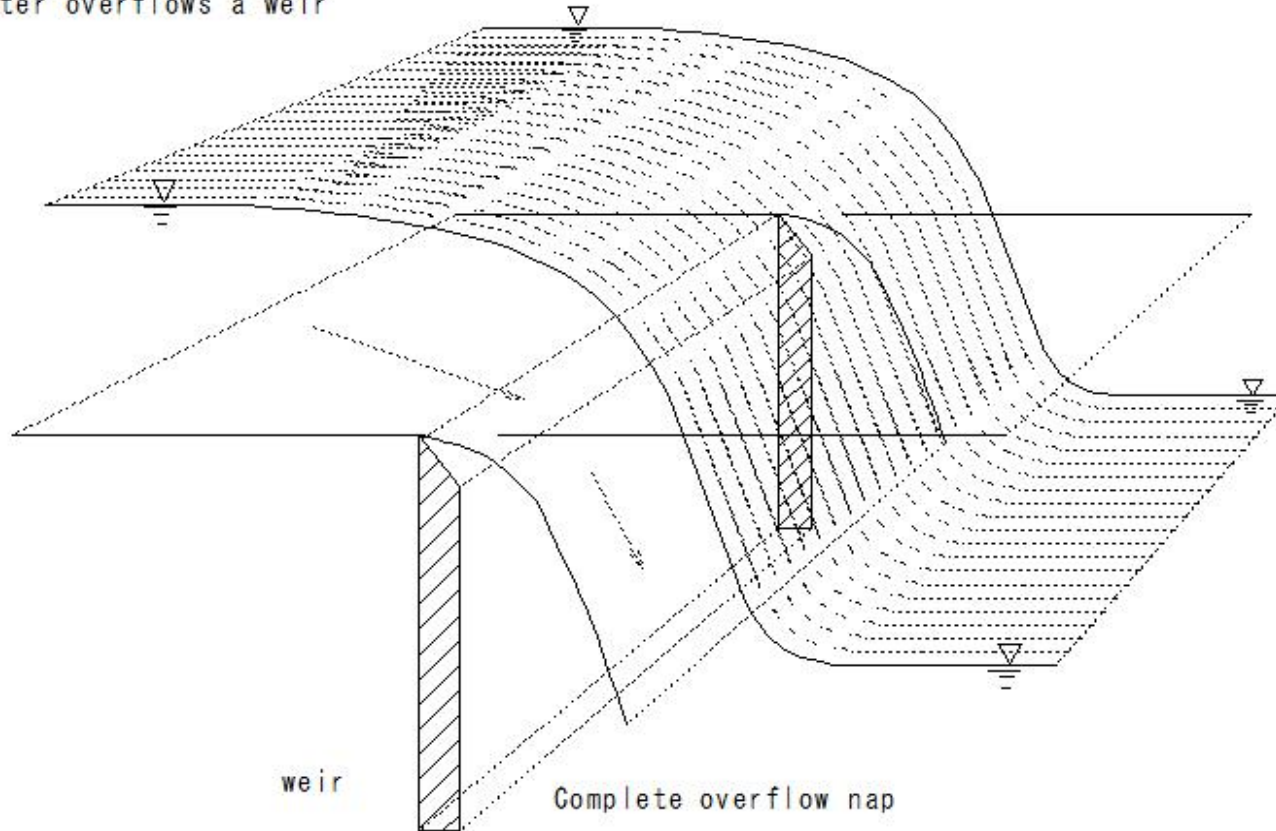


(R578)nappe

(R578) nappe

nappe

water vein -water overflows a weir



weir

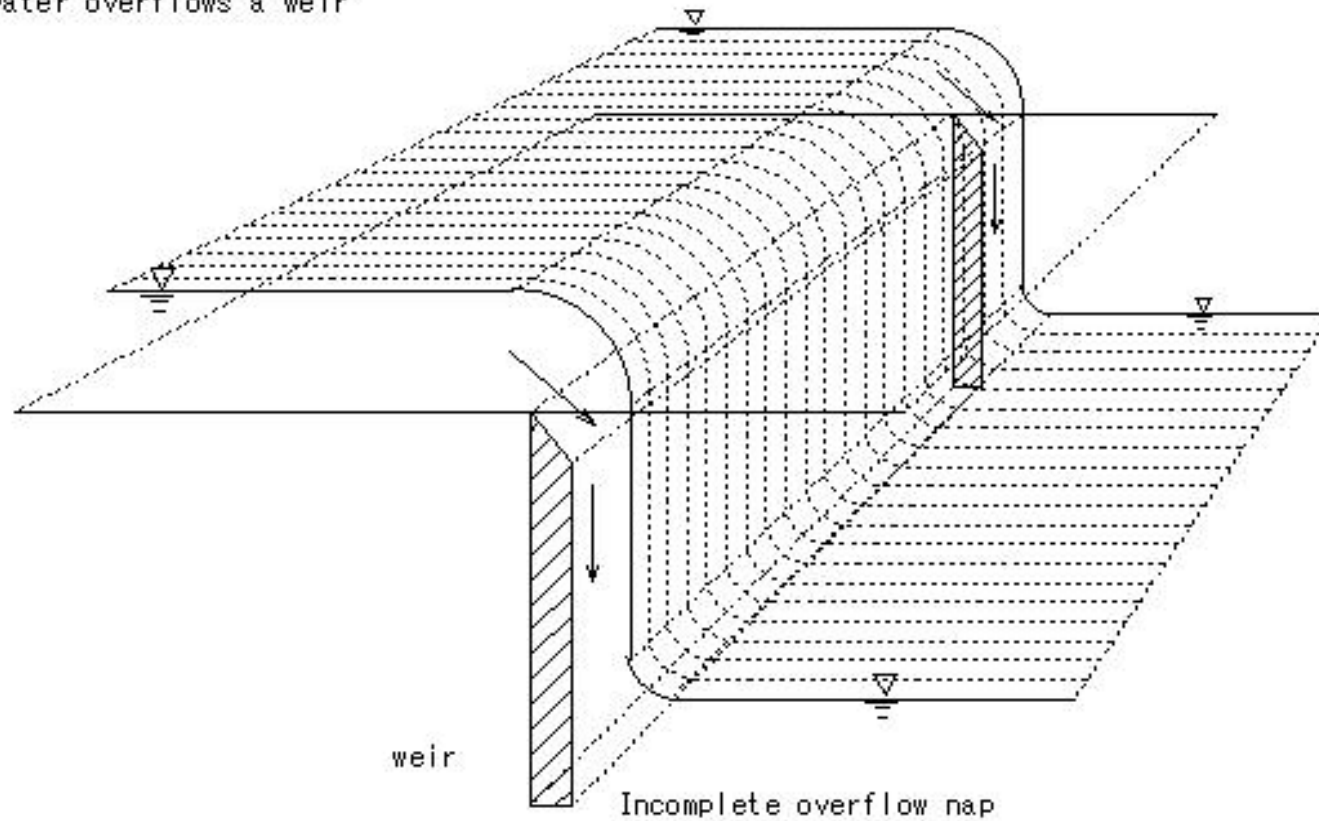
Complete overflow nappe

(R579)nappe

(R579) nappe

nappe

water vein -water overflows a weir



(R580)slope crib work

(R580)slope crib work

slope crib work

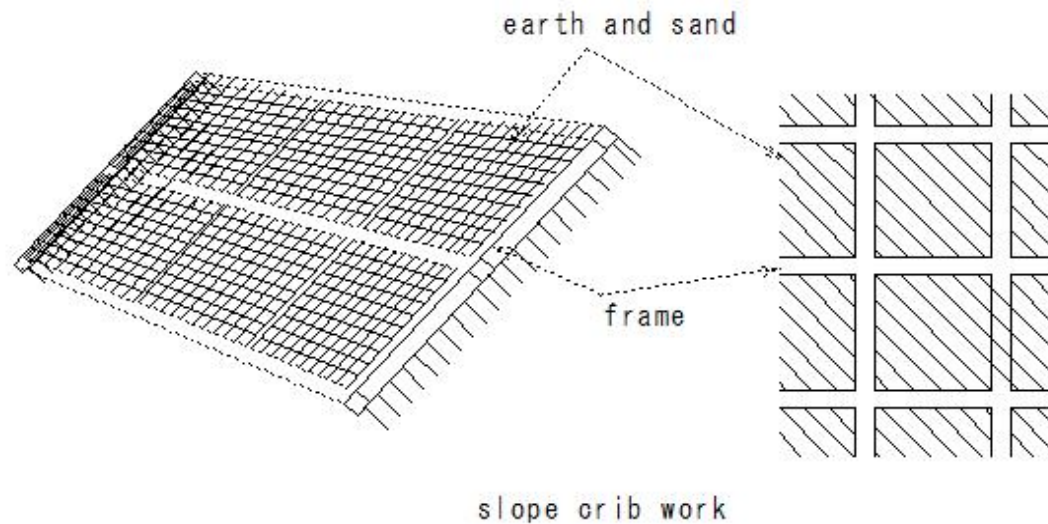
Filling material for slope crib work (earth and sand)

Earth and sand filling work

+Seed spreader

+Vegetation base material spraying work

+Fill earth and sand into the frame

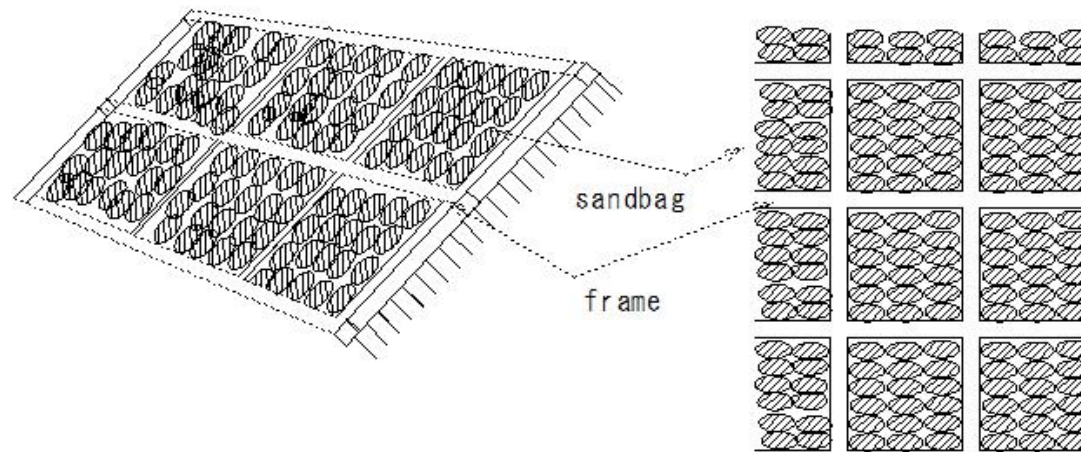


(R581)slope crib work

(R581)slope crib work

slope crib work

Filling material for sandbag construction (vegetation sandbag construction)



slope crib work

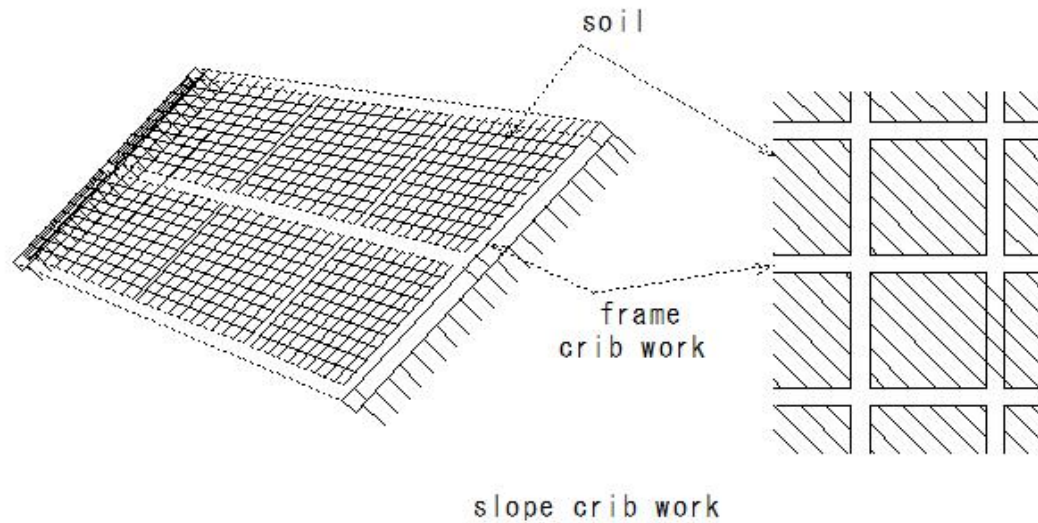
(R582)slope crib work

(R582)slope crib work

slope crib work

Filling material for slope crib work (replacement soil seed spraying work)

Spray soil mixed with seeds, fertilizer, etc. into the frame to a depth of about 1 to 3 cm.



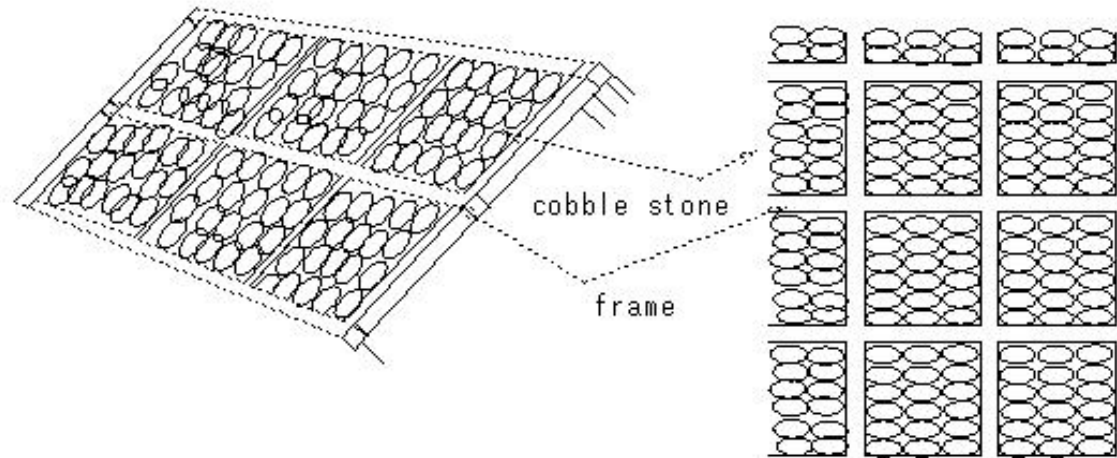
(R583)slope crib work

(R583)slope crib work

slope crib work

Filling material for slope crib work (stone masonry work)

A method of filling the frame with cobble stone, etc.



slope crib work

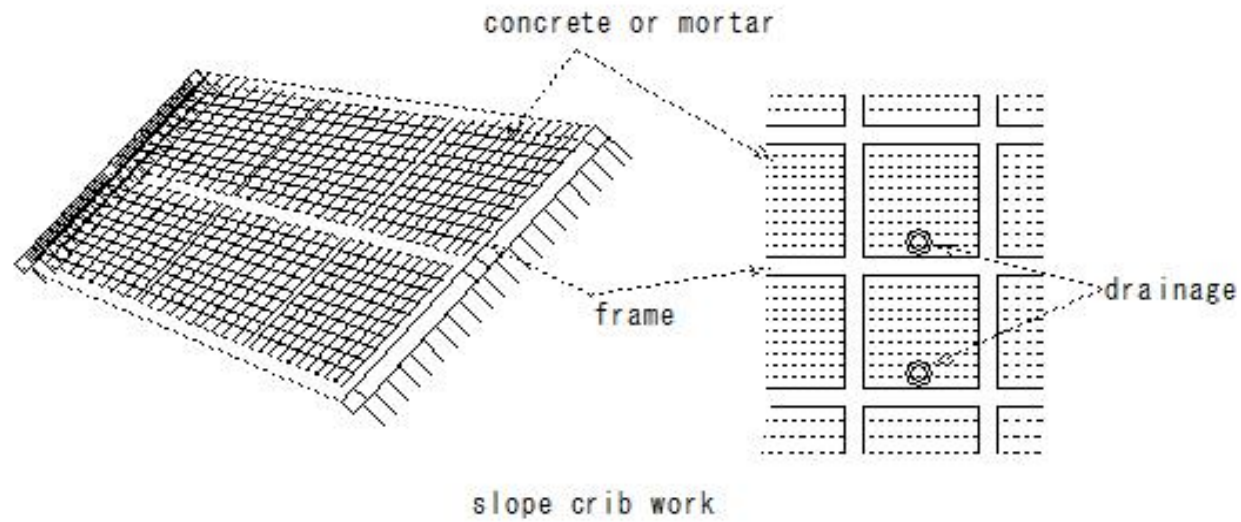
(R584)slope crib work

(R584)slope crib work

slope crib work

Filling material (concrete) for slope crib work

Place cast-in-place concrete within the frame



(R585)hydrograph

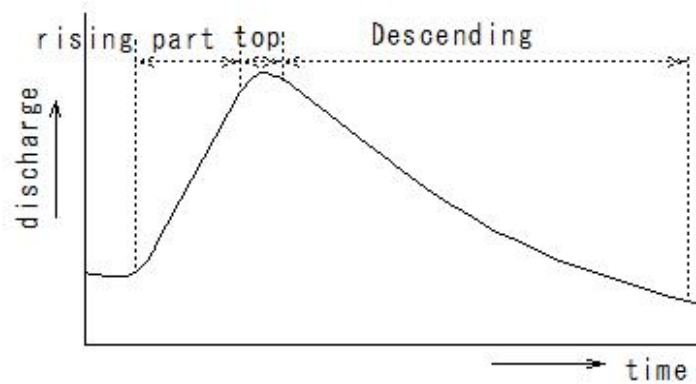
(R585) hydrograph

hydrograph

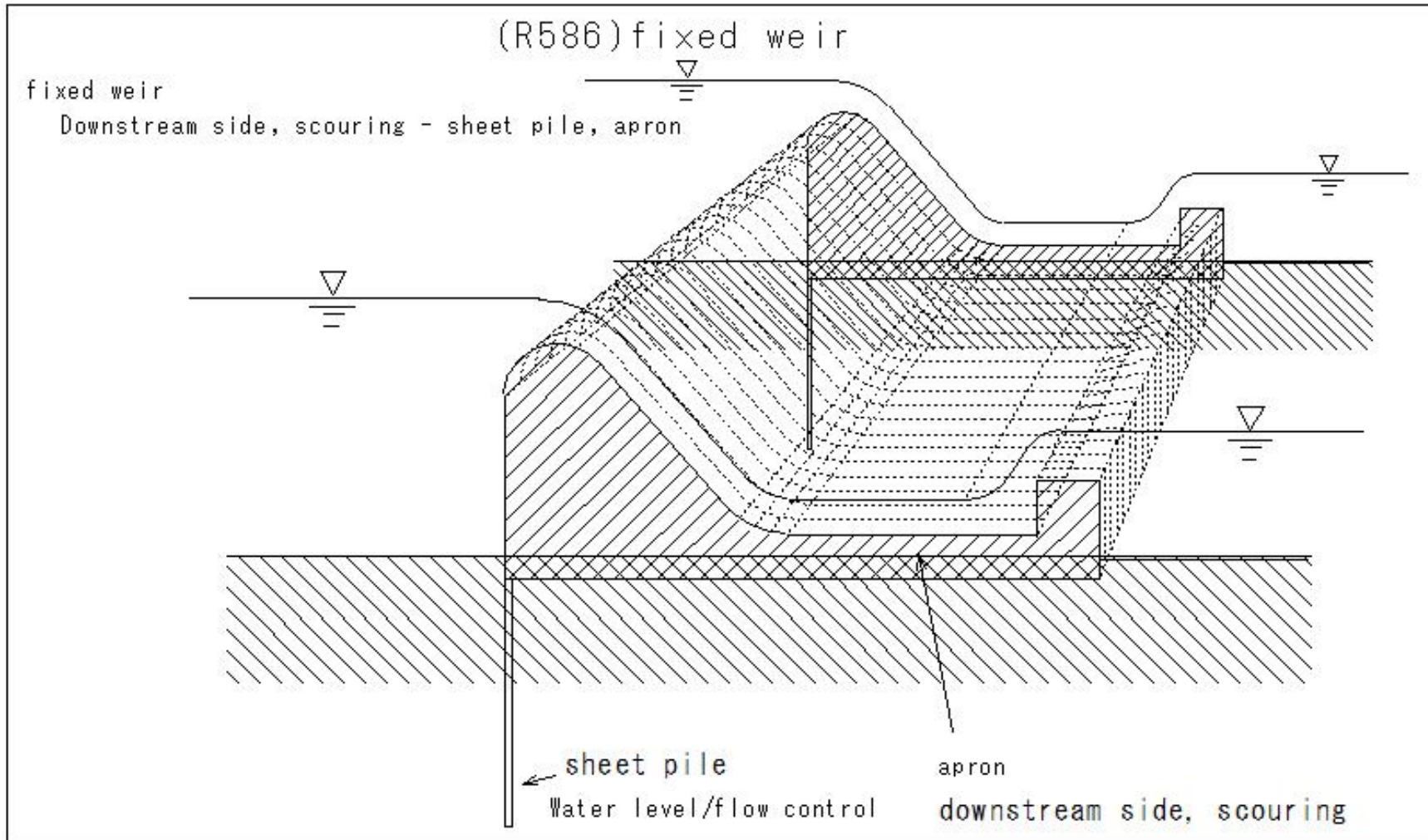
Curve diagram showing water level and discharge over time

