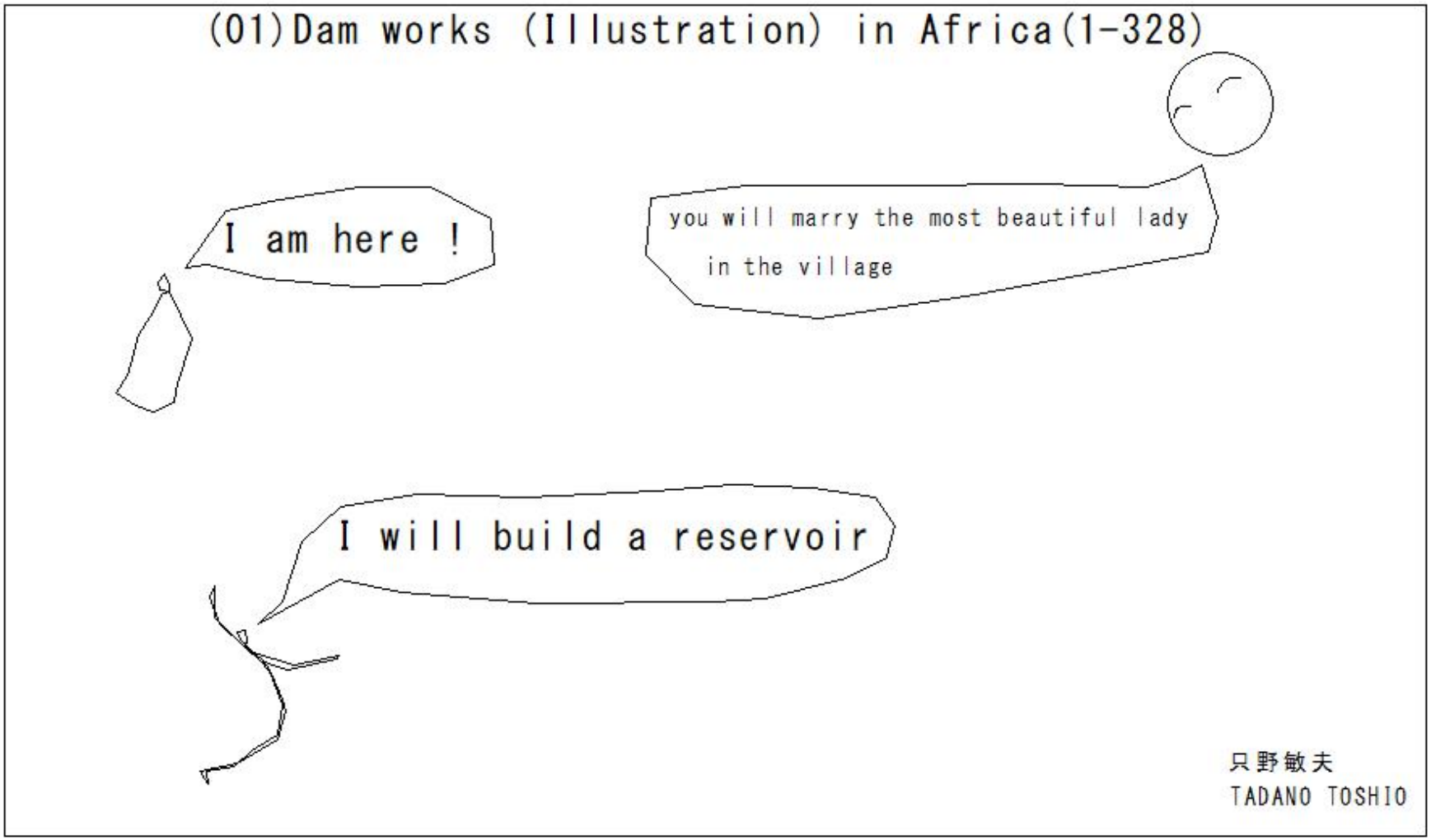
(01)Dam works (Illustration) in Africa(1-328)



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⑨Dictionary of civil engineering terms　Edited by Tokyo Engineering Study Group　Engineering Publishing Co., Ltd.

只野敏夫
Tadano Toshio

1 (D1)Classification of dams	Classification of dams
2 (D2)Dam structure	Dam structure
3 (D3)Dam structure	Dam structure
4 (D4)Dam structure	Dam structure
5 (D5)Dam structure	Dam structure
6 (D6)Dam structure	Dam structure
7 (D7)Dam structure	Dam structure
8 (D8)Dam construction plan	Dam construction plan
9 (D9)Dam construction plan	Dam construction plan
10 (D10)Dam construction plan	Dam construction plan
11 (D11)Dam construction plan	Dam construction plan
12 (D12)Dam construction plan	Dam construction plan
13 (D13)Dam construction plan	Dam construction plan
14 (D14)Concrete dam construction equipment	Concrete dam construction equipment
15 (D15)Concrete dam construction equipment	Concrete dam construction equipment
16 (D16)Concrete dam construction equipment	Concrete dam construction equipment
17 (D17)Concrete dam construction equipment	Concrete dam construction equipment
18 (D18)Concrete dam construction equipment	Concrete dam construction equipment
19 (D19)Concrete dam construction equipment	Concrete dam construction equipment
20 (D20)Concrete dam construction equipment	Concrete dam construction equipment
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23 (D23)Concrete dam construction equipment	Concrete dam construction equipment
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27 (D27)Concrete dam construction equipment	Concrete dam construction equipment
28 (D28)Concrete dam construction equipment	Concrete dam construction equipment
29 (D29)Concrete dam construction equipment	Concrete dam construction equipment
30 (D30)Concrete dam construction equipment	Concrete dam construction equipment
31 (D31)Concrete dam construction equipment	Concrete dam construction equipment
32 (D32)length of crest	dam
33 (D33)Concrete dam construction equipment(Stage grouting)	grouting
34 (D34)Concrete dam construction equipment(Stage grouting)	grouting

35 (D35)Concrete dam construction equipment(grouting)	grouting
36 (D36)Concrete dam construction equipment(grouting)	grouting
37 (D37)River treatment(Temporary drainage tunnel)	cofferdam
38 (D38)River treatment(half river cofferdam)	cofferdam
39 (D39)River treatment(Temporary drainage opening channel)	cofferdam
40 (D40)River treatment(temporary cofferdam)	cofferdam
41 (D41)River treatment(temporary cofferdam)	cofferdam
42 (D42)foundation excavation(topsoil excavation)	foundation excavation
43 (D43)foundation excavation(rough excavation)	foundation excavation
44 (D44)foundation excavation(finishing excavation)	foundation excavation
45 (D45)foundation excavation(excavation surface protection)	foundation excavation
46 (D46)Construction of concrete dam (conventional method)	placing concrete
47 (D47)Construction of concrete dam (conventional method)	placing concrete
48 (D48)Construction of concrete dam (conventional method)	placing concrete
49 (D49)Construction of concrete dam (conventional method)	placing concrete
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51 (D51)Construction of concrete dam (conventional method)	placing concrete
52 (D52)Construction of concrete dam (placing concrete)	placing concrete
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54 (D54)Construction of concrete dam (placing concrete)	placing concrete
55 (D55)Construction of concrete dam (placing concrete)	placing concrete
56 (D56)Construction of concrete dam (placing concrete)	placing concrete
57 (D57)Construction of concrete dam (placing concrete)	placing concrete
58 (D58)Construction of concrete dam (placing concrete)	placing concrete
59 (D59)Construction of concrete dam (placing concrete)	placing concrete
60 (D60)Construction of concrete dam (placing concrete)	placing concrete
61 (D61)Construction of concrete dam (placing concrete-formwork)	placing concrete-formwork
62 (D62)Construction of concrete dam (placing concrete-formwork)	placing concrete-formwork
63 (D63)Construction of concrete dam (placing concrete-formwork)	placing concrete-formwork
64 (D64)Construction of concrete dam (Concrete temperature regulation)	cooling
65 (D65)Concrete temperature regulation(Pre-cooling)	Pre-cooling
66 (D66)Concrete temperature regulation(Pipe cooling)	Pipe cooling
67 (D67)Concrete temperature regulation(Pipe cooling)	Pipe cooling
68 (D68)Concrete temperature regulation(Pipe cooling)	Pipe cooling

69	(D69)Concrete temperature regulation(Pipe cooling)	Pipe cooling
70	(D70)Concrete temperature regulation(Joint grouting)	grouting
71	(D71)Construction of concrete dam (Corridor)	Corridor
72	(D72)Construction of concrete dam (Foundation drainage hole)	grouting
73	(D73)Construction of concrete dam (Water stop plate and joint drainage hole)	Water stop plate
74	(D74)Construction of concrete dam using RCD method	RCD method
75	(D75)RCD method	RCD method
76	(D76)RCD method	RCD method
77	(D77)RCD method	RCD method
78	(D78)RCD method	RCD method
79	(D79)RCD method	RCD method
80	(D80)RCD method	RCD method
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82	(D82)RCD method	RCD method
83	(D83)RCD method	RCD method
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87	(D87)fill dam	fill dam
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125 (D125)foundation treatment(grouting)	grouting
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149 (D149)foundation treatment(grouting)	grouting
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151 (D151)dam	dam
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155 (D155)dam	dam
156 (D156)dam	dam
157 (D157)dam	dam
158 (D158)dam	dam
159 (D159)dam	dam
160 (D160)dam	dam
161 (D161)dam(Diversion works)	dam(Diversion works)
162 (D162)dam(Diversion works)	dam(Diversion works)
163 (D163)dam(Diversion works)	dam(Diversion works)
164 (D164)dam(construction order)	dam(construction order)
165 (D165)dam(construction order)	dam(construction order)
166 (D166)dam(construction order)	dam(construction order)
167 (D167)dam(construction order)	dam(construction order)
168 (D168)dam(fill dam)	fill dam
169 (D169)dam(rock fill dam)	fill dam
170 (D170)dam(rock fill dam)	fill dam

171 (D171)dam(rock fill dam)	fill dam
172 (D172)dam(earth dam)	earth dam
173 (D173)dam(earth dam)	earth dam
174 (D174)dam(arch dam)	earth dam
175 (D175)dam(RCD method)	RCD method
176 (D176)dam(potential head)	hydraulics
177 (D177)impact crusher	construction machinery
178 (D178)winch	construction machinery
179 (D179)aerial cableway	construction machinery
180 (D180)design flood discharge	hydraulics
181 (D181)cable crane	construction machinery
182 (D182)concrete bucket	construction machinery
183 (D183)conveyor	construction machinery
184 (D184)crusher	construction machinery
185 (D185)surge-tank	hydraulics
186 (D186) differential surge-tank	hydraulics
187 (D187)natural head	hydraulics
188 (D188)control section	hydraulics
189 (D189)jib crane	construction machinery
190 (D190)sheeps-foot roller	construction machinery
191 (D191)cofferdam	cofferdam
192 (D192)cofferdam	cofferdam
193 (D193)cofferdam	cofferdam
194 (D194)cofferdam	cofferdam
195 (D195)closing dyke	cofferdam
196 (D196)supercritical flow(shooting flow /rapid flow)	hydraulics
197 (D197)gravity dam	dam
198 (D198)water-intake	intake
199 (D199)intake	intake
200 (D200)intake dam	intake
201 (D201)intake dam	intake
202 (D202)dredging(Pump dredger)	dredging
203 (D203)dredging(Bucket dredger)	dredging
204 (D204)dredging(Grab dredger)	dredging

205 (D205)dredging(Dipper dredger)	dredging
206 (D206)wetted perimeter	water-level recorder
207 (D207)ordinary flow	hydraulics
208 (D208)jaw crusher	construction machinery
209 (D209)penstock root	hydraulics
210 (D210)stage	water-level recorder
211 (D211)water-level recorder	water-level recorder
212 (D212)water-level recorder	water-level recorder
213 (D213)water hammmer	hydraulics
214 (D214)chamber surge tank	hydraulics
215 (D215)hydraulic turbine	hydraulics
216 (D216)efficiency of hydraulic turbine	hydraulics
217 (D217)gate	gate
218 (D218)best hydraulic cross-section	hydraulics
219 (D219)Hydraulic water depth	hydraulics
220 (D220)conduct type water power	hydraulics
221 (D221)weir	weir
222 (D222)backwater curve	hydraulics
223 (D223)hollow gravity dam	dam
224 (D224)hydraulic jump	hydraulics
225 (D225)deflector	hydraulics
226 (D226)head works	hydraulics
227 (D227)penstock (head race)	dam
228 (D228)sediment settling	hydraulics
229 (D229)internal impervious wall	fill dam
230 (D230)internal impervious wall	fill dam
231 (D231)interflow	hydraulics
232 (D232)dentated sill	dam
233 (D233)sharp crested weir	weir
234 (D234)batcher plant	batcher plant
235 (D235)batcher plant	batcher plant
236 (D236)auxiliary dam	dam
237 (D237)unsteady flow	hydraulics
238 (D238)impermeability layer	hydraulics

239 (D239)floating dam	dam
240 (D240)watershed	hydraulics
241 (D241)equilibrium slope	hydraulics
242 (D242)parallel drainage	hydraulics
243 (D243)radial drainage	hydraulics
244 (D244)tail-race surge tank	hydraulics
245 (D245)spatter's effect	hydraulics
246 (D246)effective head	hydraulics
247 (D247)pumped storage power	hydraulics
248 (D248)pump-up head	hydraulics
249 (D249)spillway	dam
250 (D250)log-chute	dam
251 (D251)basin coefficient	hydraulics
252 (D252)discharge -duration curve	hydraulics
253 (D253)flow net	hydraulics
254 (D254)velocity of flow	hydraulics
255 (D255)water course	hydraulics
256 (D256)rock fill dam	fill dam
257 (D257)concrete arch dam	arch dam
258 (D258)roller compacted concrete dams(RCD)	RCD
259 (D259)roller compacted concrete dams(RCD)	RCD
260 (D260)roller compacted concrete dams(RCD)	RCD
261 (D261)Movable weir	weir
262 (D262)exterior concrete	dam
263 (D263)cofferdam	cofferdam
264 (D264)cofferdam	cofferdam
265 (D265)dam type power	dam
266 (D266)green cut	dam
267 (D267)clean plant	dam
268 (D268)Slanted seam	dam
269 (D269)cable crane	dam
270 (D270)dam and conduit type power	dam
271 (D271)Quarry	Quarry
272 (D272)spillway	spillway

273 (D273)concrete replacement	concrete replacement
274 (D274)RCD method(concrete vibrating joint cutter)	RCD method
275 (D275)Concrete batching and mixing plant	Concrete batching
276 (D276)Concrete pump	construction machinery
277 (D277)consolidation grouting	grouting
278 (D278)fixed jib crane	construction machinery
279 (D279)Concrete gravity dam	dam
280 (D280)joint grouting lift	grouting
281 (D281)Stage grouting	grouting
282 (D282)slide form	dam
283 (D283)dowelling method	concrete replacement
284 (D284)longitudinal joint	dam
285 (D285)Dam concrete division	dam
286 (D286)dam construction equipments	construction machinery
287 (D287)concrete replacement for faults	concrete replacement
288 (D288)Diversion works-Temporary drainage tunnel	cofferdam
289 (D289)Diversion works-Half cofferdam	cofferdam
290 (D290)Diversion works(Temporary drainage open ditch)	Diversion works
291 (D291)Training wall	dam
292 (D292)pipe cooling	cooling
293 (D293)vibrator	construction machinery
294 (D294)Fillet-gravity dam	dam
295 (D295)rod vibrator	construction machinery
296 (D296)transeverse joint	dam
297 (D297)arch dam	arch dam
298 (D298)temporary cofferdam	cofferdam
299 (D299)grouting	grouting
300 (D300)energy dissipator	dam
301 (D301)core type dam	dam
302 (D302)Concrete mixer	construction machinery
303 (D303)flood sluice of fill dam	flood sluice
304 (D304)flood sluice of fill dam	flood sluice
305 (D305)flood sluice of fill dam	flood sluice
306 (D306)flood sluice of fill dam	flood sluice

307 (D307)flood sluice of fill dam	flood sluice
308 (D308)flood sluice of fill dam	flood sluice
309 (D309)flood sluice of fill dam	flood sluice
310 (D310)flood sluice of fill dam	flood sluice
311 (D311)flood sluice of fill dam	flood sluice
312 (D312)flood control	hydraulics
313 (D313)water level	hydraulics
314 (D314)hydraulic cycle	hydraulics
315 (D315)underground dam	dam
316 (D316)regulating reservoir	dam
317 (D317)fill dam	fill dam
318 (D318)fill dam	fill dam
319 (D319)fill dam	fill dam
320 (D320)fill dam	fill dam
321 (D321)effective storage capacity	hydraulics
322 (D322)spillway	dam
323 (D323)flow net	hydraulics
324 (D324)flow net	hydraulics
325 (D325)fixed wheel gate	gate
326 (D326)Diversion works	Diversion works
327 (D327)earth dam(fill dam)	fill dam
328 (D328)RCD method(Roller Compacted Dam-Concrete)	RCD

257 (D257)concrete arch dam	arch dam
297 (D297)arch dam	arch dam
234 (D234)batcher plant	batcher plant
235 (D235)batcher plant	batcher plant
1 (D1)Classification of dams	Classification of dams
37 (D37)River treatment(Temporary drainage tunnel)	cofferdam
38 (D38)River treatment(half river cofferdam)	cofferdam
39 (D39)River treatment(Temporary drainage opening channel)	cofferdam
40 (D40)River treatment(temporary cofferdam)	cofferdam
41 (D41)River treatment(temporary cofferdam)	cofferdam
191 (D191)cofferdam	cofferdam
192 (D192)cofferdam	cofferdam
193 (D193)cofferdam	cofferdam
194 (D194)cofferdam	cofferdam
195 (D195)closing dyke	cofferdam
263 (D263)cofferdam	cofferdam
264 (D264)cofferdam	cofferdam
288 (D288)Diversion works-Temporary drainage tunnel	cofferdam
289 (D289)Diversion works-Half cofferdam	cofferdam
298 (D298)temporary cofferdam	cofferdam
275 (D275)Concrete batching and mixing plant	Concrete batching
14 (D14)Concrete dam construction equipment	Concrete dam construction equipment
15 (D15)Concrete dam construction equipment	Concrete dam construction equipment
16 (D16)Concrete dam construction equipment	Concrete dam construction equipment
17 (D17)Concrete dam construction equipment	Concrete dam construction equipment
18 (D18)Concrete dam construction equipment	Concrete dam construction equipment
19 (D19)Concrete dam construction equipment	Concrete dam construction equipment
20 (D20)Concrete dam construction equipment	Concrete dam construction equipment
21 (D21)Concrete dam construction equipment	Concrete dam construction equipment
22 (D22)Concrete dam construction equipment	Concrete dam construction equipment
23 (D23)Concrete dam construction equipment	Concrete dam construction equipment
24 (D24)Concrete dam construction equipment	Concrete dam construction equipment
25 (D25)Concrete dam construction equipment	Concrete dam construction equipment
26 (D26)Concrete dam construction equipment	Concrete dam construction equipment

27 (D27)Concrete dam construction equipment	Concrete dam construction equipment
28 (D28)Concrete dam construction equipment	Concrete dam construction equipment
29 (D29)Concrete dam construction equipment	Concrete dam construction equipment
30 (D30)Concrete dam construction equipment	Concrete dam construction equipment
31 (D31)Concrete dam construction equipment	Concrete dam construction equipment
273 (D273)concrete replacement	concrete replacement
283 (D283)dowelling method	concrete replacement
287 (D287)concrete replacement for faults	concrete replacement
177 (D177)impact crusher	construction machinery
178 (D178)winch	construction machinery
179 (D179)aerial cableway	construction machinery
181 (D181)cable crane	construction machinery
182 (D182)concrete bucket	construction machinery
183 (D183)conveyor	construction machinery
184 (D184)crusher	construction machinery
189 (D189)jib crane	construction machinery
190 (D190)sheeps-foot roller	construction machinery
208 (D208)jaw crusher	construction machinery
276 (D276)Concrete pump	construction machinery
278 (D278)fixed jib crane	construction machinery
286 (D286)dam construction equipments	construction machinery
293 (D293)vibrator	construction machinery
295 (D295)rod vibrator	construction machinery
302 (D302)Concrete mixer	construction machinery
64 (D64)Construction of concrete dam (Concrete temperature regulation)	cooling
292 (D292)pipe cooling	cooling
71 (D71)Construction of concrete dam (Corridor)	Corridor
32 (D32)length of crest	dam
150 (D150)dam	dam
151 (D151)dam	dam
152 (D152)dam	dam
153 (D153)dam	dam
154 (D154)dam	dam
155 (D155)dam	dam

156 (D156)dam	dam
157 (D157)dam	dam
158 (D158)dam	dam
159 (D159)dam	dam
160 (D160)dam	dam
197 (D197)gravity dam	dam
223 (D223)hollow gravity dam	dam
227 (D227)penstock (head race)	dam
232 (D232)dentated sill	dam
236 (D236)auxiliary dam	dam
239 (D239)floating dam	dam
249 (D249)spillway	dam
250 (D250)log-chute	dam
262 (D262)exterior concrete	dam
265 (D265)dam type power	dam
266 (D266)green cut	dam
267 (D267)clean plant	dam
268 (D268)Slanted seam	dam
269 (D269)cable crane	dam
270 (D270)dam and conduit type power	dam
279 (D279)Concrete gravity dam	dam
282 (D282)slide form	dam
284 (D284)longitudinal joint	dam
285 (D285)Dam concrete division	dam
291 (D291)Training wall	dam
294 (D294)Fillet-gravity dam	dam
296 (D296)transeverse joint	dam
300 (D300)energy dissipator	dam
301 (D301)core type dam	dam
315 (D315)underground dam	dam
316 (D316)regulating reservoir	dam
322 (D322)spillway	dam
8 (D8)Dam construction plan	Dam construction plan
9 (D9)Dam construction plan	Dam construction plan

10 (D10)Dam construction plan	Dam construction plan
11 (D11)Dam construction plan	Dam construction plan
12 (D12)Dam construction plan	Dam construction plan
13 (D13)Dam construction plan	Dam construction plan
2 (D2)Dam structure	Dam structure
3 (D3)Dam structure	Dam structure
4 (D4)Dam structure	Dam structure
5 (D5)Dam structure	Dam structure
6 (D6)Dam structure	Dam structure
7 (D7)Dam structure	Dam structure
164 (D164)dam(construction order)	dam(construction order)
165 (D165)dam(construction order)	dam(construction order)
166 (D166)dam(construction order)	dam(construction order)
167 (D167)dam(construction order)	dam(construction order)
161 (D161)dam(Diversion works)	dam(Diversion works)
162 (D162)dam(Diversion works)	dam(Diversion works)
163 (D163)dam(Diversion works)	dam(Diversion works)
290 (D290)Diversion works(Temporary drainage open ditch)	Diversion works
326 (D326)Diversion works	Diversion works
202 (D202)dredging(Pump dredger)	dredging
203 (D203)dredging(Bucket dredger)	dredging
204 (D204)dredging(Grab dredger)	dredging
205 (D205)dredging(Dipper dredger)	dredging
172 (D172)dam(earth dam)	earth dam
173 (D173)dam(earth dam)	earth dam
174 (D174)dam(arch dam)	earth dam
87 (D87)fill dam	fill dam
88 (D88)fill dam	fill dam
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93 (D93)fill dam	fill dam
94 (D94)fill dam	fill dam

95 (D95)fill dam	fill dam
96 (D96)fill dam	fill dam
97 (D97)fill dam(test filling)	fill dam
98 (D98)fill dam(test filling)	fill dam
99 (D99)fill dam(test filling)	fill dam
100 (D100)fill dam(test filling)	fill dam
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123 (D123)fill dam	fill dam
168 (D168)dam(fill dam)	fill dam
169 (D169)dam(rock fill dam)	fill dam
170 (D170)dam(rock fill dam)	fill dam
171 (D171)dam(rock fill dam)	fill dam
229 (D229)internal impervious wall	fill dam

230 (D230)internal impervious wall	fill dam
317 (D317)fill dam	fill dam
318 (D318)fill dam	fill dam
319 (D319)fill dam	fill dam
320 (D320)fill dam	fill dam
327 (D327)earth dam(fill dam)	fill dam
256 (D256)rock fill dam	fill dam
303 (D303)flood sluice of fill dam	flood sluice
304 (D304)flood sluice of fill dam	flood sluice
305 (D305)flood sluice of fill dam	flood sluice
306 (D306)flood sluice of fill dam	flood sluice
307 (D307)flood sluice of fill dam	flood sluice
308 (D308)flood sluice of fill dam	flood sluice
309 (D309)flood sluice of fill dam	flood sluice
310 (D310)flood sluice of fill dam	flood sluice
311 (D311)flood sluice of fill dam	flood sluice
42 (D42)foundation excavation(topsoil excavation)	foundation excavation
43 (D43)foundation excavation(rough excavation)	foundation excavation
44 (D44)foundation excavation(finishing excavation)	foundation excavation
45 (D45)foundation excavation(excavation surface protection)	foundation excavation
217 (D217)gate	gate
325 (D325)fixed wheel gate	gate
33 (D33)Concrete dam construction equipment(Stage grouting)	grouting
34 (D34)Concrete dam construction equipment(Stage grouting)	grouting
35 (D35)Concrete dam construction equipment(grouting)	grouting
36 (D36)Concrete dam construction equipment(grouting)	grouting
70 (D70)Concrete temperature regulation(Joint grouting)	grouting
72 (D72)Construction of concrete dam (Foundation drainage hole)	grouting
124 (D124)foundation treatment(grouting)	grouting
125 (D125)foundation treatment(grouting)	grouting
126 (D126)foundation treatment(grouting)	grouting
127 (D127)foundation treatment(grouting)	grouting
128 (D128)foundation treatment(grouting)	grouting
129 (D129)foundation treatment(grouting)	grouting

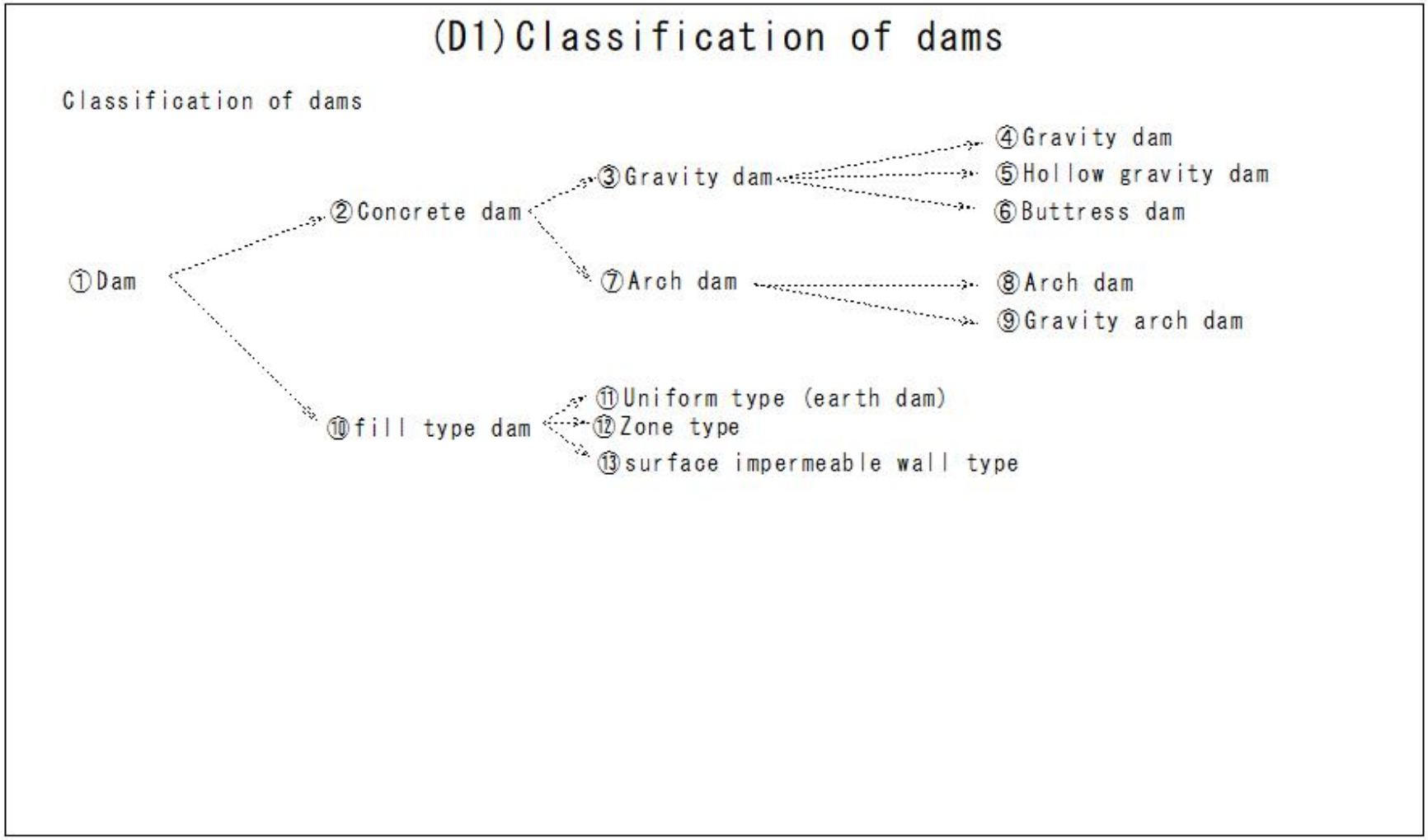
130 (D130)foundation treatment(grouting)	grouting
131 (D131)foundation treatment(grouting)	grouting
132 (D132)foundation treatment(grouting)	grouting
133 (D133)foundation treatment(grouting)	grouting
134 (D134)foundation treatment(grouting)	grouting
135 (D135)foundation treatment(grouting)	grouting
136 (D136)foundation treatment(grouting)	grouting
137 (D137)foundation treatment(grouting)	grouting
138 (D138)foundation treatment(grouting)	grouting
139 (D139)foundation treatment(grouting)	grouting
140 (D140)foundation treatment(grouting)	grouting
141 (D141)foundation treatment(grouting)	grouting
142 (D142)foundation treatment(grouting)	grouting
143 (D143)foundation treatment(grouting)	grouting
144 (D144)foundation treatment(grouting)	grouting
145 (D145)foundation treatment(grouting)	grouting
146 (D146)foundation treatment(grouting)	grouting
147 (D147)foundation treatment(grouting)	grouting
148 (D148)foundation treatment(grouting)	grouting
149 (D149)foundation treatment(grouting)	grouting
277 (D277)consolidation grouting	grouting
280 (D280)joint grouting lift	grouting
281 (D281)Stage grouting	grouting
299 (D299)grouting	grouting
176 (D176)dam(potential head)	hydraulics
180 (D180)design flood discharge	hydraulics
185 (D185)surge-tank	hydraulics
186 (D186) differential surge-tank	hydraulics
187 (D187)natural head	hydraulics
188 (D188)control section	hydraulics
196 (D196)supercritical flow(shooting flow /rapid flow)	hydraulics
207 (D207)ordinary flow	hydraulics
209 (D209)penstock root	hydraulics
213 (D213)water hammmer	hydraulics

214 (D214)chamber surge tank	hydraulics
215 (D215)hydraulic turbine	hydraulics
216 (D216)efficiency of hydraulic turbine	hydraulics
218 (D218)best hydraulic cross-section	hydraulics
219 (D219)Hydraulic water depth	hydraulics
220 (D220)conduct type water power	hydraulics
222 (D222)backwater curve	hydraulics
224 (D224)hydraulic jump	hydraulics
225 (D225)deflector	hydraulics
226 (D226)head works	hydraulics
228 (D228)sediment settling	hydraulics
231 (D231)interflow	hydraulics
237 (D237)unsteady flow	hydraulics
238 (D238)impermeability layer	hydraulics
240 (D240)watershed	hydraulics
241 (D241)equilibrium slope	hydraulics
242 (D242)parallel drainage	hydraulics
243 (D243)radial drainage	hydraulics
244 (D244)tail-race surge tank	hydraulics
245 (D245)spatter's effect	hydraulics
246 (D246)effective head	hydraulics
247 (D247)pumped storage power	hydraulics
248 (D248)pump-up head	hydraulics
251 (D251)basin coefficient	hydraulics
252 (D252)discharge -duration curve	hydraulics
253 (D253)flow net	hydraulics
254 (D254)velocity of flow	hydraulics
255 (D255)water course	hydraulics
312 (D312)flood control	hydraulics
313 (D313)water level	hydraulics
314 (D314)hydraulic cycle	hydraulics
321 (D321)effective storage capacity	hydraulics
323 (D323)flow net	hydraulics
324 (D324)flow net	hydraulics

198 (D198)water-intake	intake
199 (D199)intake	intake
200 (D200)intake dam	intake
201 (D201)intake dam	intake
66 (D66)Concrete temperature regulation(Pipe cooling)	Pipe cooling
67 (D67)Concrete temperature regulation(Pipe cooling)	Pipe cooling
68 (D68)Concrete temperature regulation(Pipe cooling)	Pipe cooling
69 (D69)Concrete temperature regulation(Pipe cooling)	Pipe cooling
46 (D46)Construction of concrete dam (conventional method)	placing concrete
47 (D47)Construction of concrete dam (conventional method)	placing concrete
48 (D48)Construction of concrete dam (conventional method)	placing concrete
49 (D49)Construction of concrete dam (conventional method)	placing concrete
50 (D50)Construction of concrete dam (conventional method)	placing concrete
51 (D51)Construction of concrete dam (conventional method)	placing concrete
52 (D52)Construction of concrete dam (placing concrete)	placing concrete
53 (D53)Construction of concrete dam (placing concrete)	placing concrete
54 (D54)Construction of concrete dam (placing concrete)	placing concrete
55 (D55)Construction of concrete dam (placing concrete)	placing concrete
56 (D56)Construction of concrete dam (placing concrete)	placing concrete
57 (D57)Construction of concrete dam (placing concrete)	placing concrete
58 (D58)Construction of concrete dam (placing concrete)	placing concrete
59 (D59)Construction of concrete dam (placing concrete)	placing concrete
60 (D60)Construction of concrete dam (placing concrete)	placing concrete
61 (D61)Construction of concrete dam (placing concrete-formwork)	placing concrete-formwork
62 (D62)Construction of concrete dam (placing concrete-formwork)	placing concrete-formwork
63 (D63)Construction of concrete dam (placing concrete-formwork)	placing concrete-formwork
65 (D65)Concrete temperature regulation(Pre-cooling)	Pre-cooling
271 (D271)Quarry	Quarry
258 (D258)roller compacted concrete dams(RCD)	RCD
259 (D259)roller compacted concrete dams(RCD)	RCD
260 (D260)roller compacted concrete dams(RCD)	RCD
328 (D328)RCD method(Roller Compacted Dam-Concrete)	RCD
74 (D74)Construction of concrete dam using RCD method	RCD method
75 (D75)RCD method	RCD method

76 (D76)RCD method	RCD method
77 (D77)RCD method	RCD method
78 (D78)RCD method	RCD method
79 (D79)RCD method	RCD method
80 (D80)RCD method	RCD method
81 (D81)RCD method	RCD method
82 (D82)RCD method	RCD method
83 (D83)RCD method	RCD method
84 (D84)RCD method	RCD method
85 (D85)RCD method	RCD method
86 (D86)RCD method	RCD method
175 (D175)dam(RCD method)	RCD method
274 (D274)RCD method(concrete vibrating joint cutter)	RCD method
272 (D272)spillway	spillway
73 (D73)Construction of concrete dam (Water stop plate and joint drainage hole)	Water stop plate
206 (D206)wetted perimeter	water-level recorder
210 (D210)stage	water-level recorder
211 (D211)water-level recorder	water-level recorder
212 (D212)water-level recorder	water-level recorder
221 (D221)weir	weir
233 (D233)sharp crested weir	weir
261 (D261)Movable weir	weir

(D1)Classification of dams



(D2)Dam structure

(D2)Dam structure

Dam structure

①Gravity dam

- Spillway: Possible to install on the downstream side of the embankment body

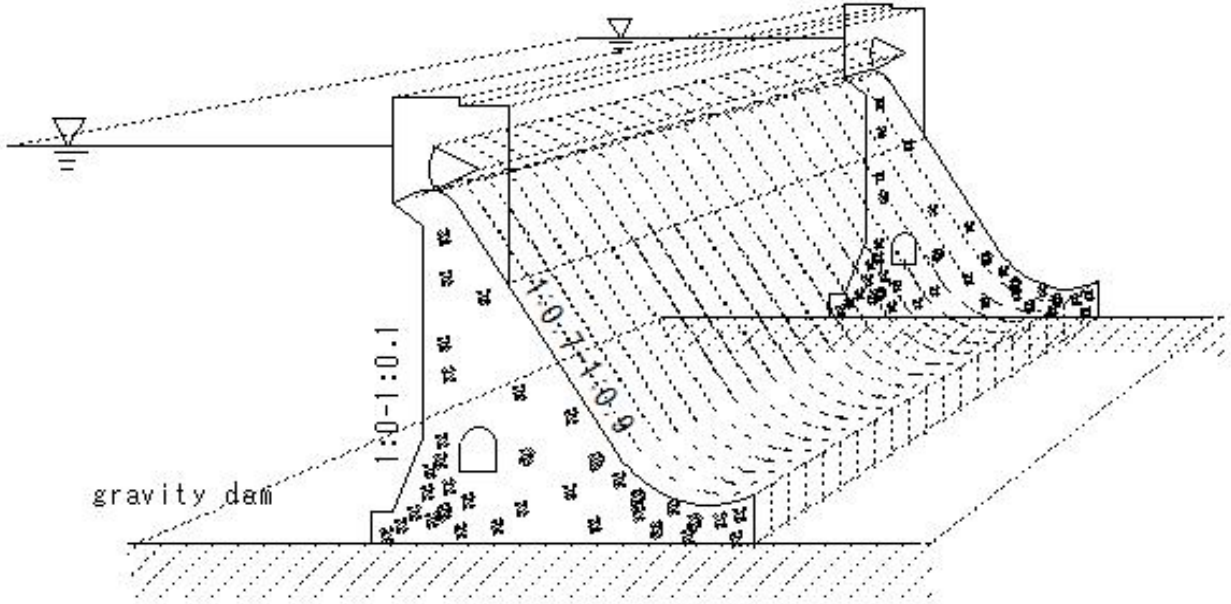
・Structural stability of gravity dams

①No vertical tensile stress is generated on the upstream surface of the dam body.