water level or discharge

discharge changes over time



(R586)fixed weir



(R587) surface runoff

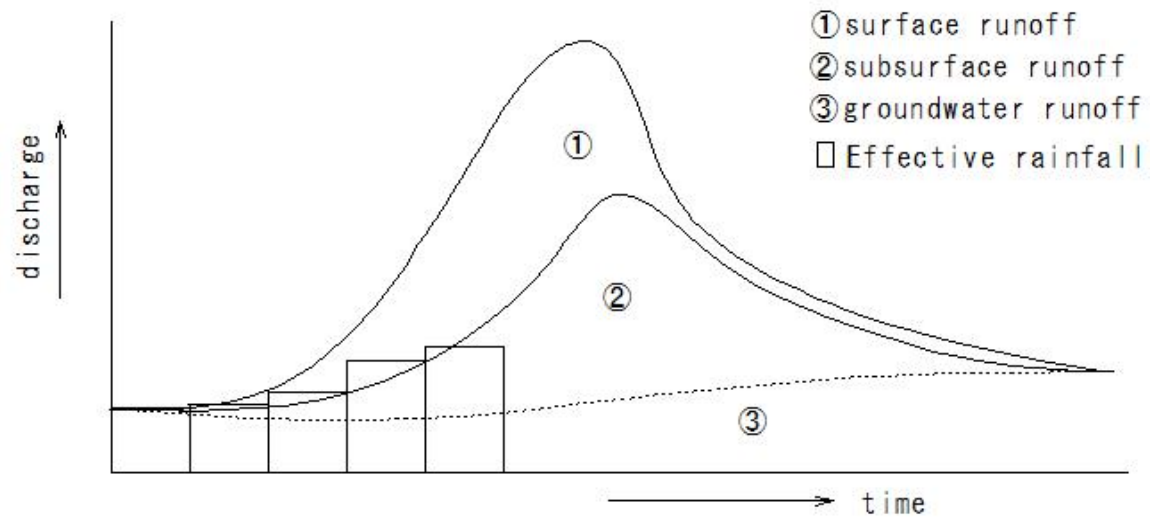
(R587) surface runoff

surface runoff

Runoff components (surface runoff, subsurface runoff, groundwater runoff)

Rainwater that reaches the ground surface flows down the ground surface

Components that enter the river channel and flow out

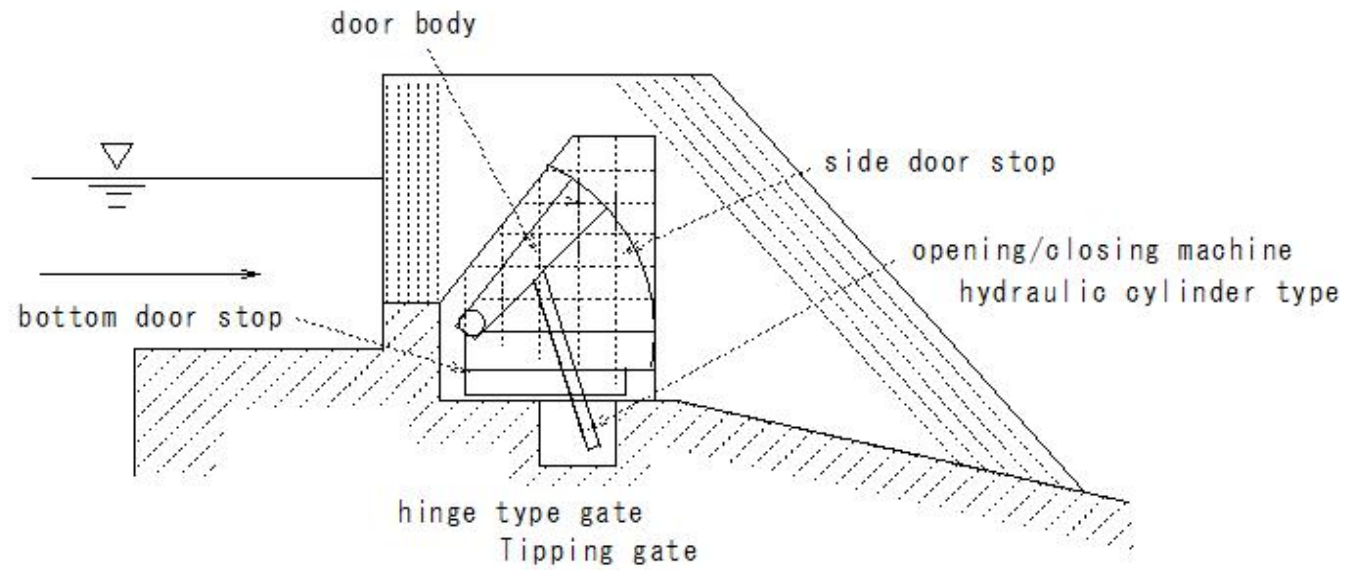


(R588)hinge type gate

(R588)hinge type gate

hinge type gate

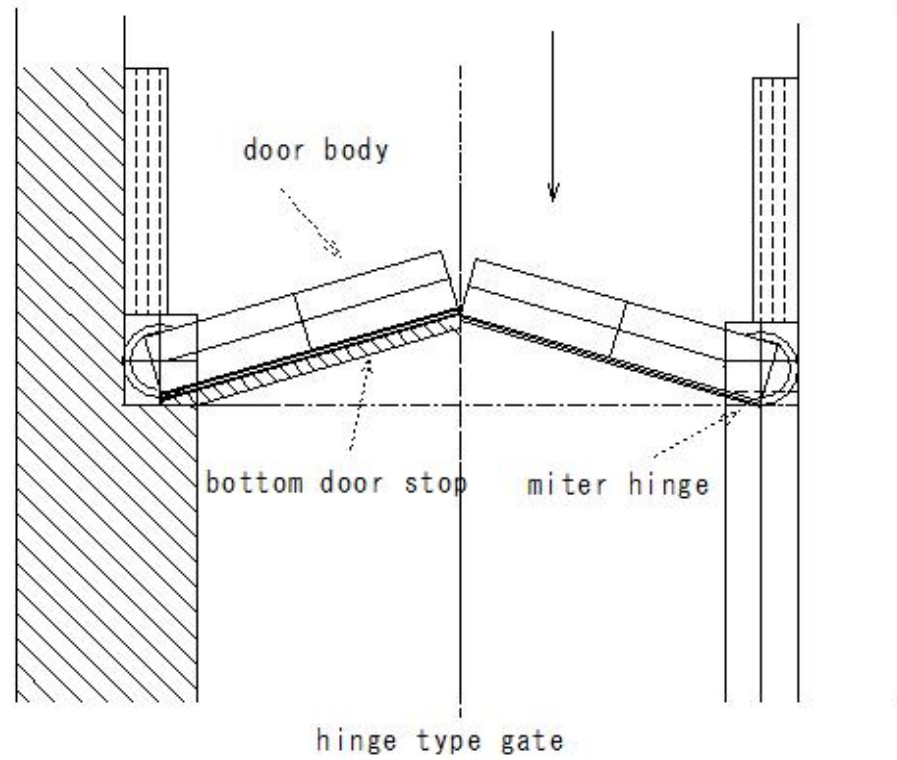
Tipping gate



(R589)miter gate

(R589)miter gate

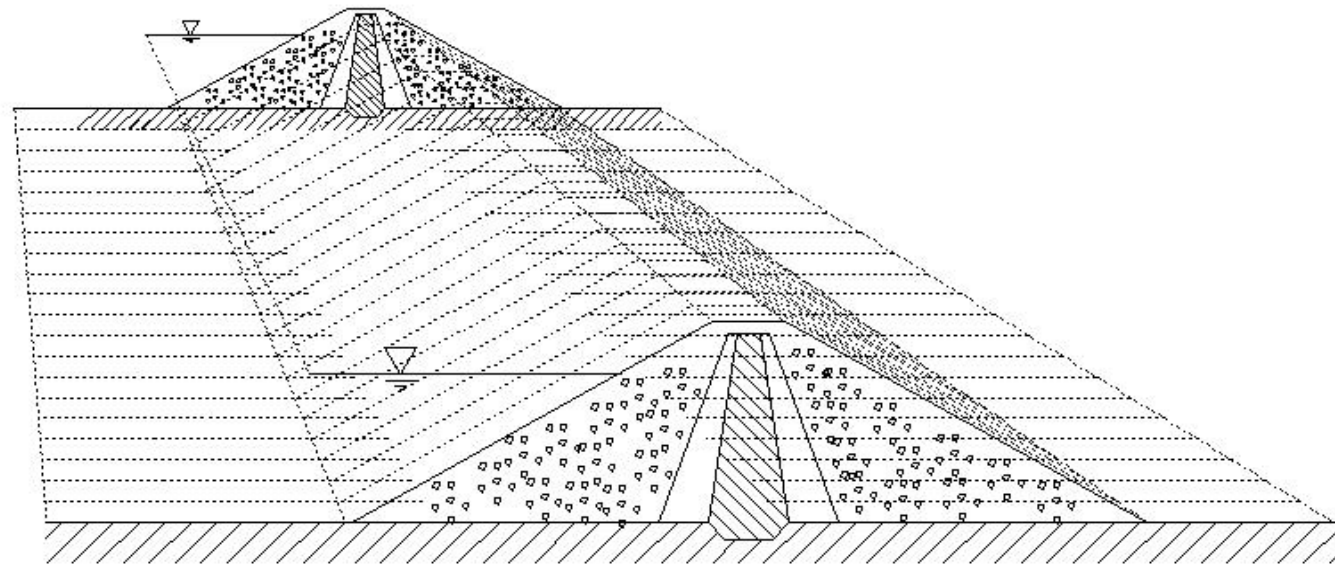
miter gate
hinge type gate



(R590)fill-type dam

(R590)fill-type dam

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



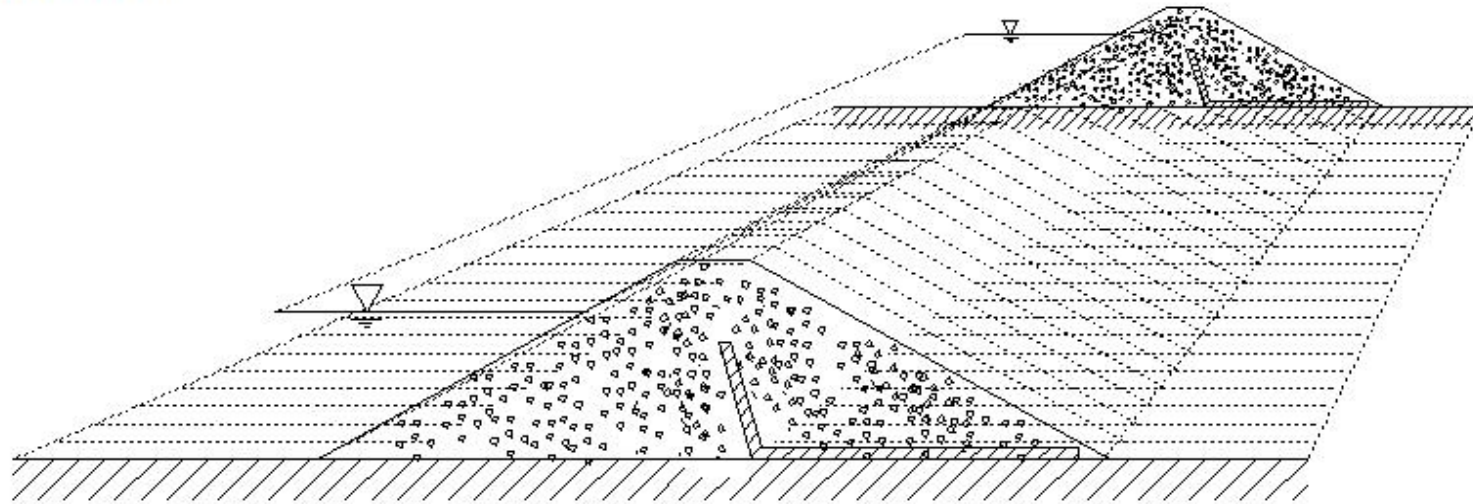
zone type

spillway installed on the ground

(R591)fill-type dam

(R591)fill-type dam

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



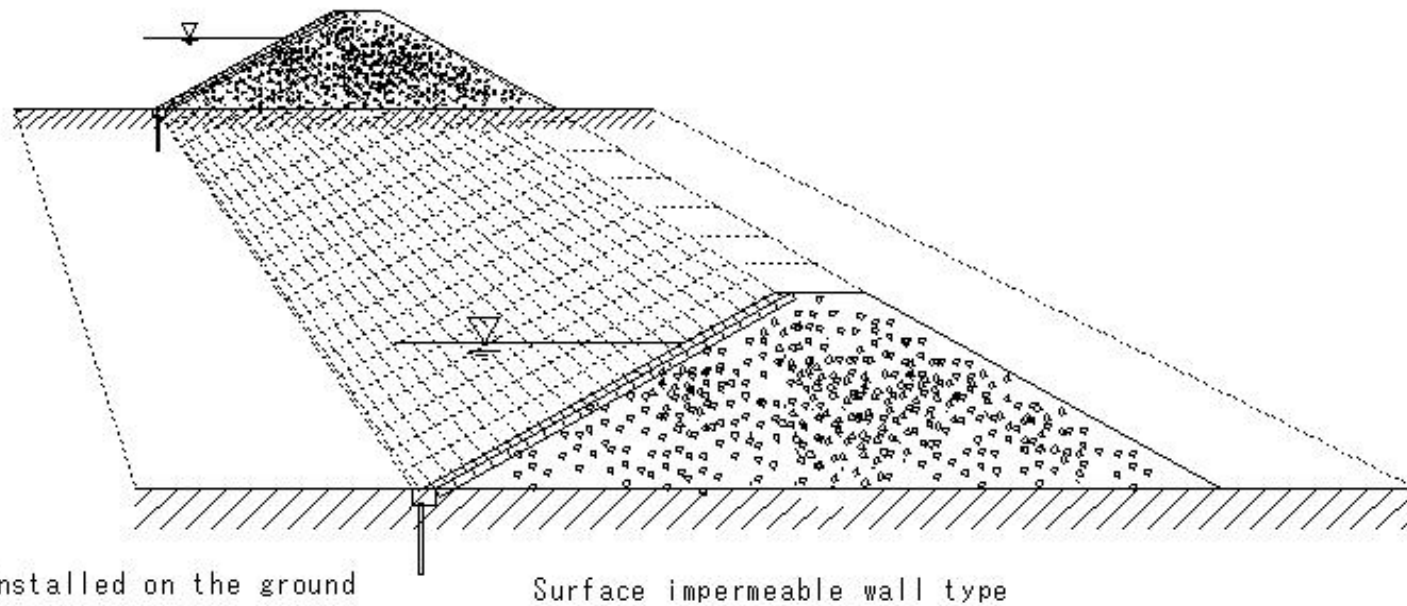
Uniform type

spillway installed on the ground

(R592)fill-type dam

(R592)fill-type dam

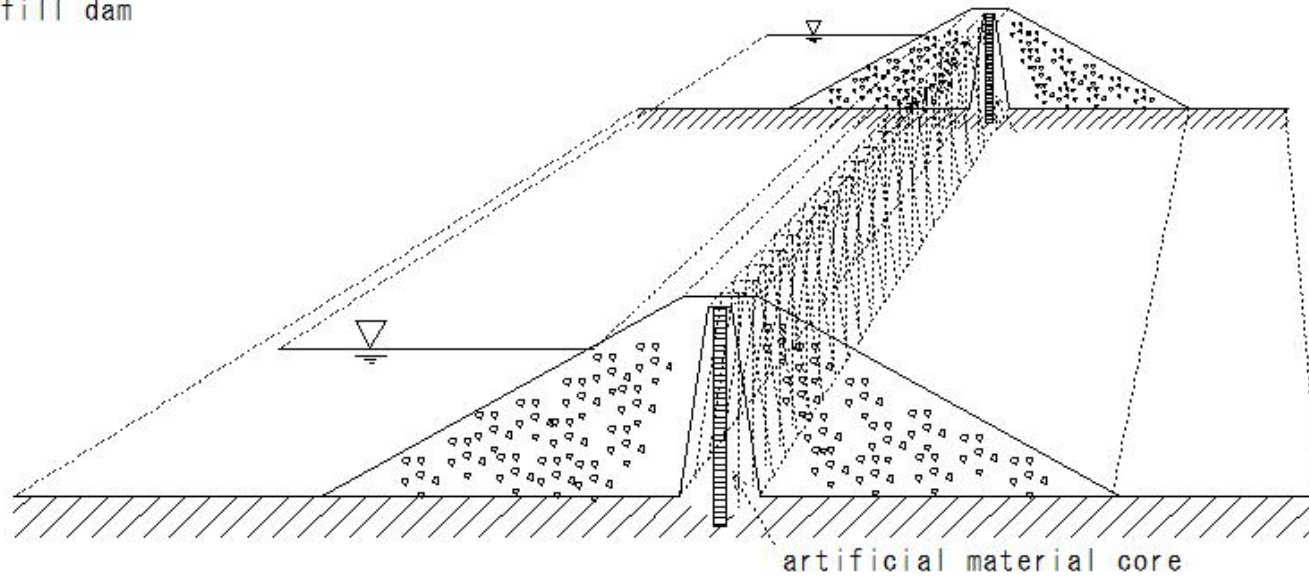
fill-type dam
soil, gravel, rock
Embankment materials
earth dam
rockfill dam



(R593)fill-type dam

(R593) fill-type dam

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



spillway installed on the ground

Core type

(R594)retarding basin(flood storage basin)

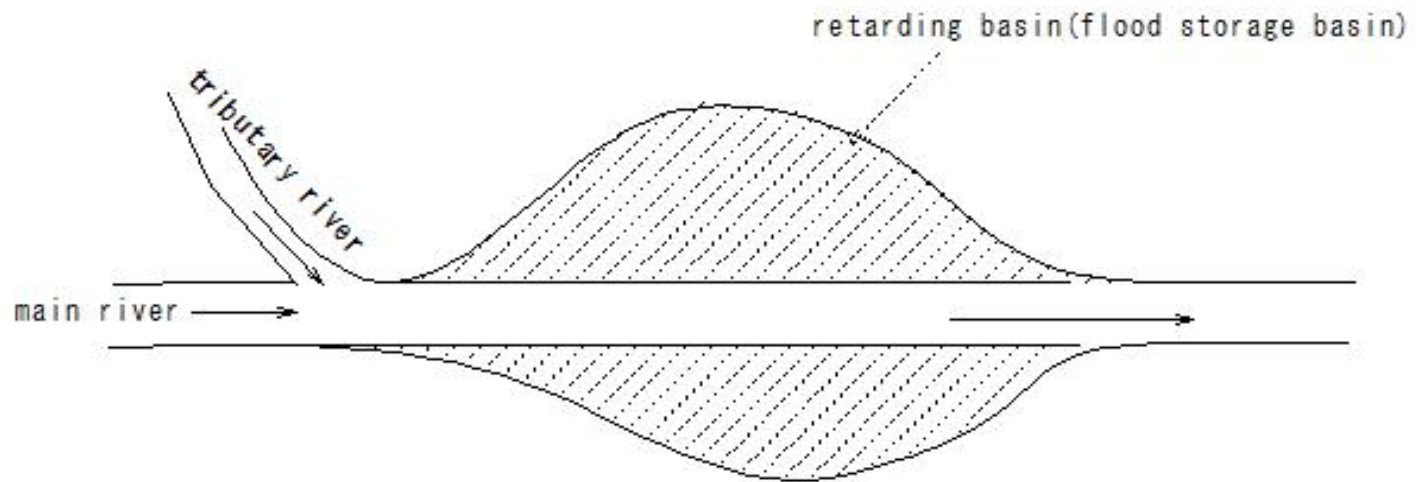
(R594)retarding basin(flood storage basin)

retarding basin(flood storage basin)

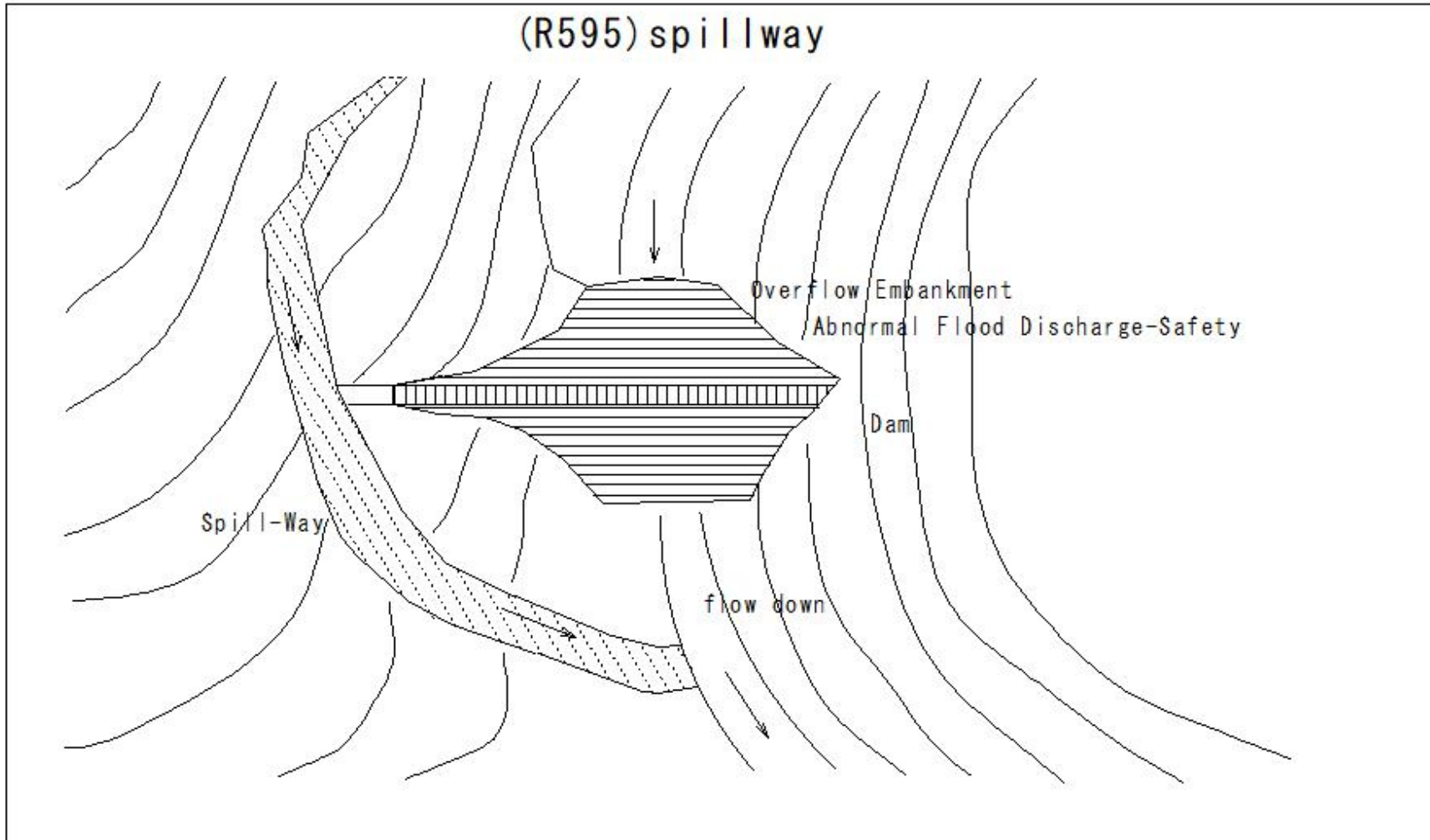
Reservoir pond

Temporary storage of flood water

Reduce peak discharge



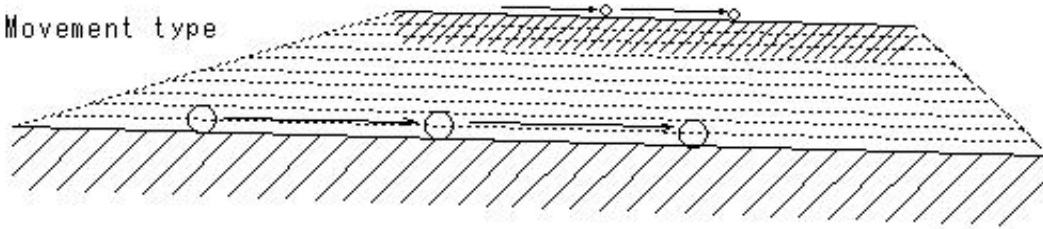
(R595)spillway



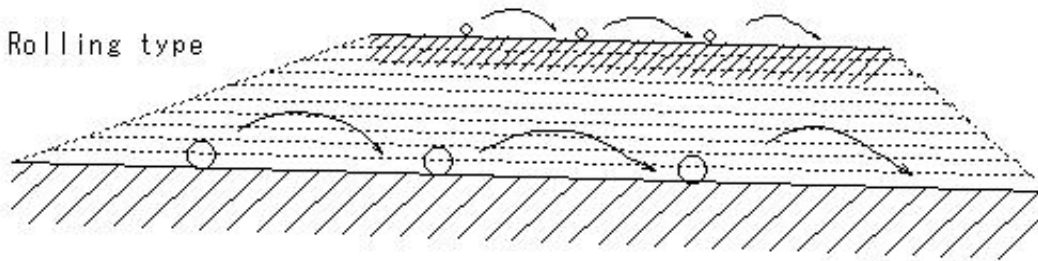
(R596)sediment(sediment load)

(R596)sediment(sediment load)

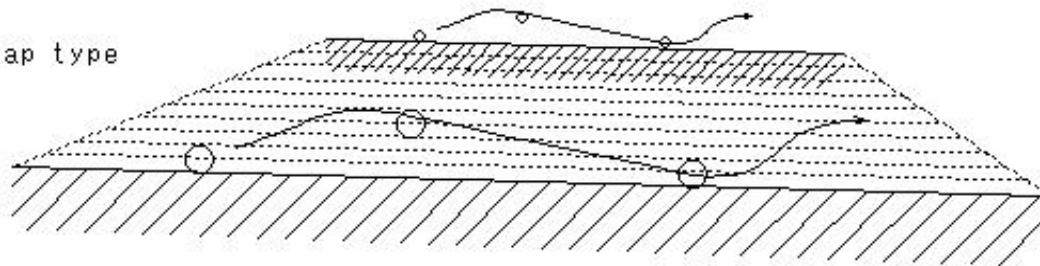
Movement type



Rolling type

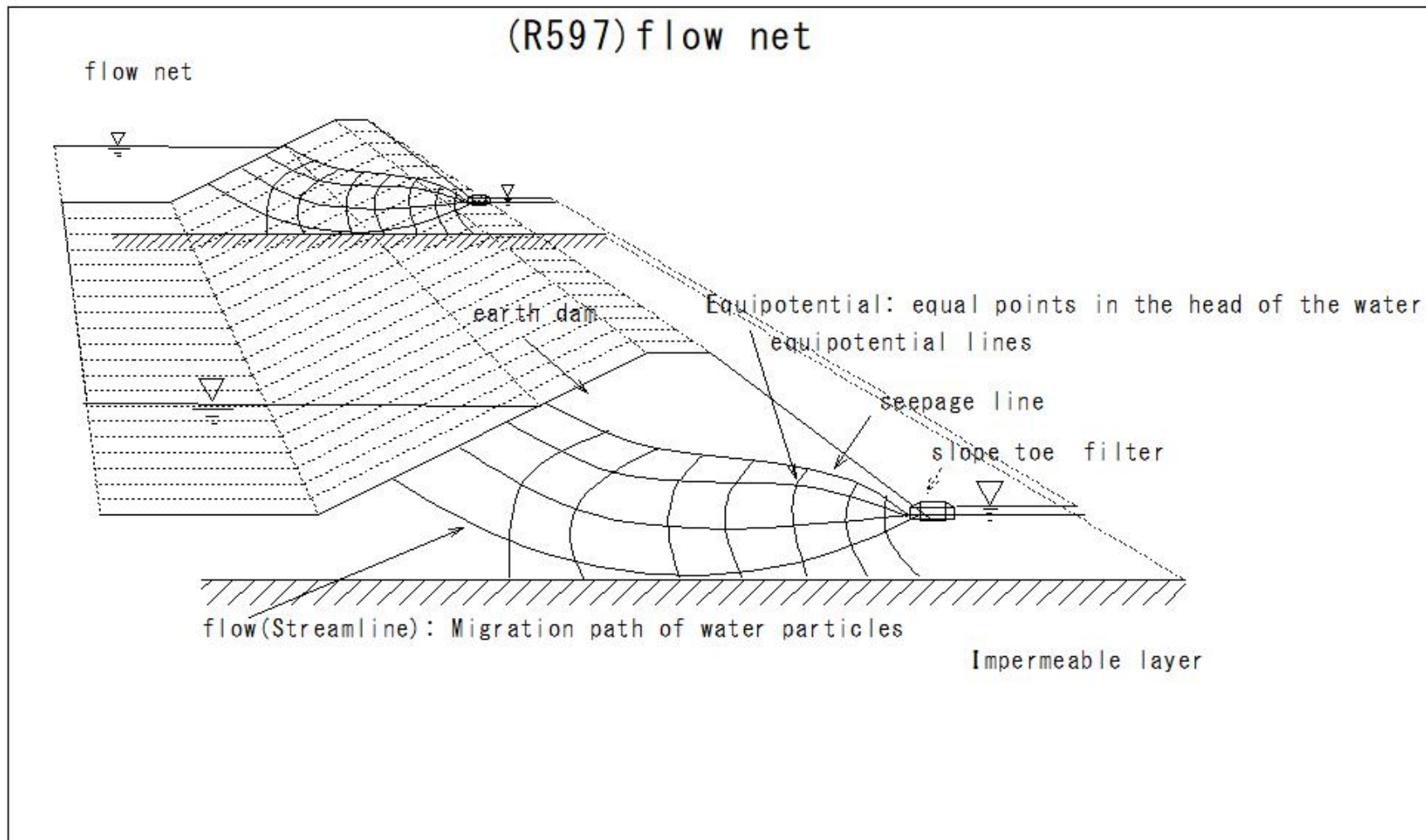


Leap type

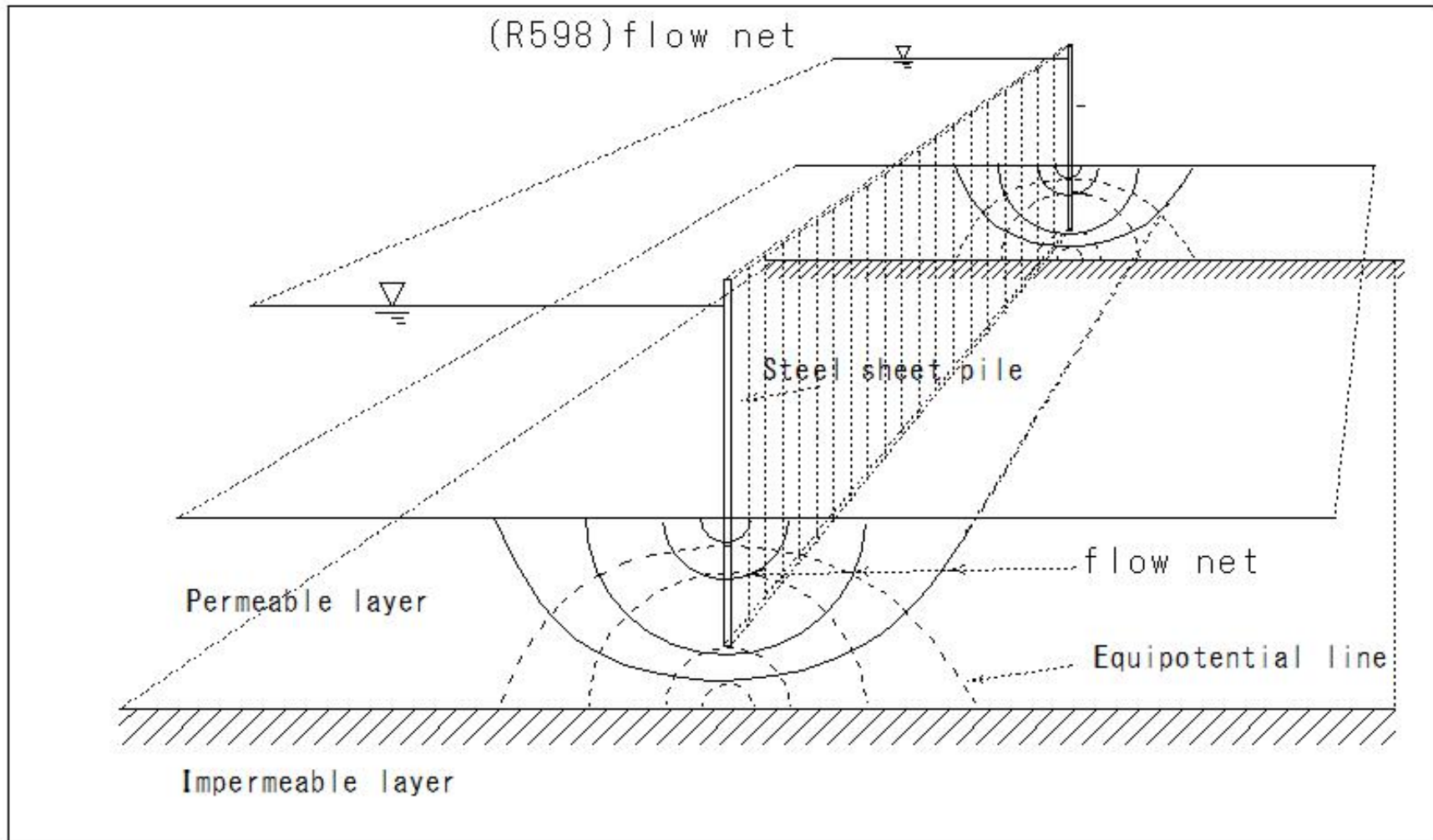


Flowing sand River bed

(R597)flow net

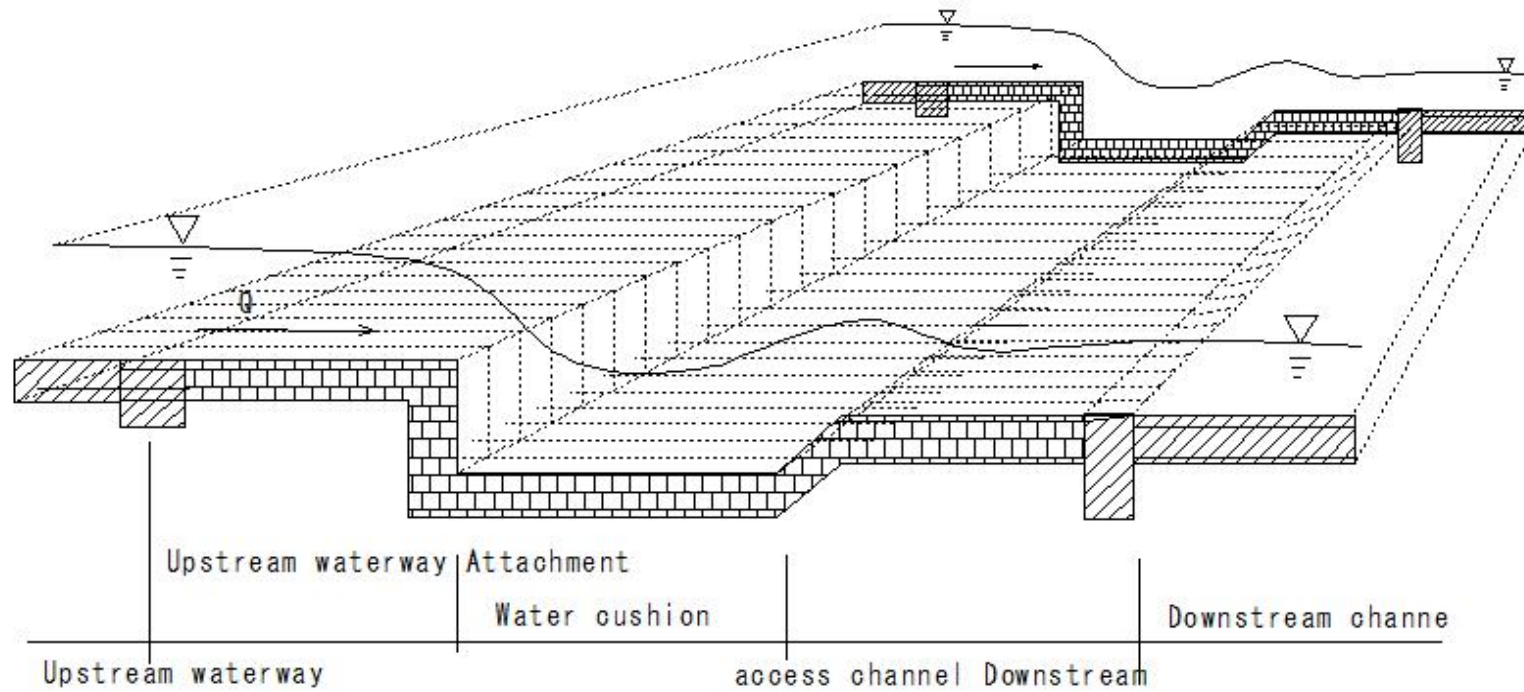


(R598)flow net



(R599)head-fall-drop

(R599) head-fall-drop

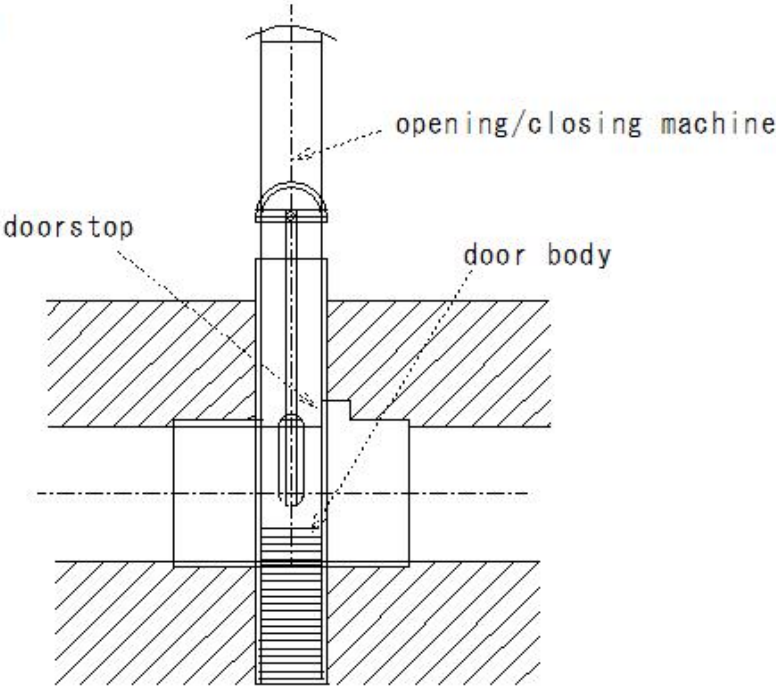


Water cushion Downstream access channel Downstream channel

(R600)fixed wheel gate(roller gate)

(R600)fixed wheel gate(roller gate)

fixed wheel gate(roller gate)



ring seal gate(roller gate)

(R601)River (grade)

(R601)River (grade)