②Contact surface between dam body and foundation rock

Be safe against shear forces

③The stress within the dam body does not exceed the allowable stress of the concrete.



(D3)Dam structure

(D3)Dam structure

Dam structure

②Arch dam

・External forces such as water pressure are transmitted to both banks by the arching action of the embankment body.

Supported by the shear resistance of the foundation rock

・Both cross section and planar shape have a convex curve upstream.

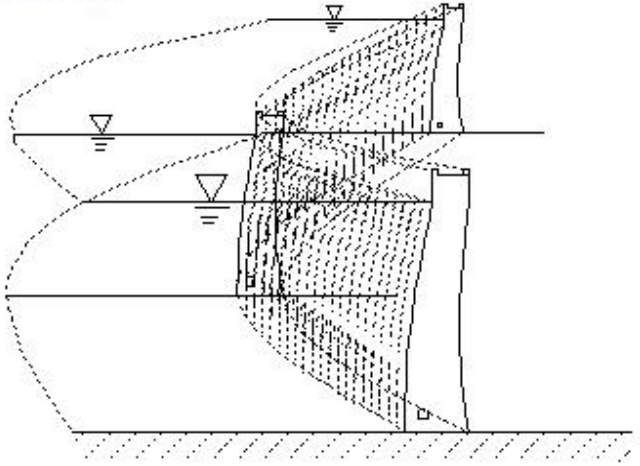
・Solid rock is required from the riverbed to the high areas on both banks.

・Structural stability of arch dam

①The stress within the dam body does not exceed the allowable stress of the concrete.

②Contact surface between dam body and foundation rock

Be safe against shear forces



(D4)Dam structure

(D4)Dam structure

Dam structure

②fill type dam

- The stress acting on the foundation ground is small.
- The embankment body adapts to slight deformation of the foundation.
- Can be constructed on all types of ground
- Seepage failure: It is necessary to consider damage to the embankment body due to overflow.
- Do not install a spillway (discharge facility) on the embankment body.

fill type dam stability condition

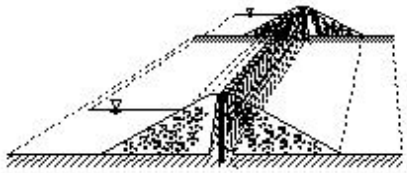
- Safe against infiltration water
- Safe against slipping

Uniform type

R591

Surface impermeable wall type

R592



artificial material core

R593

(D5)Dam structure

(D5)Dam structure

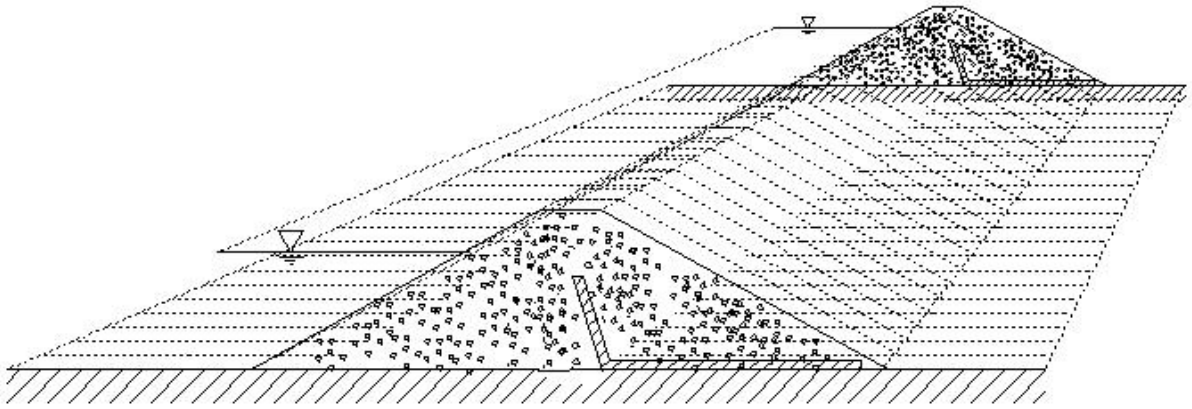
Dam structure

②fill type dam

①Uniform type

Drain placed downstream

- Easy to construct
- Pore water pressure is difficult to dissipate during construction
- shear strength of material-low
- Used for dams with low embankments (30 m or less)



Uniform type

spillway installed on the ground

R591

(D6)Dam structure

(D6)Dam structure

Dam structure

②fill type dam

②Zone type

composition

・impermeable zone(Waterproof zone)

・Semi-permeable zone

・Permeable zone

・Central core type and inclined core type at the position of the water-blocking zone

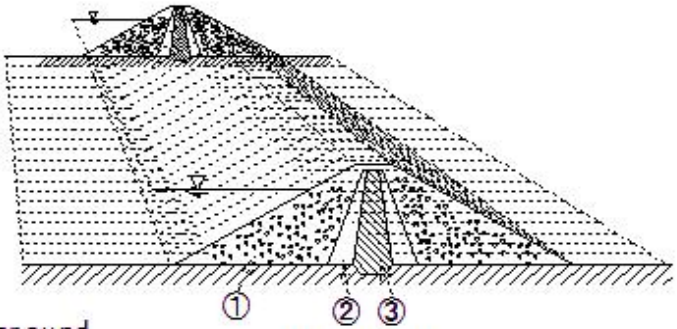
・The most suitable design can be made according to the topography, geology, and materials of the dam.

・It has the widest range of application and is adopted for large-scale field dams.

①permeable material

②Semi-permeable material

③Waterproof(Impermeable) material

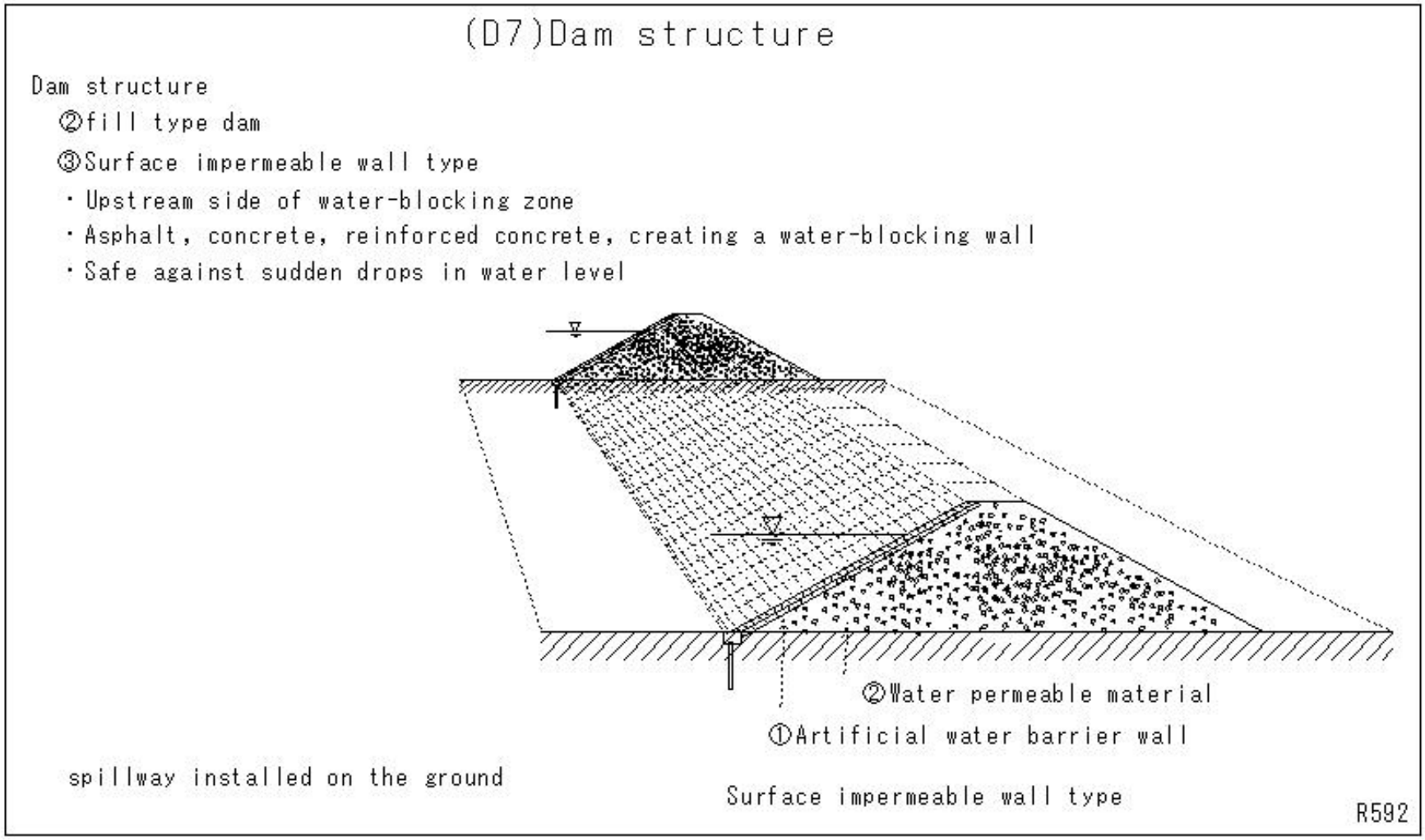


spillway installed on the ground

zone type

R590

(D7)Dam structure

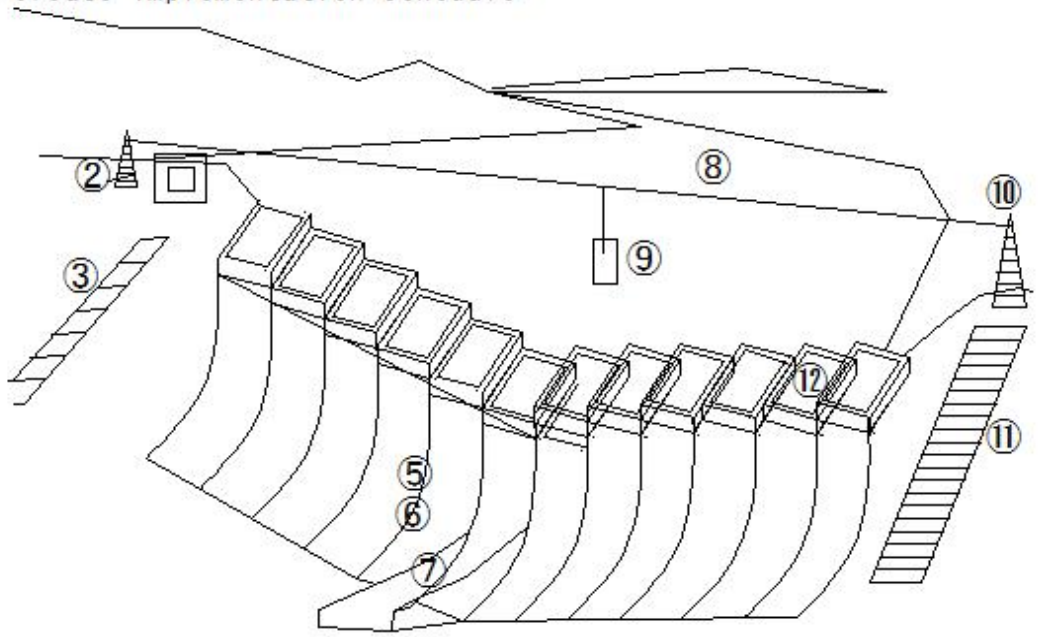


(D8)Dam construction plan

(D8)Dam construction plan

Dam construction plan

- Process planning
- Dam construction: A collection of various construction works
- Understand critical work types that affect the entire process
- Create implementation schedule



①Layer construction method
②crane fixed tower
③transfer car
④Precautions when transporting concrete
⑤transverse seam
⑥insert the water stop plate
⑦drainage channel
⑧cable crane
⑨concrete bucket
⑩crane running tower
⑪Adjust the position according to the placement location
⑫sliding formwork
⑬no vertical seams
⑭Laitance processing
⑮green cut
⑯continuous driving
⑰1 lift: 1.5m to 2.0m
⑱Construction in 3 to 4 layers
⑲hydration heat treatment
⑳Consideration for cold joints

C906

(D9)Dam construction plan

(D9)Dam construction plan

Dam construction plan

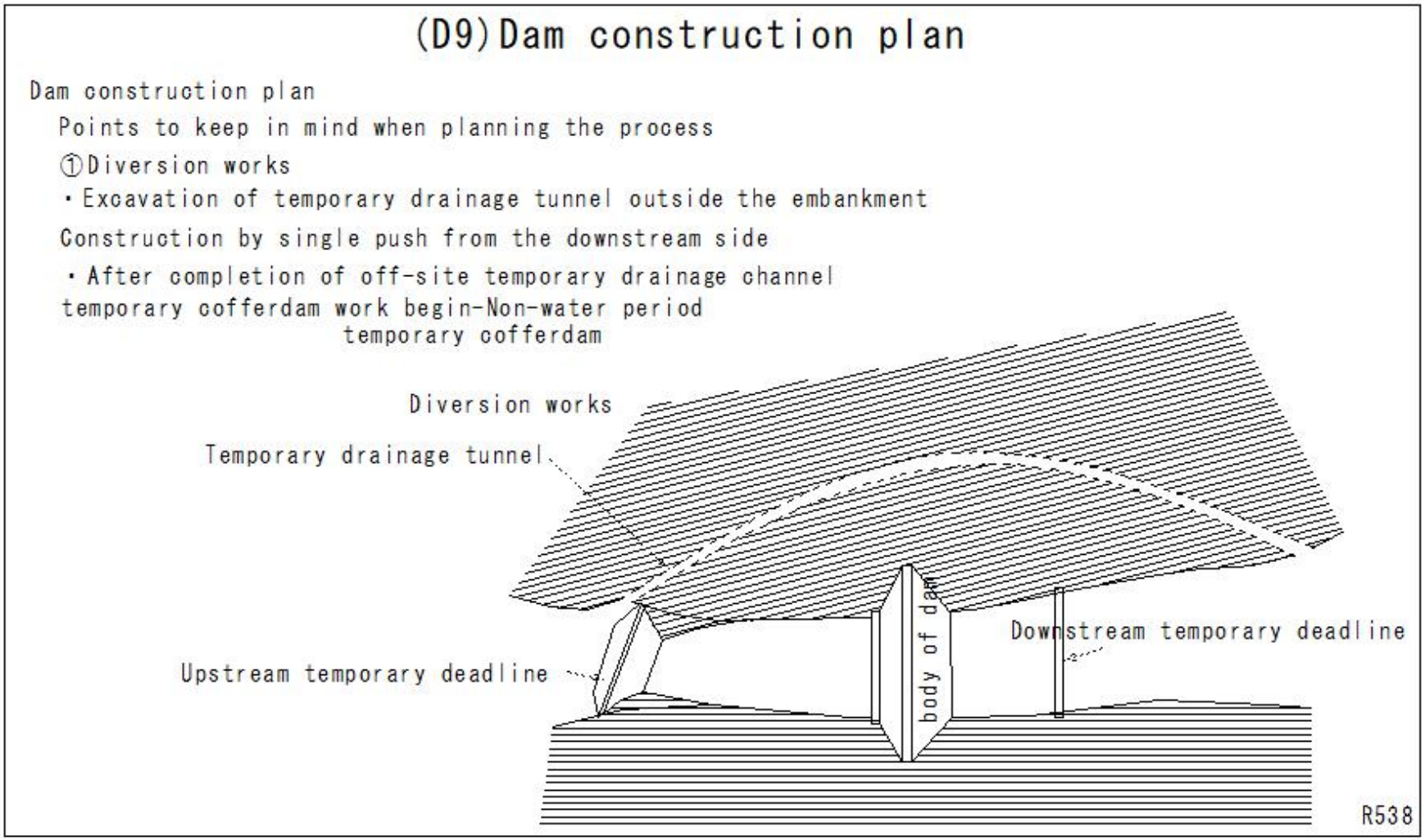
Points to keep in mind when planning the process

①Diversion works

・Excavation of temporary drainage tunnel outside the embankment

Construction by single push from the downstream side

・After completion of off-site temporary drainage channel temporary cofferdam work begin-Non-water period



(D10)Dam construction plan

(D10)Dam construction plan

Dam construction plan

Points to keep in mind - planning the process

②foundation treatment

・Grouching: Simultaneous construction at the same location as the main construction

Process adjustment between both parties is required.

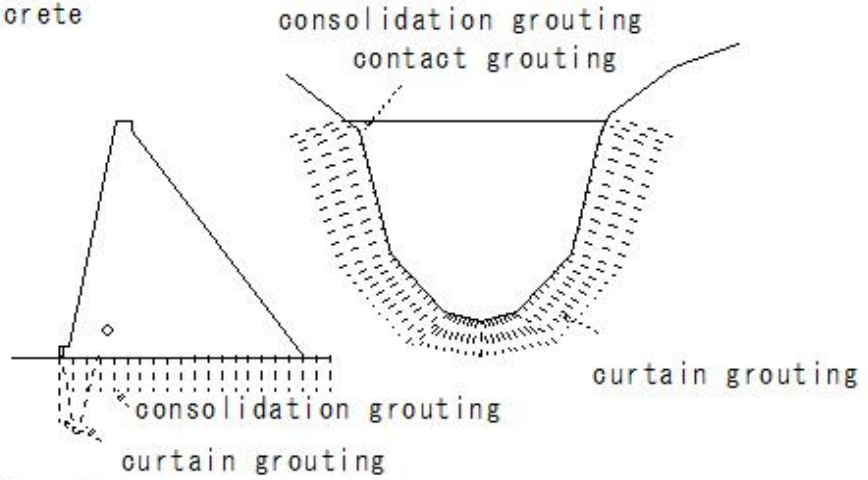
・Concrete dam

①Between consolidation grouting and main concrete

fill dam stability condition

Between blanket grouting and body raising

Process adjustment required



Adjustment of basic treatment process

①Increase in the number of machinery and equipment

②Construction during main construction suspension period in winter

③Speed up with Packachon boring machine

(D11)Dam construction plan

(D11)Dam construction plan

Dam construction plan

Points to keep in mind- planning the process

③main body work

①Concrete dam

Main body concrete placement process

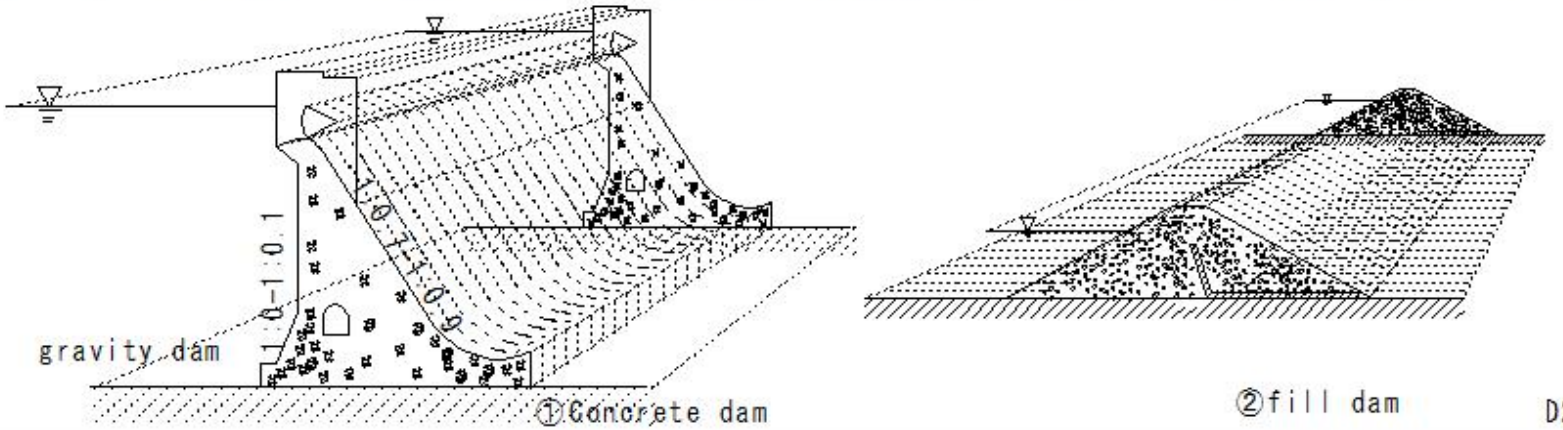
・Create a lift schedule that takes into consideration construction capacity, pouring intervals, lift differences, etc.

・Highly accurate study

②fill dam

・Determine construction capacity from the rough construction period of heaving

Consider the selection and placement of construction machinery that suits the site conditions



D2 D4

(D12)Dam construction plan

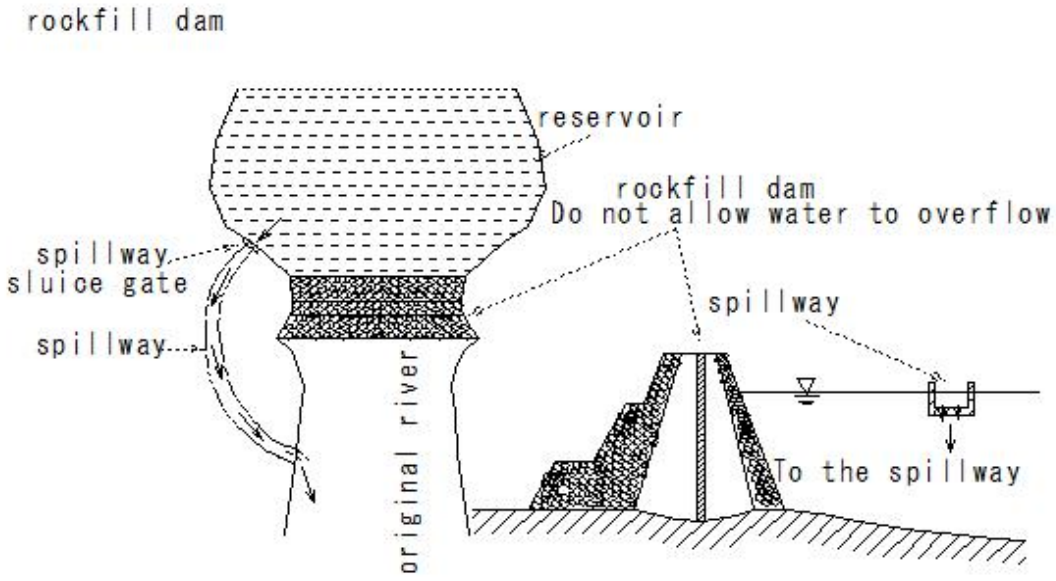
(D12)Dam construction plan

Dam construction plan

Points to keep in mind - planning the process

④Closure work

・The period of blockage for both the off-site temporary drainage channel and the on-site temporary drainage channel is the non-flow period.



R505

(D13)Dam construction plan

(D13)Dam construction plan

Dam construction plan

Points to keep in mind -planning the process

⑤spillway(floodway) of fill type dam

・Floodwaters of field dams must not be built on the embankment body.

・Rocks on the ground

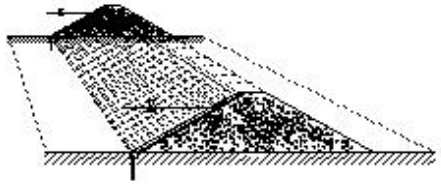
・case of the spillway(floodway) contact with the body

To avoid any hindrance to the embankment filling process

Advance concrete pouring

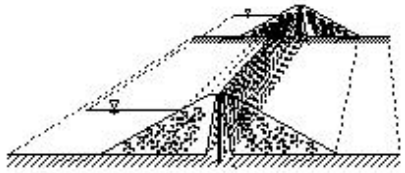
Uniform type

R591



Surface impermeable wall type

R592



artificial material core

R593

(D14)Concrete dam construction equipment

(D14)Concrete dam construction equipment

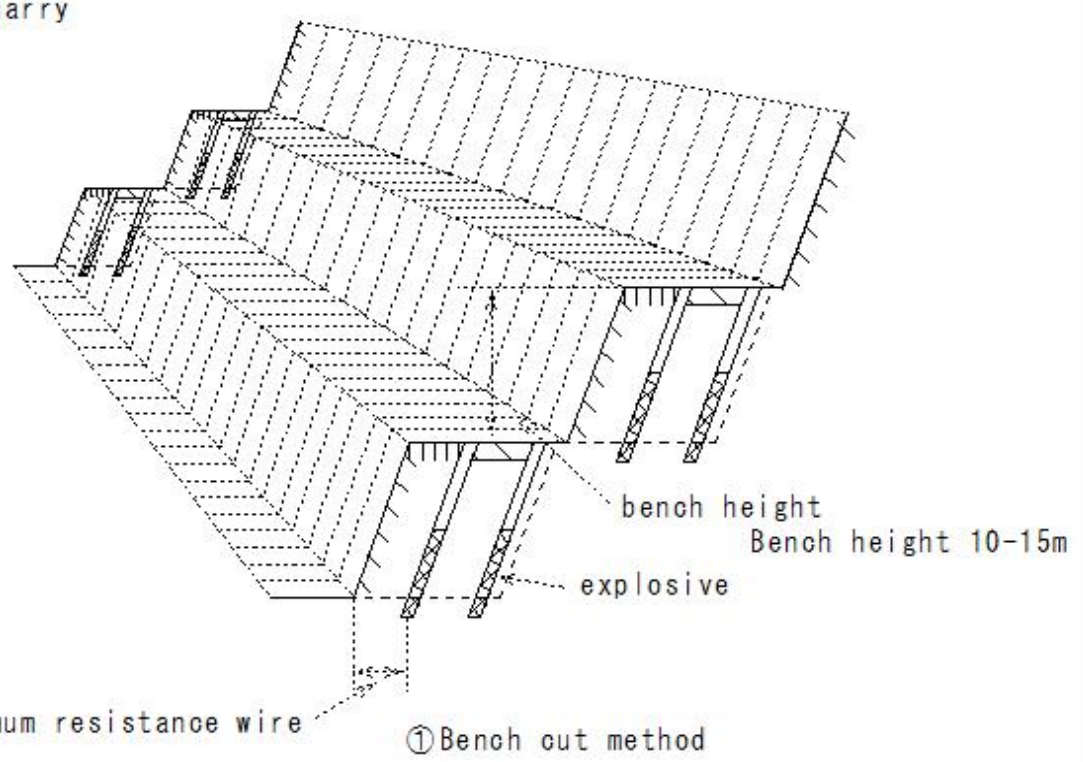
Aggregate manufacturing equipment

①Aggregate collection

・Aggregate: River gravel

Collecting rough stones from the Quarry

Excavation of Quarry



①Bench cut method

(D15)Concrete dam construction equipment

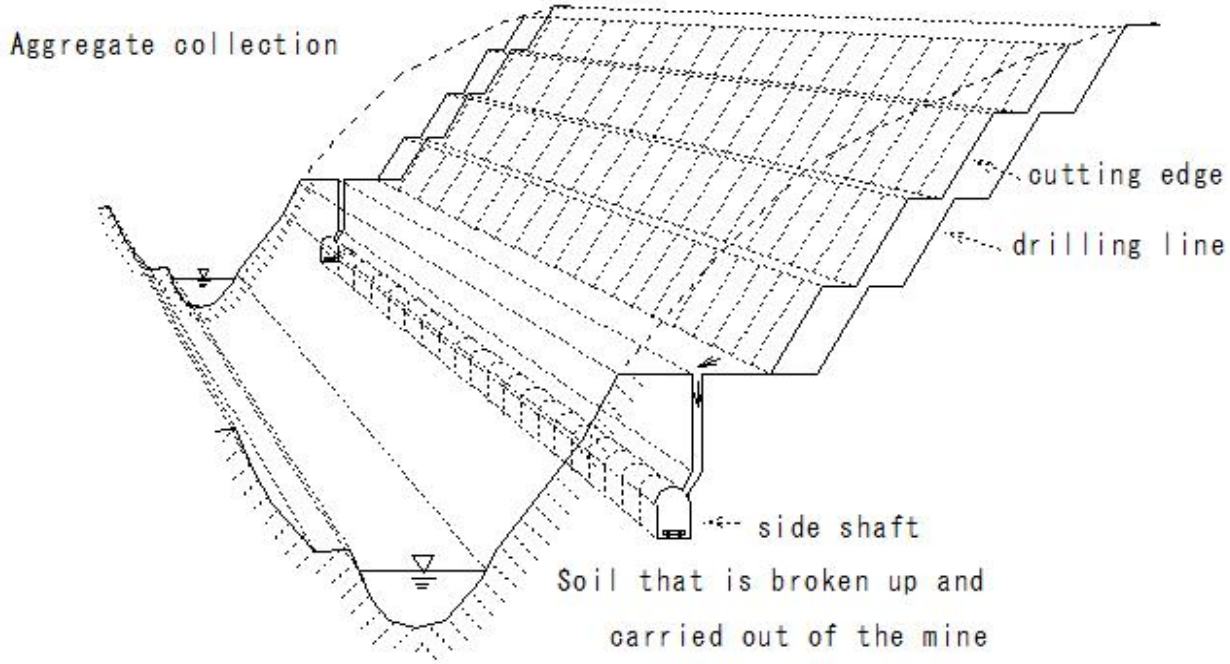
(D15)Concrete dam construction equipment

Concrete dam construction equipment

Aggregate manufacturing equipment

①Aggregate collection

②side shaft:Soil that is broken up and carried out of the mine



(D16)Concrete dam construction equipment

(D16)Concrete dam construction equipment

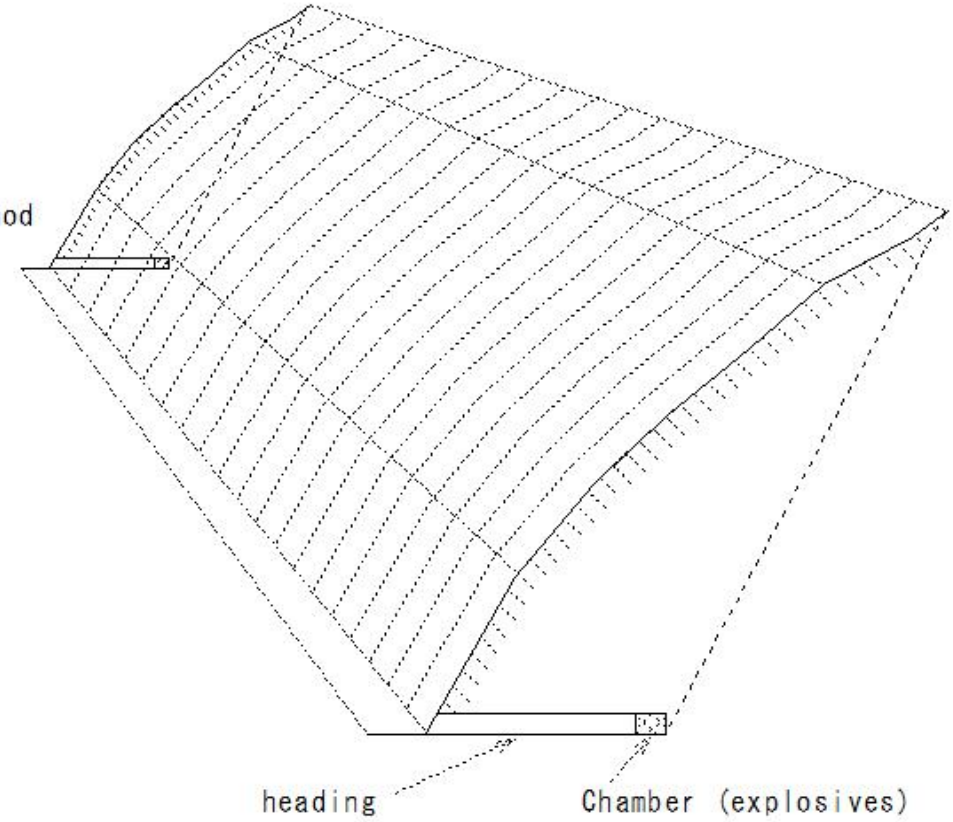
Concrete dam construction equipment

Aggregate manufacturing equipment

①Aggregate collection

③heading blasting method

heading blasting method



(D17)Concrete dam construction equipment

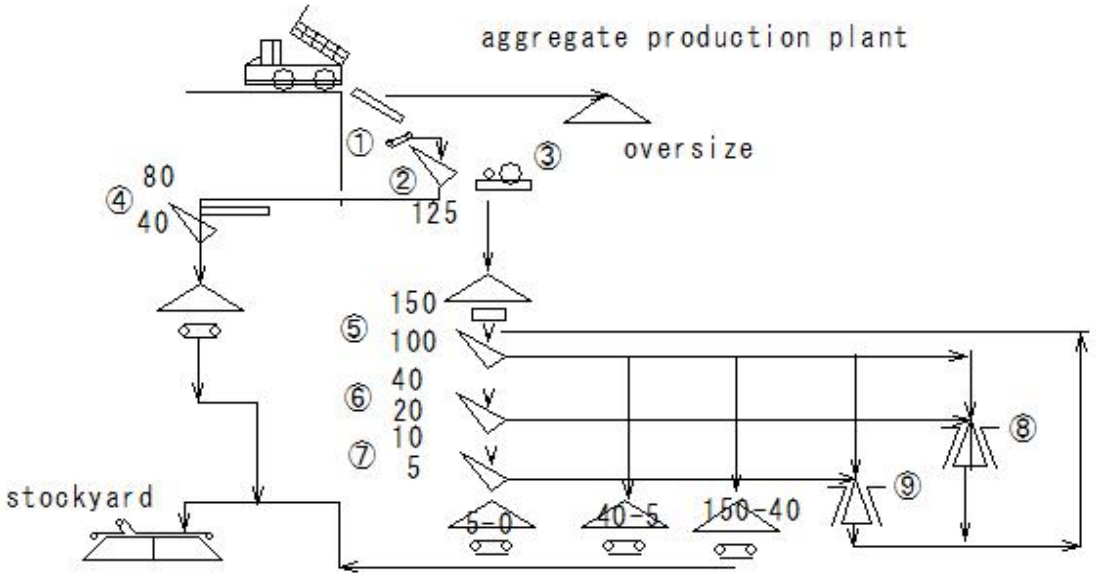
(D17)Concrete dam construction equipment