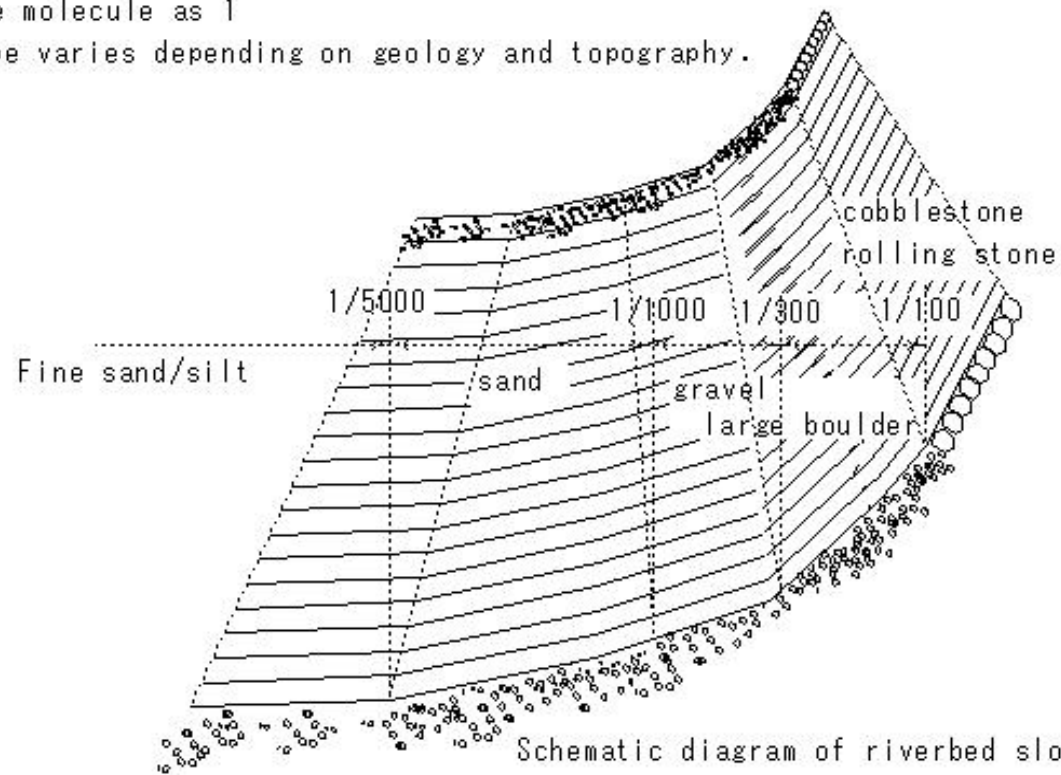
River (grade)

Ratio of process difference between upper and lower 2 points

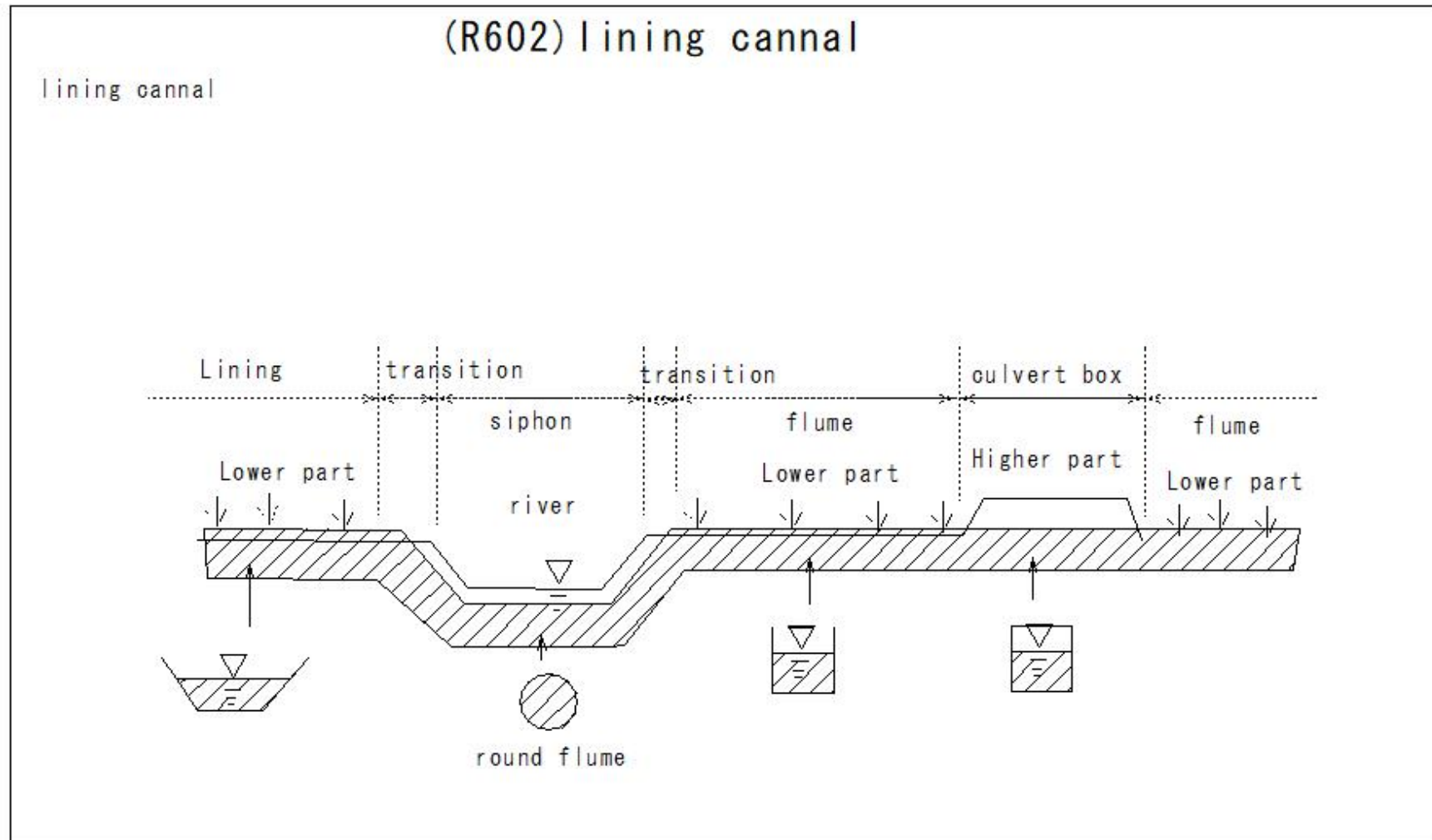
River longitudinal gradient

Represent the molecule as 1

Vertical slope varies depending on geology and topography.



(R602)lining cannal



(R603)loading bank

(R603) loading bank

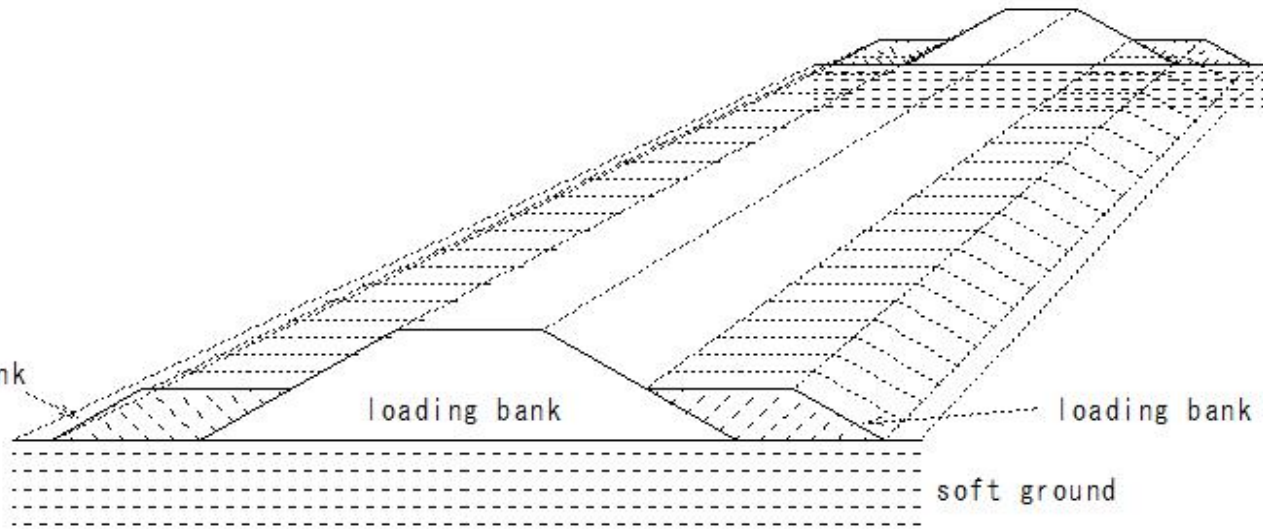
loading bank

loading bank

loading bank

loading bank

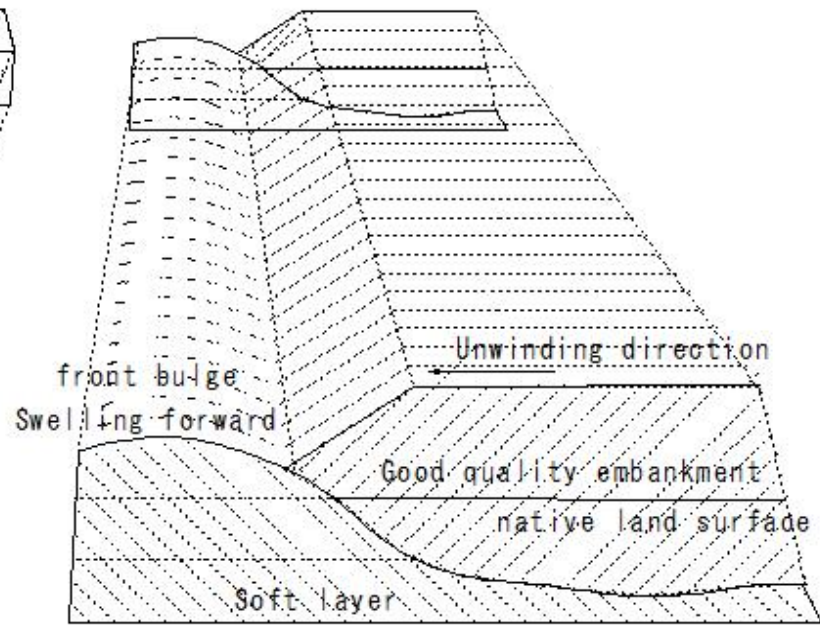
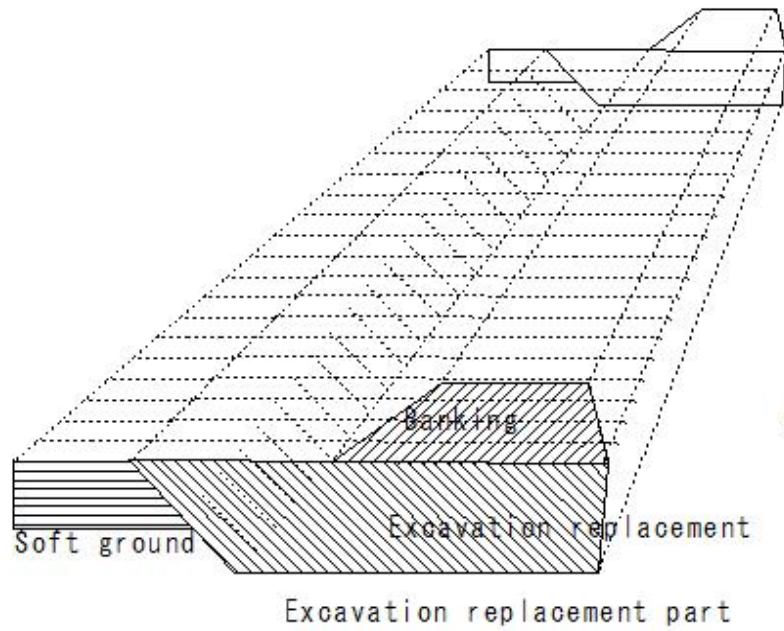
soft ground