Concrete dam construction equipment

Aggregate manufacturing equipment

- Crushing, sorting, and cleaning of rough stone
- Have specified particle size and quality
- Equipment capacity: lift schedule
- Consideration of aggregate production volume that corresponds to the monthly maximum pouring volume

aggregate production plant



aggregate production plant

①Apron feeder

②Vibrating sieve

③Jaw crusher

④Vibrating sieve

⑤Vibrating sieve

⑥Vibrating sieve

⑦Vibrating sieve

⑧Cone crusher

⑨Super fine crusher

(D18)Concrete dam construction equipment

(D18)Concrete dam construction equipment

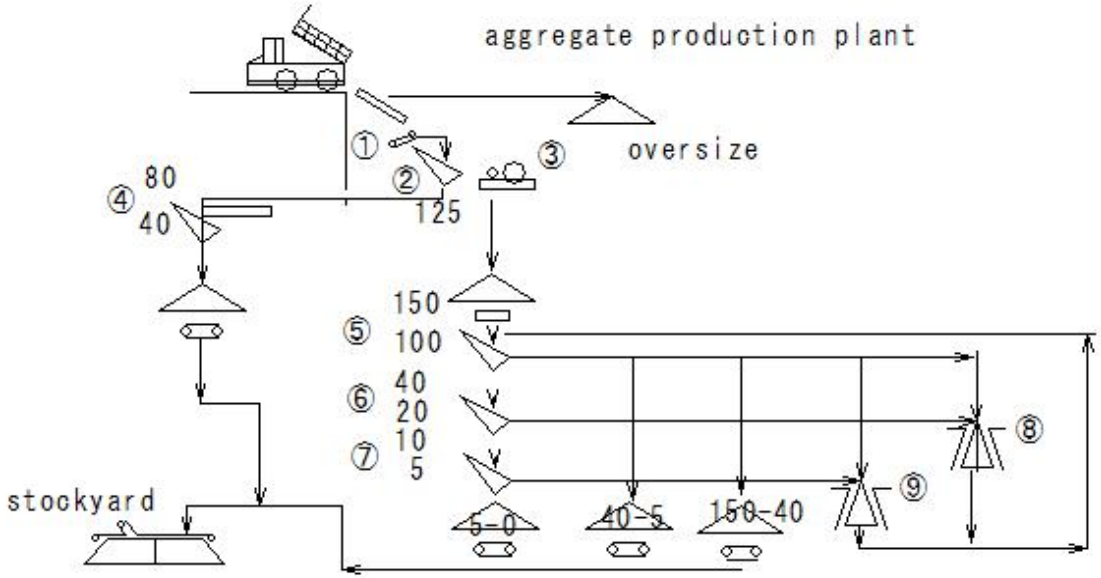
Concrete dam construction equipment

Aggregate manufacturing equipment

①Crushing equipment

・Primary crushing equipment: jaw crusher

・Second and tertiary crushing equipment: Cone crusher



aggregate production plant

①Apron feeder

②Vibrating sieve

③Jaw crusher

④Vibrating sieve

⑤Vibrating sieve

⑥Vibrating sieve

⑦Vibrating sieve

⑧Cone crusher

⑨Super fine crusher

(D19)Concrete dam construction equipment

(D19)Concrete dam construction equipment

Concrete dam construction equipment

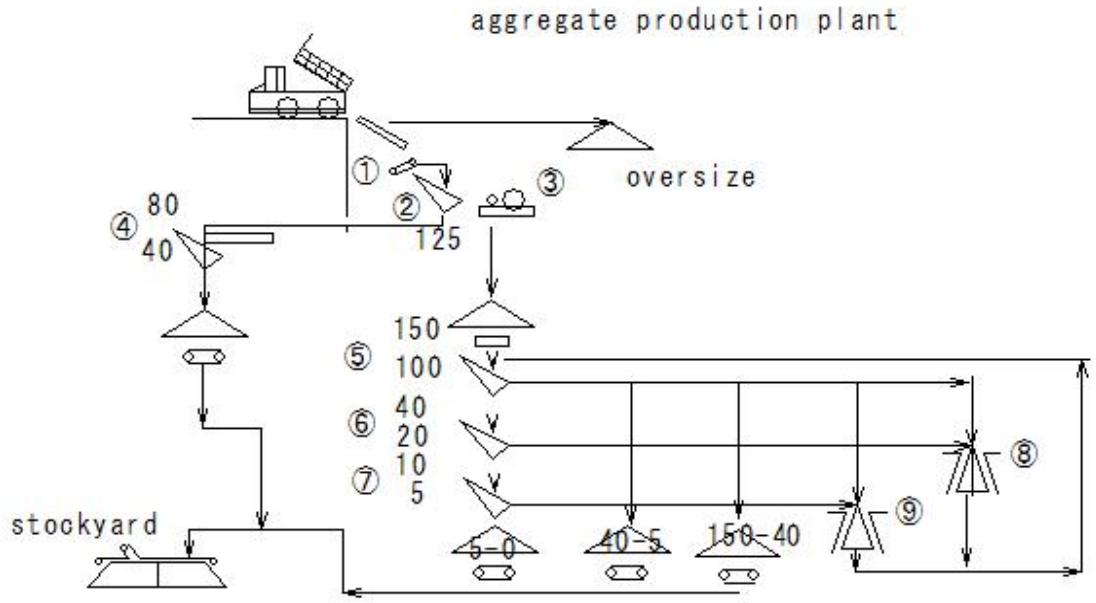
Aggregate manufacturing equipment

②Sieving equipment

・Sieving of aggregate: vibrating sieve

・Slanted type (for large particle size)

・Horizontal type (for medium and small particle size)



aggregate production plant

①Apron feeder

②Vibrating sieve

③Jaw crusher

④Vibrating sieve

⑤Vibrating sieve

⑥Vibrating sieve

⑦Vibrating sieve

⑧Cone crusher

⑨Super fine crusher

(D20)Concrete dam construction equipment

(D20)Concrete dam construction equipment

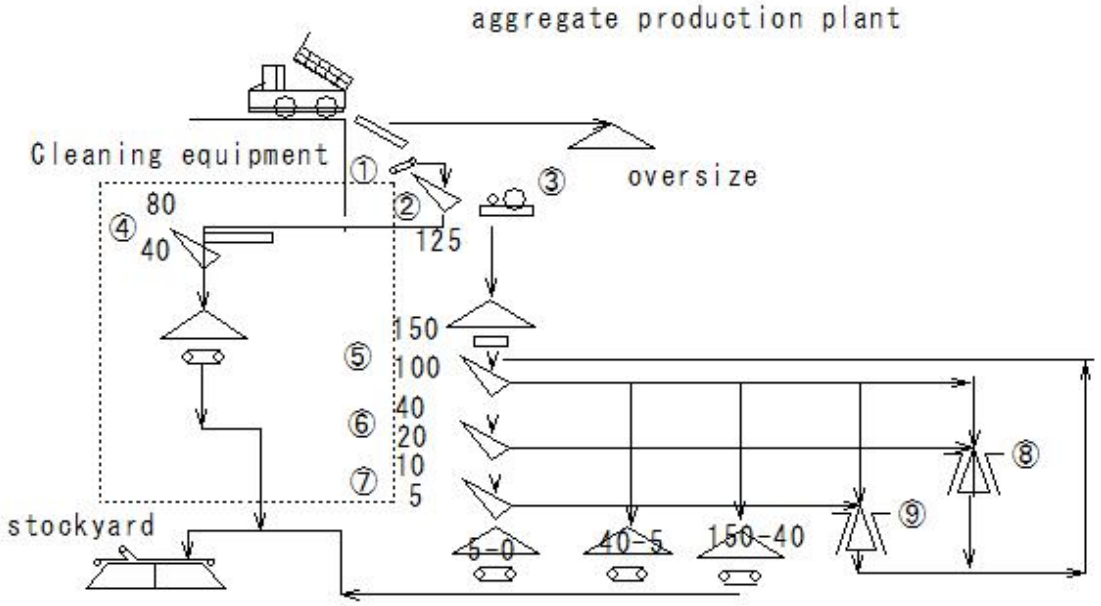
Concrete dam construction equipment

Aggregate manufacturing equipment

③Cleaning equipment

・Cleaning: Removes clay and harmful minerals mixed with aggregate

・Spray pressurized water during sieving



aggregate production plant

①Apron feeder

②Vibrating sieve

③Jaw crusher

④Vibrating sieve

⑤Vibrating sieve

⑥Vibrating sieve

⑦Vibrating sieve

⑧Cone crusher

⑨Super fine crusher

(D21)Concrete dam construction equipment

(D21)Concrete dam construction equipment

Concrete dam construction equipment

Aggregate manufacturing equipment

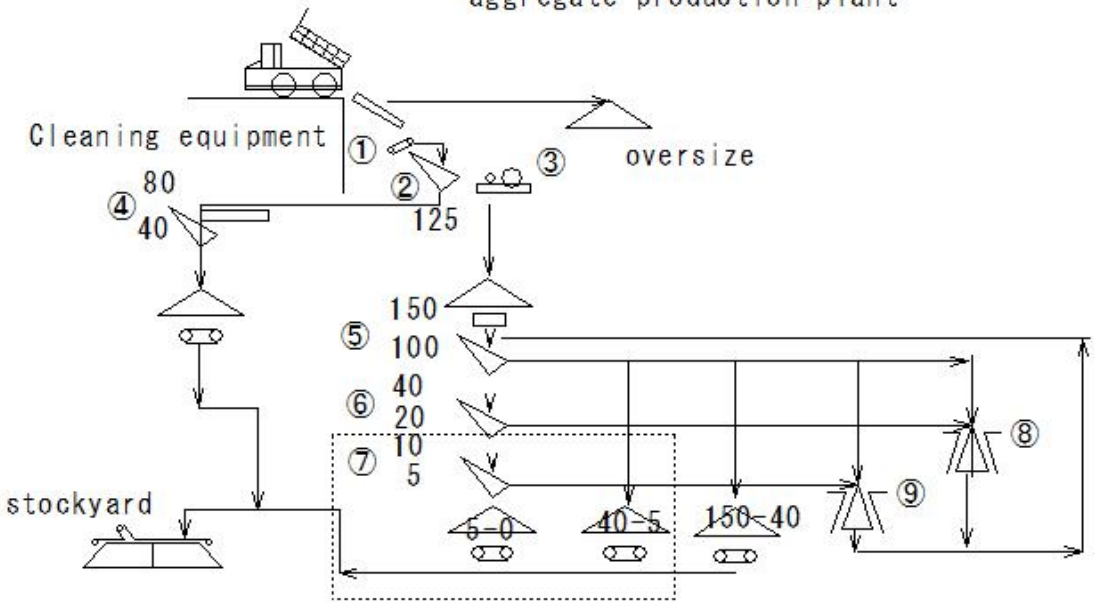
④Sand making equipment

・Aggregates with a diameter of 20 mm or less are used as raw materials.

・Manufactured with a rod mill

・Installing rough stone bins to ensure uniform supply of material

aggregate production plant



aggregate production plant

①Apron feeder

②Vibrating sieve

③Jaw crusher

④Vibrating sieve

⑤Vibrating sieve

⑥Vibrating sieve

⑦Vibrating sieve

⑧Cone crusher

⑨Super fine crusher

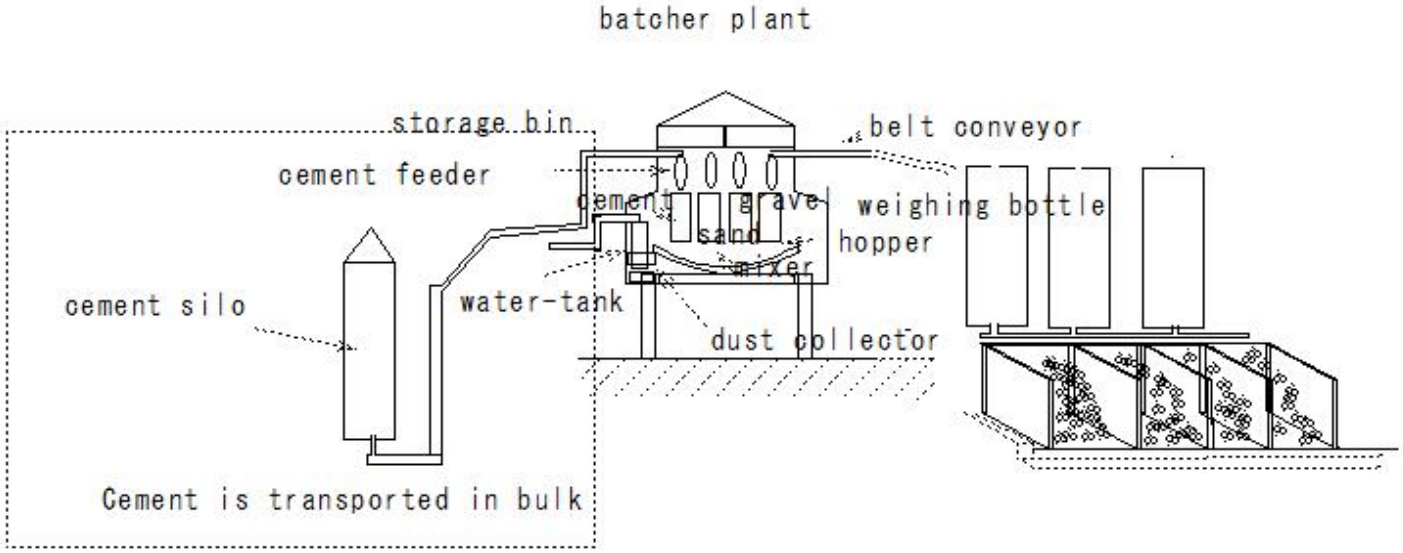
(D22)Concrete dam construction equipment

(D22)Concrete dam construction equipment

Concrete dam construction equipment

cement storage equipment

- Cement silo: Steel cylindrical silo
- Capacity: 2-5 days worth of average daily usage fee



C860

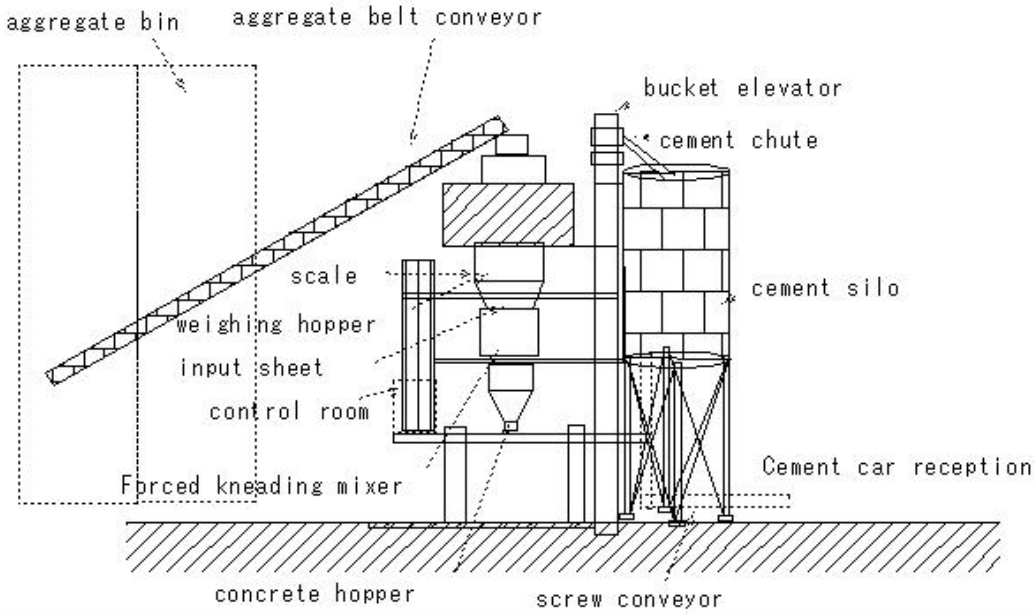
(D23)Concrete dam construction equipment

(D23)Concrete dam construction equipment

concrete manufacturing equipment

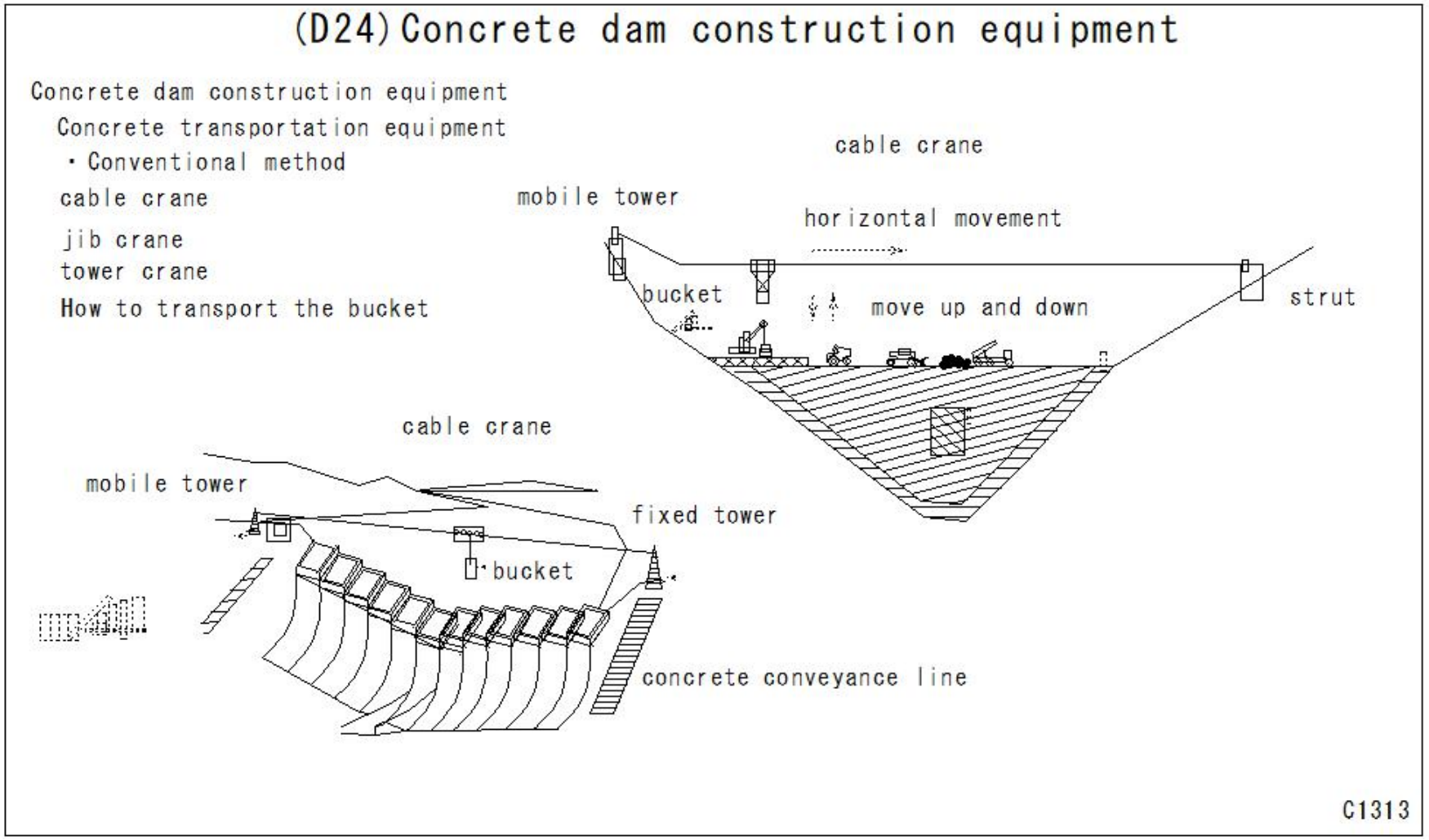
Batcher plant capacity: Based on monthly maximum pouring volume

- Operating hours per working day
- Considering the maximum pouring capacity of concrete transport equipment
- Represented by mixer capacity
- Mixer: Tilting mixer, 2-shaft forced kneading mixer

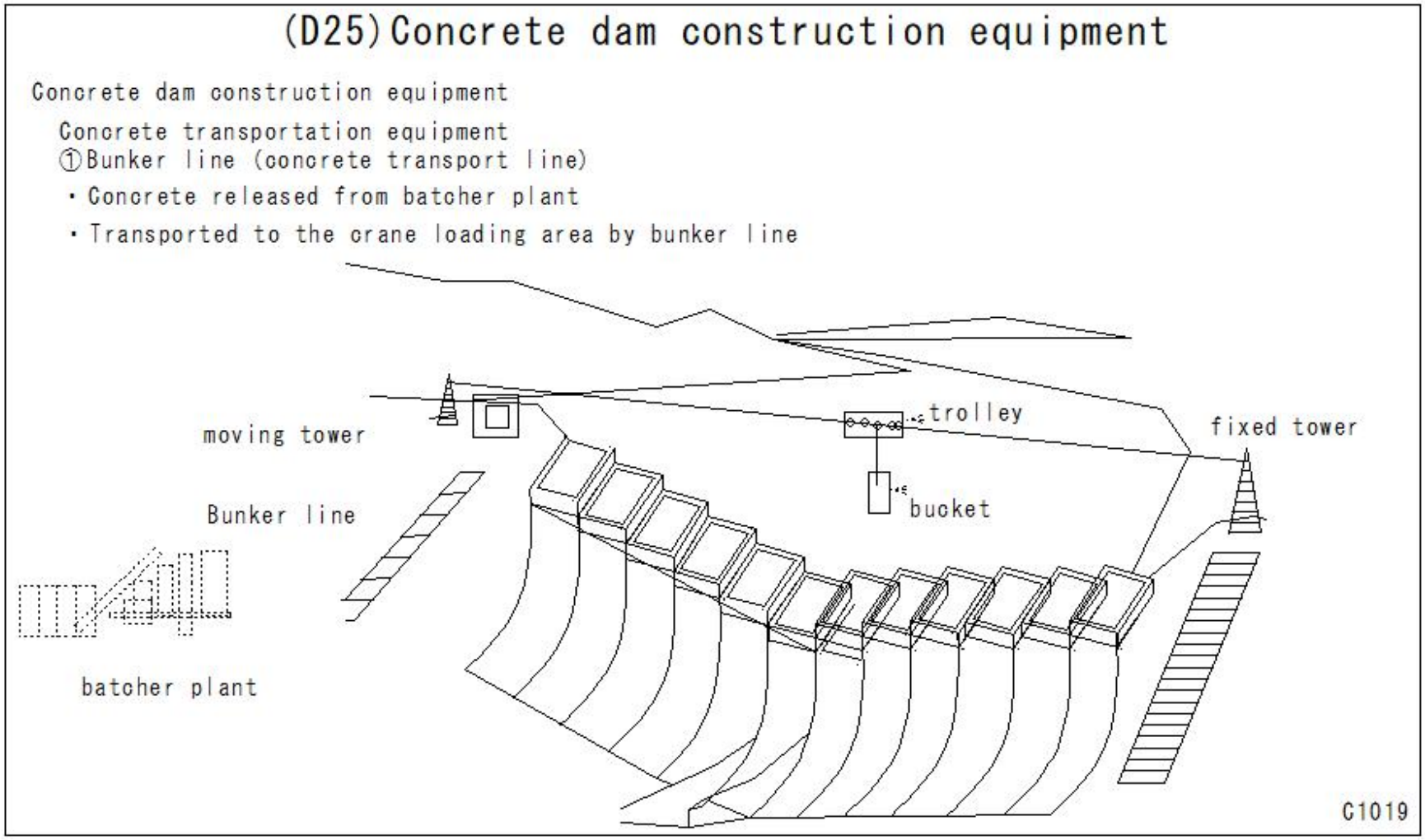


C1031

(D24)Concrete dam construction equipment



(D25)Concrete dam construction equipment



(D26)Concrete dam construction equipment

(D26)Concrete dam construction equipment

Concrete dam construction equipment

Concrete transportation equipment

②Main concrete transportation equipment

(a)Cable crane

・Used in many dams

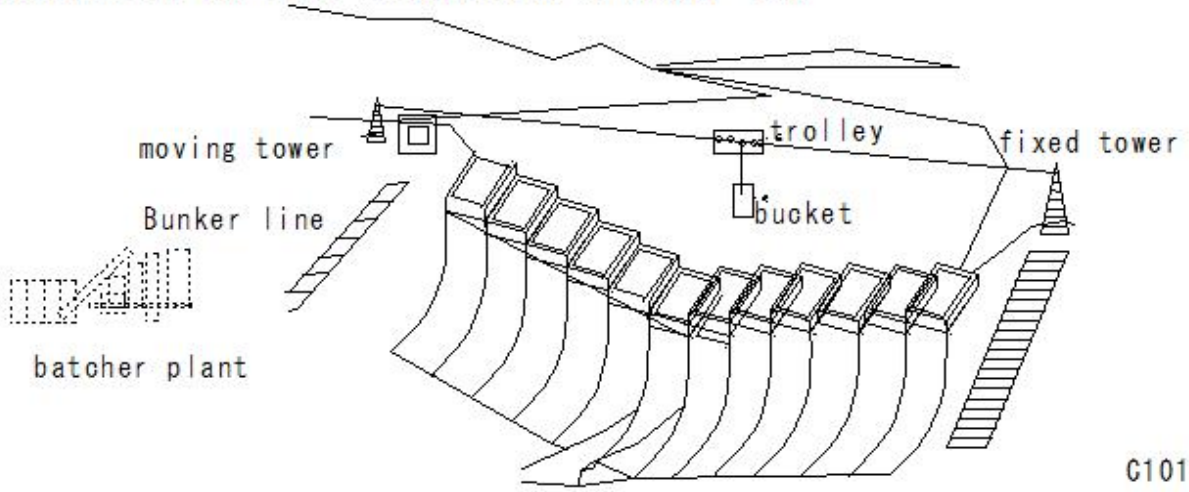
・Fixed type, traveling type, track type

Traveling type: wide coverage area and good workability

・High impact on the natural environment

Cable crane

・Transported to the crane loading area by bunker line



C1019

(D27)Concrete dam construction equipment

(D27) Concrete dam construction equipment

Concrete dam construction equipment

Concrete transportation equipment

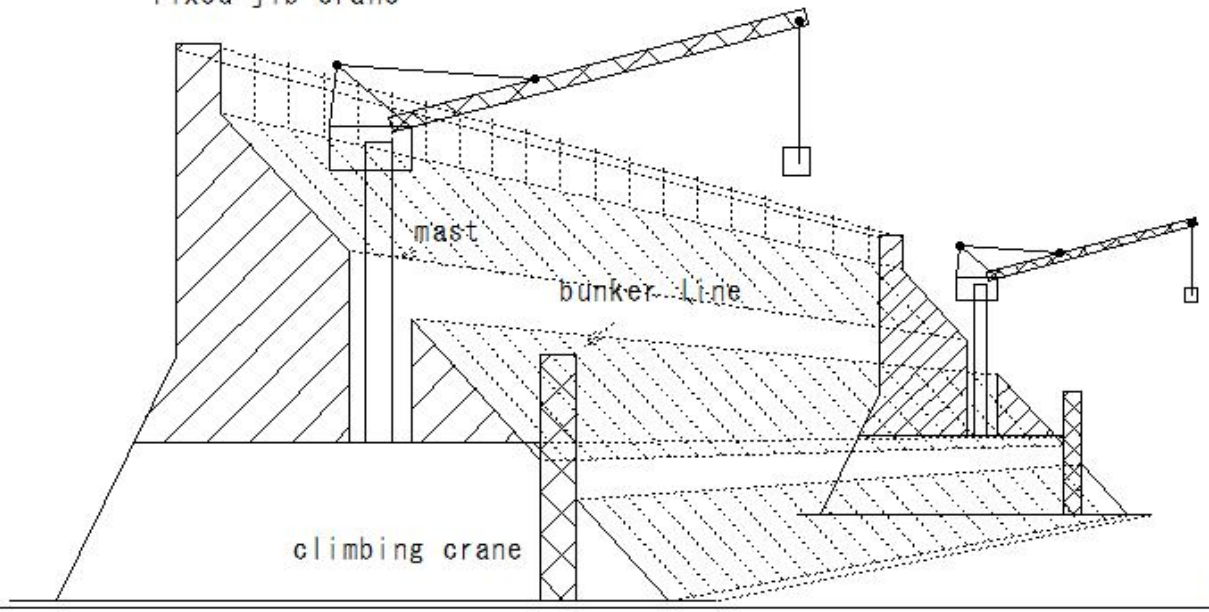
②Main concrete transportation equipment

(b)Jib crane

・Installed parallel to the dam axis

・It takes time to install and relocate

Great benefits in terms of environmental conservation



(D28)Concrete dam construction equipment

(D28)Concrete dam construction equipment

Concrete dam construction equipment

Concrete transportation equipment

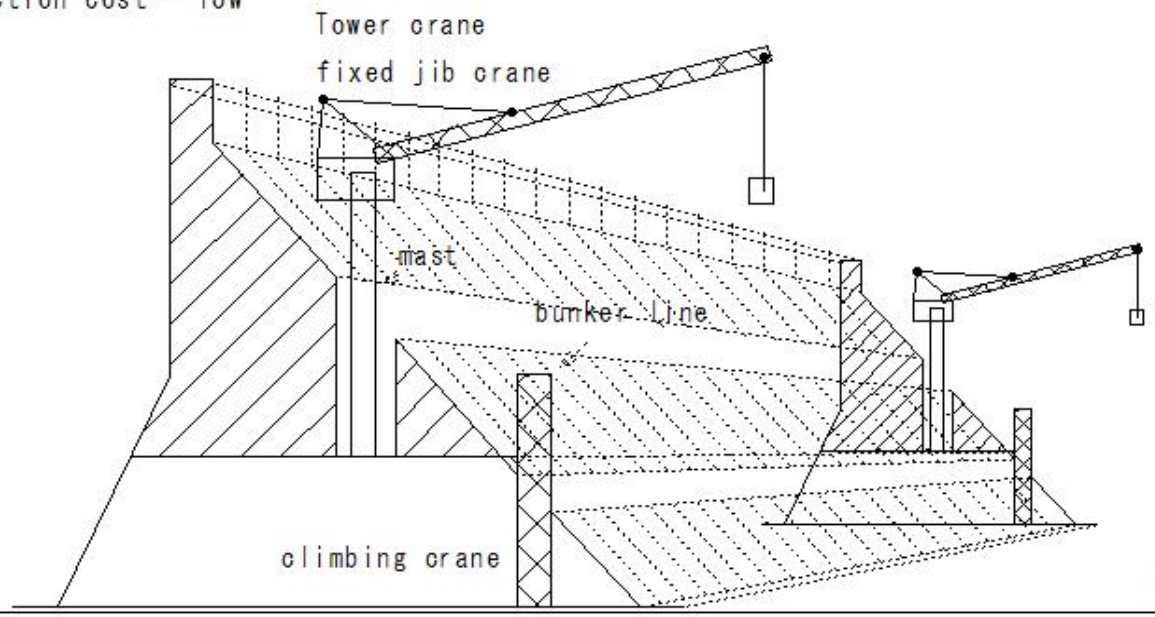
③Tower crane

Fixed jib crane with swivel on top of a high tower

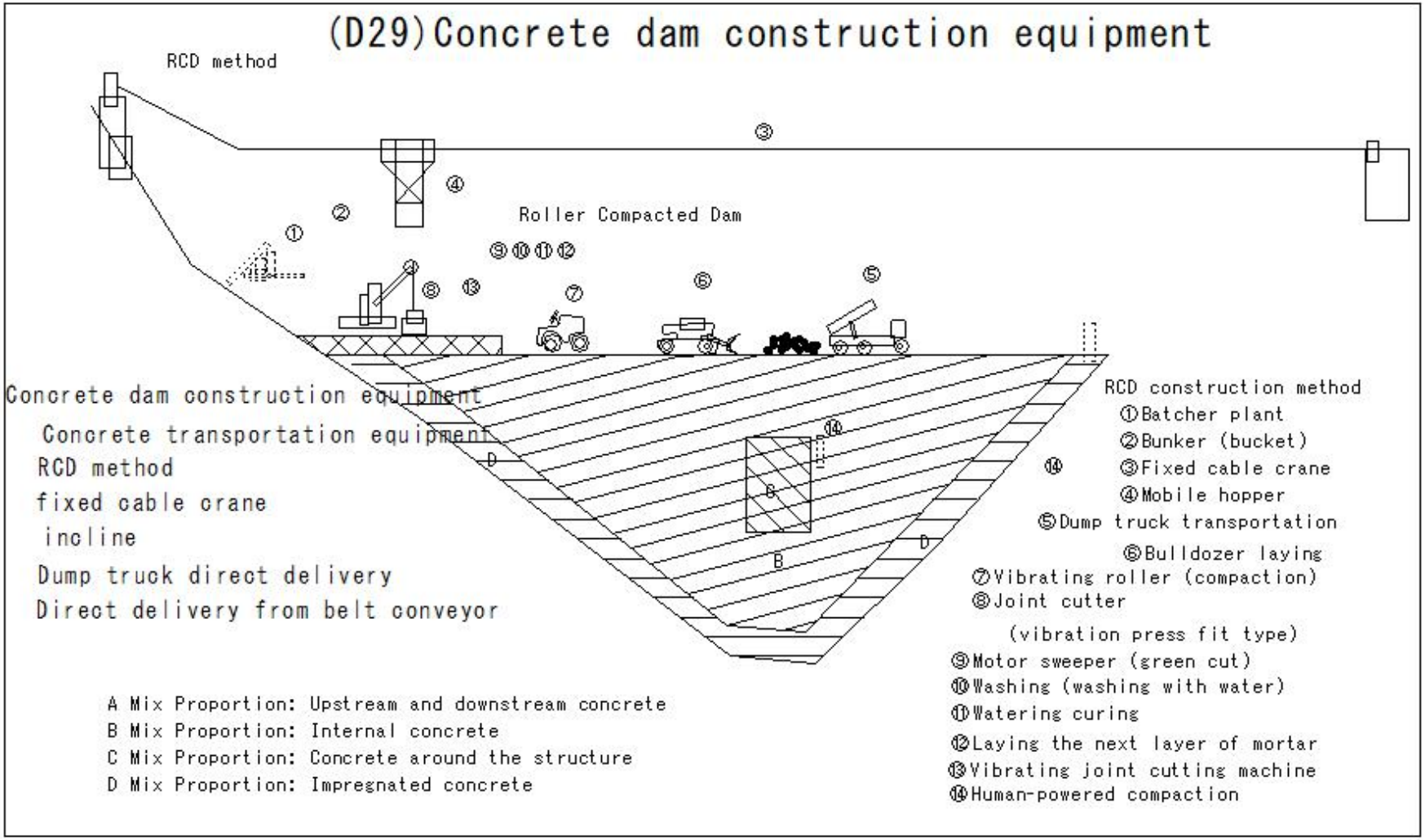
Main transportation equipment for small and medium sized dams

・Bunker lines are easy to place

・Foundation construction cost - low



(D29)Concrete dam construction equipment

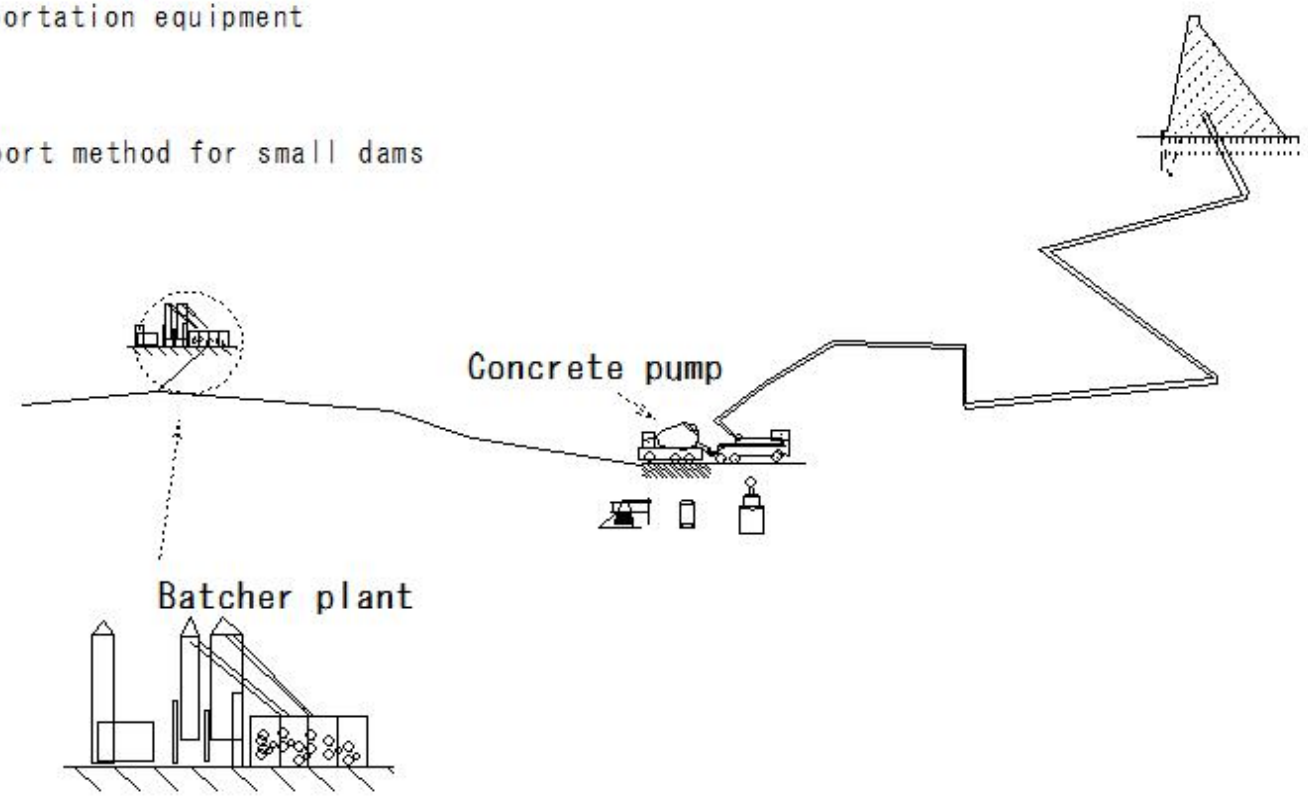


(D30)Concrete dam construction equipment

(D30)Concrete dam construction equipment

Concrete dam construction equipment

- Concrete transportation equipment
- PCD method
- concrete pump
- Concrete transport method for small dams



(D31)Concrete dam construction equipment

(D31)Concrete dam construction equipment

Concrete dam construction equipment

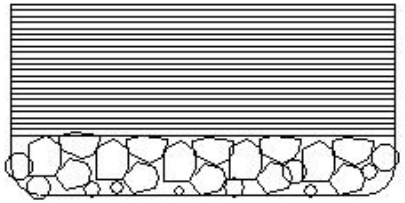
cooling equipment

・Prevention of concrete cracking due to temperature stress

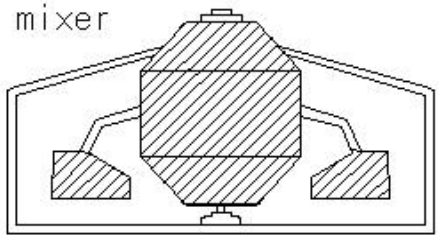
・Pre-cooling

Aggregate cooling

Cooling (air cooling/water cooling)



mixer



Cement

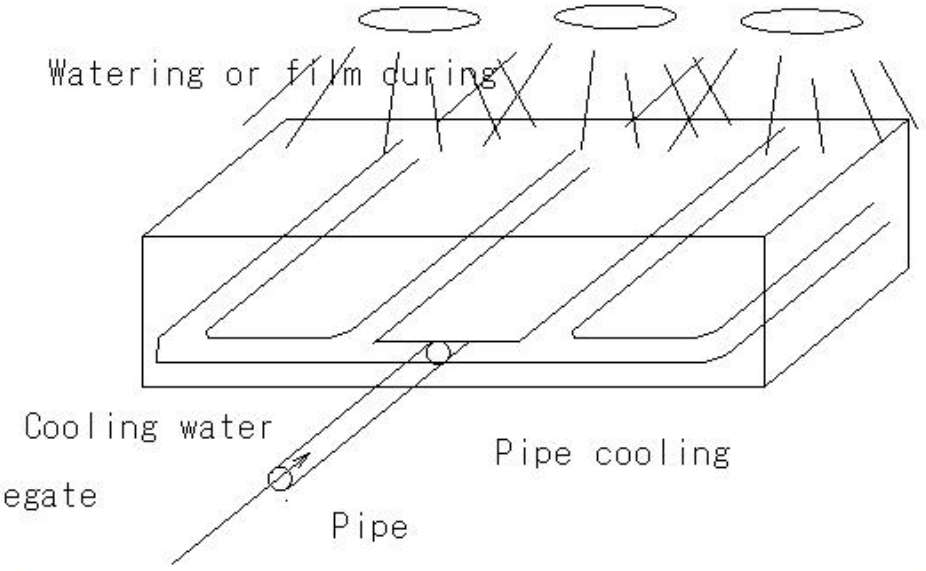
Cooling aggregate

Cold water

Ice

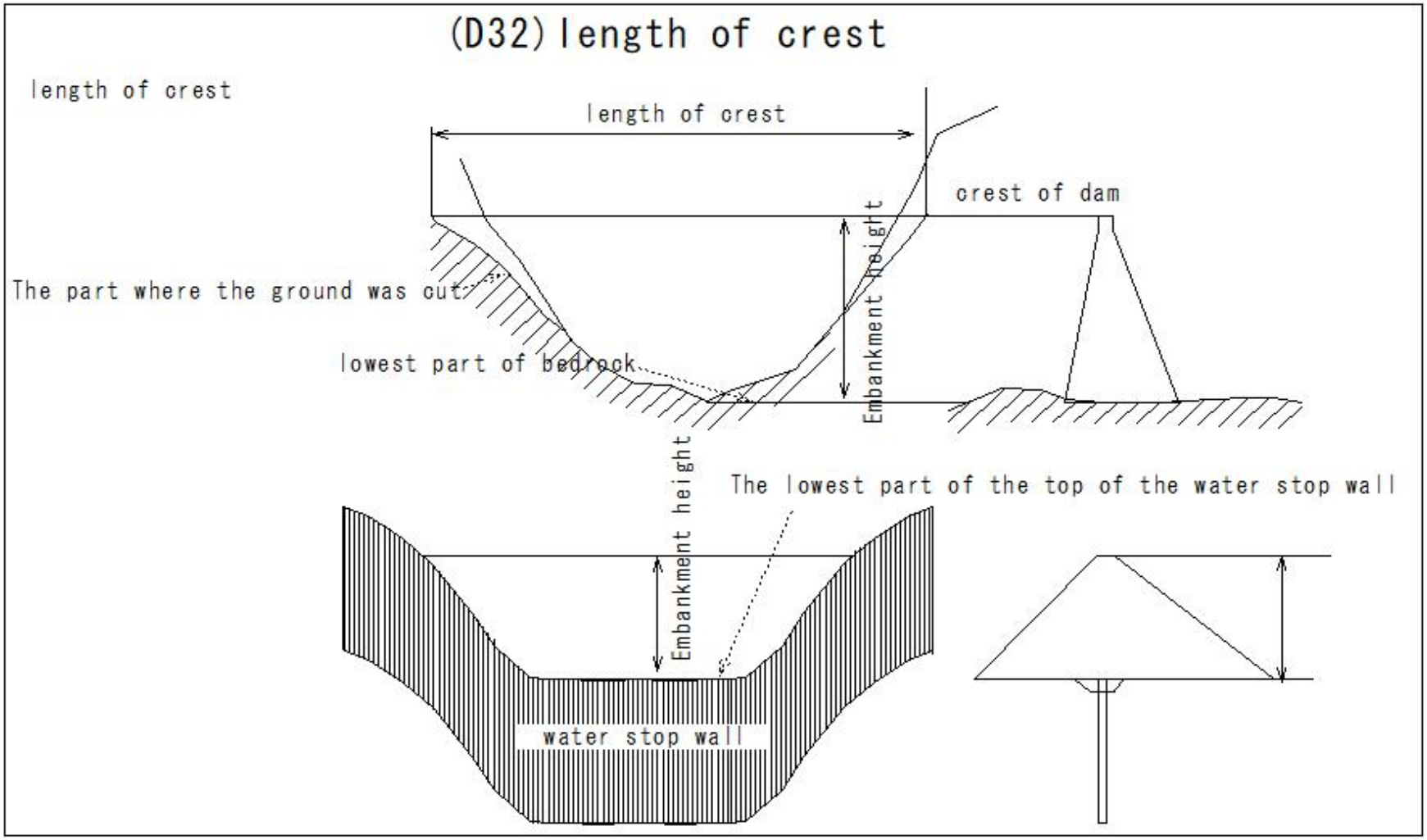
C1388

・Pipe cooling

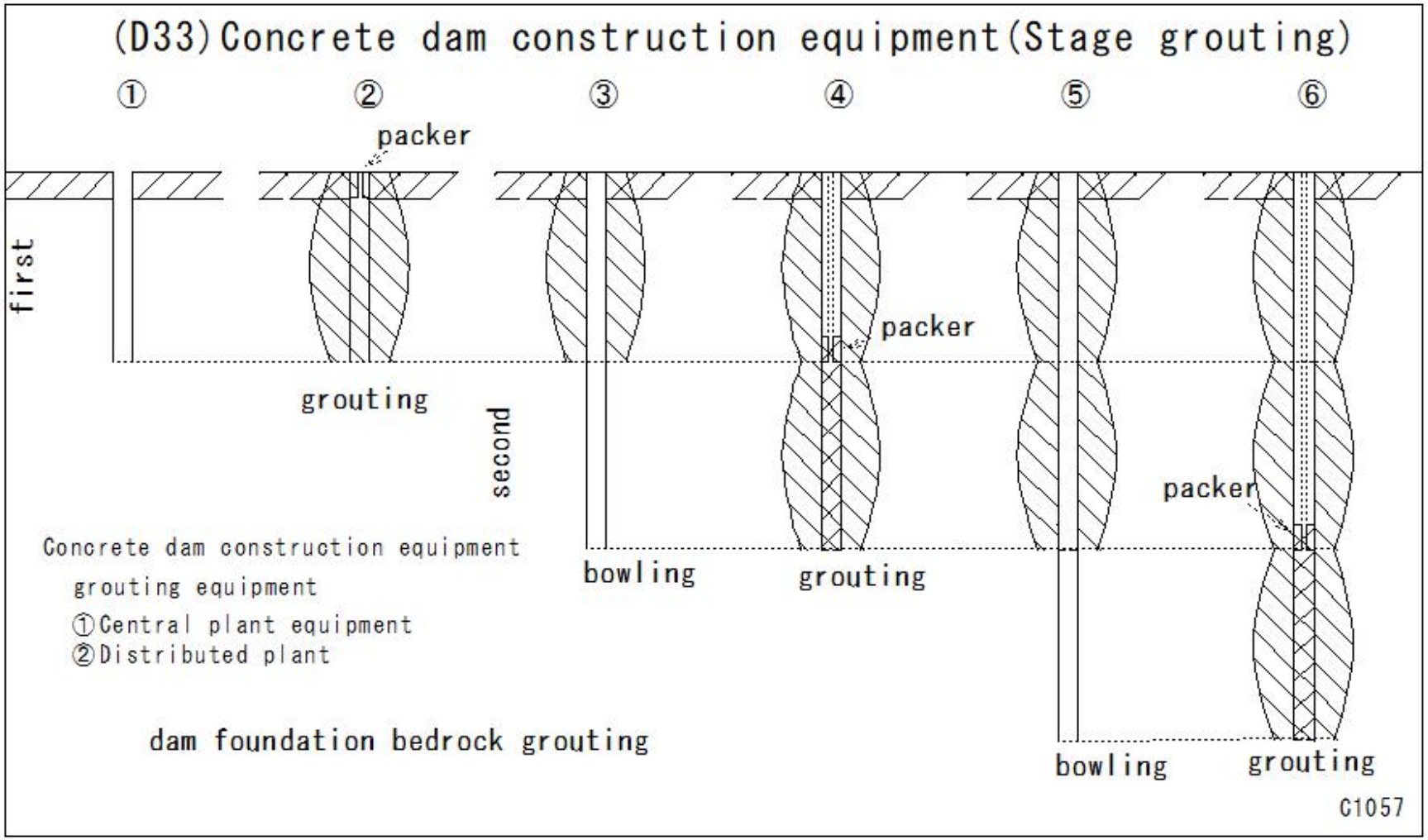


C867

(D32)length of crest



(D33)Concrete dam construction equipment



(D34)Concrete dam construction equipment(grouting)

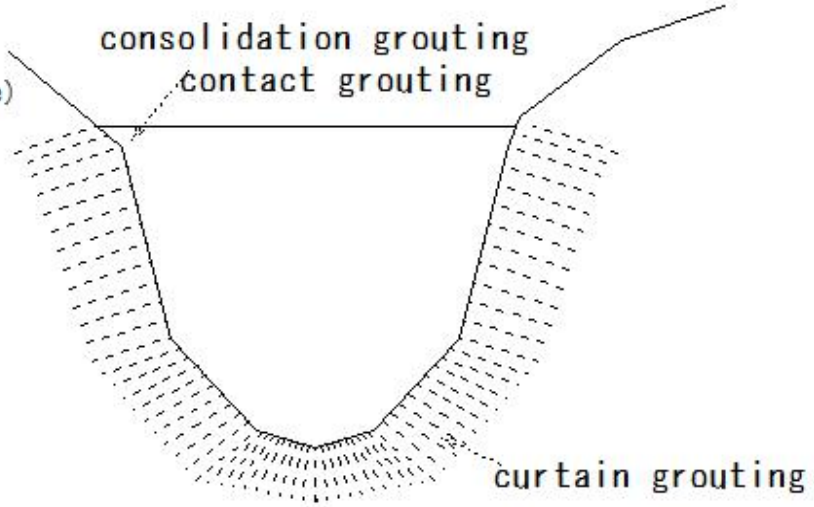
(D34)Concrete dam construction equipment(grouting)

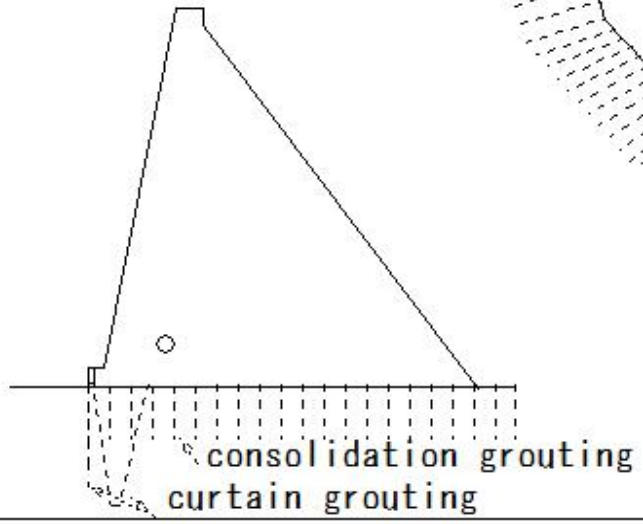
Concrete dam construction equipment

bowling machine

①Rotary boring machine

- Suitable for deep drilling depth (15 m or more)
- Able to work in narrow spaces
- Drilling speed - slow and expensive
- Curtain grout
- Consolidation grouting on steep slopes





F327

(D35)Concrete dam construction equipment(grouting)

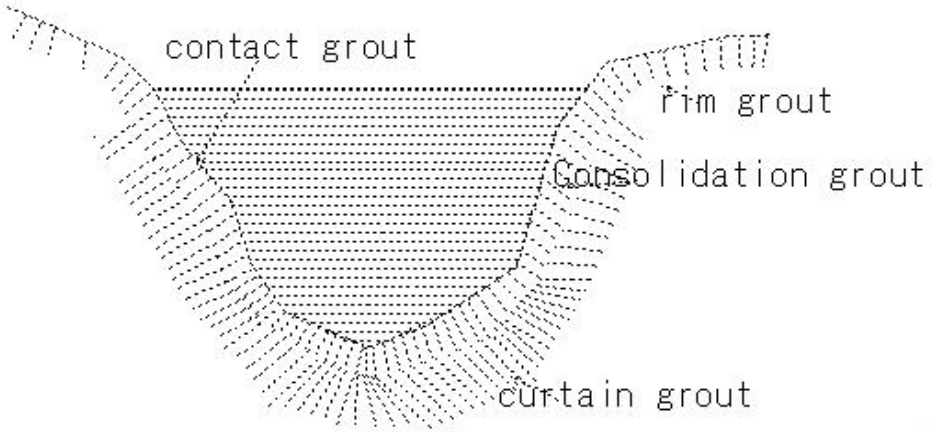
(D35)Concrete dam construction equipment(grouting)

Concrete dam construction equipment

bowling machine

②percussion boring machine

- Drilling speed - fast
- Economic
- Generation of rock powder - large
- Drilling depth limit: approximately 15m
- Consolidation grouting for dams based on hard rock
  Used for blanket grouting
- Drilling hole diameter 65mm



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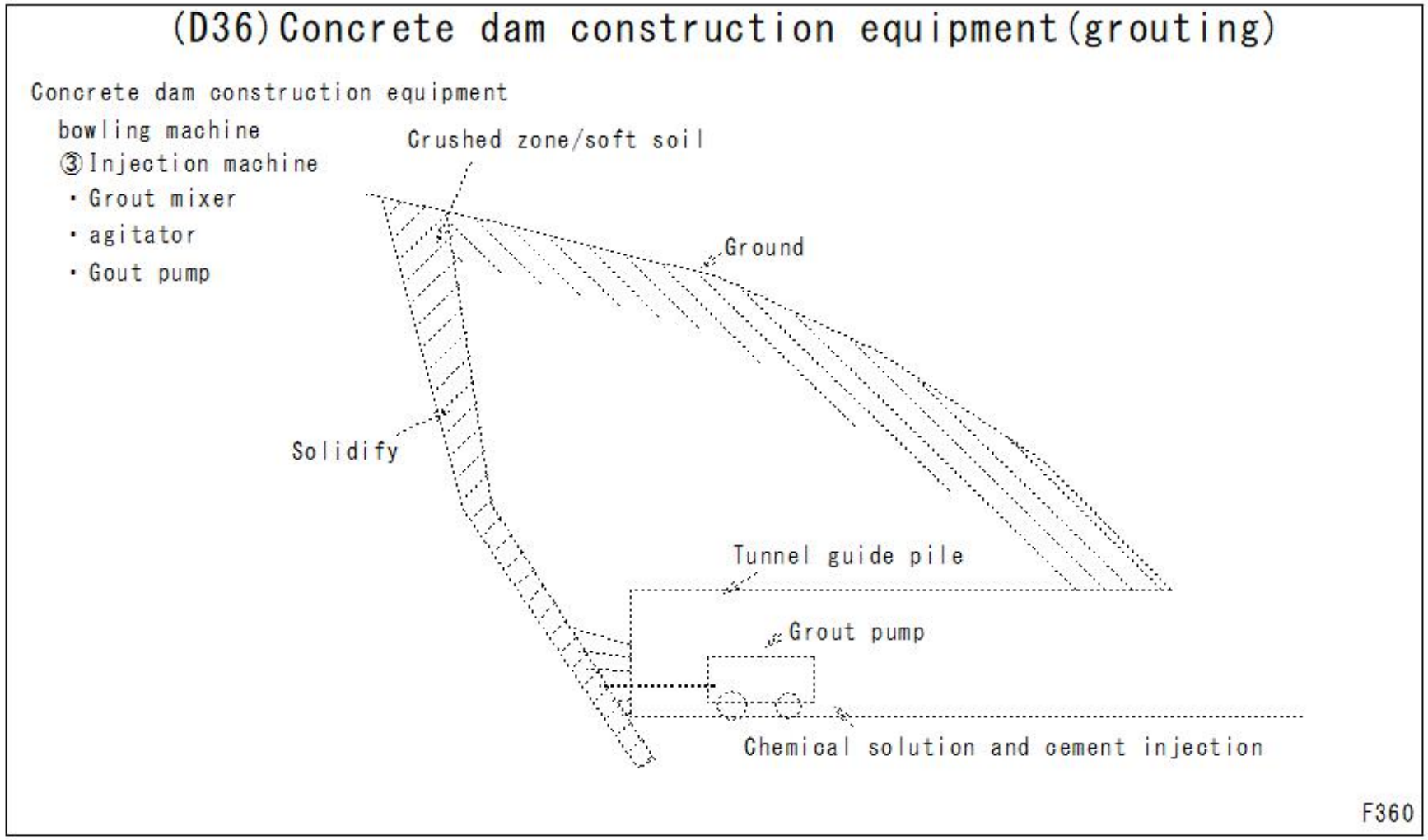
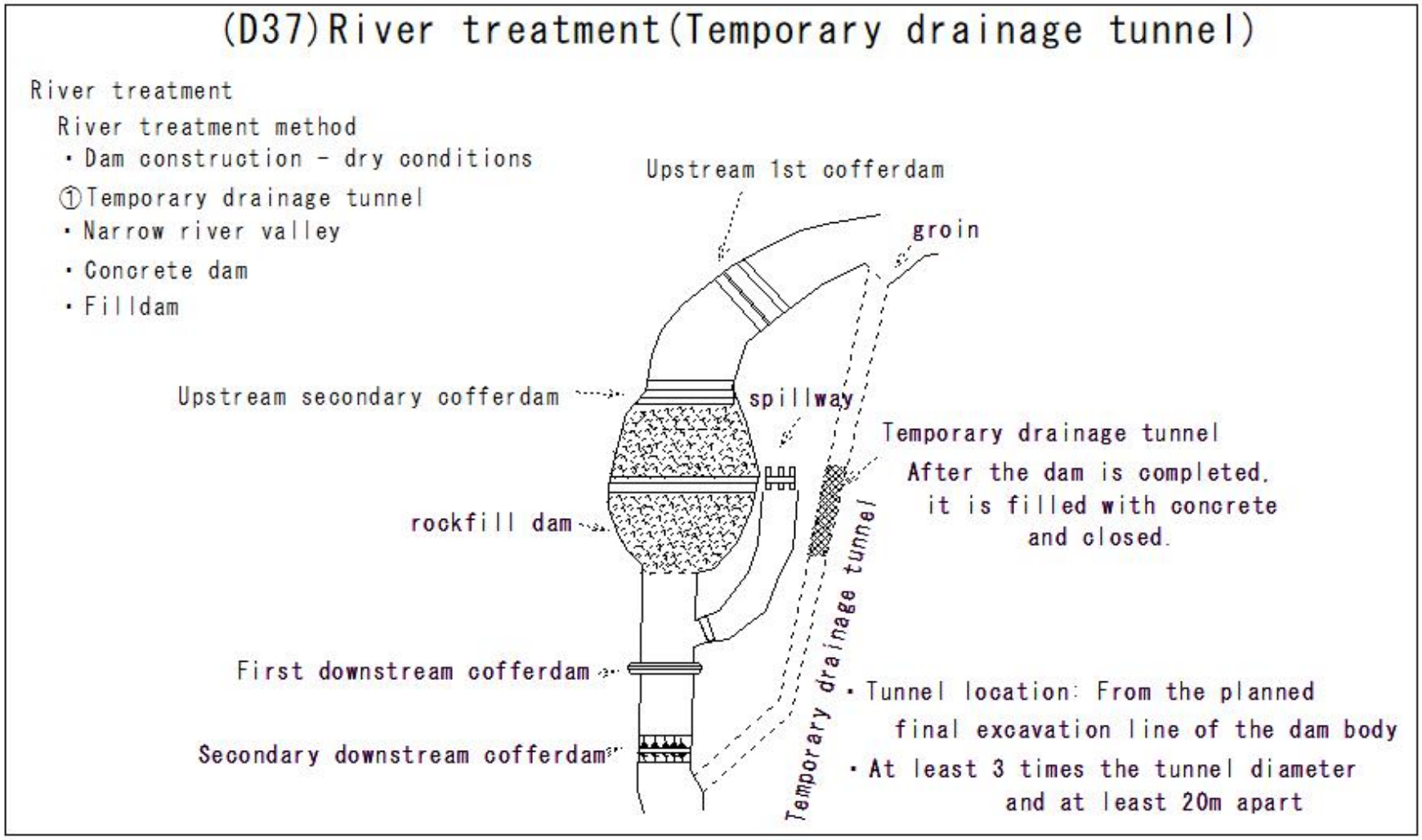
(D36)Concrete dam construction equipment(grouting)



(D37)River treatment(Temporary drainage tunnel)



(D38)River treatment(half river cofferdam)

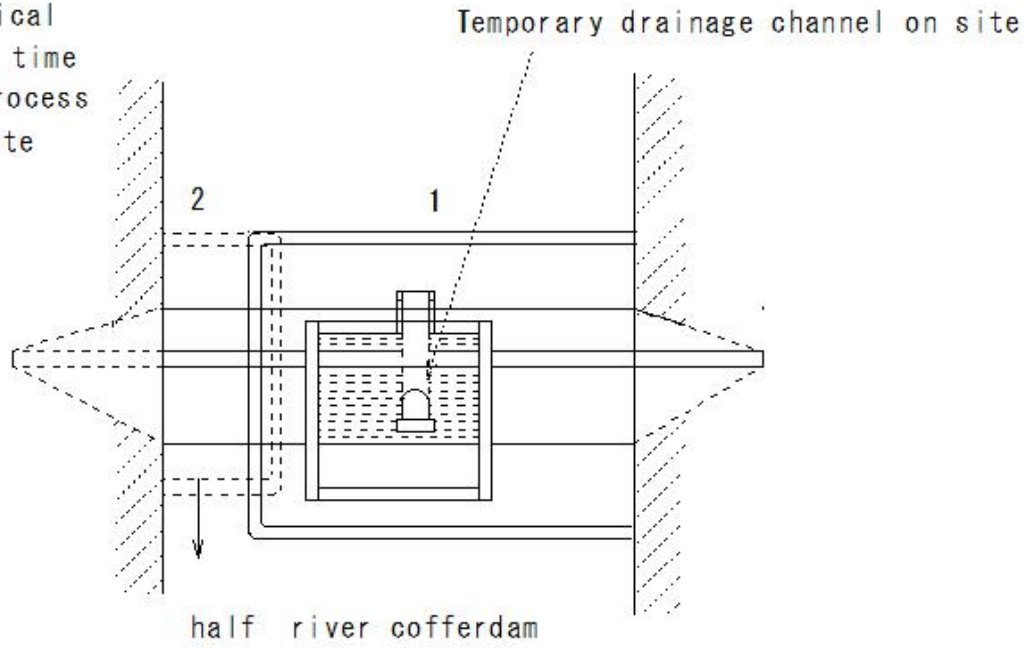
(D38)River treatment(half river cofferdam)

River treatment

②half river cofferdam

- River width - wide river
- Flow rate - large
- Temporary drainage tunnel-
  temporary drainage opening channel
  Difficult to adopt - Uneconomical
- Construction on one side at a time
- case of no problem with the process

Temporary drainage channel on site



(D39)River treatment(Temporary drainage opening channel)

(D39)River treatment(Temporary drainage opening channel)

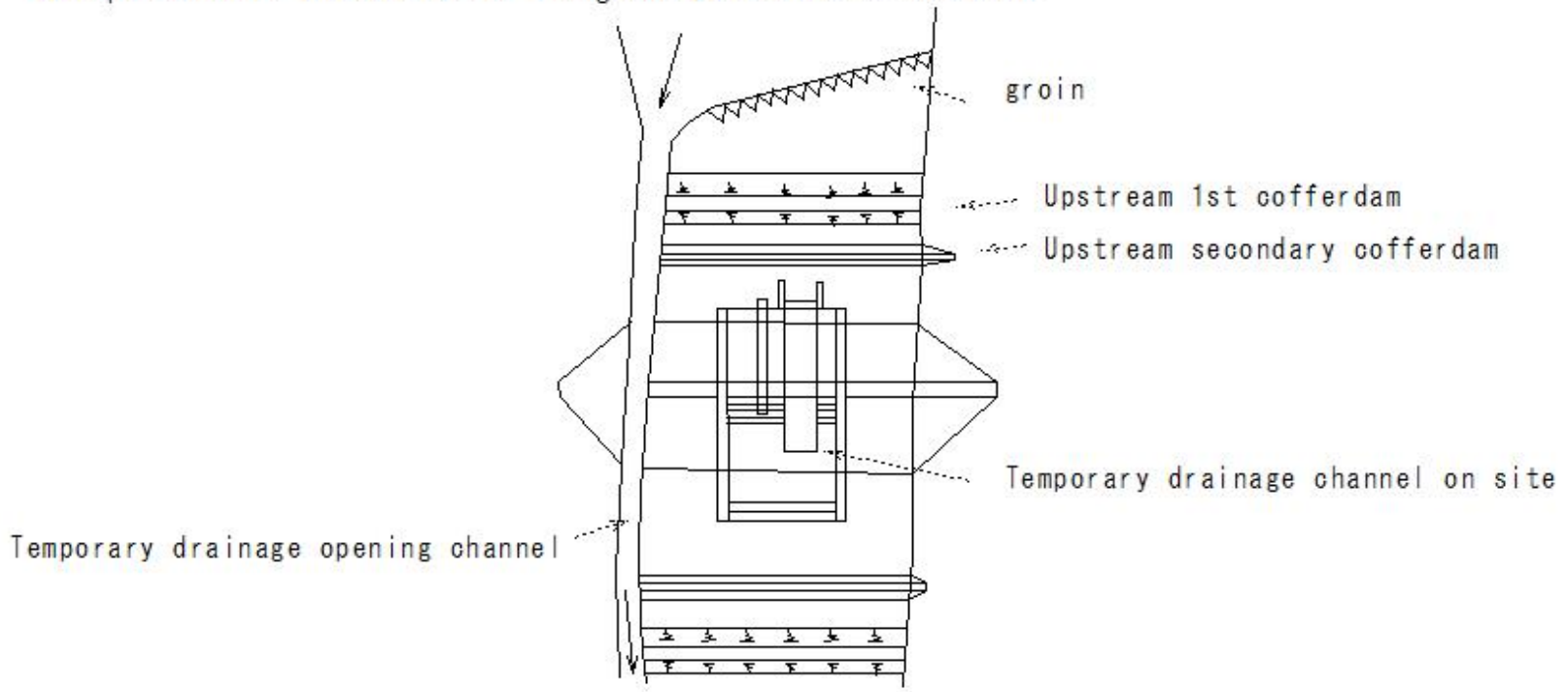
River treatment

③Temporary drainage opening channel

・discharge - not large

・River width - wide

An open channel was installed along the riverbank on one side.