(R604)displacement methodr

(R604) displacement method

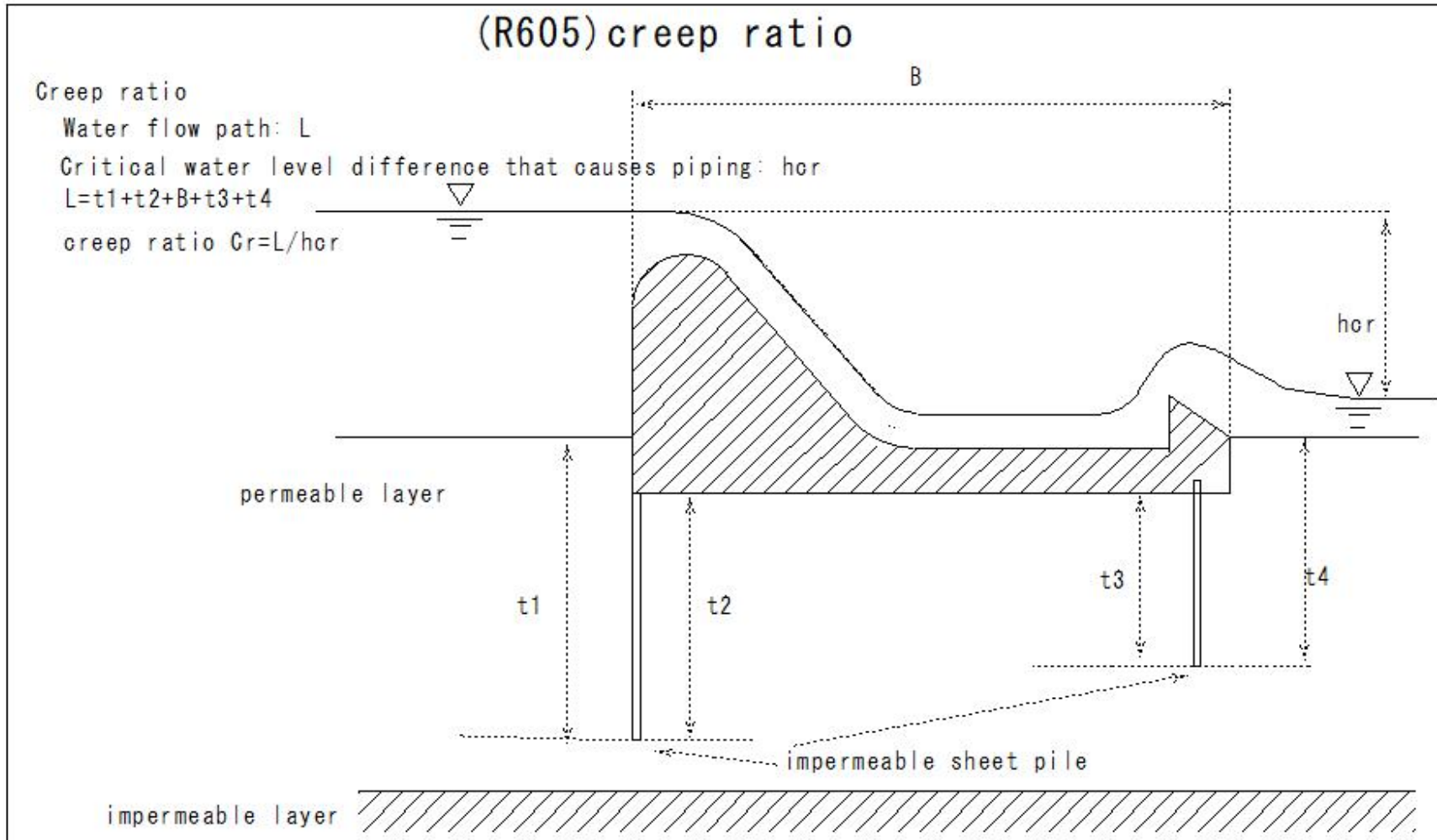
displacement method



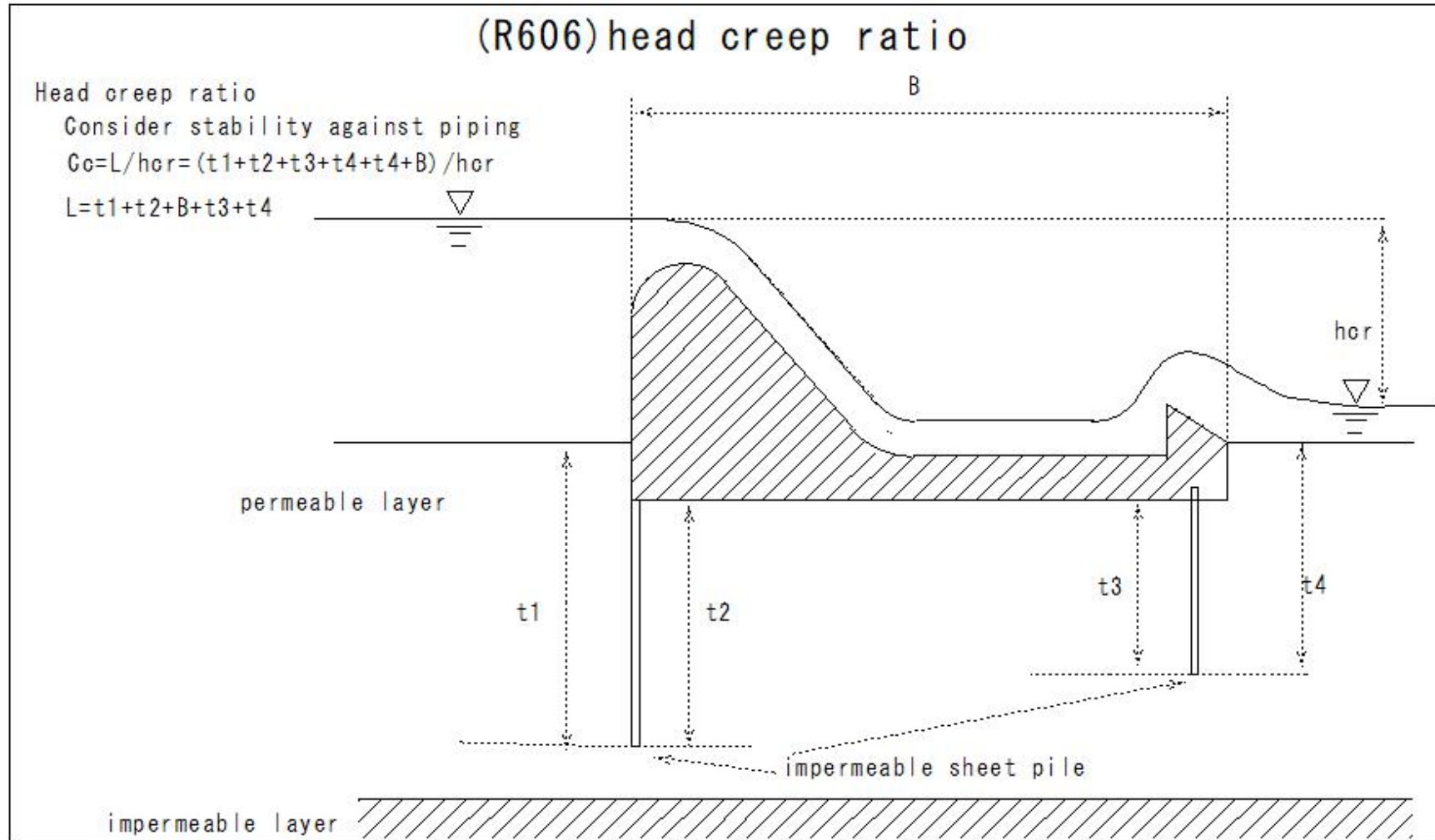
displacement method

E473

(R605)creep ratio



(R606)head creep ratio

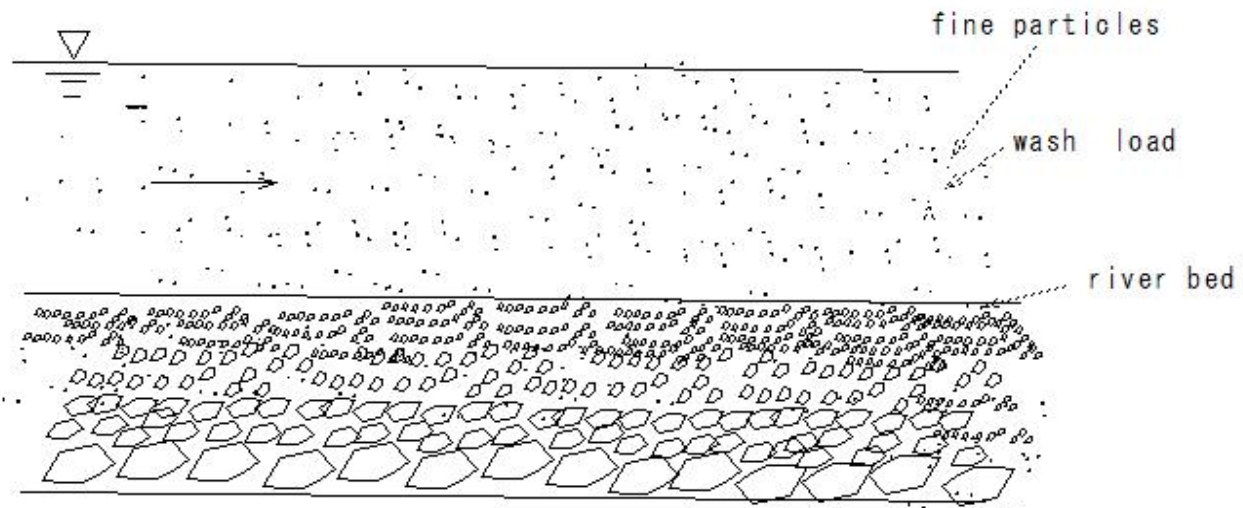


(R607)wash load

(R607)wash load

wash load

Fine particles
Transported from upstream
Reservoir - Buried



(R608)underground dam

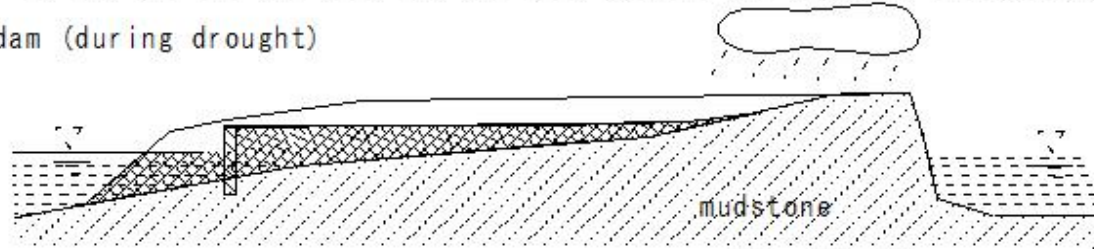
(R608) underground dam

underground dam

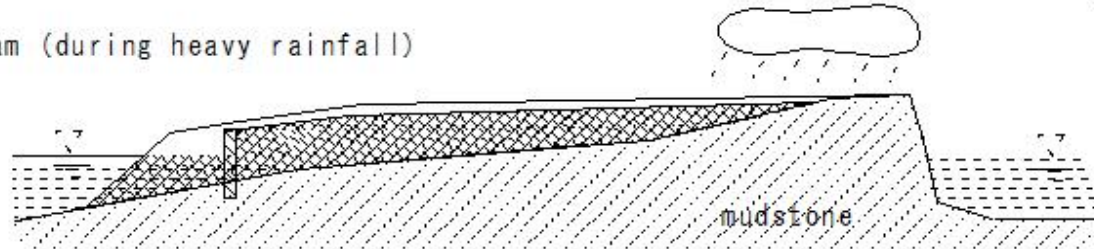
no underground dam



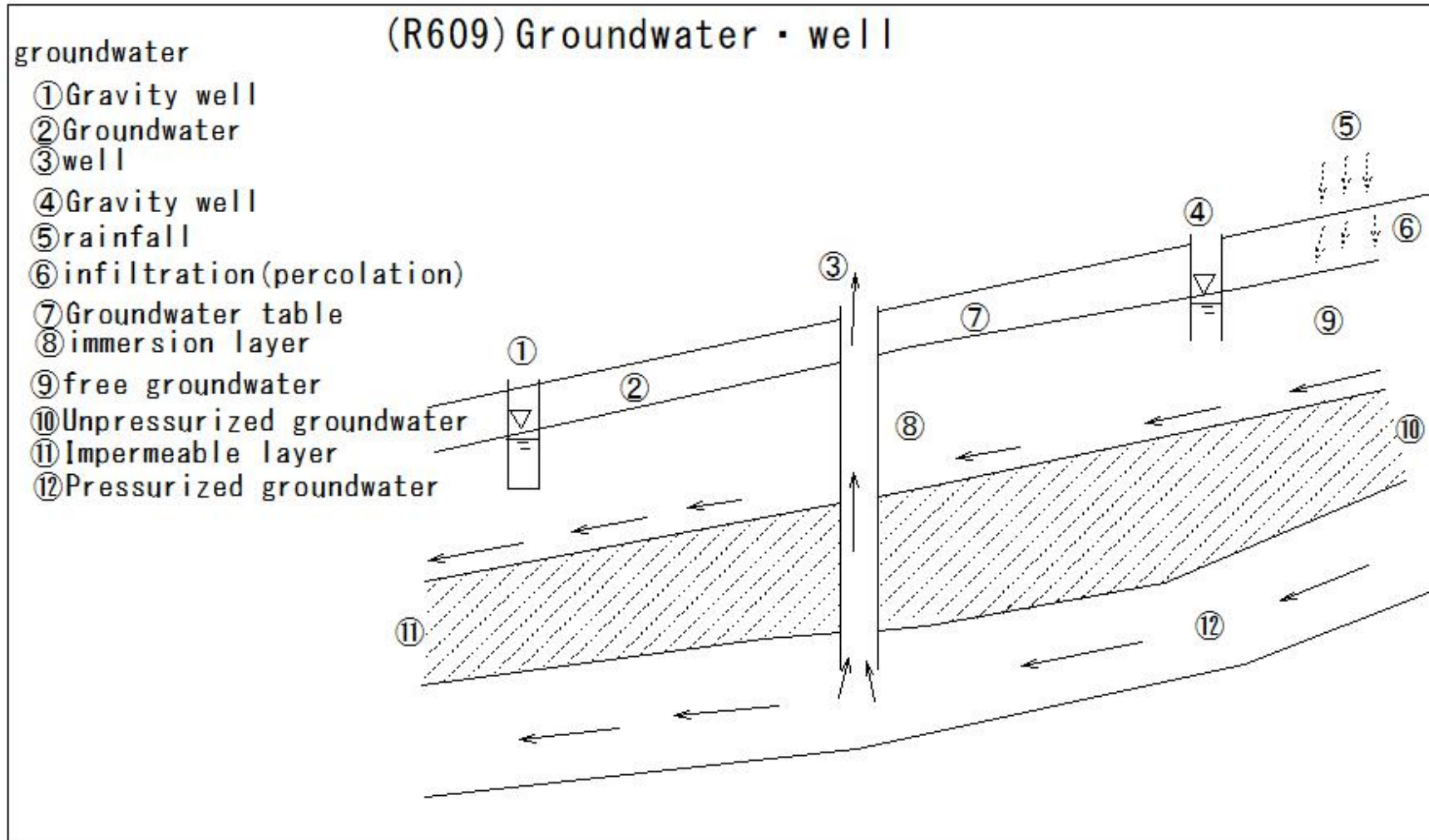
underground dam (during drought)



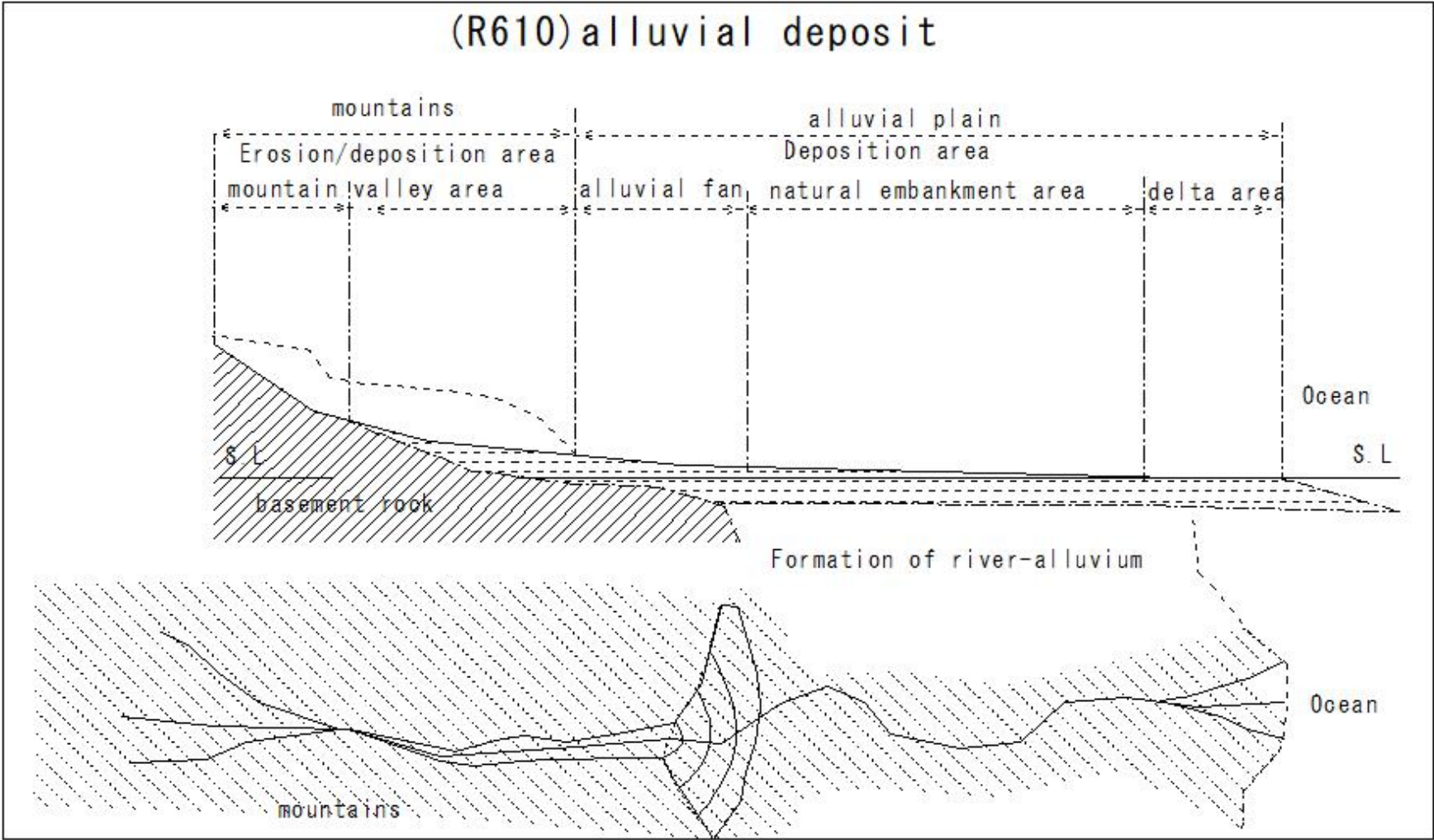
underground dam (during heavy rainfall)



(R609)Groundwater · well



(R610)alluvial deposit

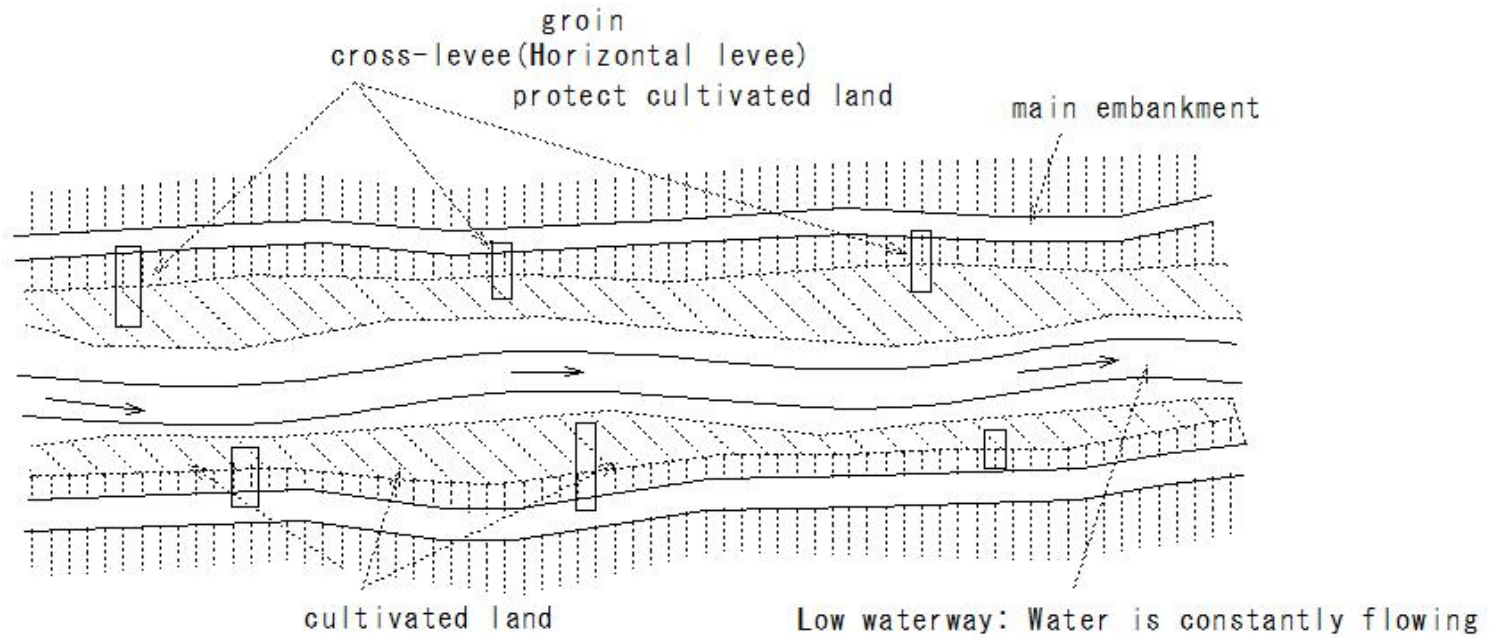


(R611)cross-levee(Horizontal levee)

(R611) cross- levee (Horizontal levee)

cross- levee (Horizontal levee)

Embankment parallel to the main embankment

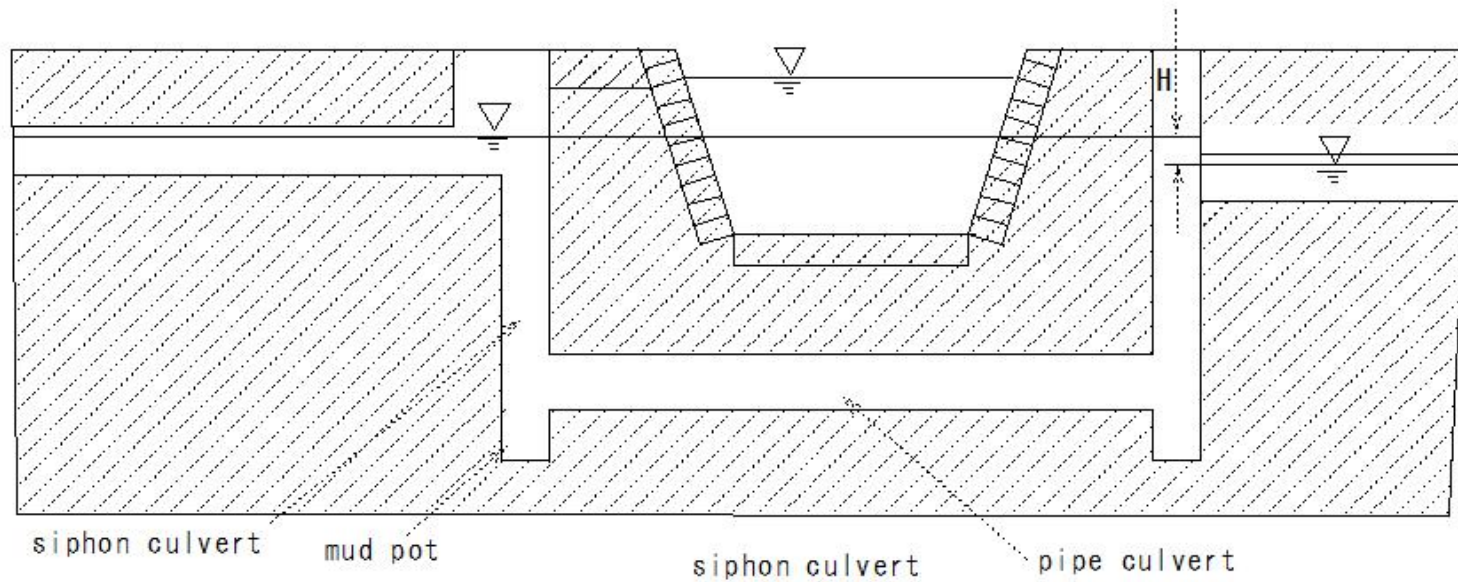


(R612)siphon culvert

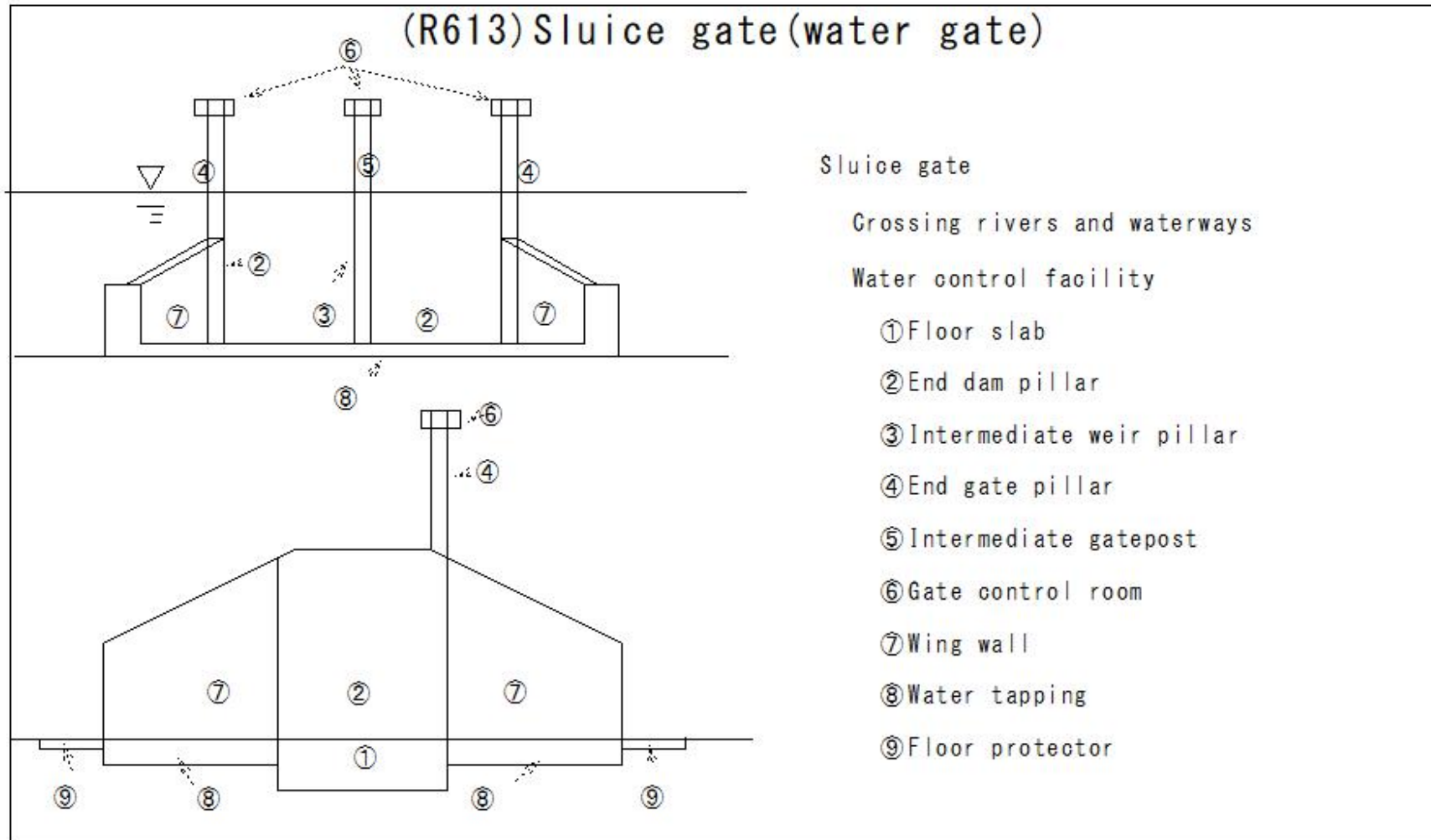
(R612) siphon culvert

siphon culvert

Waterways that cross under waterways, railways, and roads

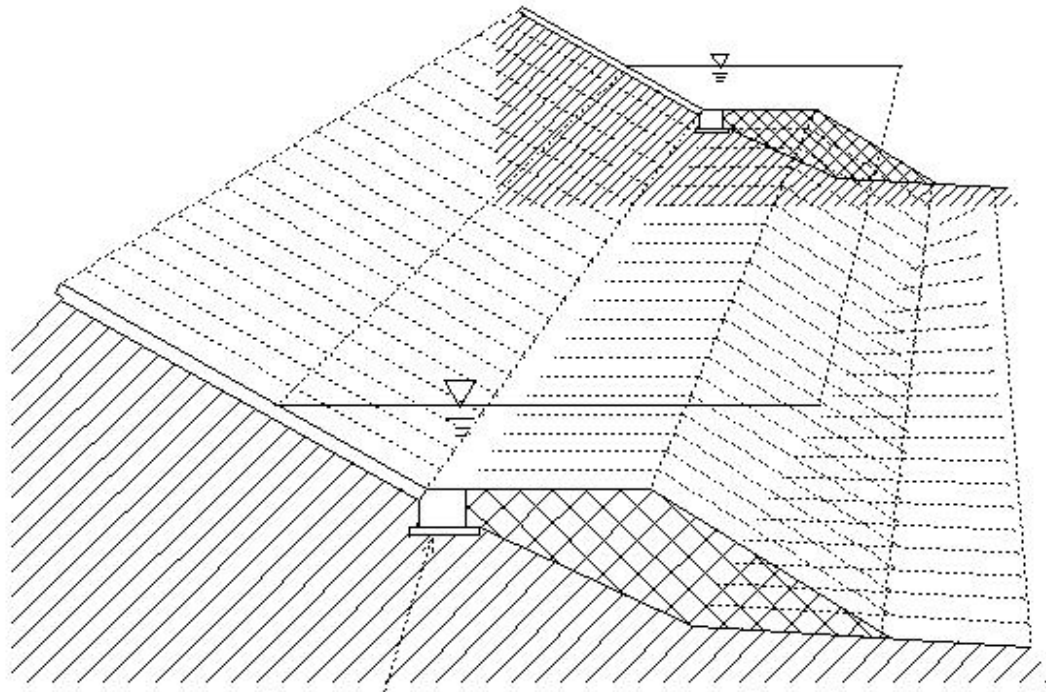


(R613)Sluice gate(water gate)



(R614)Foot protection

(R614)Foot protection



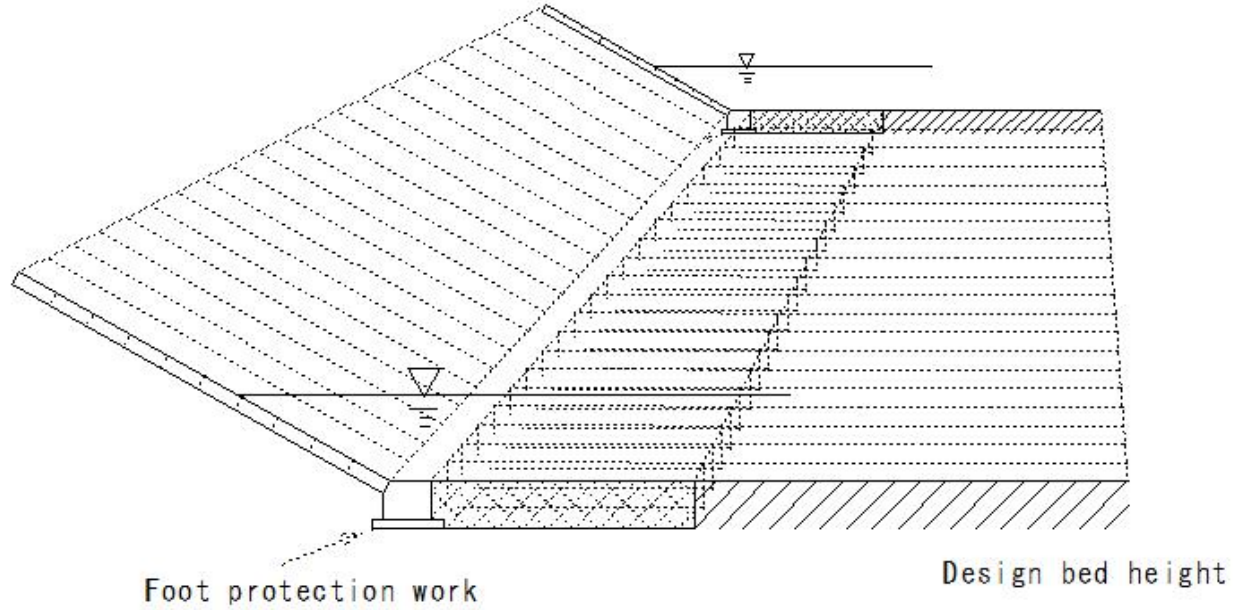
Foot protection work
Embankment/revetment/breakwater Placed in front to prevent scouring

c 1 0 8 3

(R615)Foot protection

(R615)Foot protection

Foot protection

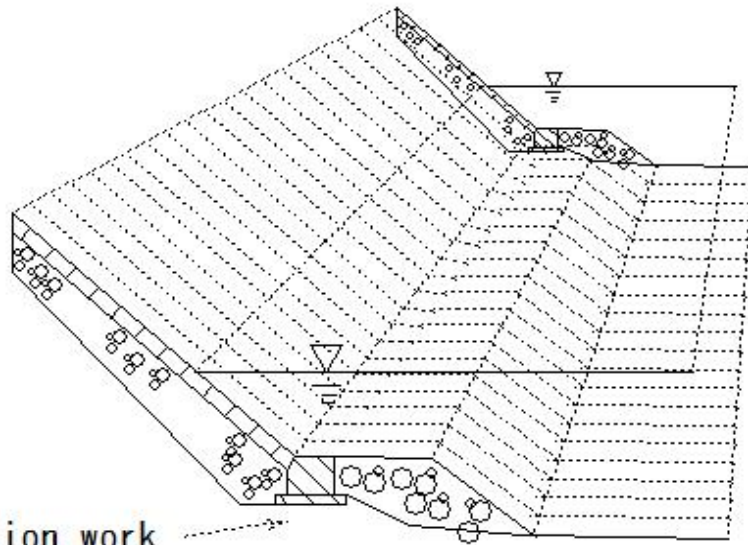


Foot protection work
Embankment/revetment/breakwater Placed in front to prevent scouring

c 1 0 8 4

(R616)Foot protection

(R616)Foot protection



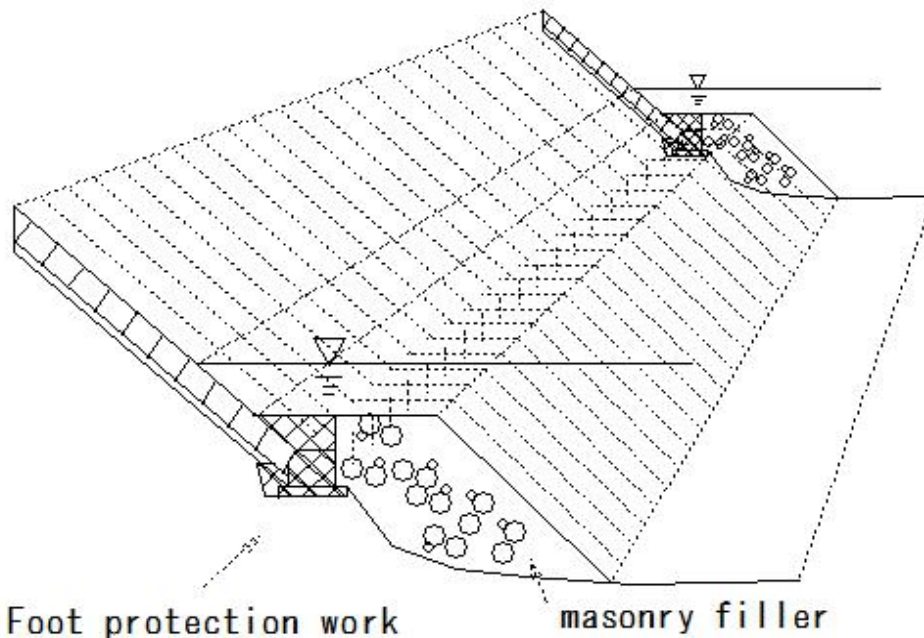
Foot protection work

Embankment/revetment/breakwater Placed in front to prevent scouring

c 1 0 8 5

(R617)Foot protection

(R617)Foot protection

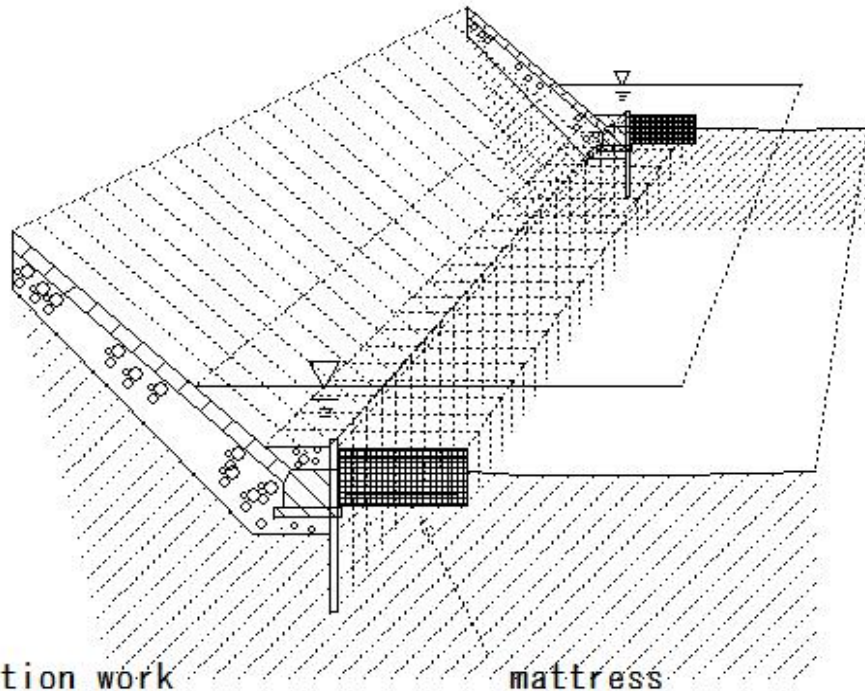


Embankment/revetment/breakwater Placed in front to prevent scouring

c1086

(R618)Foot protection

(R618)Foot protection



Foot protection work

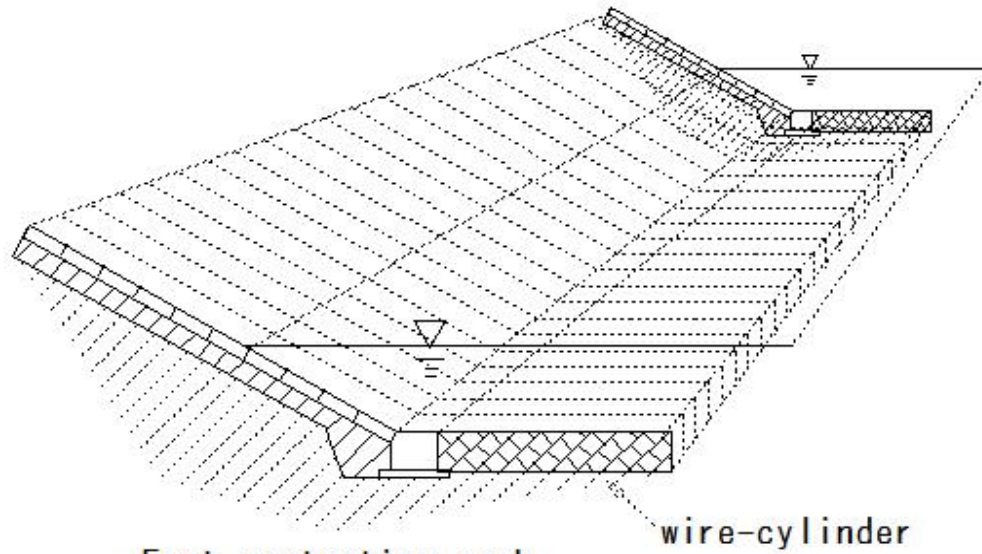
mattress

Embankment/revetment/breakwater Placed in front to prevent scouring

c1087

(R619)Foot protection

(R619)Foot protection



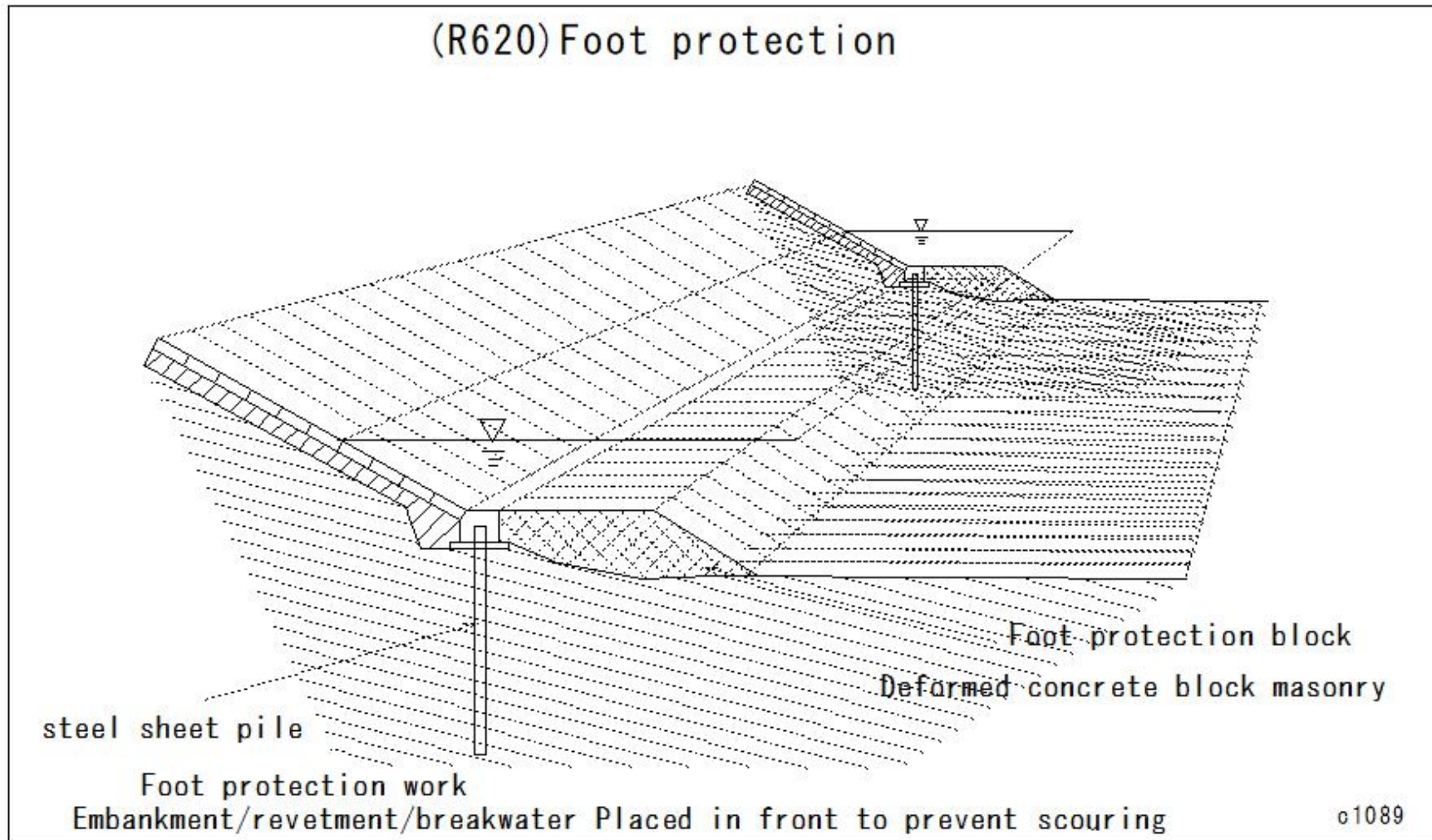
Foot protection work

Embankment/revetment/breakwater Placed in front to prevent scouring

c 1 0 8 8

(R620)Foot protection

(R620)Foot protection



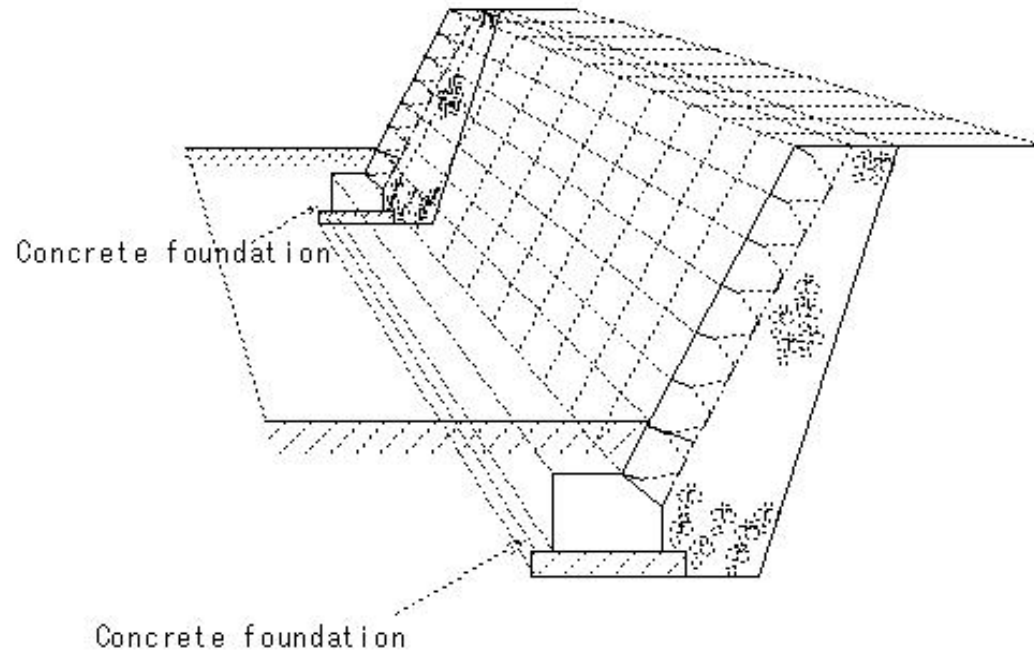
(R621)slope work (sure-footing)

(R621)slope work (sure-footing)

slope work (sure-footing)

Provided at the bottom of the slope work (sure-footing)