(D40)River treatment(temporary cofferdam)

(D40)River treatment(temporary cofferdam)

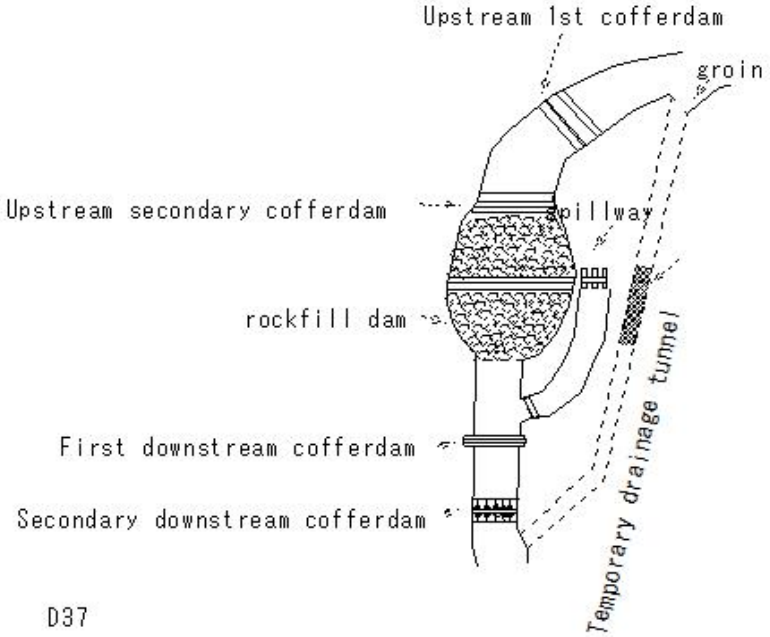
River treatment

temporary cofferdam

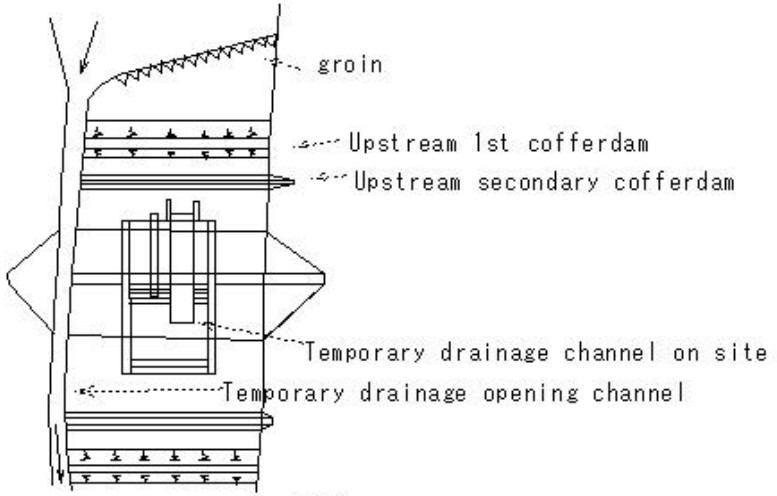
Upstream/downstream cofferdam

Secondary cofferdam - case of riverbed sediment is shallow- Concrete type

Secondary cofferdam - case of river bed sediment is thick - fill type



D37



D39

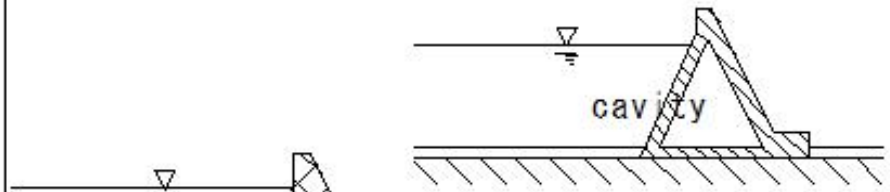
(D41)River treatment(temporary cofferdam)

(D41)River treatment(temporary cofferdam)

River treatment

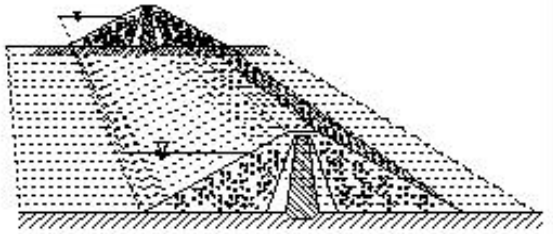
discharge for river flow treatment

format	discharge for river flow treatment
gravity dam	Probable flood volume once or twice a year
hollow gravity dam arch dam	2-1.5 year probability flood volume
fill dam	15-20 year probability flood volume



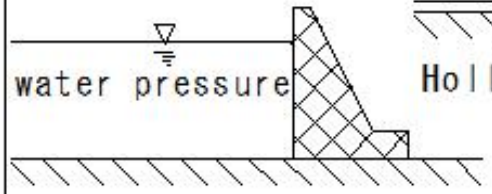
Hollow gravity dam

C904



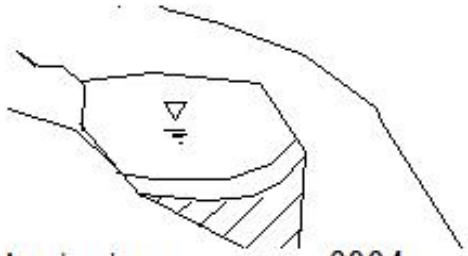
fill dam

R590



Gravity dam

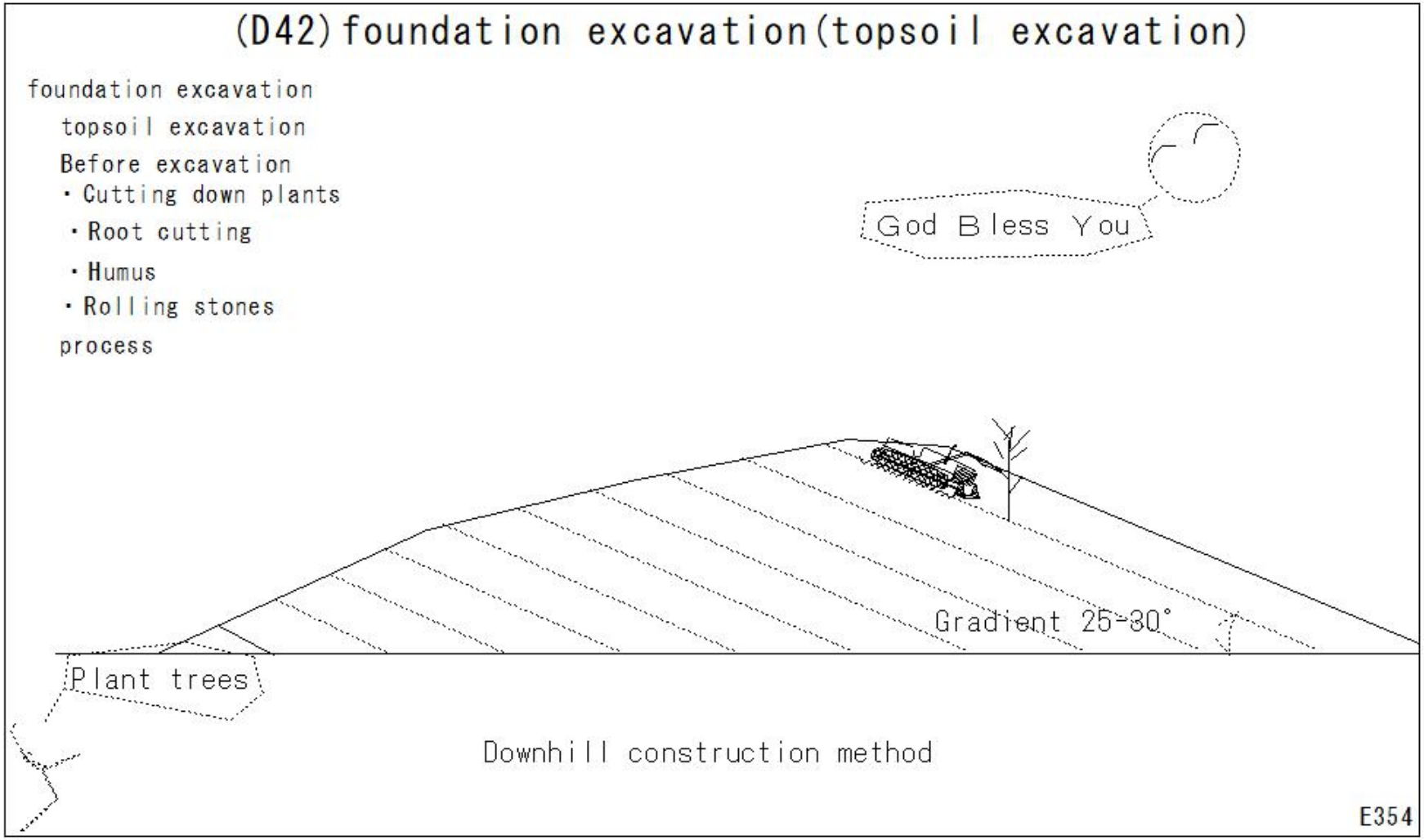
C904



Arch dam

C904

(D42)foundation excavation(topsoil excavation)



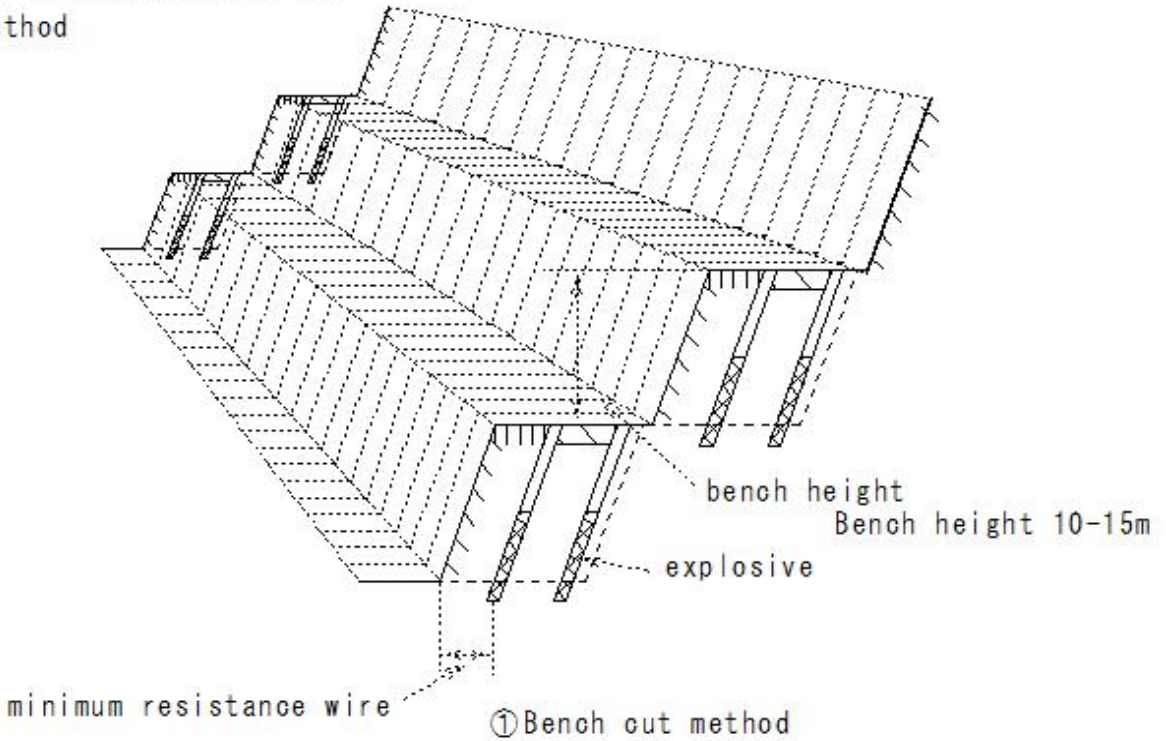
(D43)foundation excavation(rough excavation)

(D43)foundation excavation(rough excavation)

foundation excavation

rough excavation

- Mechanical excavation of weathered rock
- Gunpowder drilling of medium hard rock
- Blast-bench cut method



①Bench cut method

D14

(D44)foundation excavation(finishing excavation)

(D44)foundation excavation(finishing excavation)

foundation excavation

finishing excavation

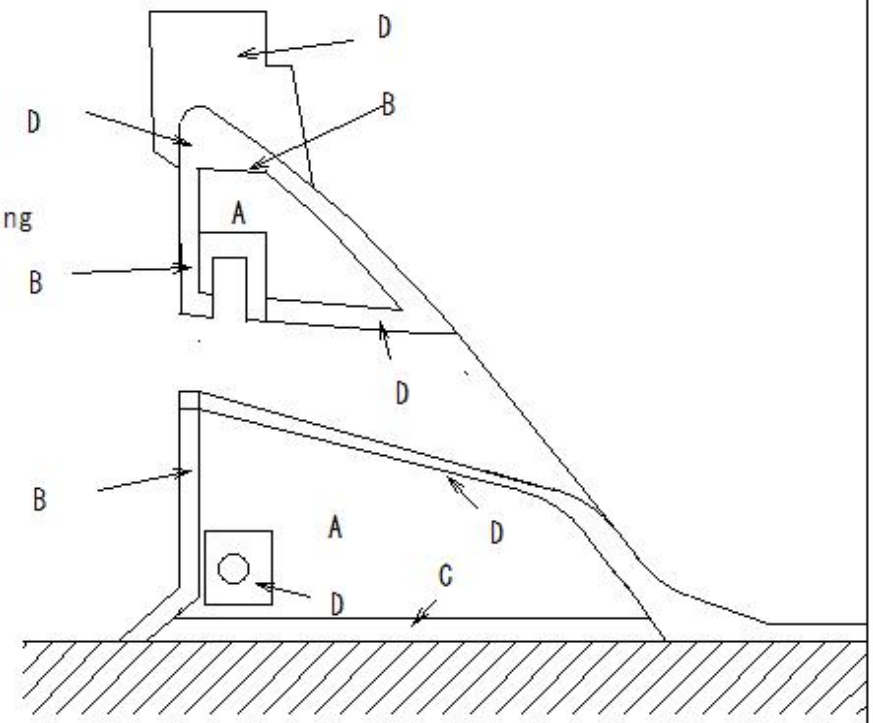
- Near the planned excavation surface
- Reduces the impact on the foundation rock
- Prevention of loosening
- Pick hammer, crowbar
- Final excavation by hand
- Final excavation is done before concrete pouring
- Just before preparing the core
- Thickness about 50cm

A:Internal concrete: Poor mix

B:External concrete

C:Rock-clad concrete:
watertightness and durability

D:Structural concrete: Rich
mix concrete: Maximum particle
size small



C1064

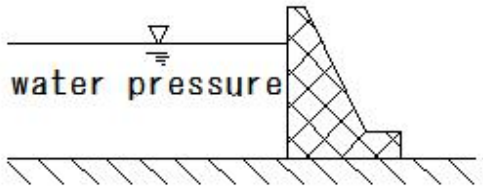
(D45)foundation excavation(excavation surface protection)

(D45)foundation excavation(excavation surface protection)

foundation excavation

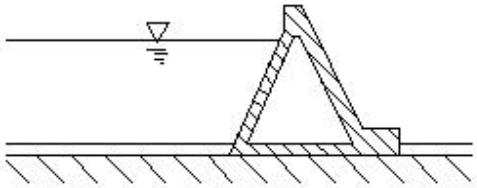
excavation surface protection

- After rough excavation
- Until main body construction
- Prevents weathering and loosening
- cover
- Mortar spraying
- Concrete spraying



Gravity dam

C904



Hollow gravity dam

C904

Arch dam

C904

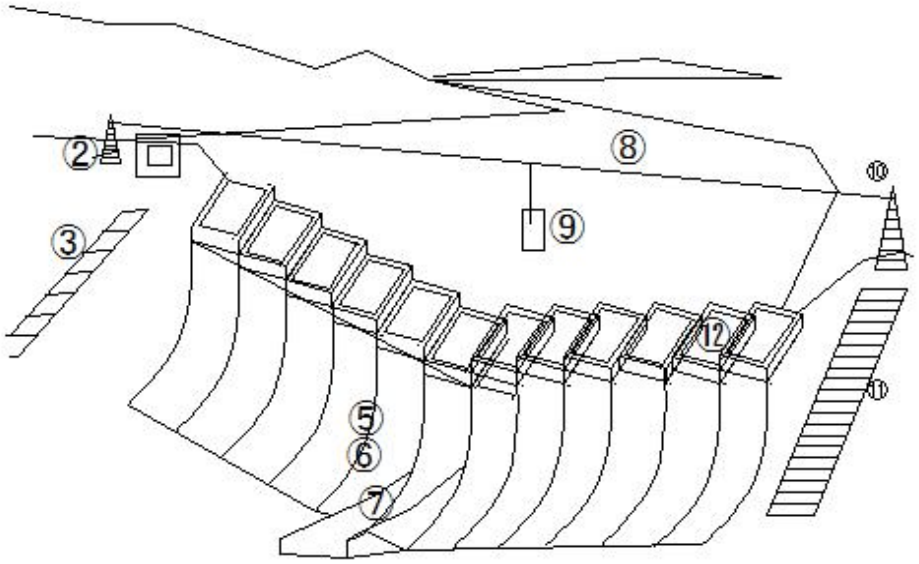
(D46)Construction of concrete dam (conventional method)

(D46)Construction of concrete dam (conventional method)

Construction of concrete dam (conventional method)

shrink seam

- Temperature cracking: due to concrete hydration heat
- Establish contraction joints
- Horizontal joints: Perpendicular to the dam axis - spacing of 15 m or less
- Vertical joints: Parallel to the dam axis - spacing of 40 m or less



Place concrete block by block

C965

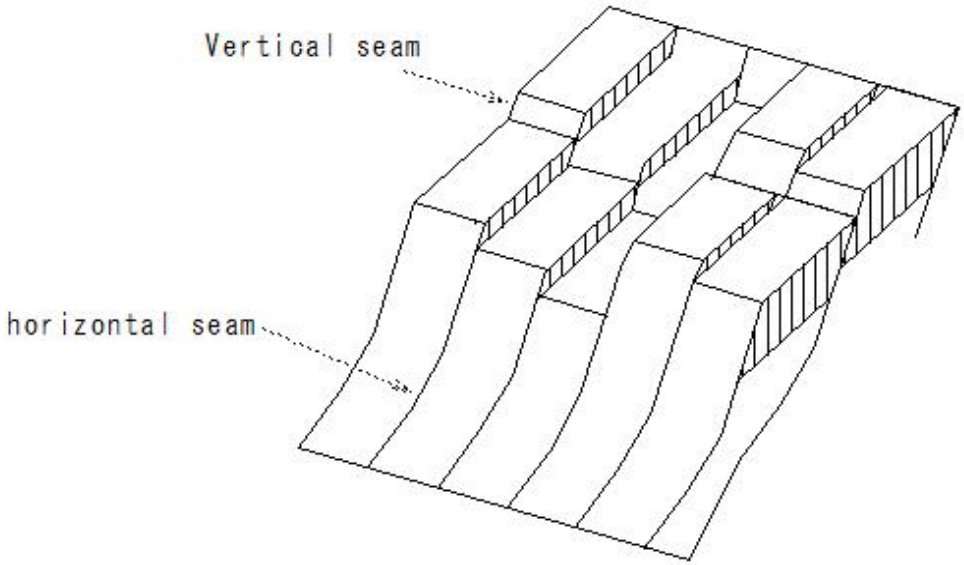
(D47)Construction of concrete dam (conventional method)

(D47)Construction of concrete dam (conventional method)

Construction of concrete dam (conventional method)

・place method

①Block method (column construction method)
placing method divided by vertical and horizontal seams



block method

(D48)Construction of concrete dam (conventional method)

(D48) Construction of concrete dam (conventional method)

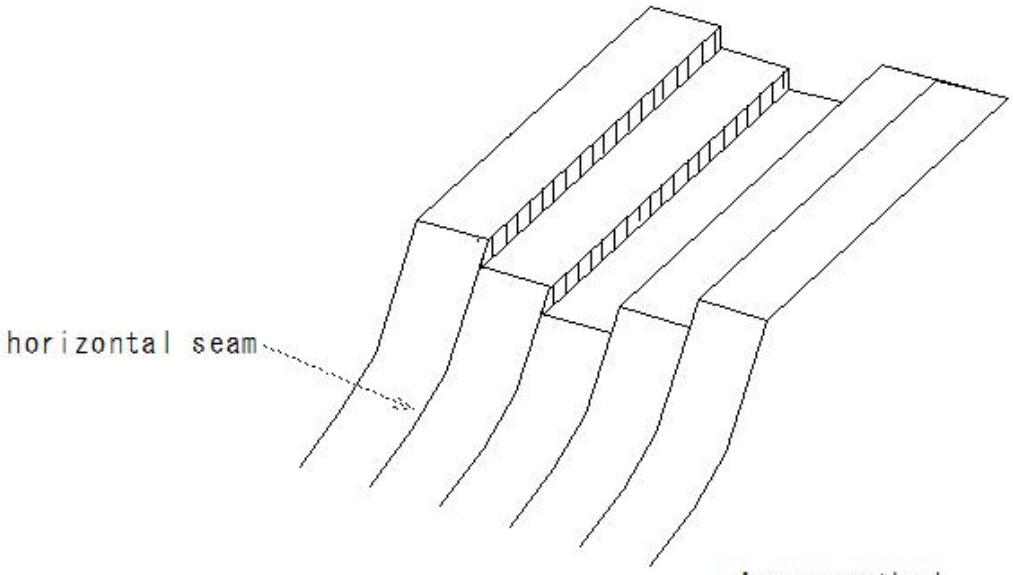
Construction of concrete dam (conventional method)

・placing method

②Layer method

・Horizontal seams only

No vertical seams



Layer method

(D49)Construction of concrete dam (conventional method)

(D49)Construction of concrete dam (conventional method)

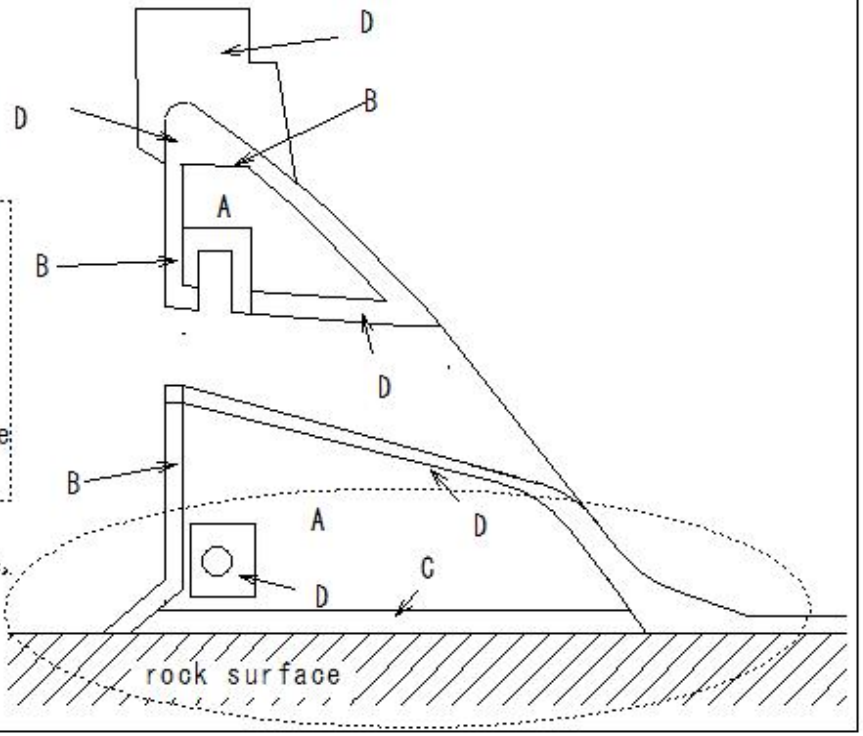
Construction of concrete dam (conventional method)

・Processing before placing

①Treatment of rock surface

・Improve the adhesion between the foundation rock and embankment concrete

・Removal of sprayed mortar
・Excavation of weathered rock
・Removal of floating rocks
・Filling of open cracks
・Replacement of faults etc. with concrete
・Laying mortar on the bedrock when pouring concrete
mortar thickness 2cm



(D50)Construction of concrete dam (conventional method)

(D50)Construction of concrete dam (conventional method)

Construction of concrete dam (conventional method)

・Processing before placing

②Horizontal seam processing

・Concrete lift surface

・ laitance concentration by bleeding

・Water jet (high pressure water) - perform green cutting

・Green cutting period

Summer - 6-12 hours after pouring concrete

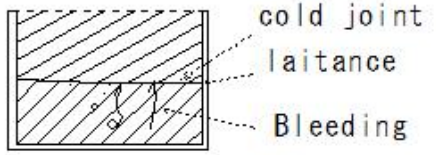
Winter - 12-24 hours after concrete pouring

・Remove artifacts and dirt attached to the concrete surface and apply mortar

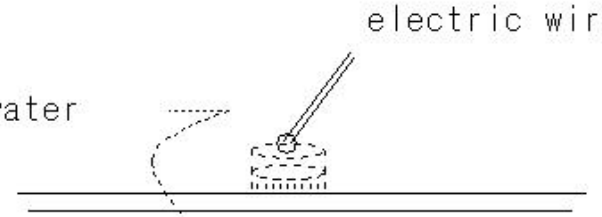
・Mortar thickness 1.5cm

・Rainfall during concrete pouring (approx. 4mm/h) - Canceled

・Cold joint part: Perform treatment similar to horizontal pouring joint.



C880



C1016

(D51)Construction of concrete dam (conventional method)

(D51)Construction of concrete dam (conventional method)

Construction of concrete dam (conventional method)

・Pour concrete

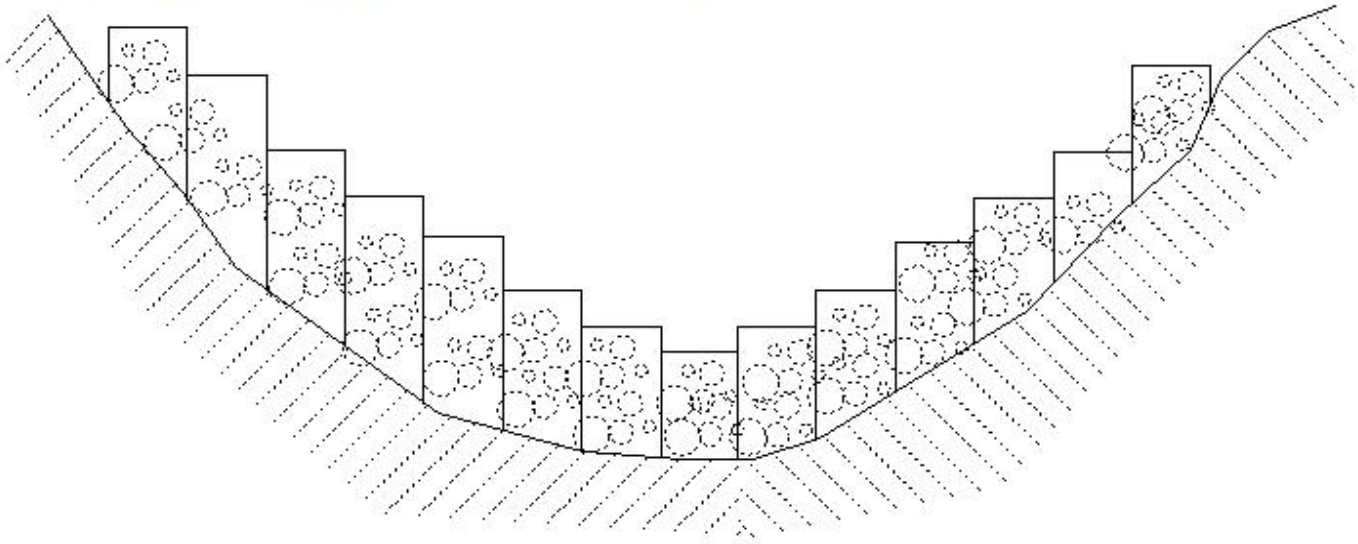
①Lift thickness

・1.5－2.0m

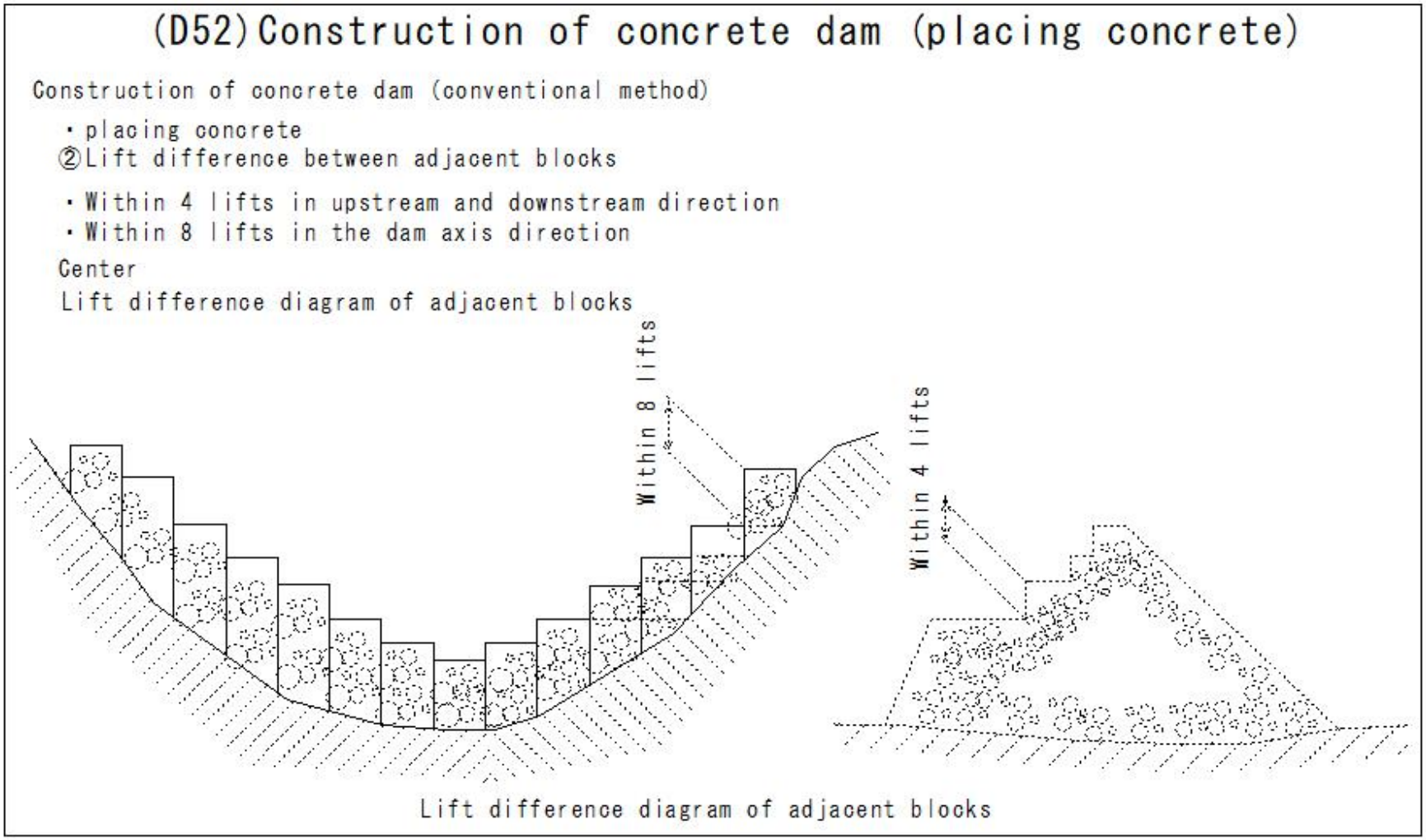
・Rock landing area: pouring concrete onto concrete that has been suspended for a long time

・Prevention of temperature cracks

・0.75-1.0m lift (half lift) - several lifts



(D52)Construction of concrete dam (placing concrete)



(D53)Construction of concrete dam (placing concrete)

(D53)Construction of concrete dam (placing concrete)

Construction of concrete dam (conventional method)

・placing concrete

③Block construction order

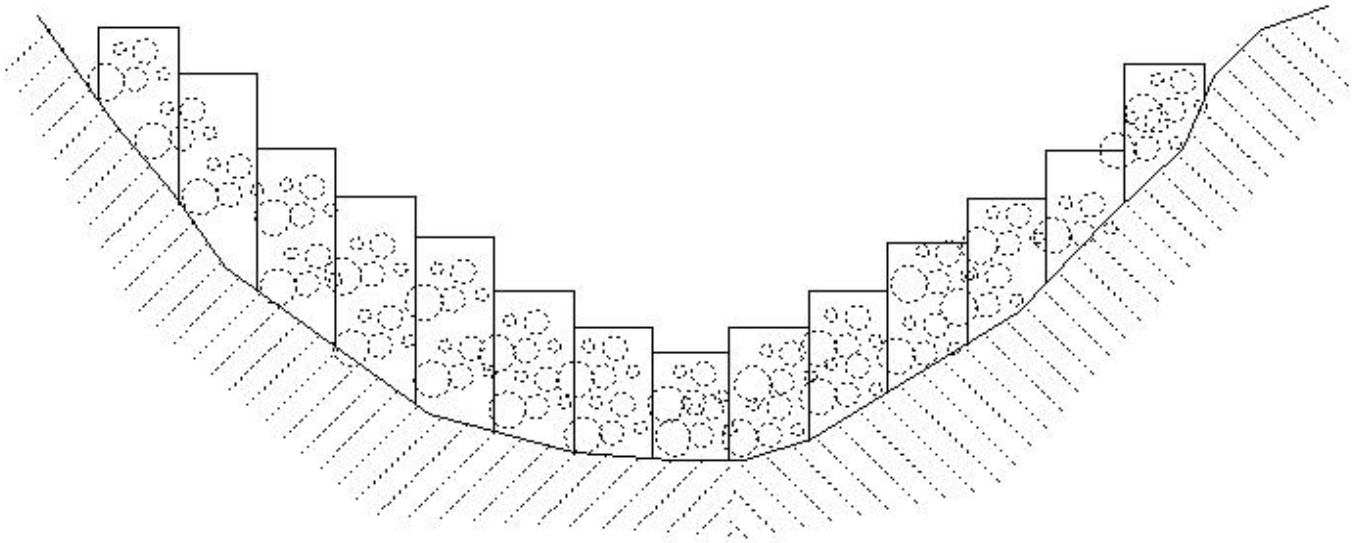
・To increase construction efficiency by increasing the number of placing blocks

・Alternately create unevenness and launch evenly

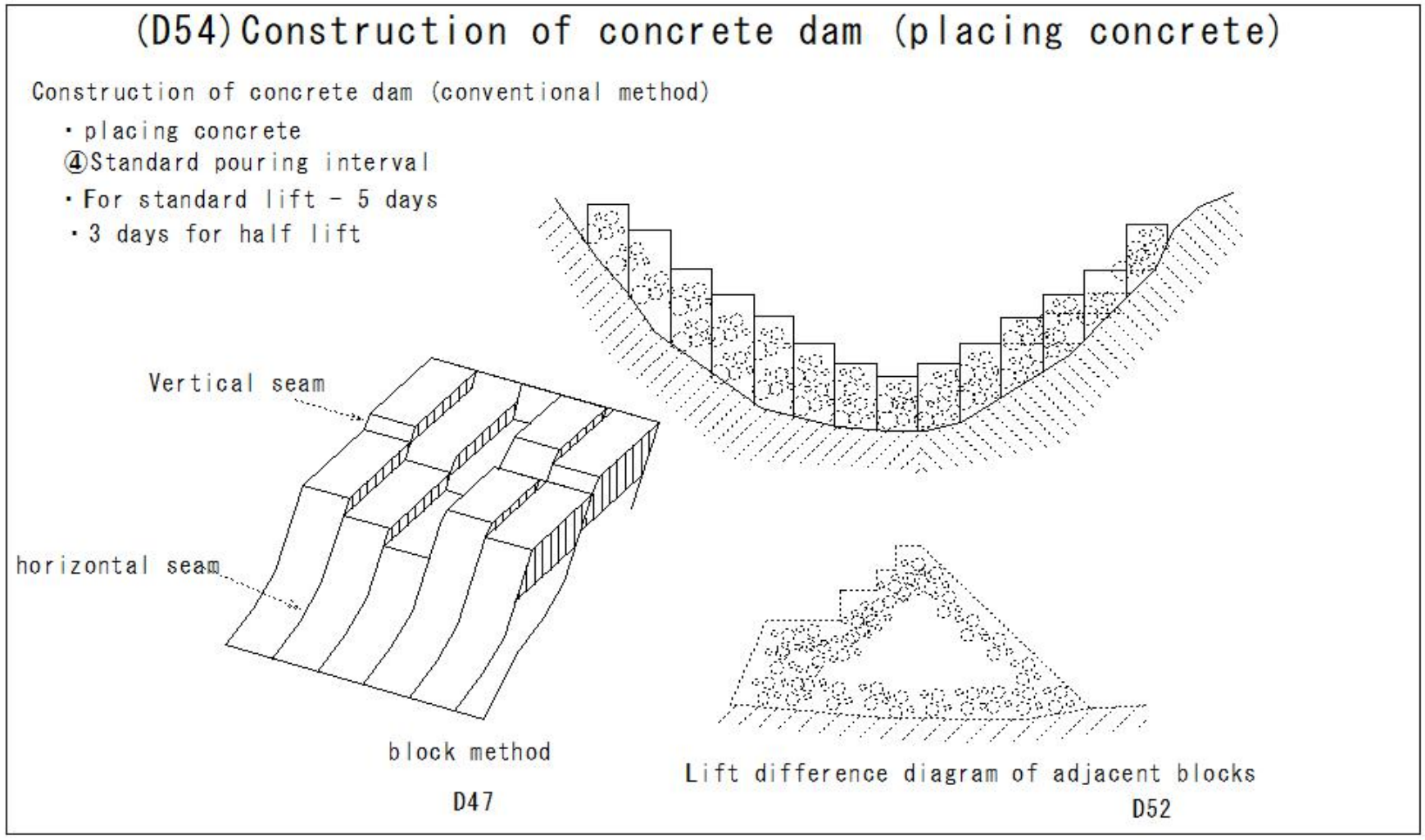
・Prevent flood water from flowing down on the foundation rock during floods