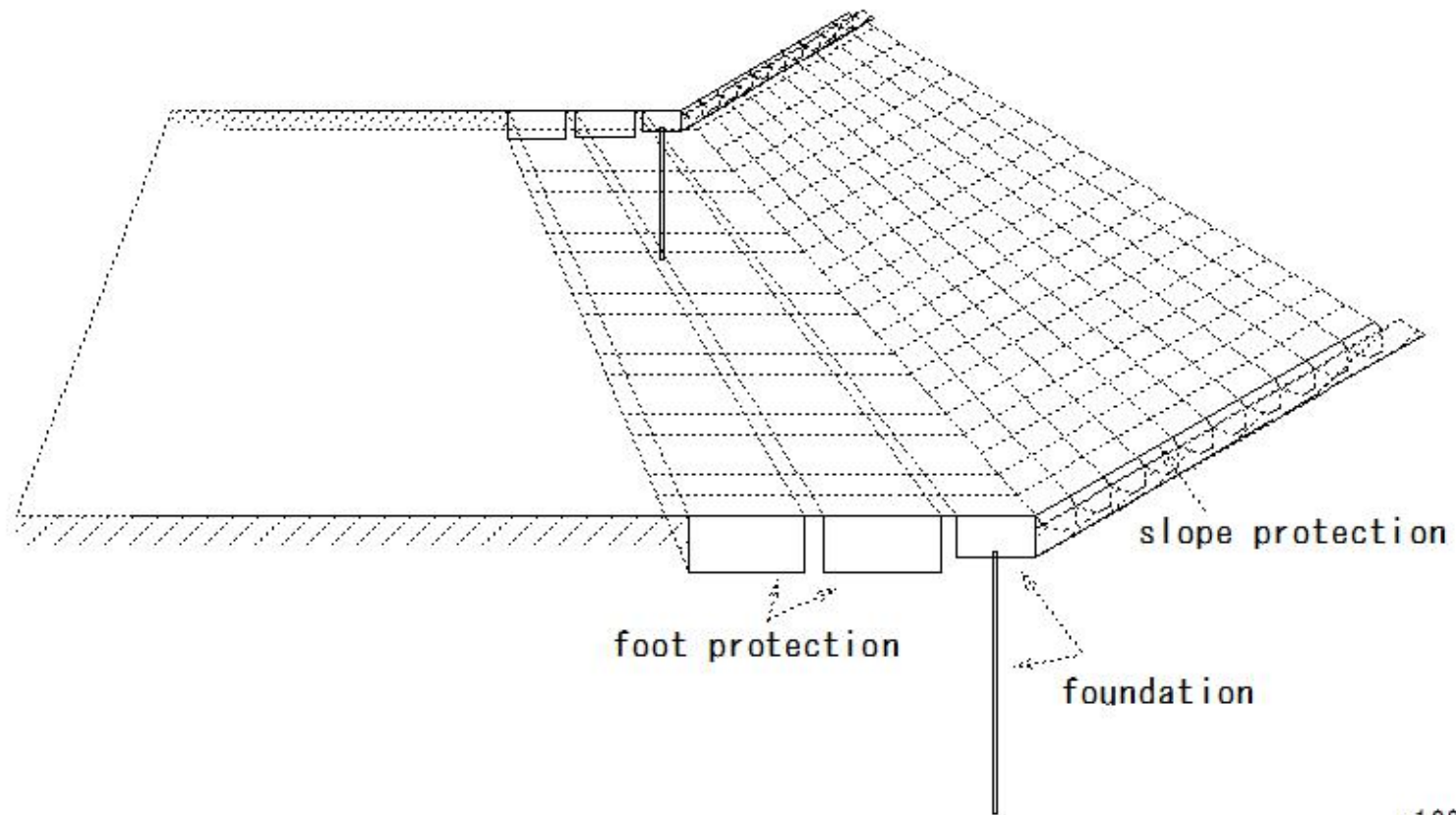
Concrete foundation work



c1090

(R622)slope work (sure-footing)

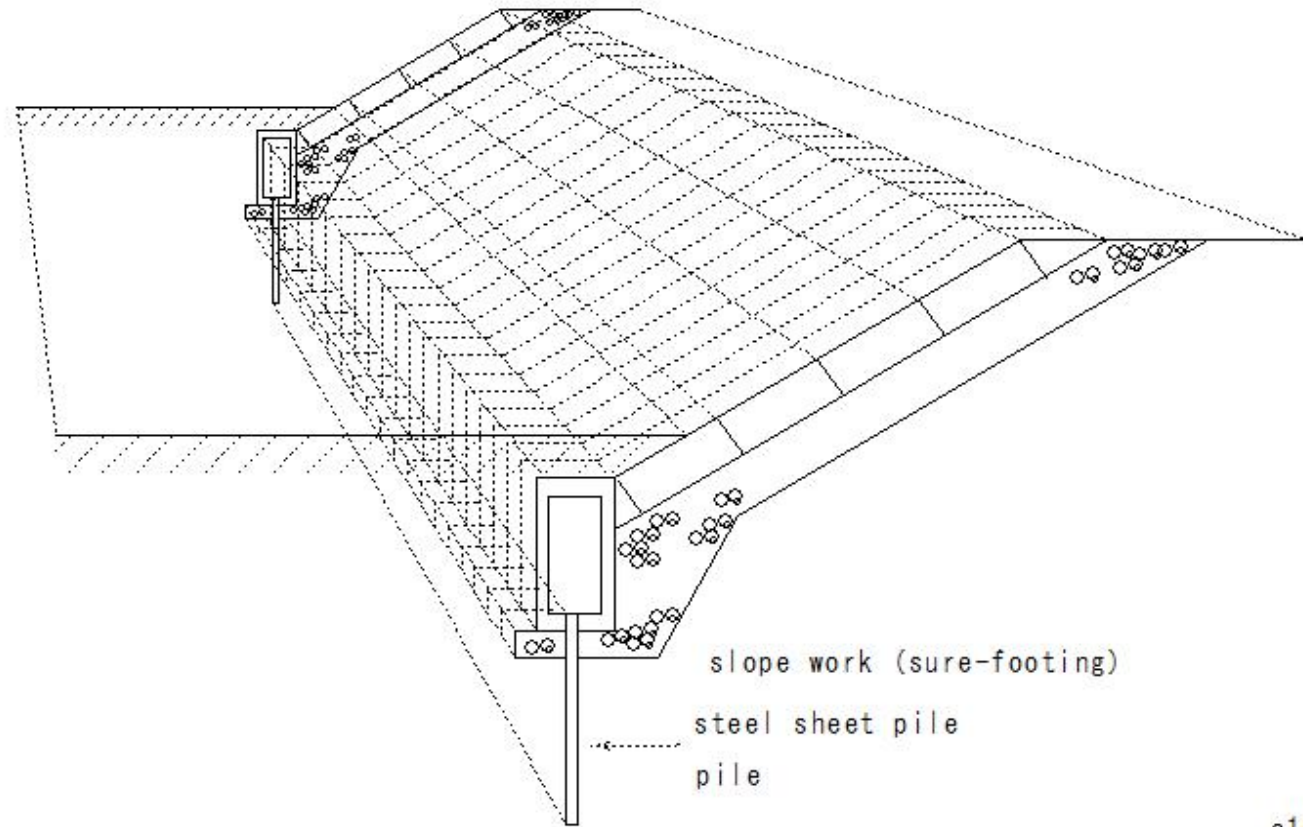
(R622)slope work (sure-footing)



c1091

(R623)slope work (sure-footing)

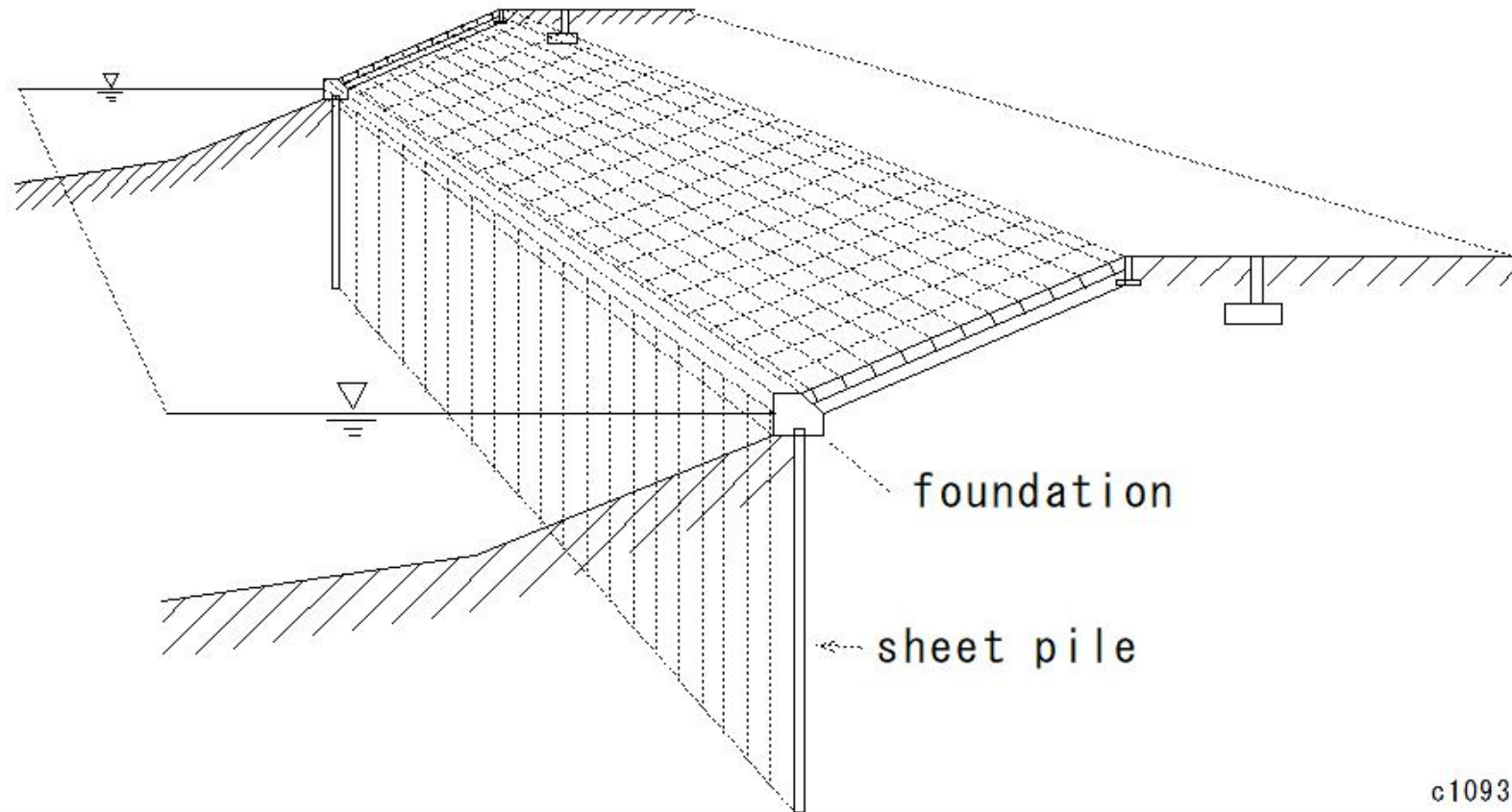
(R623)slope work (sure-footing)



c1092

(R624)slope work (sure-footing)

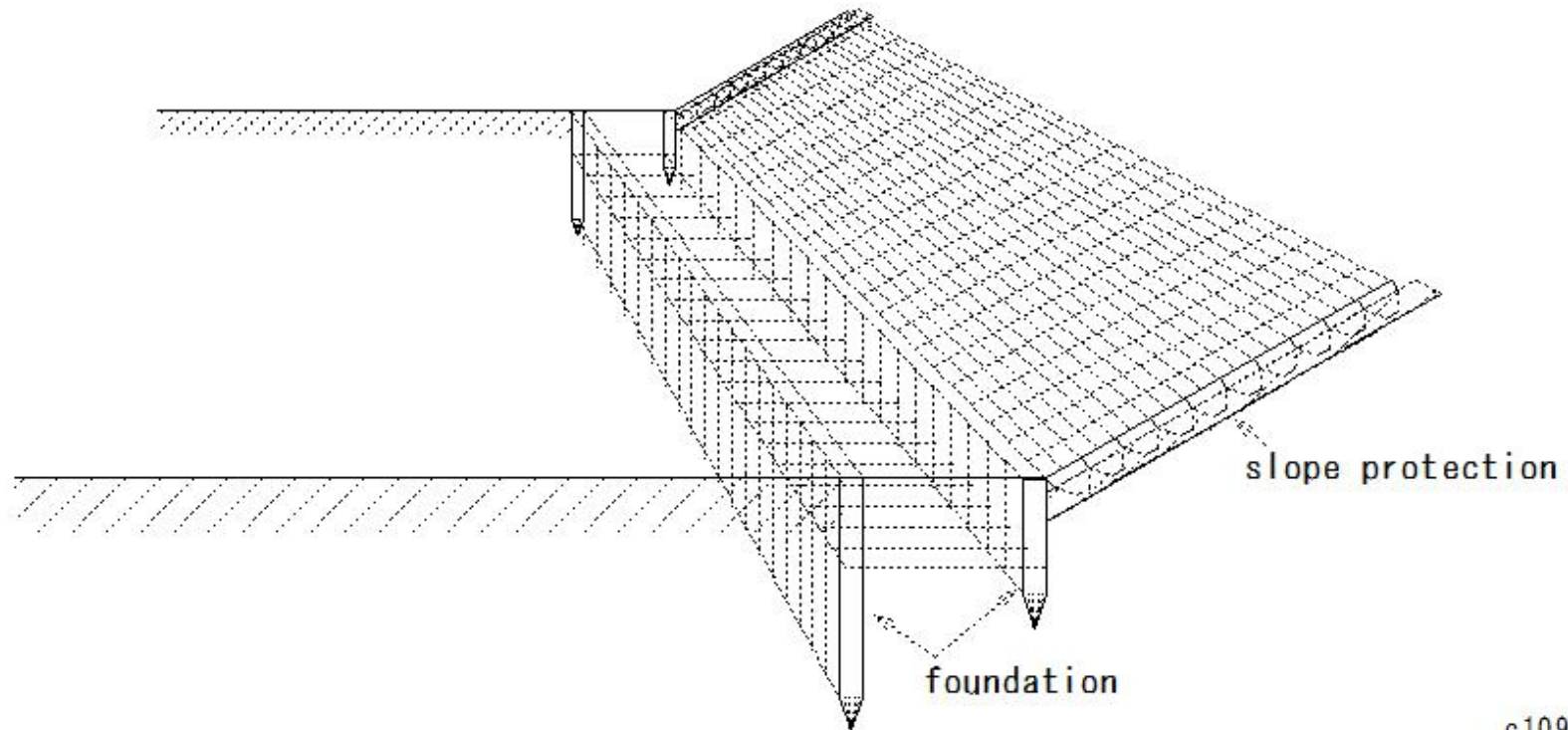
(R624) slope work (sure-footing)



c1093

(R625)slope work (sure-footing)

(R625)slope work (sure-footing)

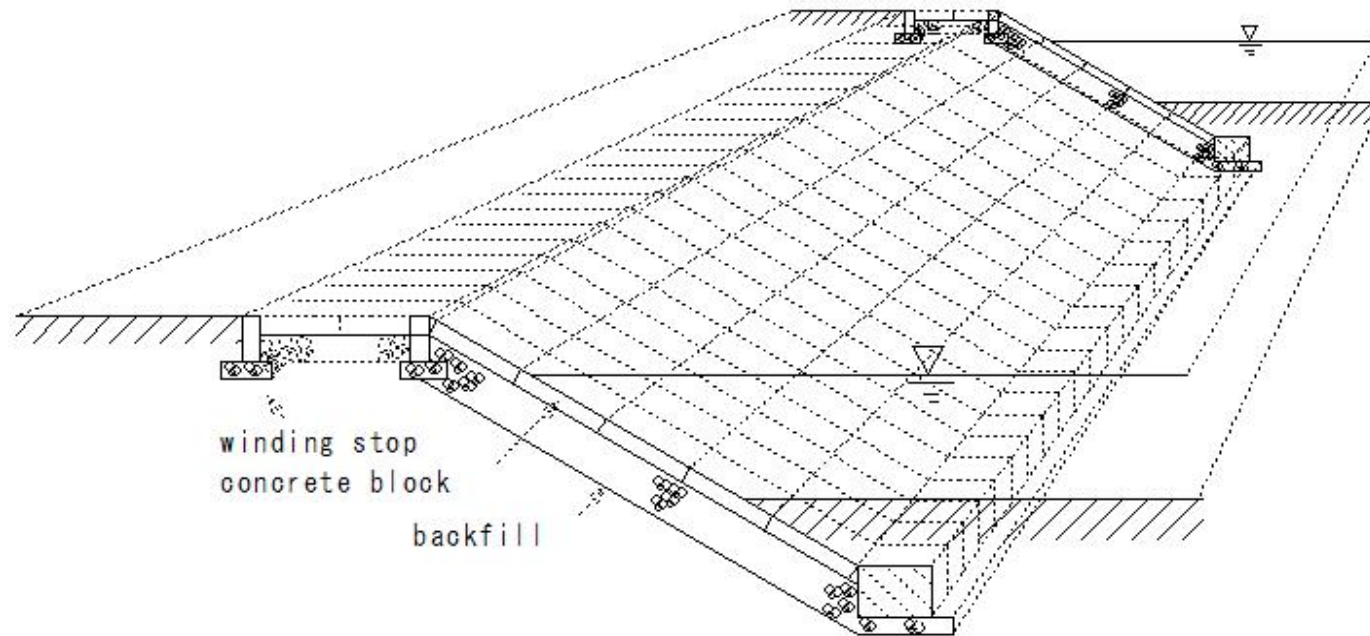


c1094

(R626)slope work (sure-footing)

(R626) slope work (sure-footing)

Low water revetment

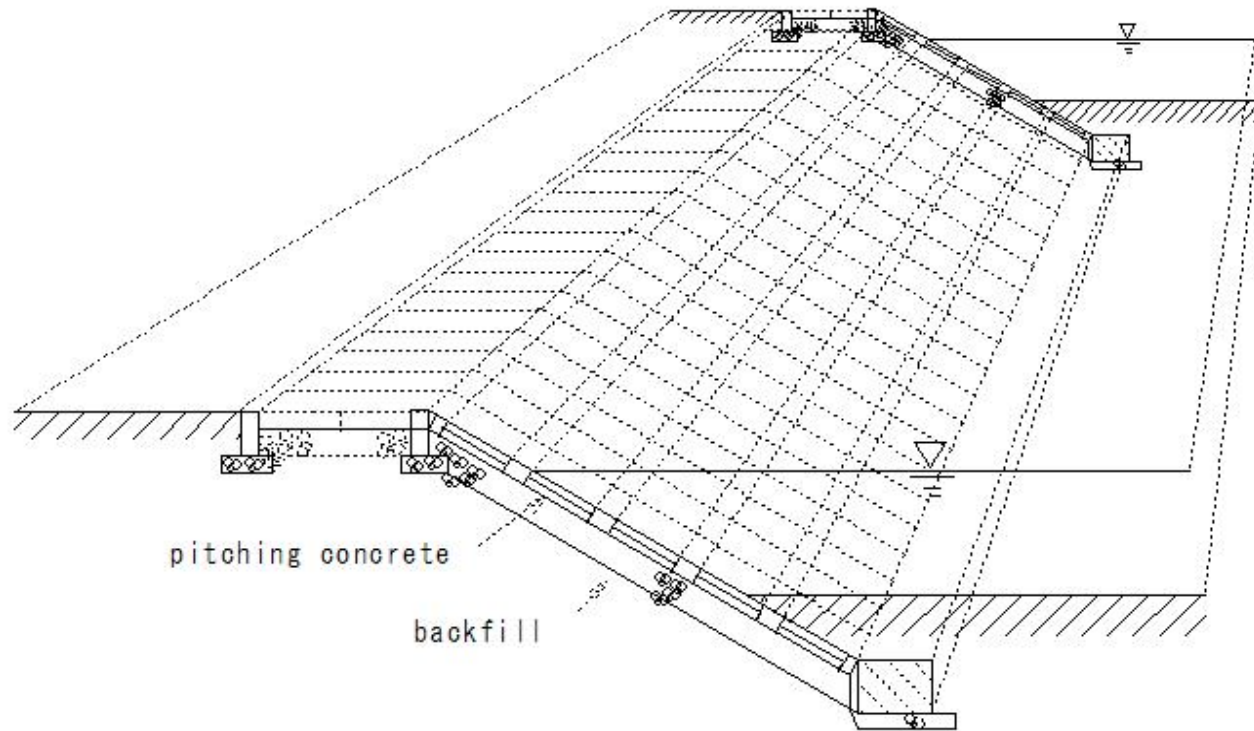


c1095

(R627) Slope protection (Pitching concrete/ crib work)

(R627) Slope protection (Pitching concrete/ crib work)

Low water revetment

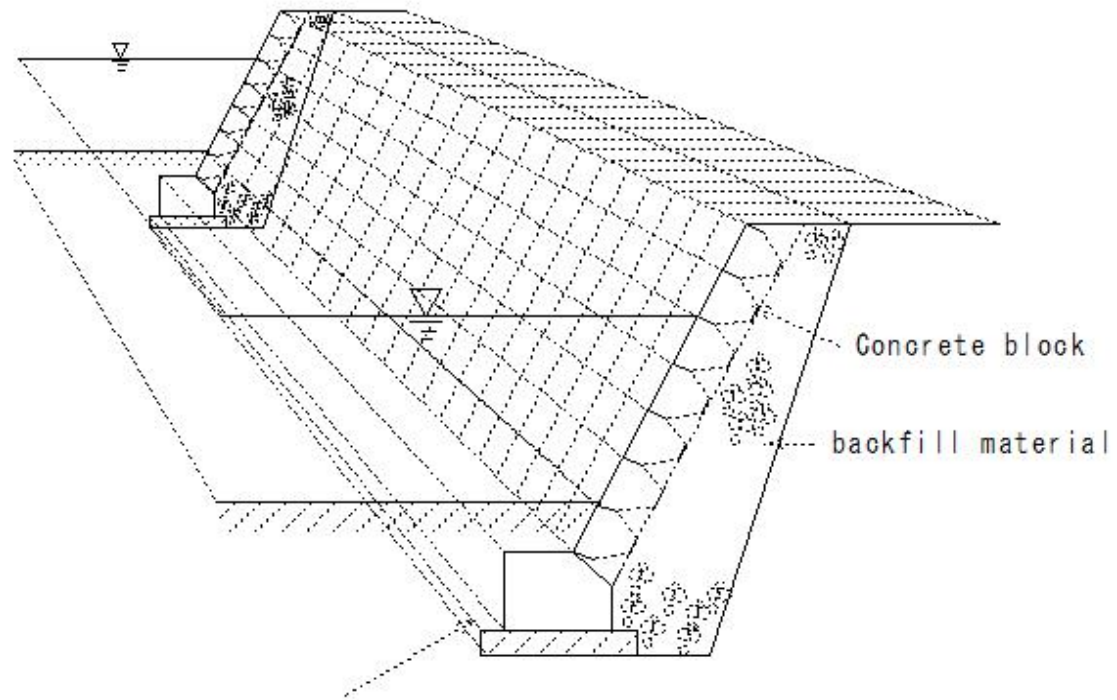


c1096

(R628) Slope protection (concrete block)

(R628) Slope protection (concrete block)

Low water revetment



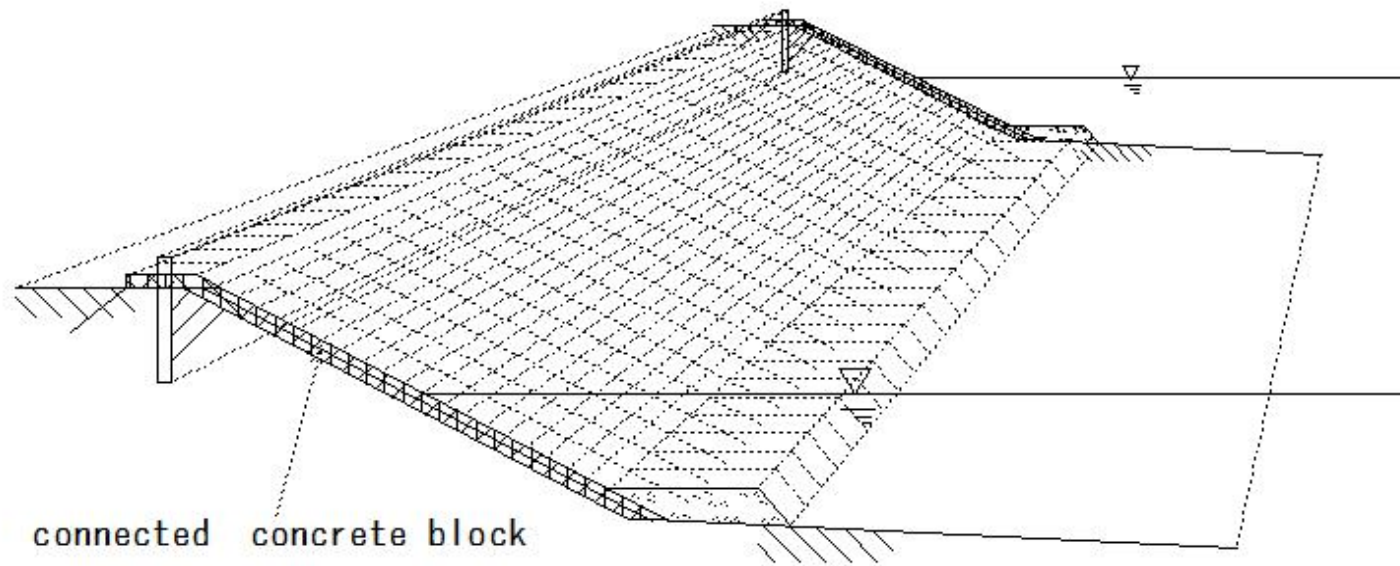
Concrete foundation

c1097

(R629) Slope protection (Connected concrete block)

(R629) Slope protection (Connected concrete block)

Low water revetment

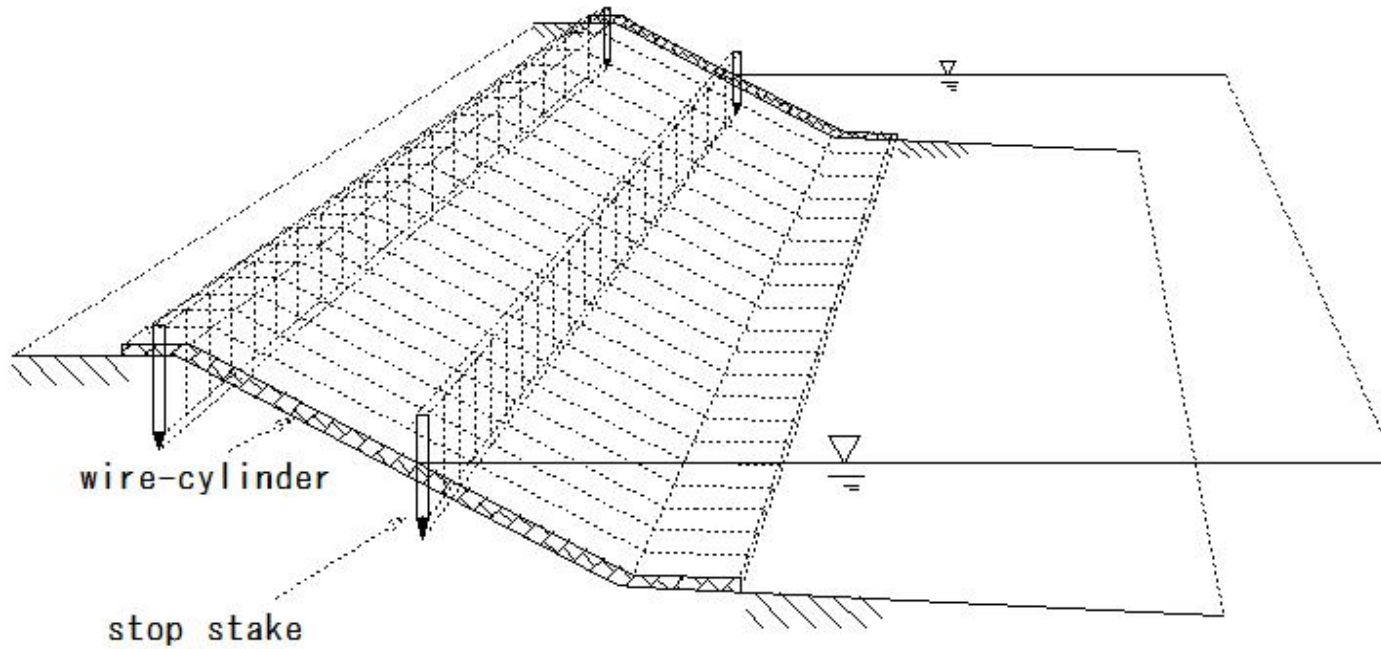


c1098

(R630) Slope protection (pile/gabion)

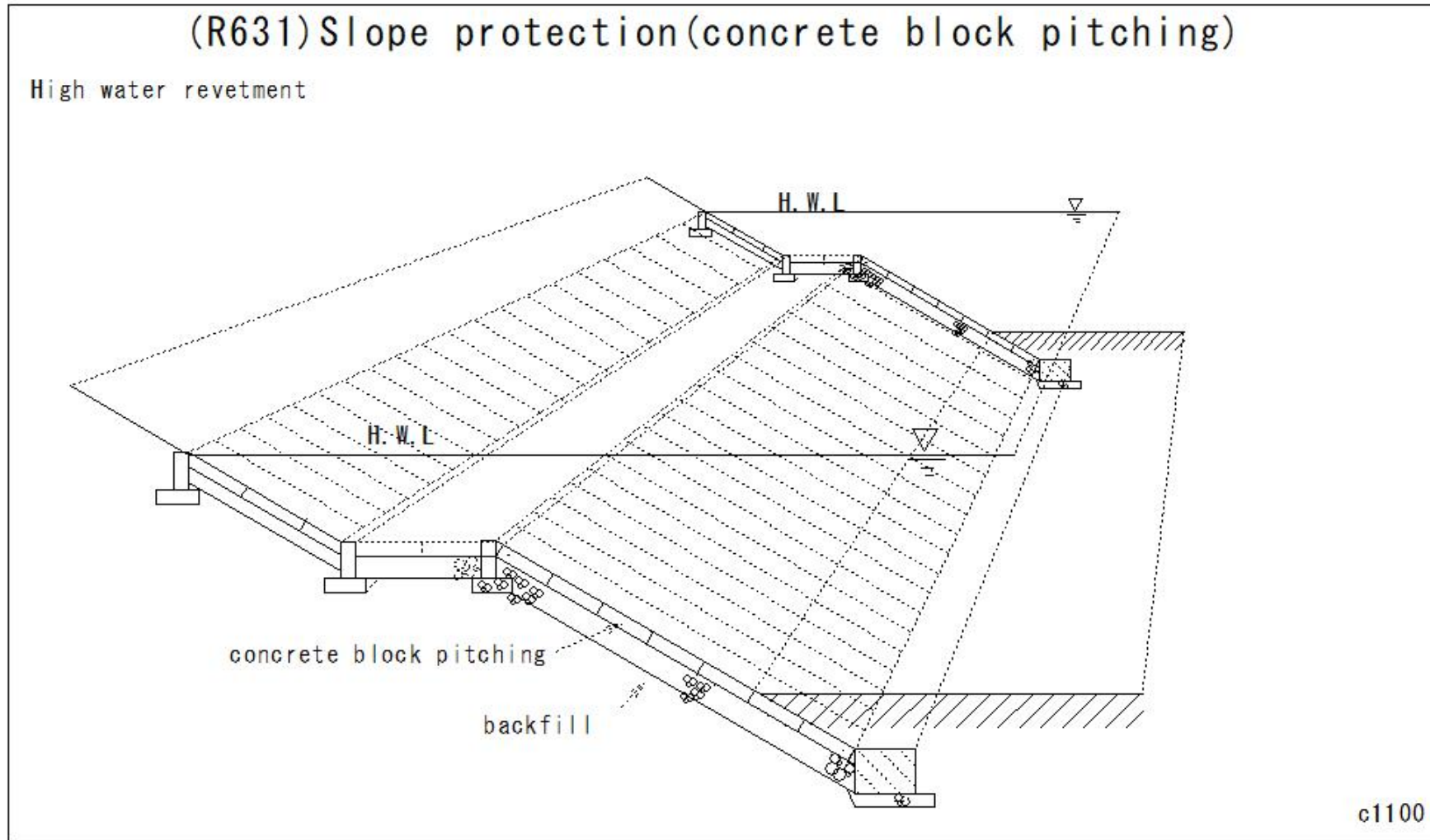
(R630) Slope protection (pile/gabion)

Low water revetment



c1099

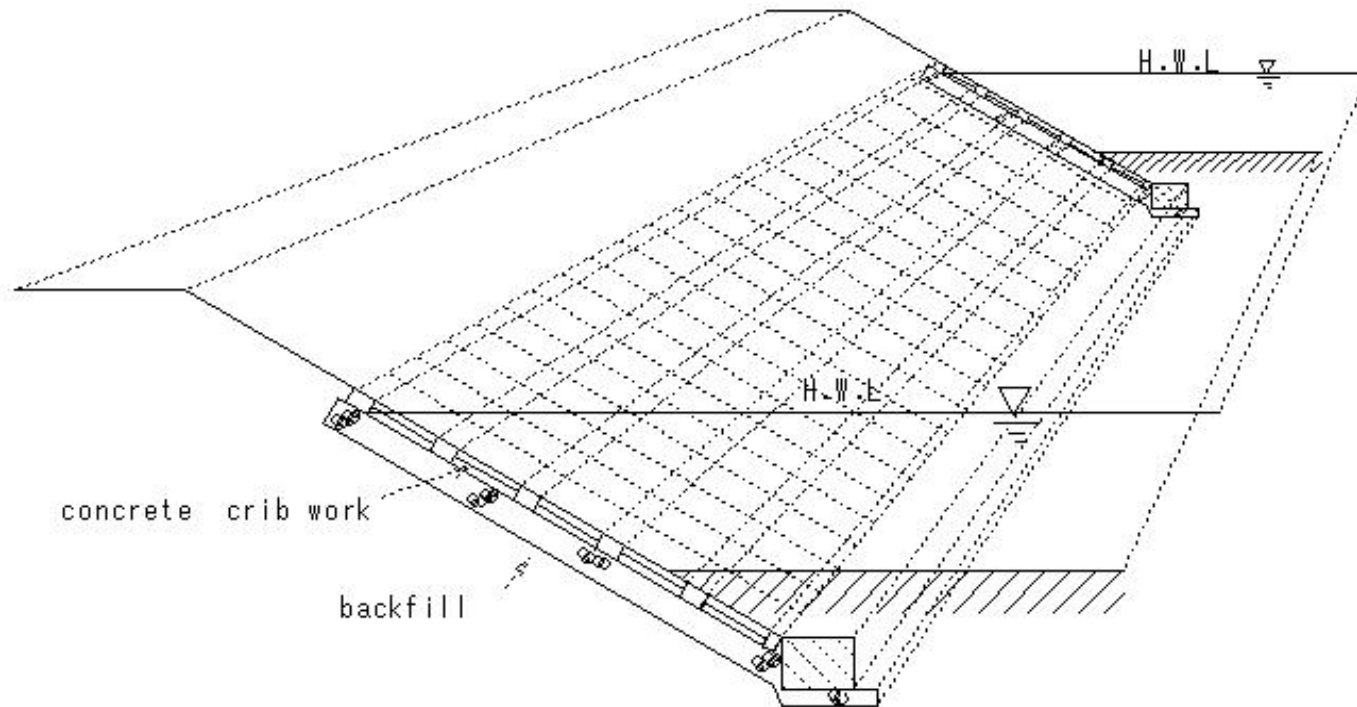
(R631) Slope protection (concrete block pitching)



(R632)Slope protection(concrete crib work)

(R632)Slope protection(concrete crib work)

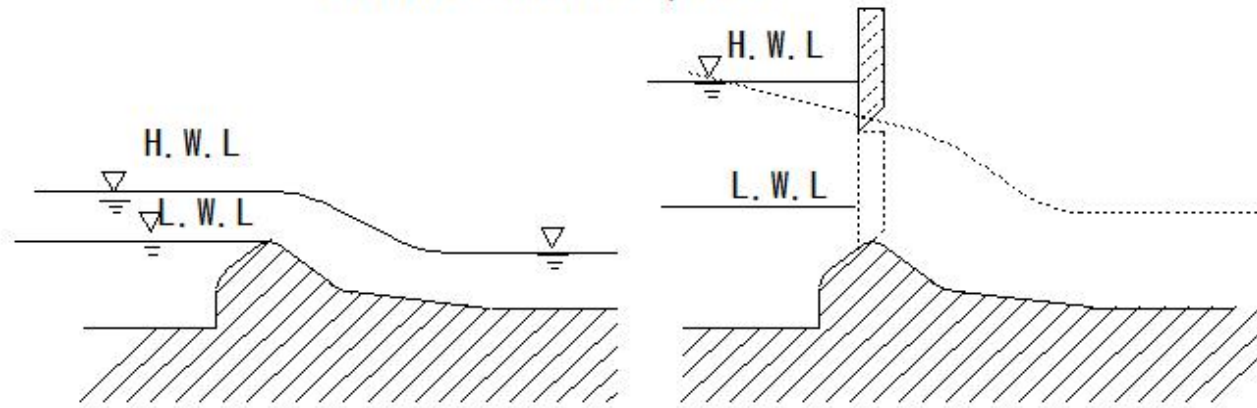
High water revetment



c1101

(R633) Baffle pier

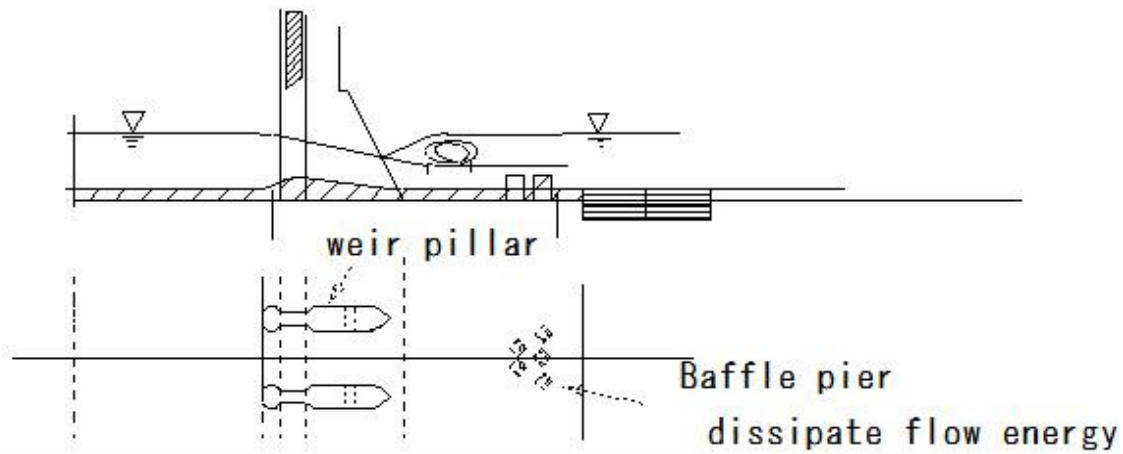
(R633) Baffle pier



Fixed weir

Movable weir

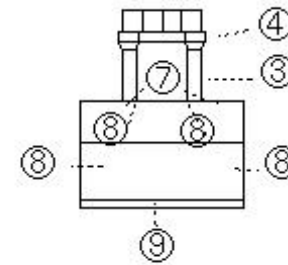
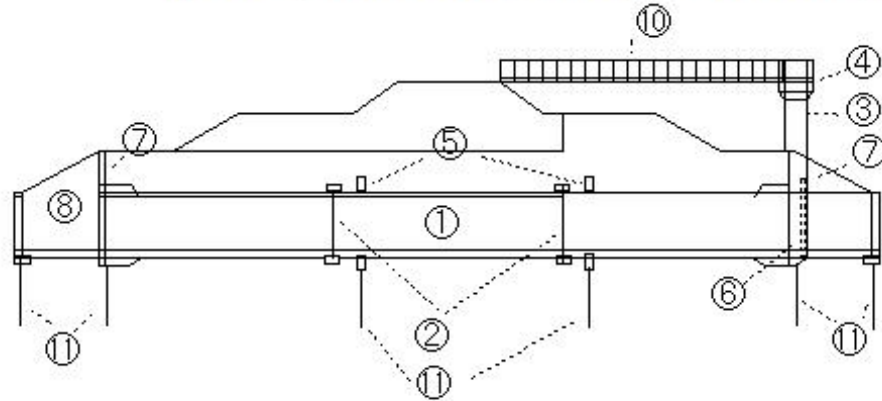
Baffle pier



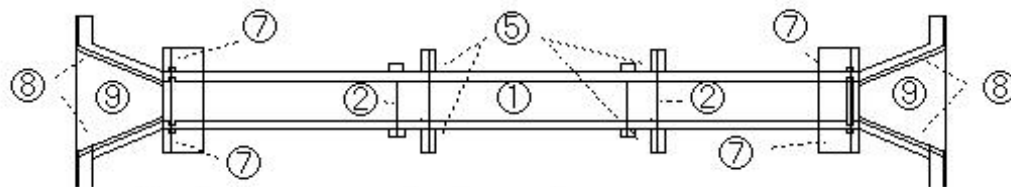
c1104

(R634)Sluice gate, sluice pipe

(R634) Sluice gate, sluice pipe



Front view



Sluice gate, sluice pipe

- ① Box ditch
- ② Joint
- ③ Gatepost
- ④ Gate operation table
- ⑤ Impermeable wall
- ⑥ Gate

- ⑦ Battlements
- ⑧ Wing wall
- ⑨ Water tapping
- ⑩ Management bridge
- ⑪ Waterproof work