・Slightly lower the river bed

・Concreting on slopes - advance



(D54)Construction of concrete dam (placing concrete)



(D55)Construction of concrete dam (placing concrete)

(D55)Construction of concrete dam (placing concrete)

Construction of concrete dam (conventional method)

・placing concrete

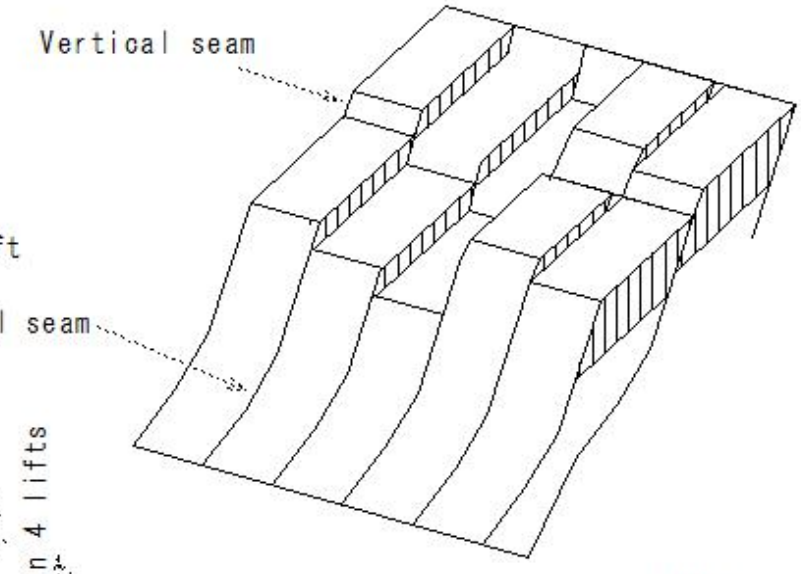
⑤Concrete placing

・Concrete 1 lift thickness 1.5-2.0m

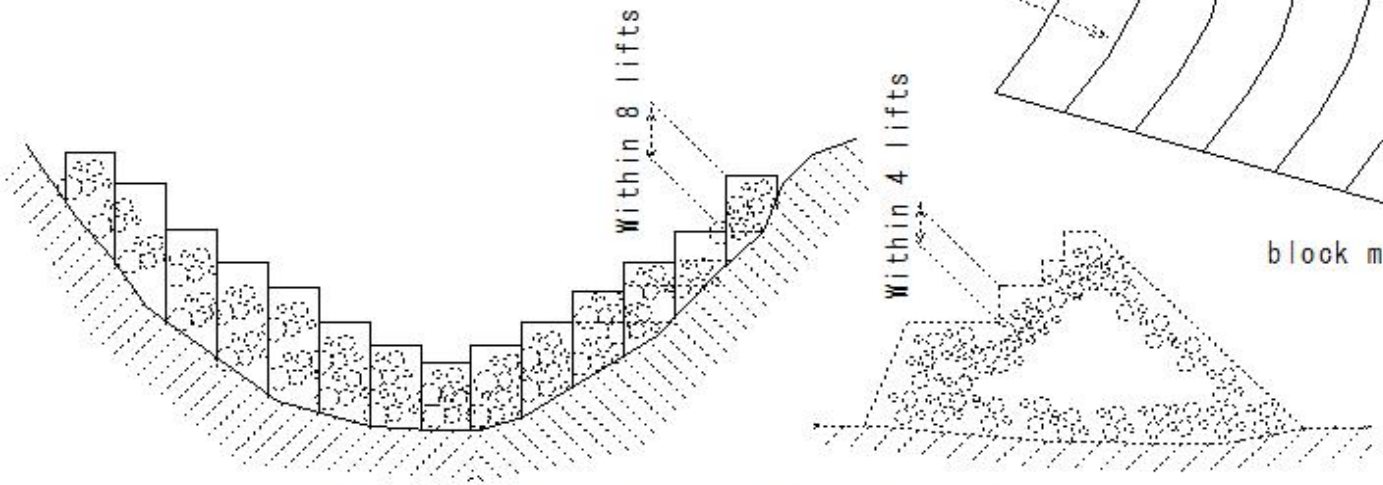
・Concrete unrolling thickness

50cm thickness after compaction

・Unrolling 3-4 layers and compacting to form 1 lift



block method D47



Lift difference diagram of adjacent blocks D52

(D56)Construction of concrete dam (placing concrete)

(D56)Construction of concrete dam (placing concrete)

Construction of concrete dam (conventional method)

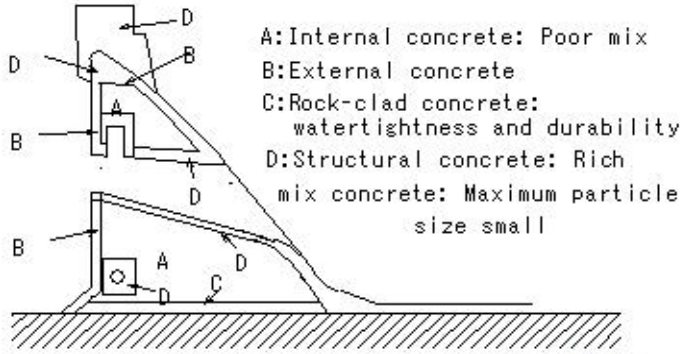
・placing concrete

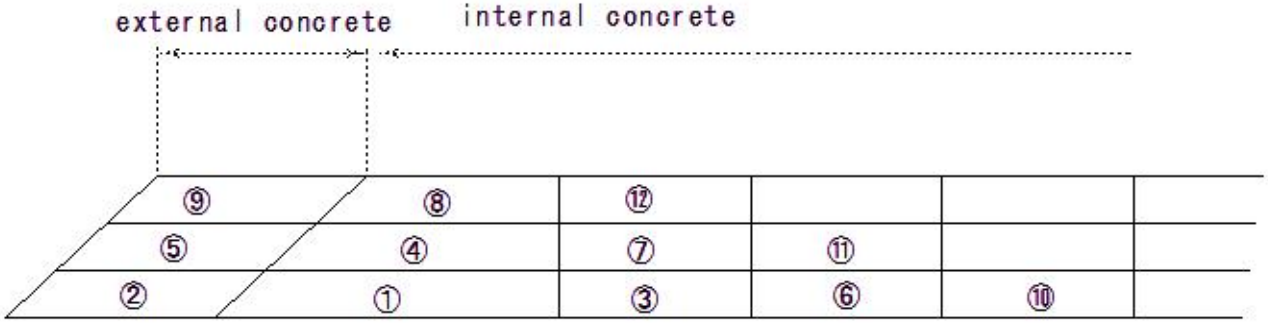
⑤Concrete placing

・Concrete placing order

・case of unloading concrete from the bucket

Unloading height: within 1m





Concrete unrolling order

(D57)Construction of concrete dam (placing concrete)

(D57)Construction of concrete dam (placing concrete)

Construction of concrete dam (placing concrete)

・placing concrete

Ⓔ Compaction

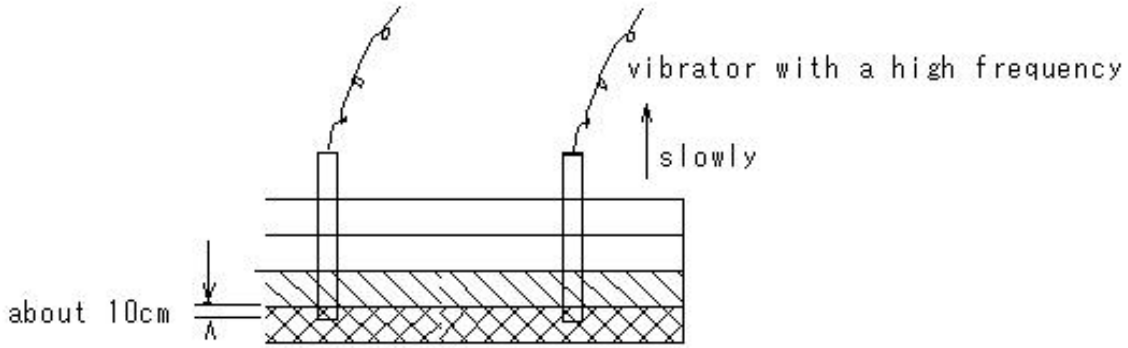
・Dam concrete internal vibrator

・Put the tip into the concrete below for about 10cm.

Pull out the vibrator slowly

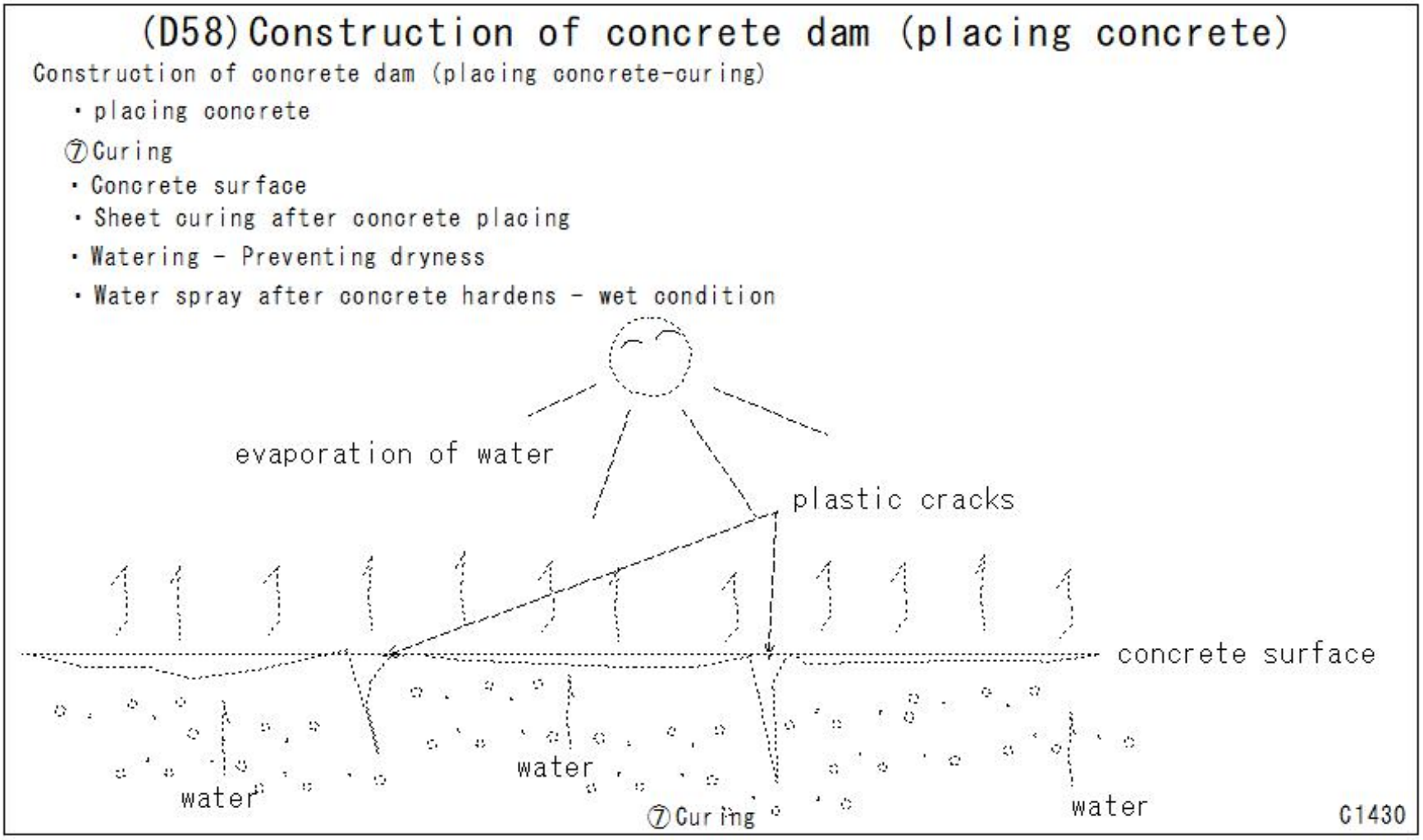
・Do not leave any holes

・Concrete mixing (slump is small) - use a vibrator with a high frequency



Ⓔ Compaction

(D58)Construction of concrete dam (placing concrete)



(D59)Construction of concrete dam (placing concrete)

(D59)Construction of concrete dam (placing concrete)

Construction of concrete dam (placing concrete)

・placing concrete

⑦Curing

In the case of hot weather concrete

・Evaporation of water from the surface

・Plastic cracks due to drying

・Measures to prevent the surface from drying out immediately after pouring

・case of concrete temperature exceeds 25 degrees

・Temperature cracks - concrete materials - pre-cooling

・Concrete placing - night

・Concrete temperature drop

Cooling during kneading

Cement

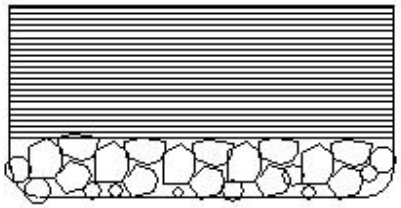
Cooling aggregate

Cold water

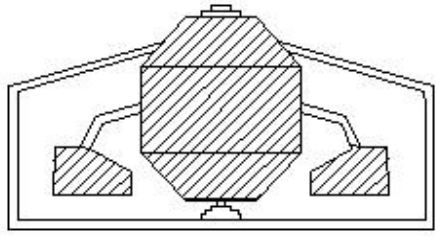
Ice

Aggregate cooling

Cooling (air cooling/water cooling)



Pre-cooling



mixer

C1388

Construction of concrete dam (placing concrete)

(D60)Construction of concrete dam (placing concrete)

Construction of concrete dam (placing concrete)

・placing concrete

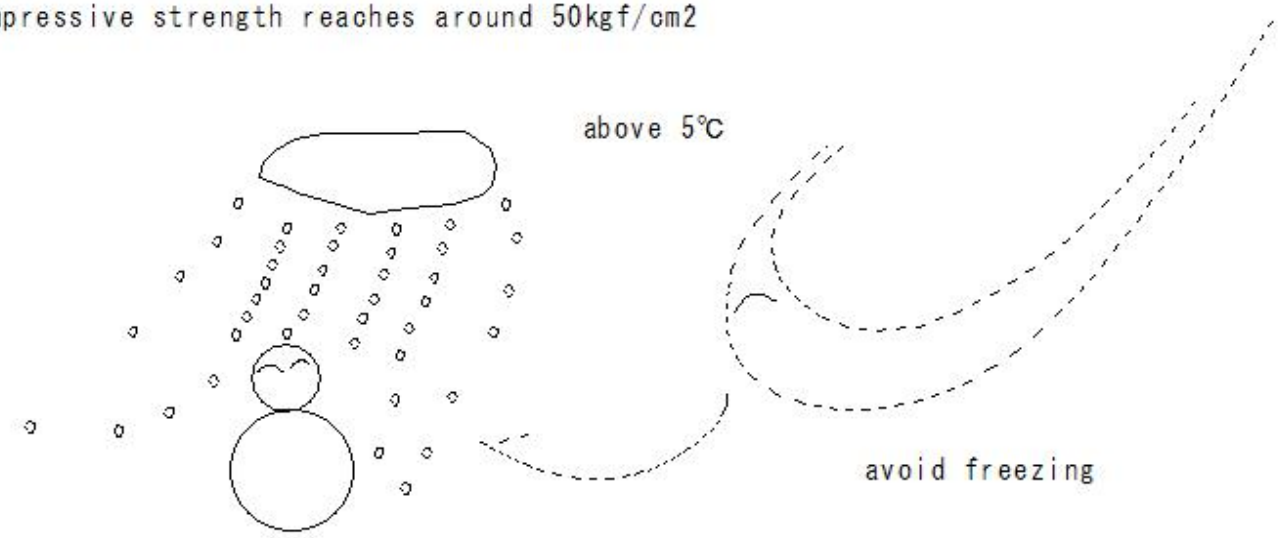
⑦Curing

Cold weather concrete

・Concrete surface - avoid freezing

・to keep above 5℃

・until concrete compressive strength reaches around 50kgf/cm2



Cold weather concrete

(D61)Construction of concrete dam (placing concrete-formwork)

(D61)Construction of concrete dam (placing concrete-formwork)

Construction of concrete dam (placing concrete-formwork)

・placing concrete

⑧ Formwork

① Formwork for upstream and downstream surfaces

② Horizontal joint Vertical joint formwork

③ Corridor formwork

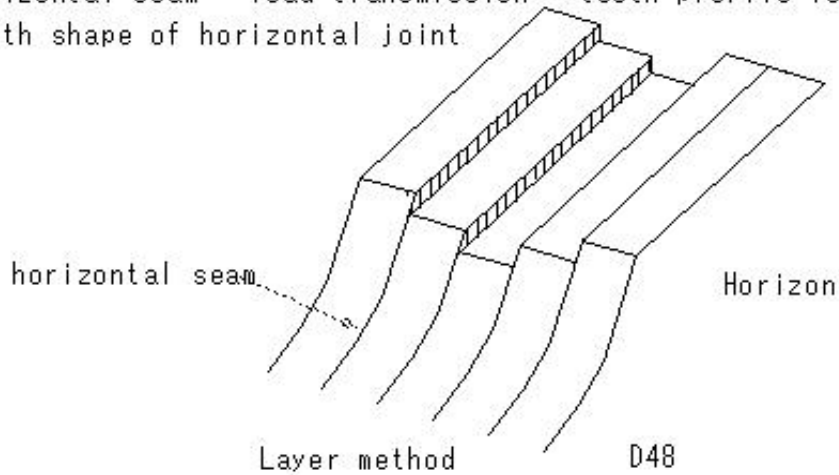
④ Formwork for overflow surface

⑤ Formwork for the pier

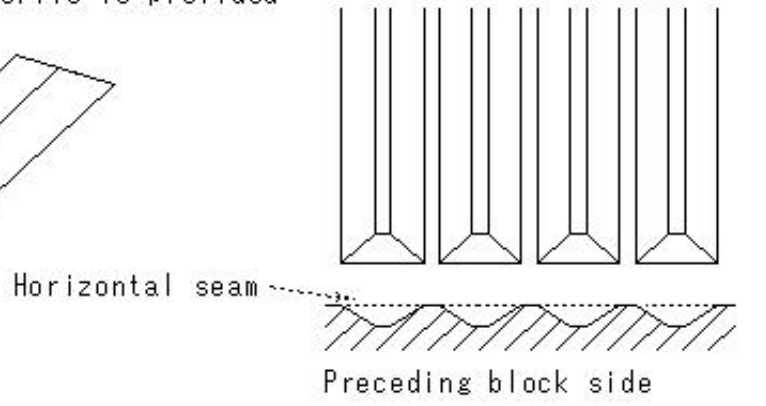
⑥ Other formwork

Horizontal seam - load transmission - tooth profile is provided

Tooth shape of horizontal joint



Layer method



Tooth shape of horizontal joint

(D62)Construction of concrete dam (placing concrete-formwork)

(D62)Construction of concrete dam (placing concrete-formwork)

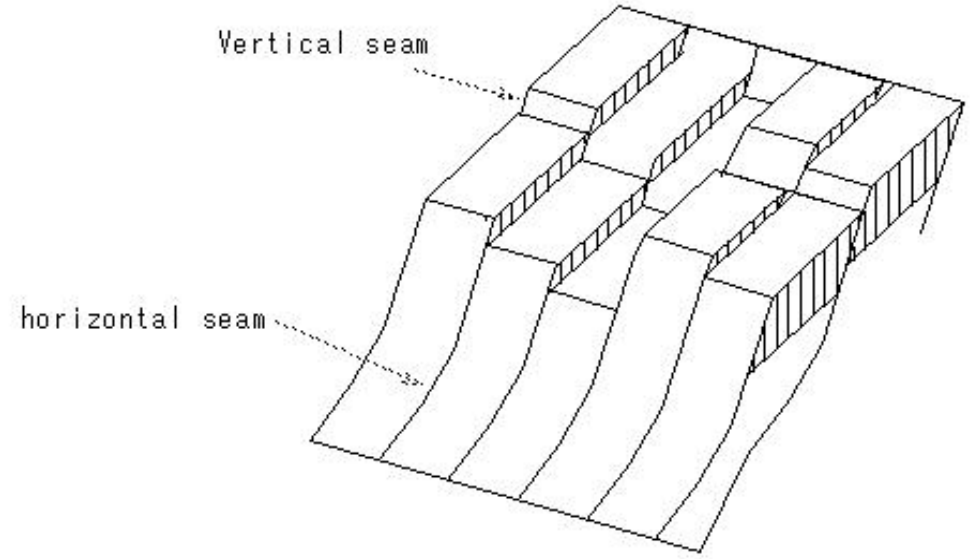
Construction of concrete dam (placing concrete-formwork)

・placing concrete

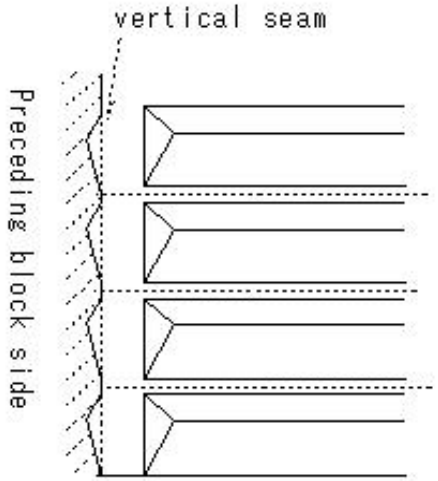
⑧Formwork

Horizontal seam - load transmission - tooth profile is provided

Tooth shape of vertical seam



block method



Tooth shape of vertical seam

(D63)Construction of concrete dam (placing concrete-formwork)

(D63)Construction of concrete dam (placing concrete-formwork)

Construction of concrete dam (placing concrete-formwork)

・placing concrete

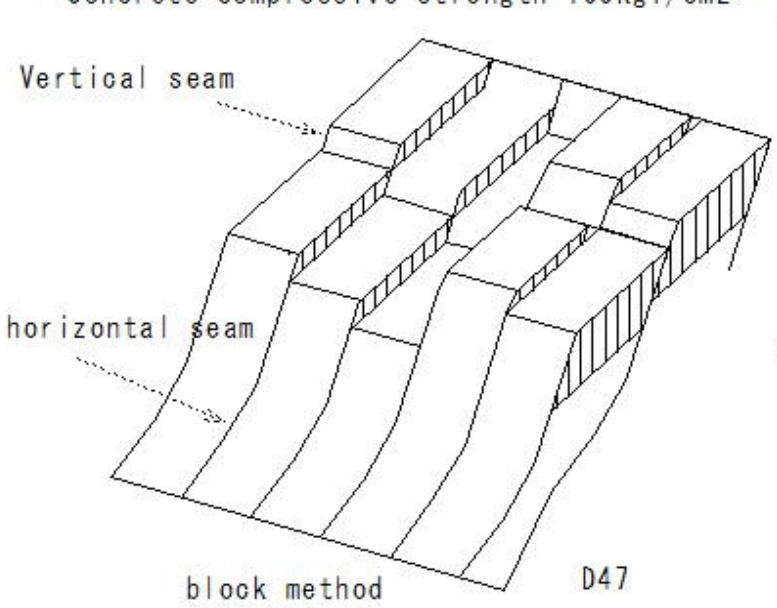
⑧Formwork

・Formwork removal time

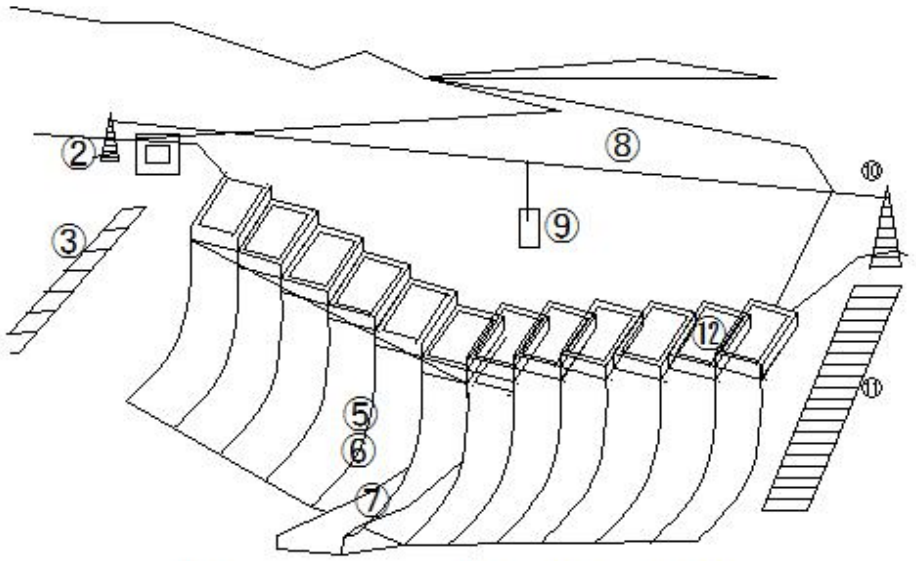
・Vertical surface - Concrete compressive strength 35kgf/cm2

・Arch opening inside the corridor/dam body

Concrete compressive strength 100kgf/cm2



D47



Place concrete block by block

(D64)Construction of concrete dam (Concrete temperature regulation)

(D64)Construction of concrete dam (Concrete temperature regulation)

Construction of concrete dam (Concrete temperature regulation)

・Concrete temperature regulation

①Purpose

・concrete hardens

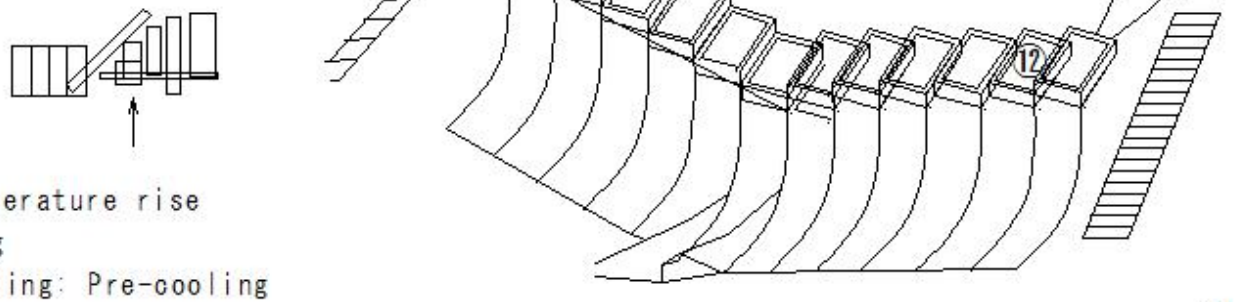
Temperature rise due to heat of hydration of cement

・Mass concrete construction

・control of concrete temperature rise

・Prevention of temperature cracks

・Countermeasures (temperature regulation)



Clean plant

mass concrete

Suppression of temperature rise

①Aggregate cooling

②Mixing water cooling: Pre-cooling

③Pipe cooling

C1017

(D65)Concrete temperature regulation(Pre-cooling)

(D65)Concrete temperature regulation(Pre-cooling)

Construction of concrete dam (Concrete temperature regulation)

・Concrete temperature regulation

②Pre-cooling

・Cooling concrete materials before mixing

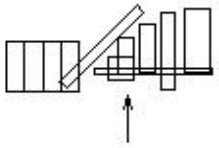
lower concrete temperature

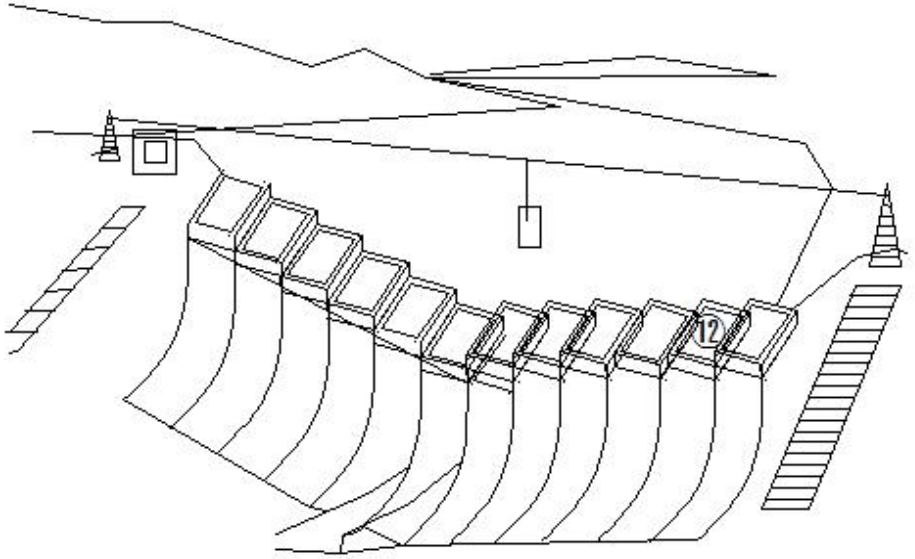
・Method: Cooling of mixing water

・Cooling of mixing water、replace with ice

・Cooling of coarse aggregate

・No cooling of cemen,fine aggregate:





Clean plant

mass concrete

Suppression of temperature rise

①Aggregate cooling

②Mixing water cooling: Pre-cooling

③Pipe cooling

C1017

(D66)Concrete temperature regulation(Pipe cooling)

(D66)Concrete temperature regulation(Pipe cooling)

Construction of concrete dam (Concrete temperature regulation)

・Concrete temperature regulation

③Pipe cooling

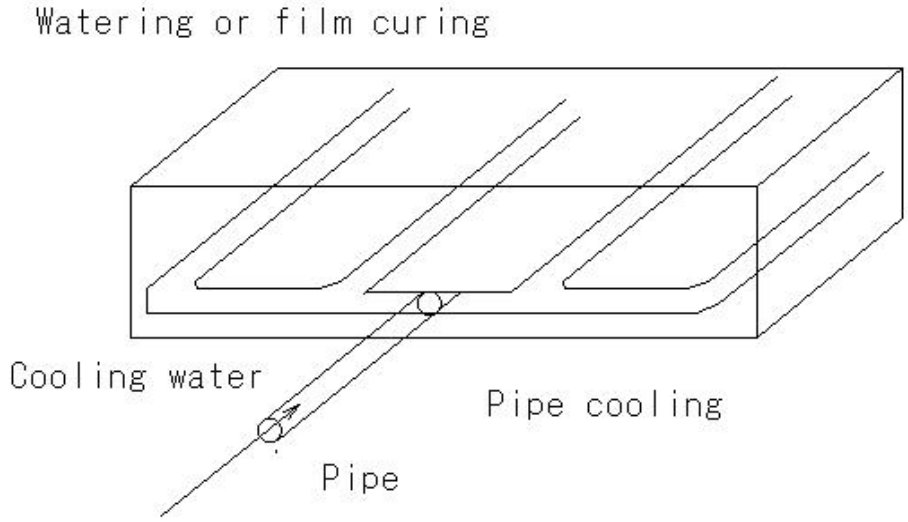
・Concrete cooling

・Block construction method (column construction method)

・Used with joint grouting

1st cooling

Secondary cooling



C867

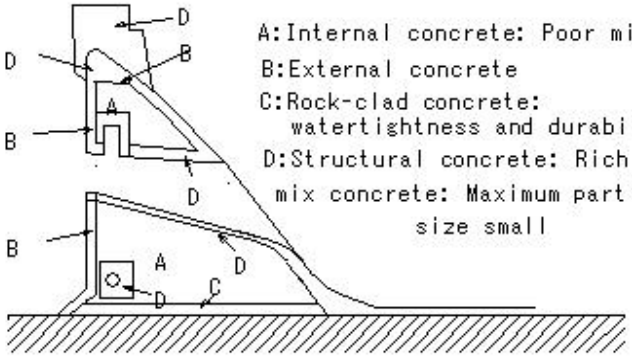
(D67)Concrete temperature regulation(Pipe cooling)

(D67)Concrete temperature regulation(Pipe cooling)

Construction of concrete dam (Concrete temperature regulation)

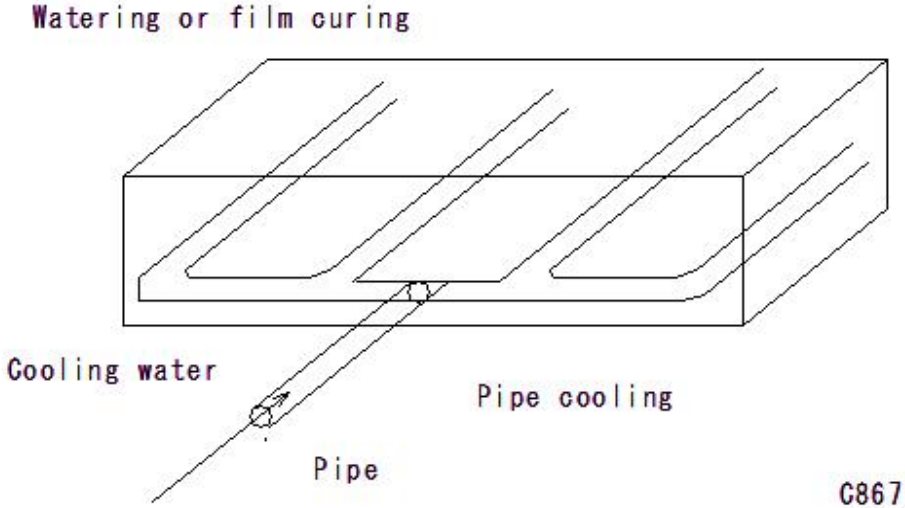
③Pipe cooling

- Diameter 1 inch 25.4mm
- Cooling pipe
- Piping in the dam axis direction (left and right bank direction)
- Prevent water paths



A:Internal concrete: Poor mix
B:External concrete
C:Rock-clad concrete: watertightness and durability
D:Structural concrete: Rich mix concrete: Maximum particle size small

C1064



C867

(D68)Concrete temperature regulation(Pipe cooling)

(D68)Concrete temperature regulation(Pipe cooling)

Concrete temperature regulation(Pipe cooling)

③Pipe cooling

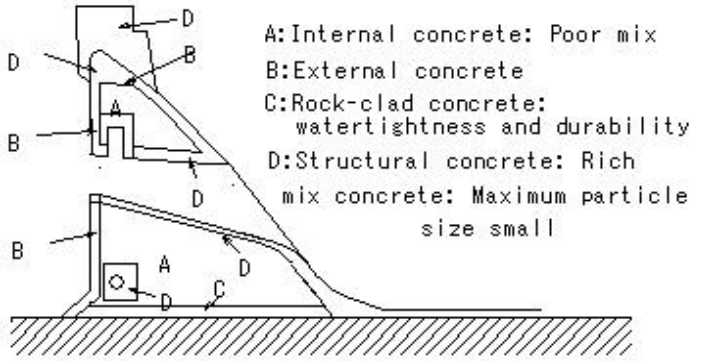
Pipe cooling period

・First cooling period

Immediately after placing, approximately 2 weeks to 1 month

・Second cooling period

for about 40-60 days



A:Internal concrete: Poor mix
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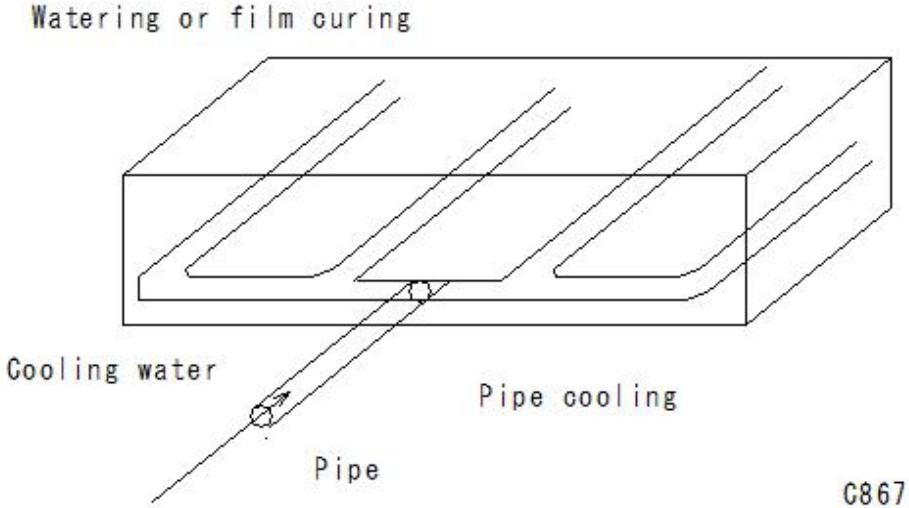
D:Structural concrete: Rich mix concrete: Maximum particle size small

C1064



C867

(D69)Concrete temperature regulation(Pipe cooling)

(D69)Concrete temperature regulation(Pipe cooling)

Concrete temperature regulation(Pipe cooling)

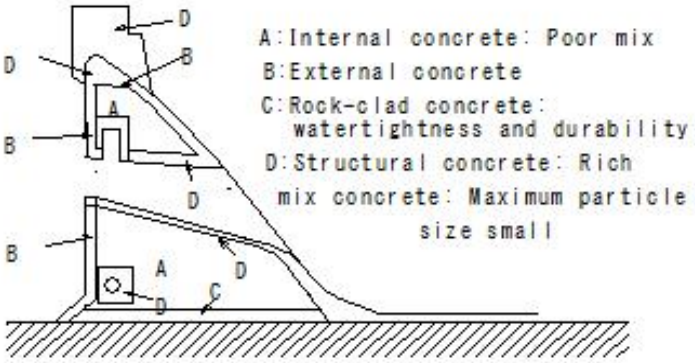
・Concrete temperature regulation

③Pipe cooling

④Cooling management

・Cold water flow direction in the cooling pipe

・Reverse cold water flow direction every other day (every 24 hours) cools uniformly



A:Internal concrete: Poor mix
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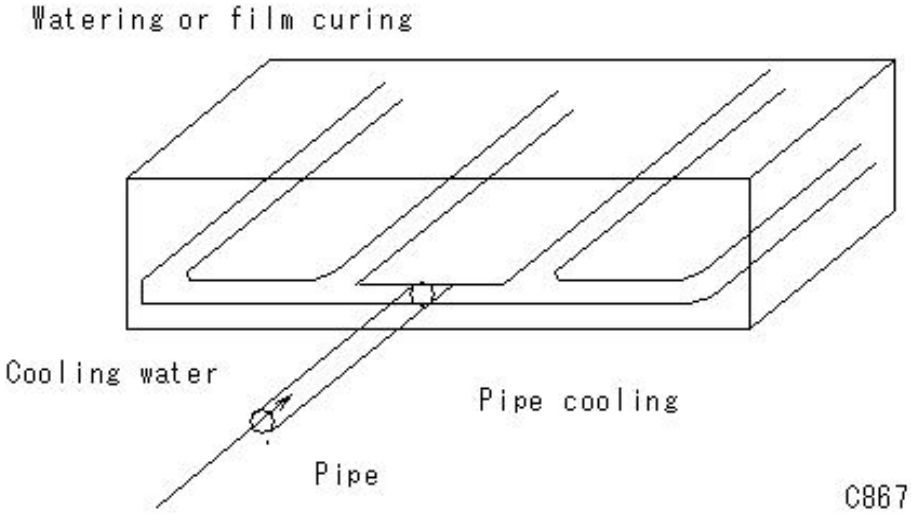
D:Structural concrete: Rich mix concrete: Maximum particle size small

C1064



C867

(D70)Concrete temperature regulation(Joint grouting)

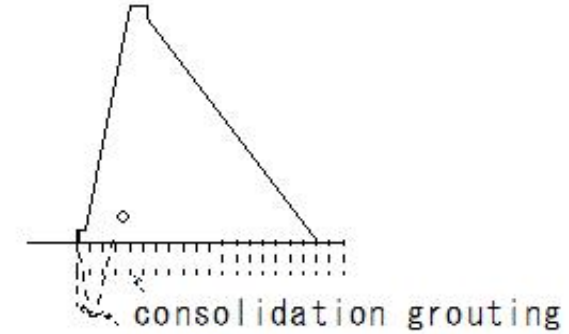
(D70)Concrete temperature regulation(Joint grouting)

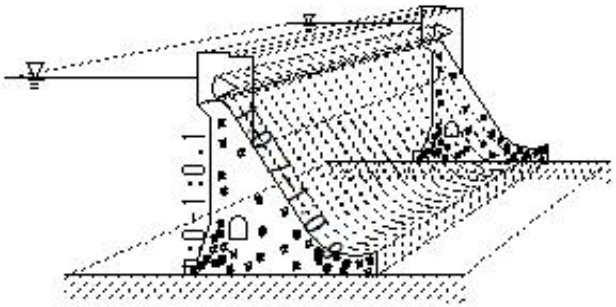
Concrete temperature regulation(Joint grouting)

④Joint grouting

- Unify structures that are divided into blocks
- Vertical joint of gravity dam
- Horizontal joint of arch dam

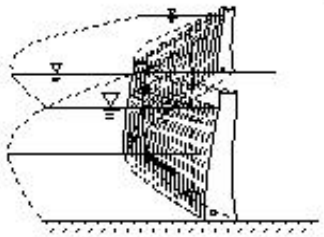
  Detracts from integration
- Perform joint grouting on the seams
- The standard lift height for joint grouting is 15-16 m.





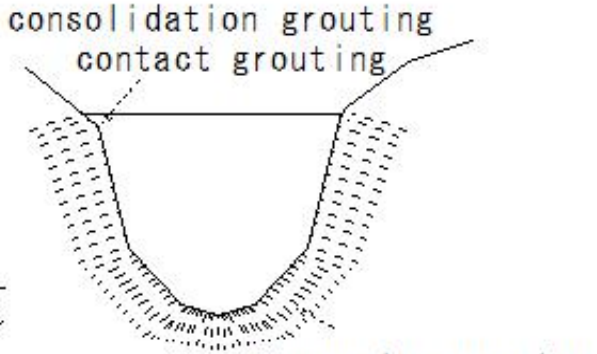
gravity dam

D2



Arch dam

D3



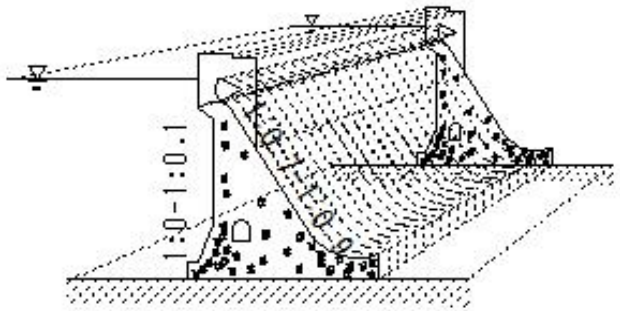
F327

(D71)Construction of concrete dam (Corridor)

(D71)Construction of concrete dam (Corridor)

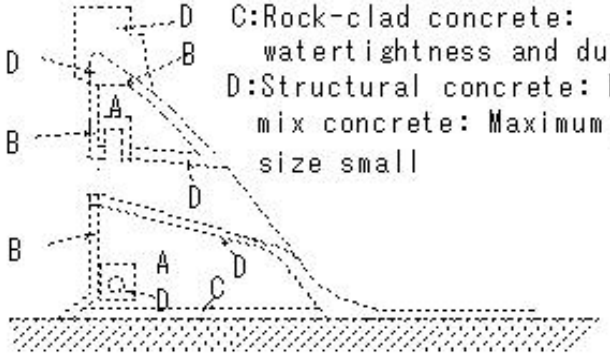
Construction of concrete dam (Corridor)

- Corridor
- Safety management of embankment body
- Construction of curtain grouting
- Installation of drainage holes
- Connection route to discharge equipment
- Minimum distance between corridor and upstream surface: 3m
- Minimum distance between corridor and foundation rock: around 2m



gravity dam
D2

A:Internal concrete: Poor mix
B:External concrete
C:Rock-clad concrete: watertightness and durability
D:Structural concrete: Rich mix concrete: Maximum particle size small



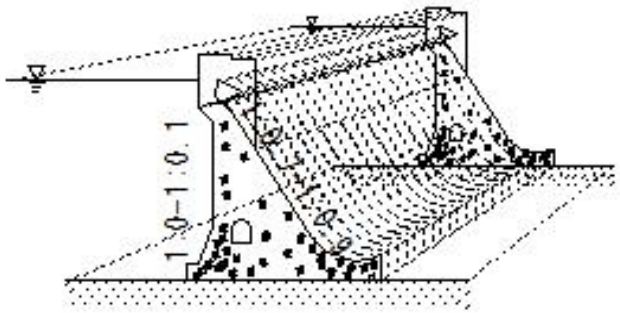
gravity dam
C1064

(D72)Construction of concrete dam (Foundation drainage hole)

(D72)Construction of concrete dam (Foundation drainage hole)

Construction of concrete dam (Foundation drainage hole)

- Foundation drainage hole
- Concrete dam
  Install foundation drainage holes to reduce uplift pressure acting on the dam body.
- Foundation drainage holes are drilled from the safety corridor provided parallel to the dam axis.
- Drainage hole depth: about 3-5m



gravity dam
D2

A:Internal concrete: Poor mix
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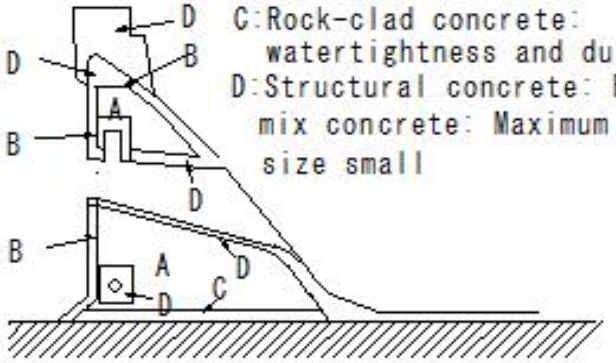


gravity dam
C1064

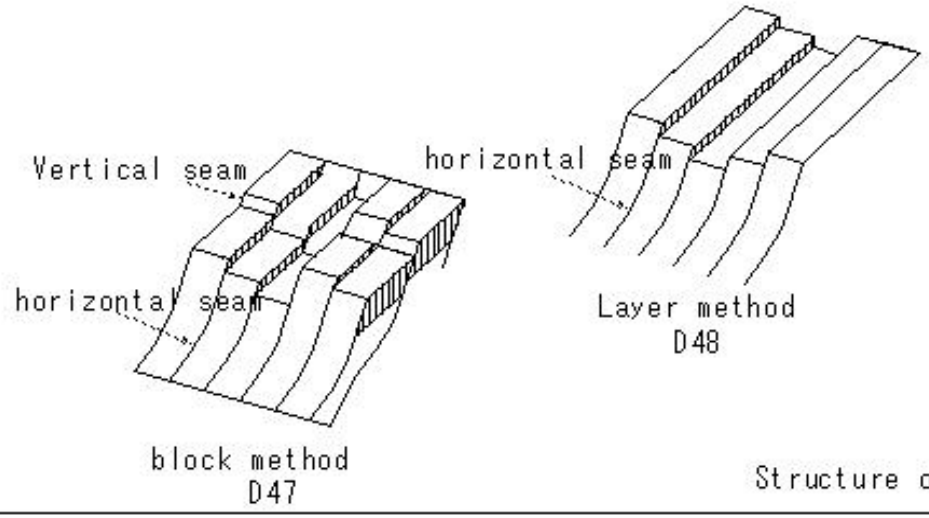
(D73)Construction of concrete dam (Water stop plate and joint drainage hole)

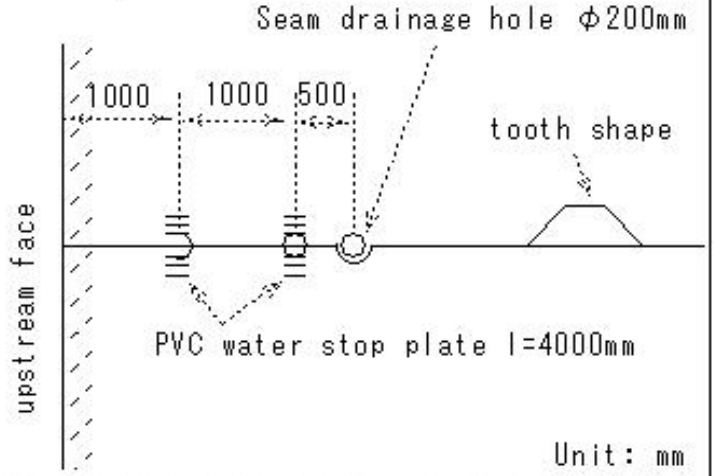
(D73)Construction of concrete dam (Water stop plate and joint drainage hole)

Construction of concrete dam

- Water stop plate and joint drainage hole
- Horizontal joint of concrete dam
- Reservoir water leakage route

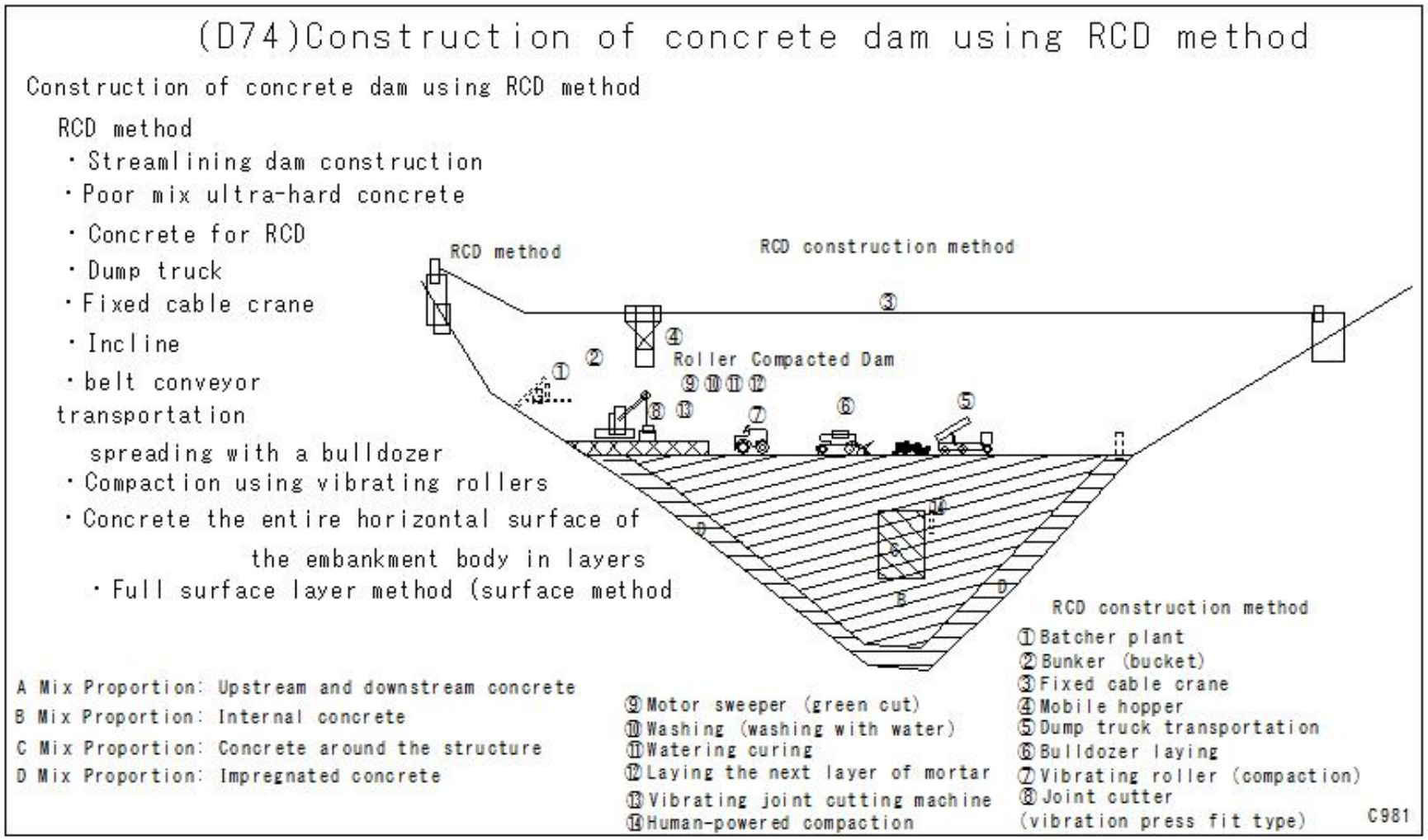
  Install a water stop plate near the upstream end of the horizontal joint
- Seam drainage holes are provided after the water stop plate.
- Collect and drain water leakage that occurs when the water stop plate is incomplete
- Water stop plate: Placed only on the upstream side of the non-overflow area
- Water stop plate: Placed on both sides of overflow section - upstream and downstream sides



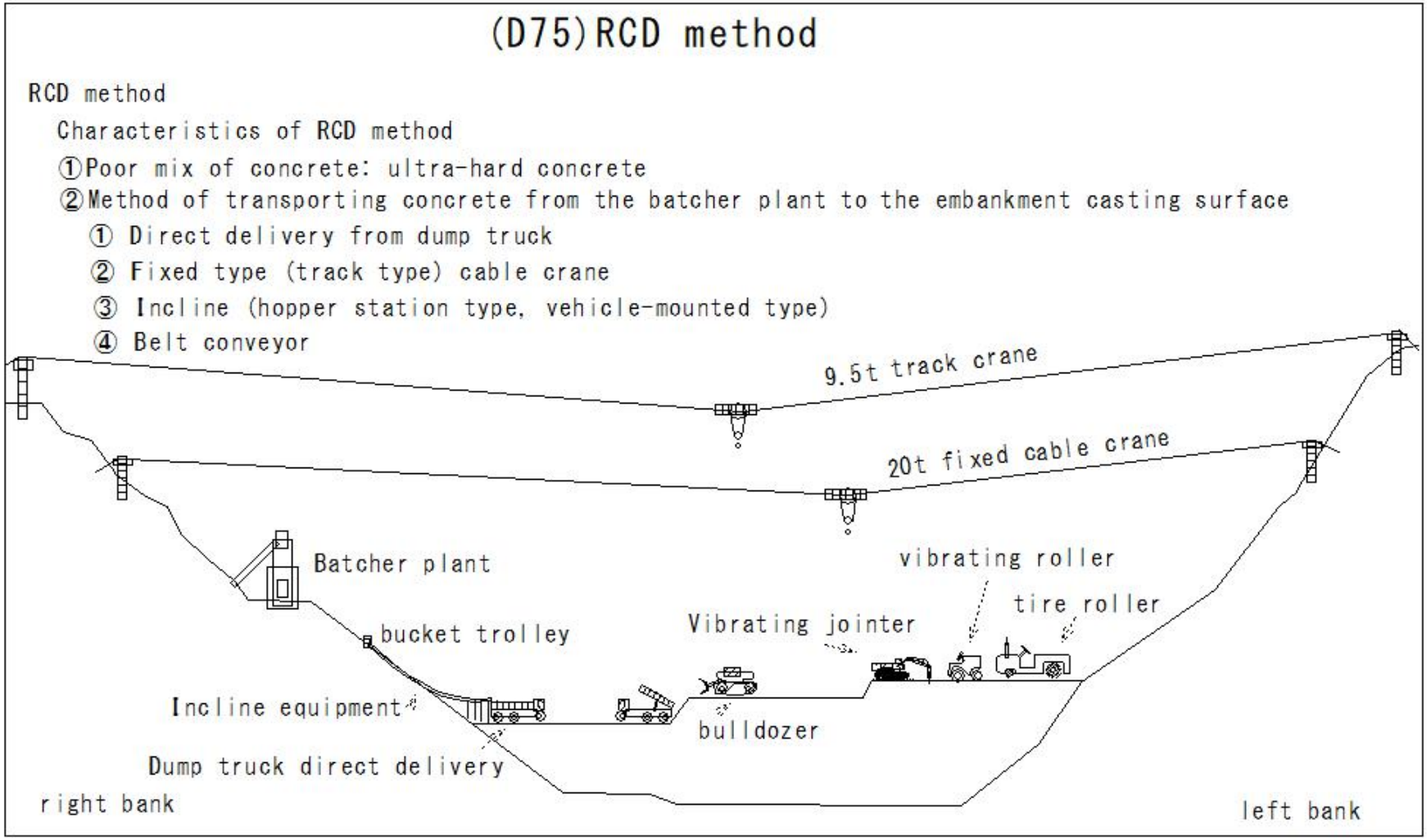


Structure of water stop plate and joint drainage hole

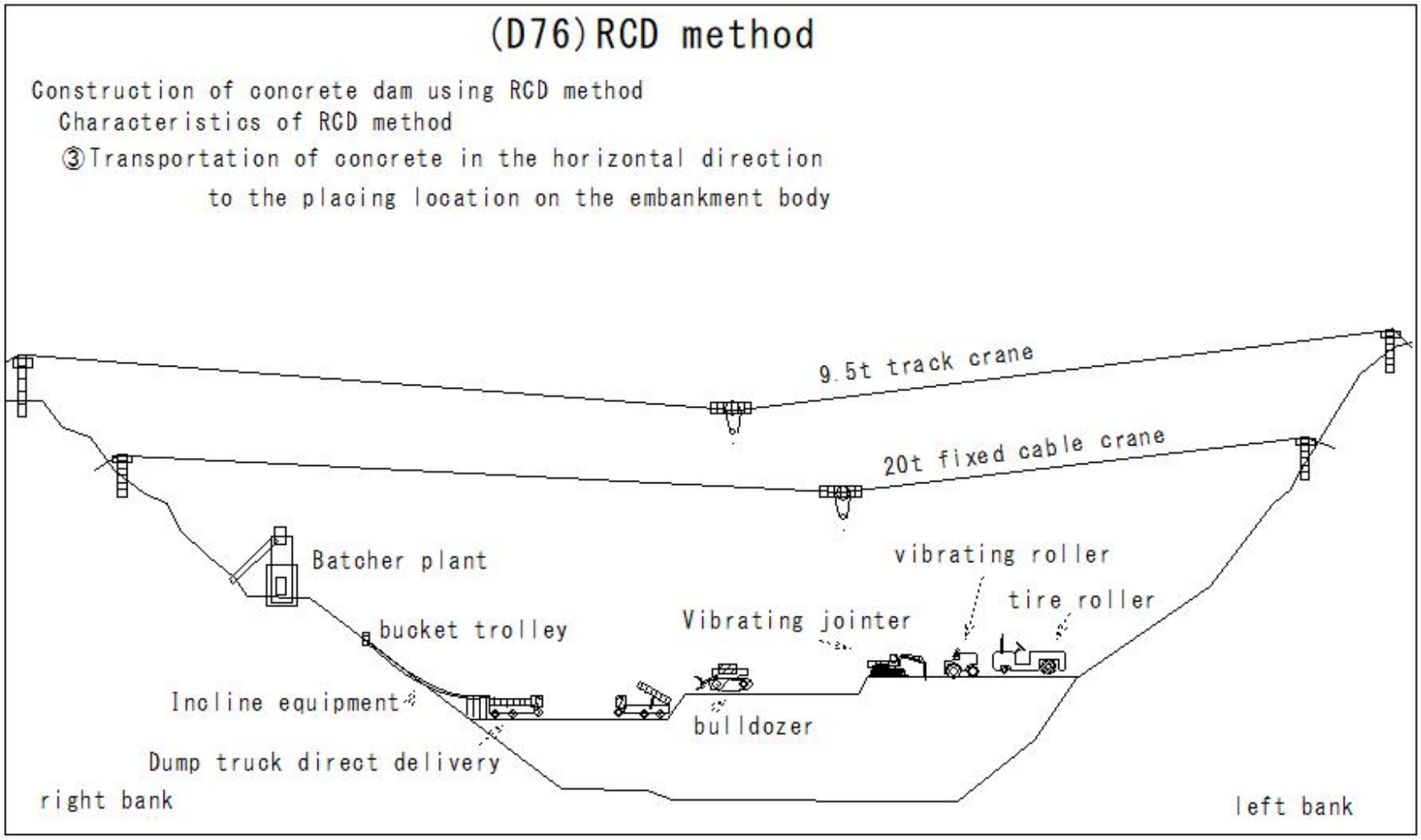
(D74)Construction of concrete dam using RCD method



(D75)RCD method



(D76)RCD method



(D77)RCD method

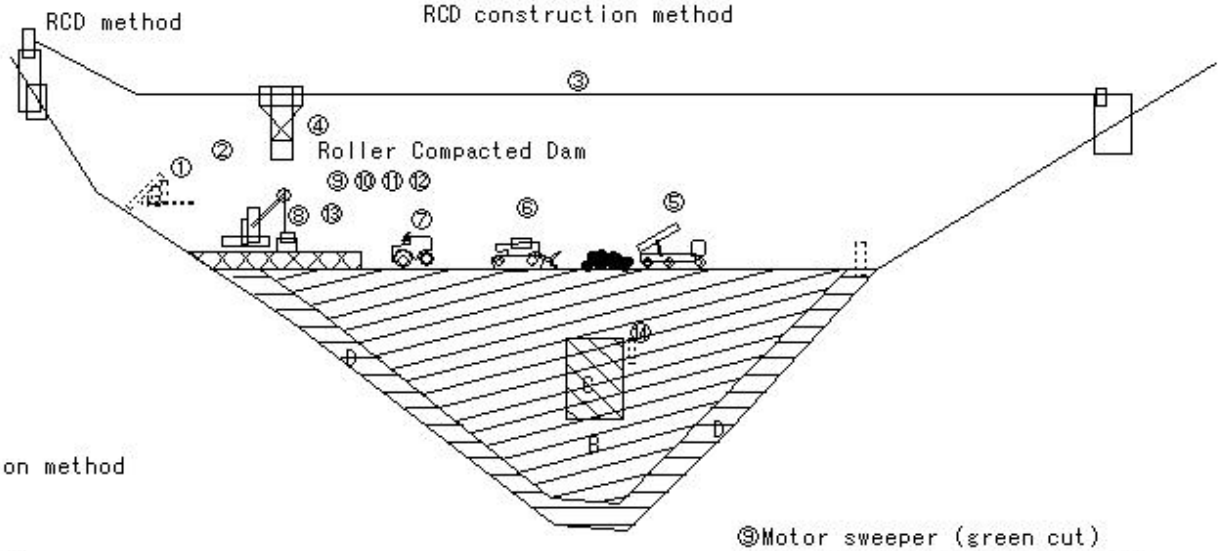
(D77)RCD method

Construction of concrete dam using RCD method

Characteristics of RCD method

④Placing method

Full layer method



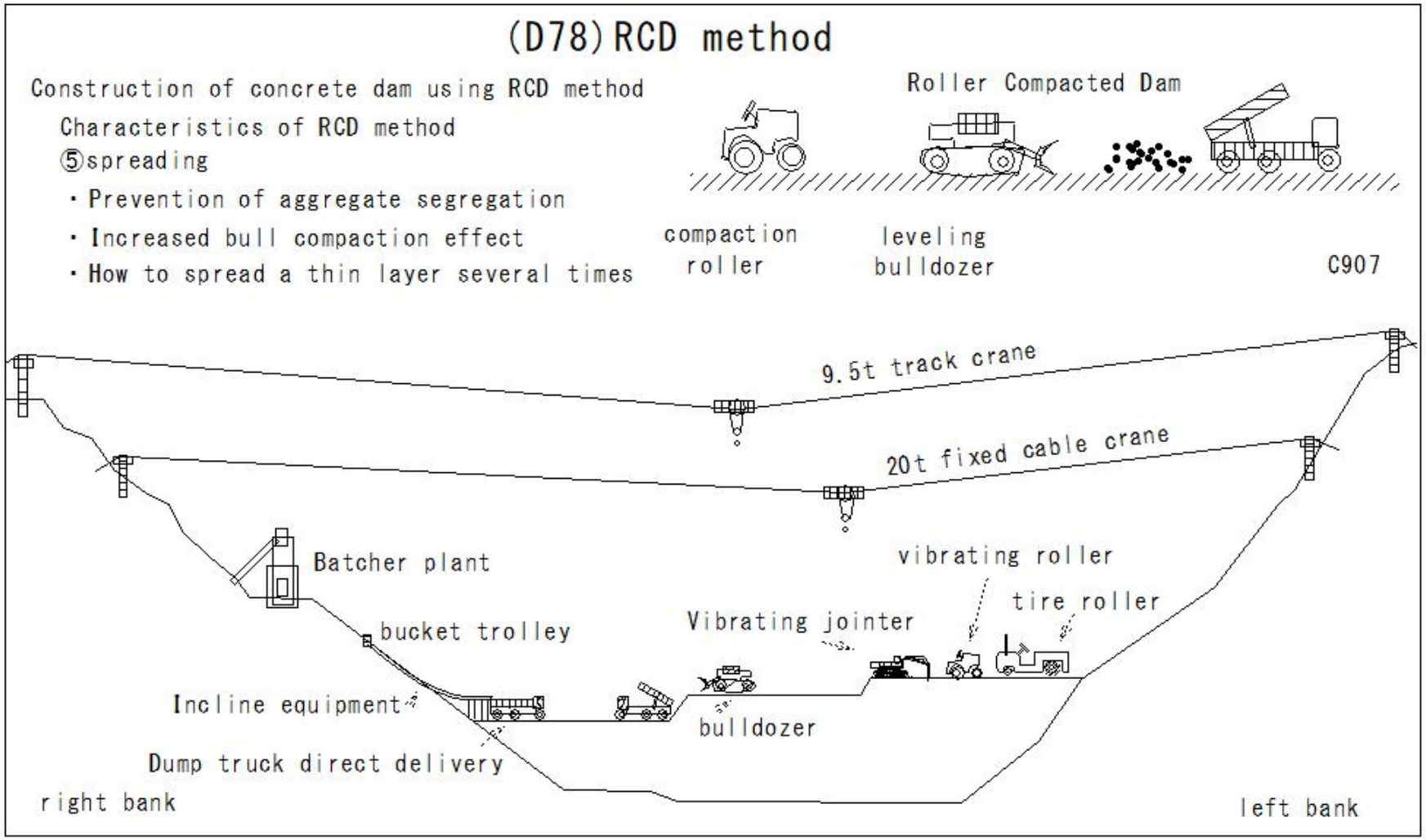
RCD construction method

①Batcher plant
②Bunker (bucket)
③Fixed cable crane
④Mobile hopper
⑤Dump truck transportation
⑥Bulldozer laying
⑦Vibrating roller (compaction)
⑧Joint cutter
(vibration press fit type)

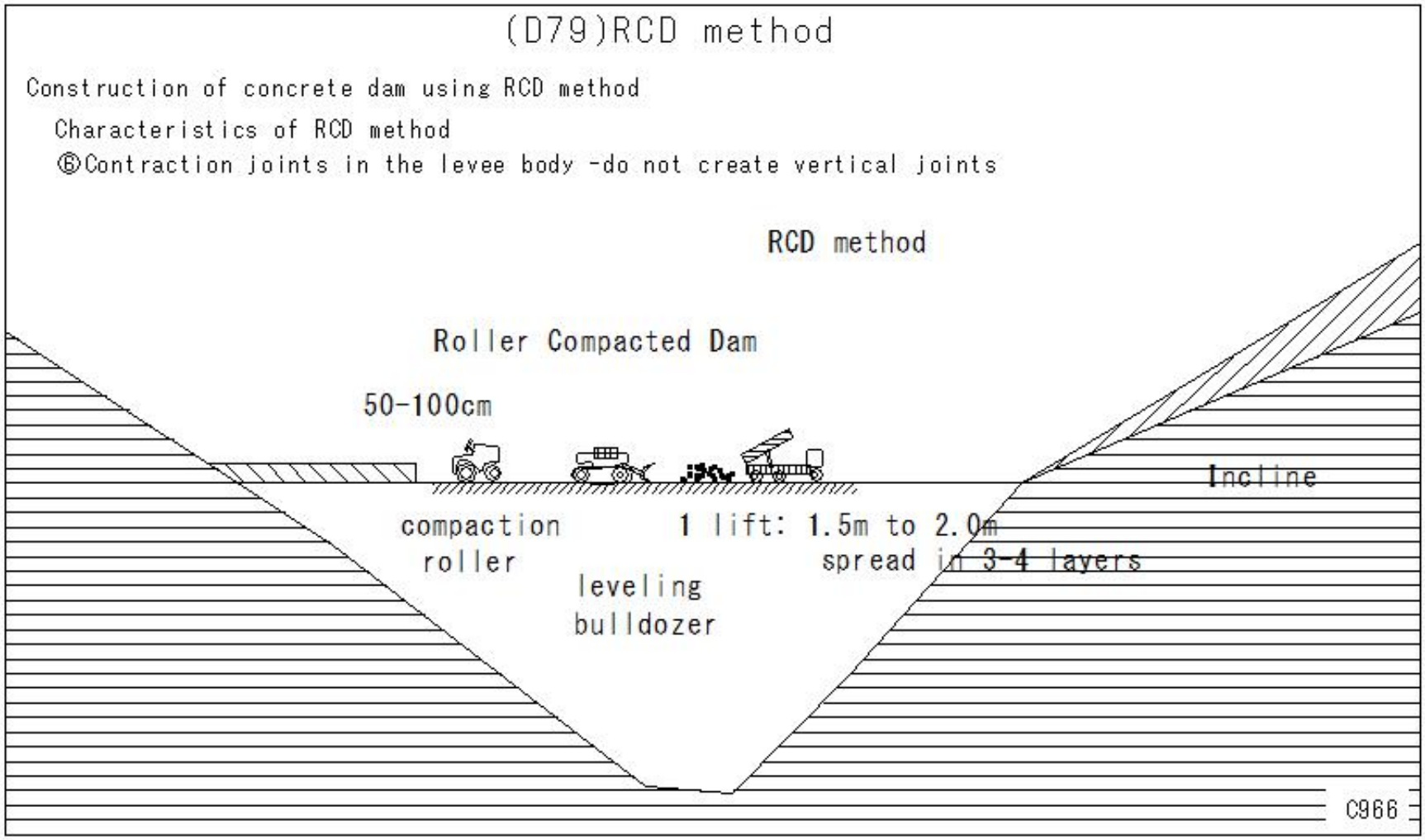
⑨Motor sweeper (green cut)
⑩Washing (washing with water)
⑪Watering curing
⑫Laying the next layer of mortar
⑬Vibrating joint cutting machine
⑭Human-powered compaction

C981

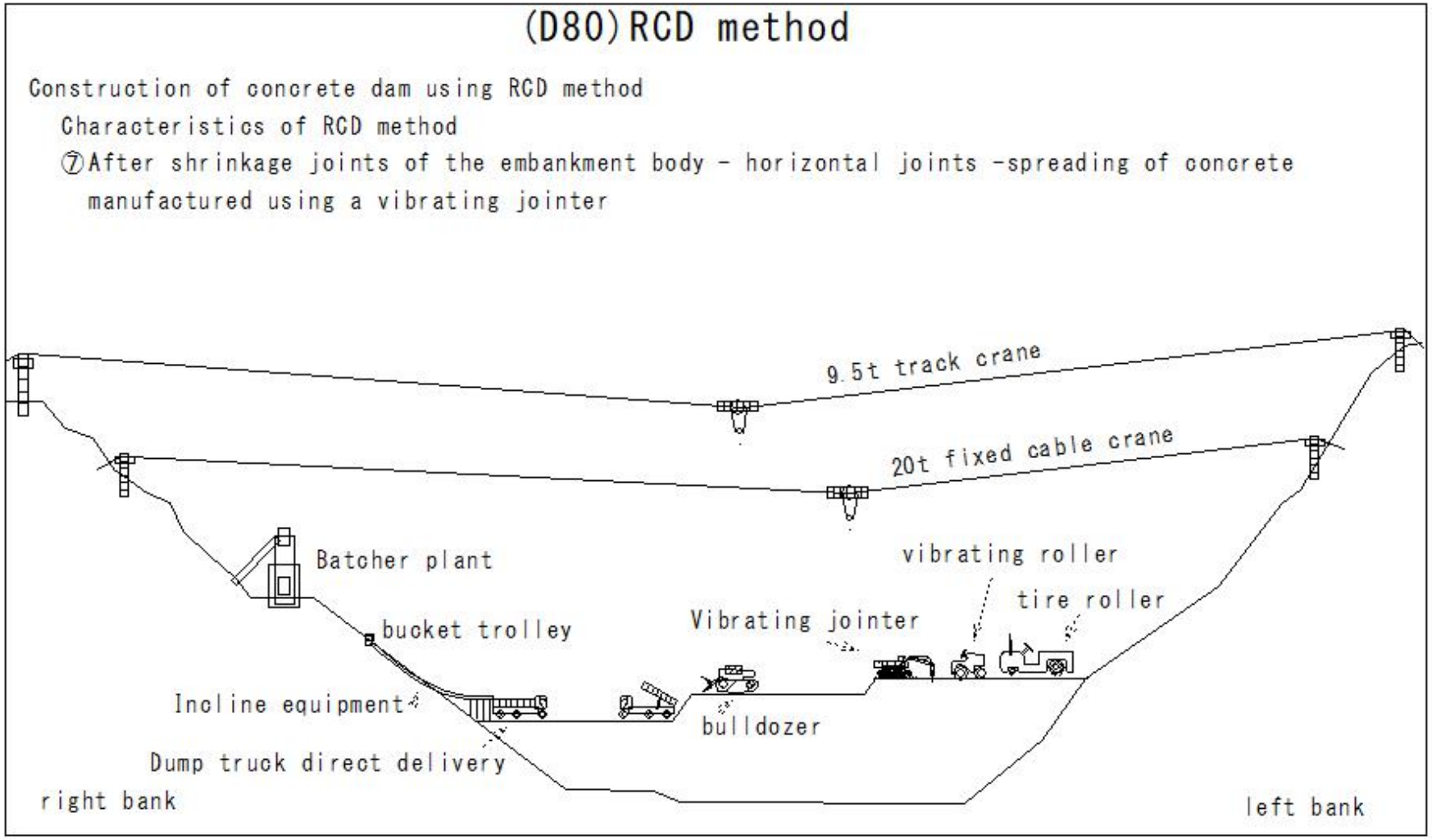
(D78)RCD method



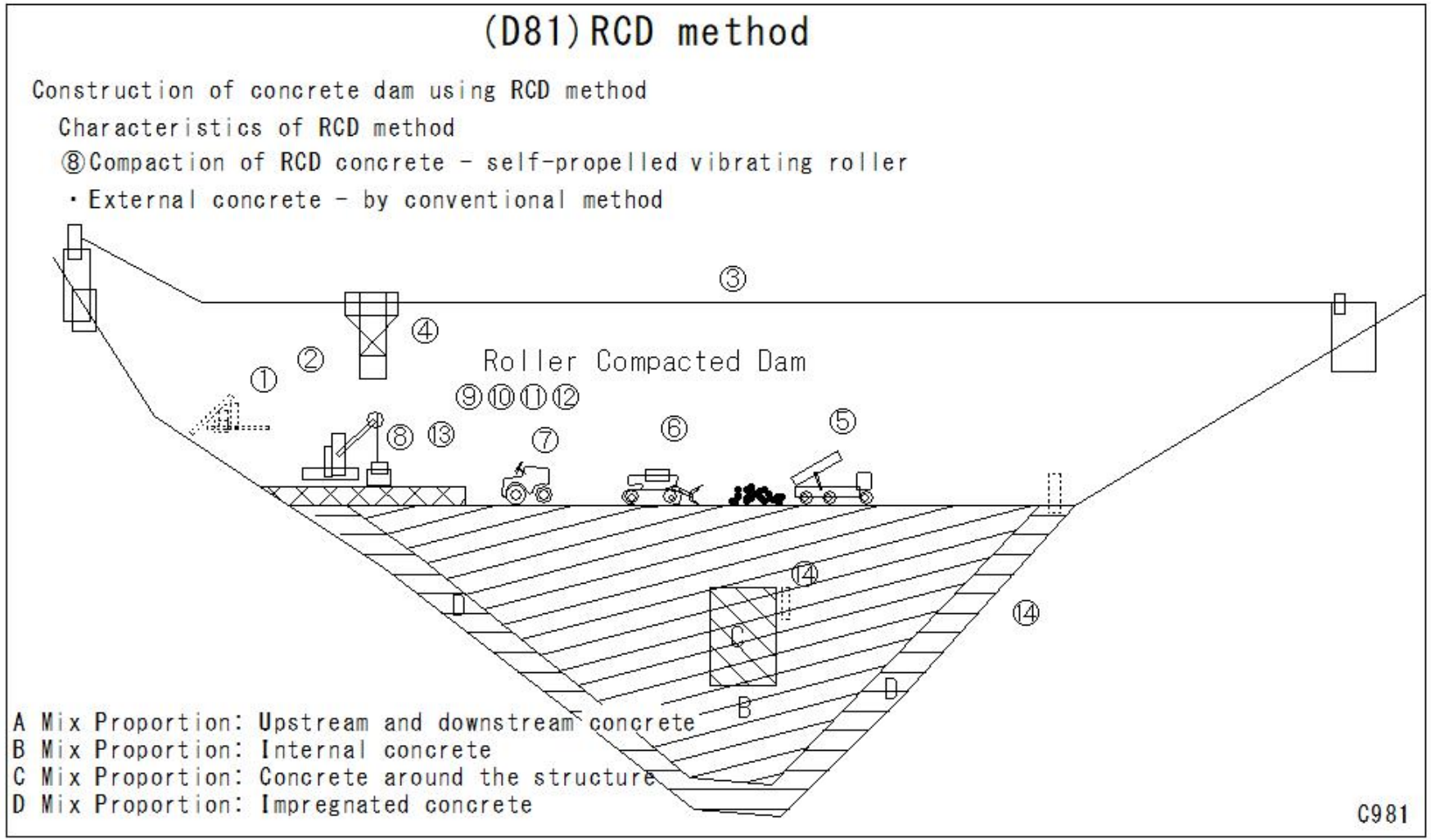
(D79)RCD method



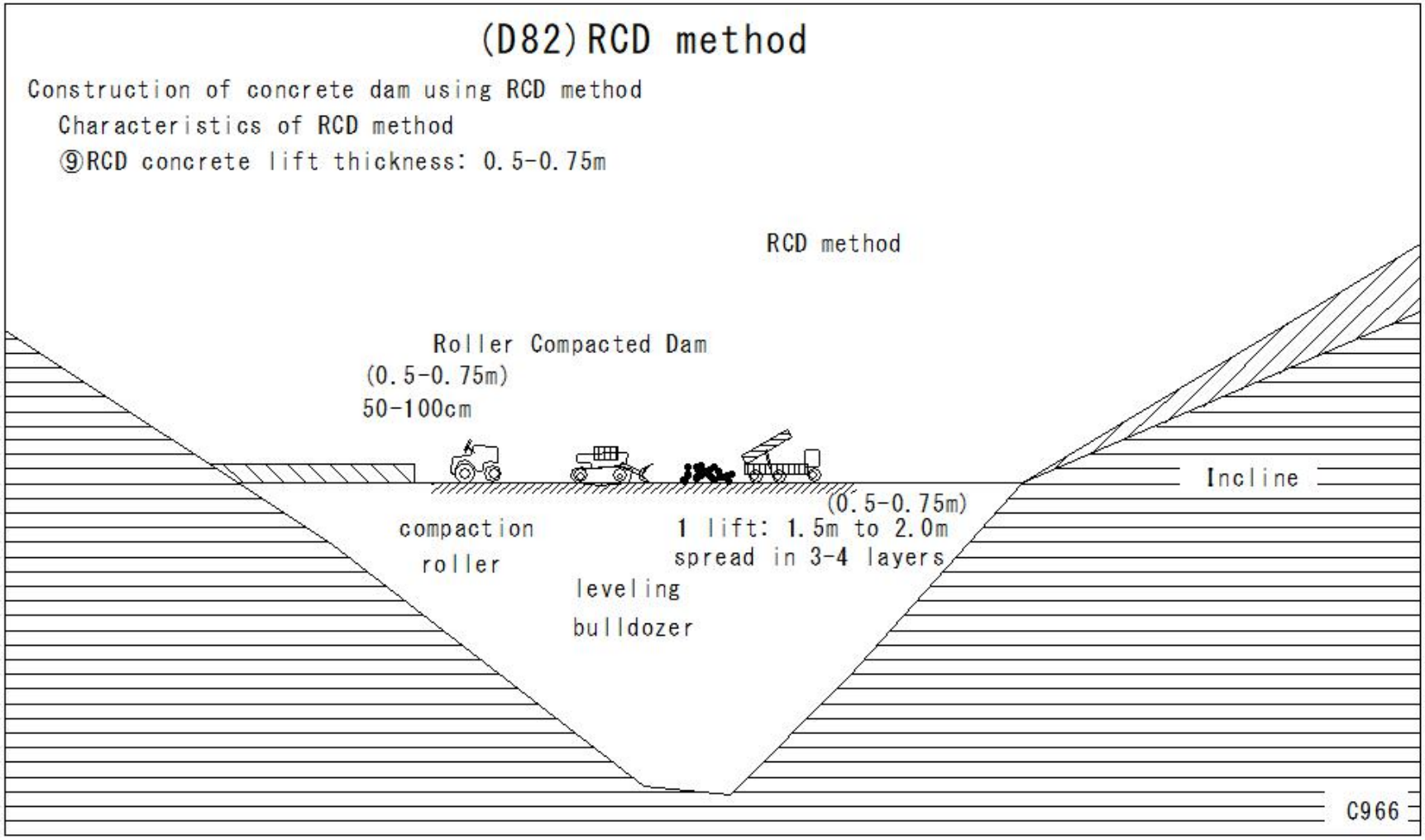
(D80)RCD method



(D81)RCD method



(D82)RCD method



(D83)RCD method

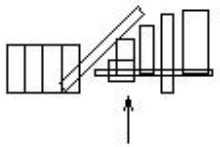
(D83)RCD method

Construction of concrete dam using RCD method

Characteristics of RCD method

⑩Temperature regulation pre-cooling

Do not perform pipe cooling



plant

mass concrete

Suppression of temperature rise

①Aggregate cooling

②Mixing water cooling: Pre-cooling

③Pipe cooling

D65

Cement

Cooling aggregate

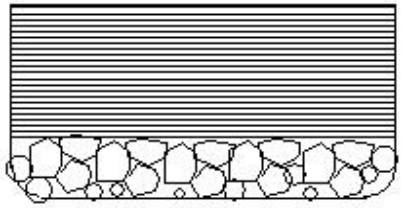
Cold water

Ice

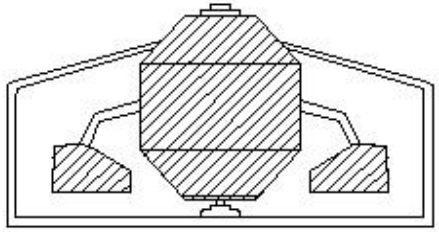
Cooling during kneading

Aggregate cooling

Cooling (air cooling/water cooling)



Pre-cooling



mixer

D59

C1388

(D84)RCD method

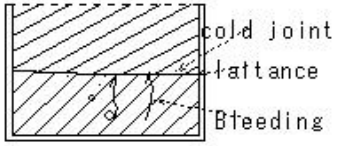
(D84)RCD method

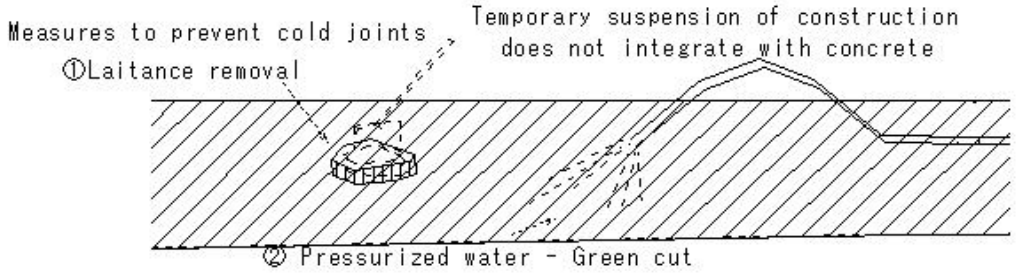
Construction of concrete dam using RCD method

Characteristics of RCD method

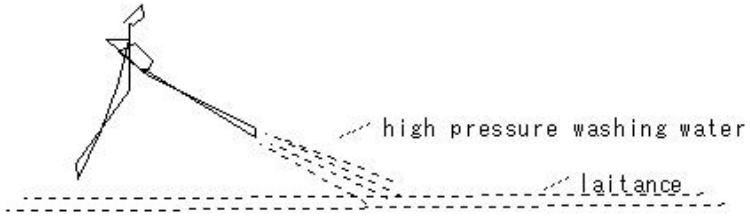
⑪Green cut at horizontal placing seam

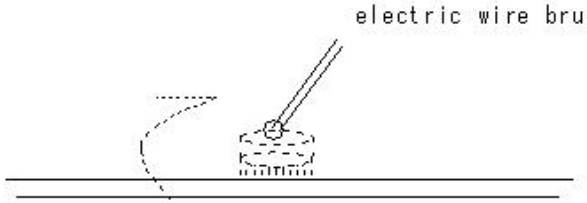
・Self-propelled type such as motor sweeper





C880





C1016

(D85)RCD method

(D85)RCD method

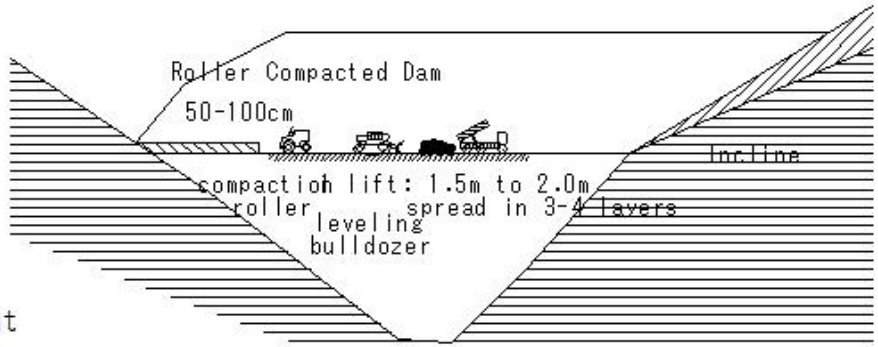
Construction of concrete dam using RCD method

Characteristics of RCD method

⑫Consistency management of RCD concrete

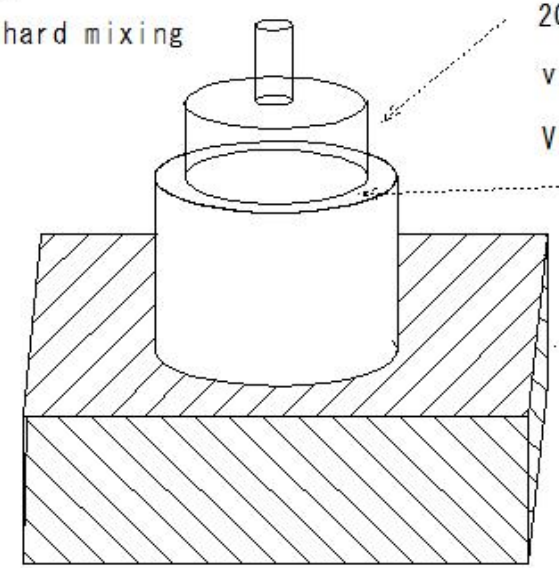
VC exam-value

RCD method



VC test

Super hard mixing



20kg weight

vibrating compaction value

VC value

time required for mortar bleeding on surface

RCD concrete

vibration

C1124

(D86)RCD method

(D86)RCD method

Construction of concrete dam using RCD method

Characteristics of RCD method

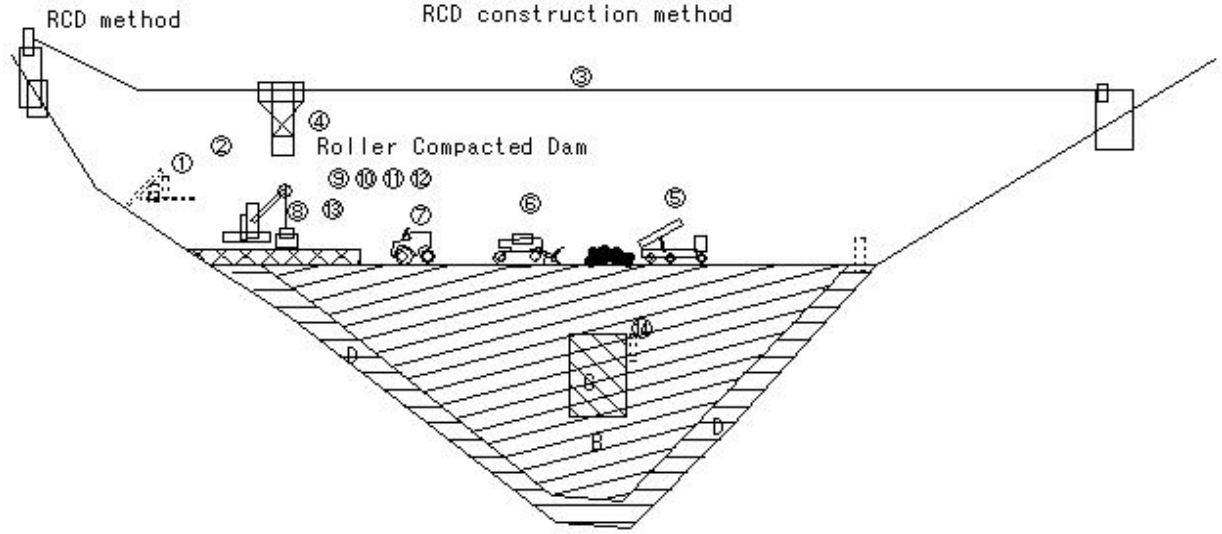
- Economic
- Shorten construction period - Possible

①Valley shape of the dam site: V-shaped steep topography

②case of discharge equipment many buried objects such as corridors

③Dam-small scale

④Rainfall: Rainfall of 2mm or more per hour -placing is prohibited



D77

(D87)fill dam

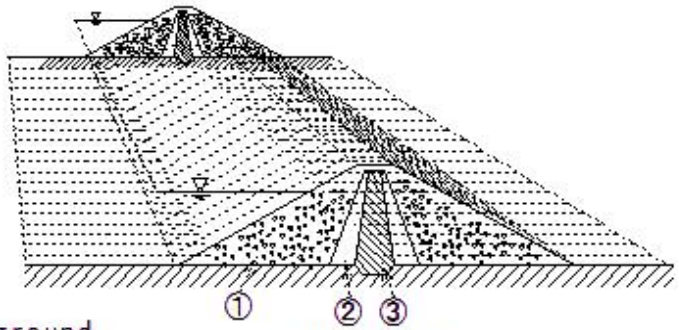
(D87)fill dam

fill dam

Characteristics of field material

- Coarse grain material - Water permeable material, semi-water permeable material
- Impermeable materials - soil materials, artificial Impermeable materials
- permeable material-shear strength
- Compaction construction - easy
- Consolidation settlement after compaction - small
- not contain harmful amounts of organic matter
- Contains about 10-20% of clay + silt fine particles (0.074 mm or less)
- Material with high plasticity index containing about 50% gravel

①permeable material
②Semi-permeable material
③Waterproof material



spillway installed on the ground

zone type

D6
R590

(D88)fill dam

(D88)fill dam

fill dam

Characteristics of field material

・Coarse grain material - Water permeable material, semi-water permeable material

・Water-shielding materials - soil materials, artificial water-shielding materials

② Semi-permeable material

・particle size - appropriate

・Has the required shear strength and water permeability

①Filter material

・Only water is discharged for seepage water from the water-blocking zone

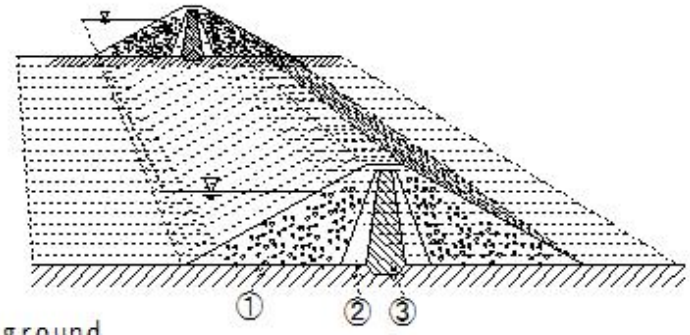
・Prevents fine particles from flowing out in water-blocking materials

②Transition material

・Between the impermeable zone and the permeable zone

・Reducing sudden changes in rigidity and water permeability

①permeable material
②Semi-permeable material
③Waterproof material



spillway installed on the ground

zone type

D6
R590

(D89)fill dam

(D89)fill dam

fill dam

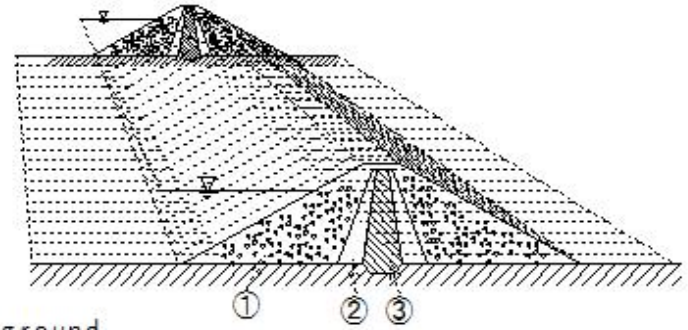
Characteristics of field material

- Coarse grain material - Water permeable material, semi-water permeable material
- Impermeable materials - soil materials, artificial Impermeable materials

③permeable material

- Hardness and durability
- Shear strength-improves drainage
- Rock - hard
  appropriately large and small particle shapes - mixed
- Density - large

①permeable material
②Semi-permeable material
③Waterproof material



spillway installed on the ground

zone type

D6
R590

(D90)fill dam

(D90)fill dam

fill dam

material collection

①Collection and adjustment of water-Impermeable materials

Uniform particle size and water content ratio

・case of appropriate materials cannot be obtained

Stockpile creation

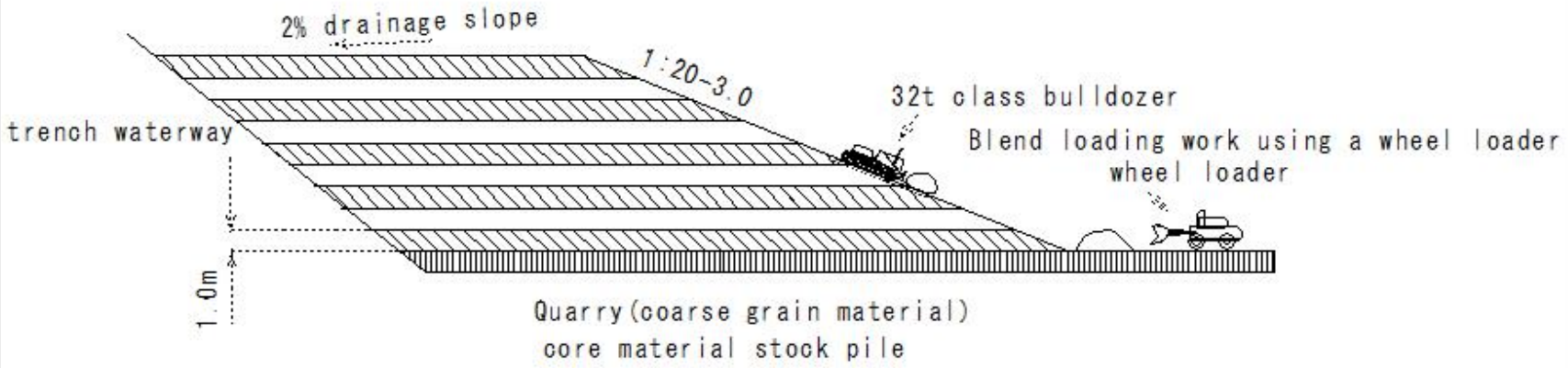
Moisture content ratio/particle size adjustment

・Adjustment of water content ratio

Aeration Water sprinkling

・Particle size adjustment uniformity

Temporarily mix 2-3 types of materials in layers



(D91)fill dam

(D91)fill dam

fill dam

material collection

②Collection and preparation of semi-permeable materials

・Used as filter material for embankment body

filter law criteria

・Materials with specified particle size range

・Materials used: riverbed gravel, quarry: semi-weathered rock

・Adjustment of filter material - particle size adjustment

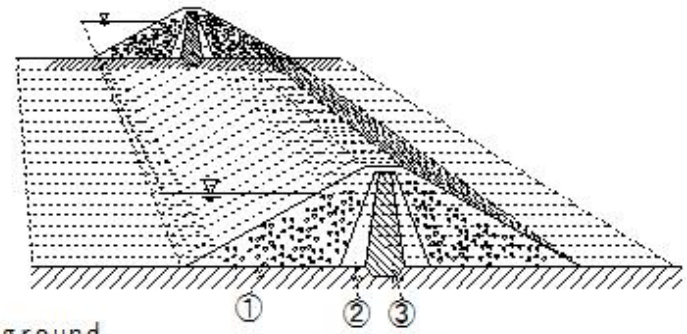
oversize removal

Washing with water

Coarse grain material - blend - fine grain

Crushing plant - overall particle size control - combination

①permeable material
②Semi-permeable material
③Waterproof material

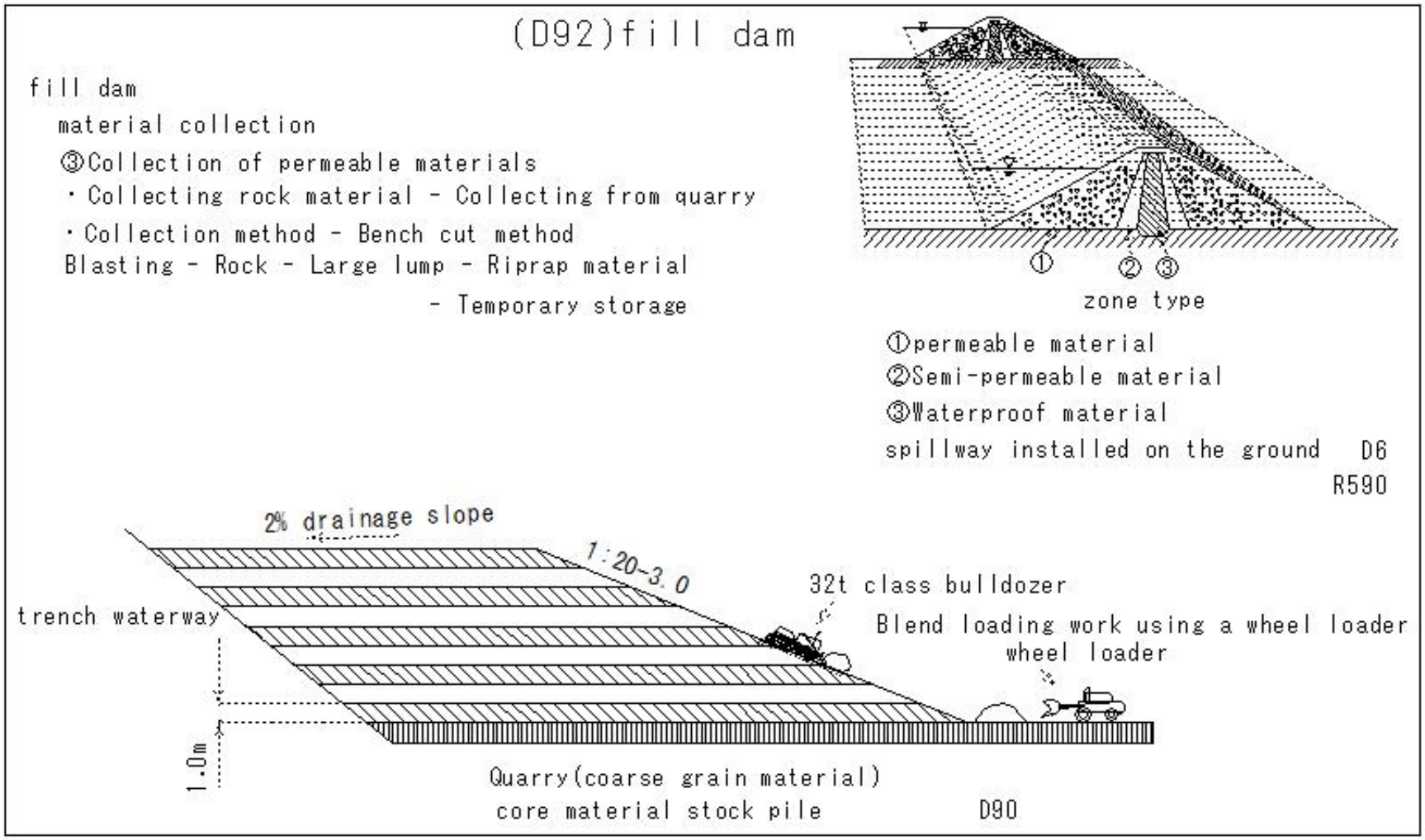


spillway installed on the ground

zone type

D89
D6
R590

(D92)fill dam


(D92)fill dam
fill dam
material collection
③Collection of permeable materials
・Collecting rock material - Collecting from quarry
・Collection method - Bench cut method
Blasting - Rock - Large lump - Riprap material
- Temporary storage
①
② ③
zone type
①permeable material
②Semi-permeable material
③Waterproof material
spillway installed on the ground D6
R590
2% drainage slope
1:20~3.0
32t class bulldozer
Blend loading work using a wheel loader
wheel loader
trench waterway
1.0m
Quarry(coarse grain material)
core material stock pile D90

(D93)fill dam

(D93)fill dam

fill dam

foundation of fill dam

①foundation of the water-Impermeable zone

・Supporting capacity and permeability

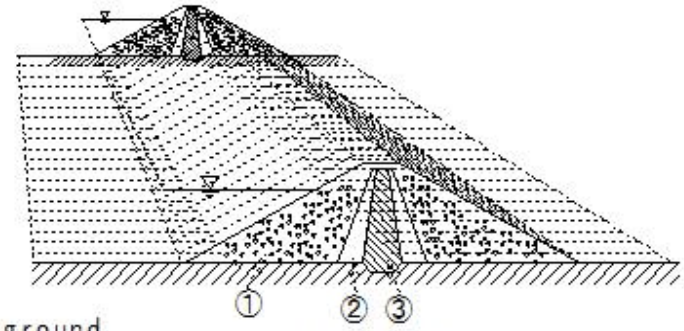
・Excavation to bedrock

・Smooth finish

①permeable material

②Semi-permeable material

③Impermeable zone



spillway installed on the ground

zone type

D6

R590

(D94)fill dam

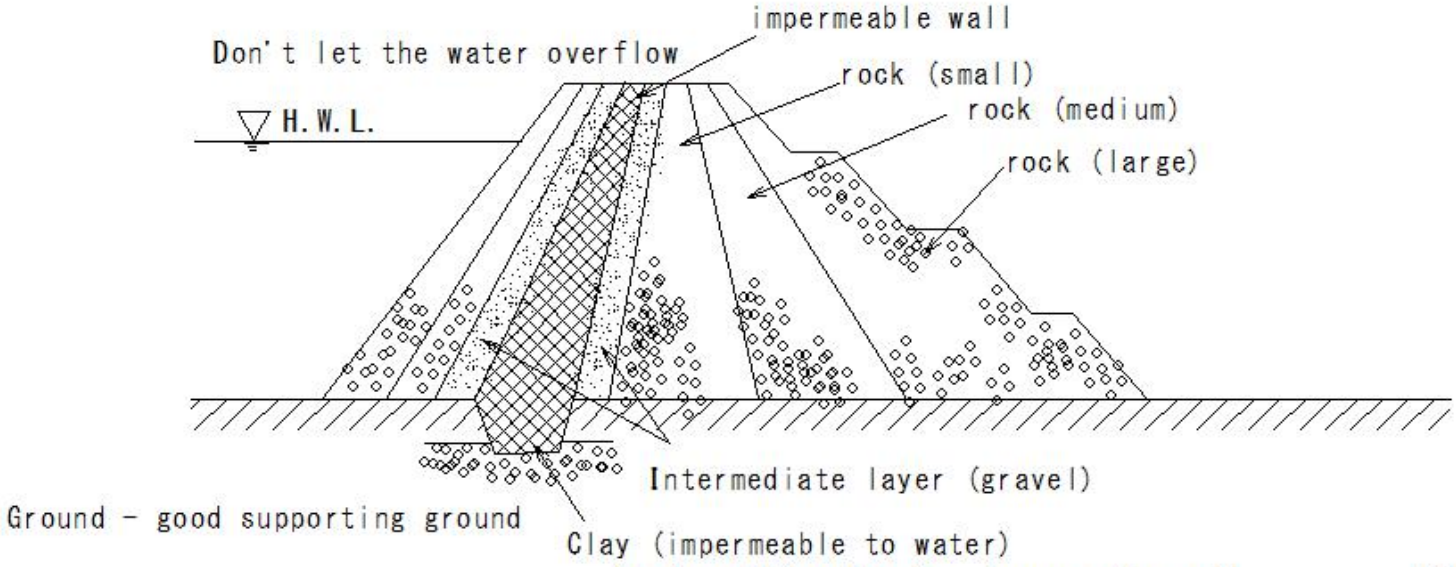
(D94)fill dam

fill dam

foundation of fill dam

②Foundation of semi-permeable zone

・Variable section between impermeable zone and permeable zone



R526

(D95)fill dam

(D95)fill dam

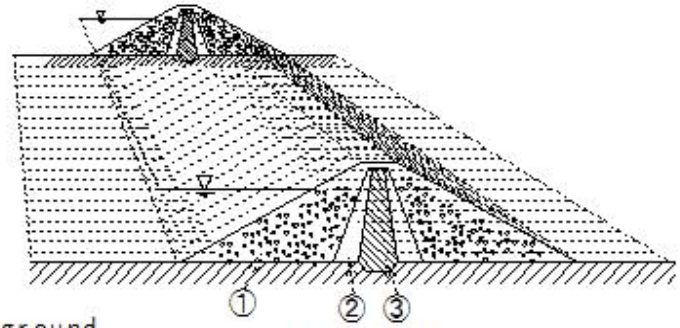
fill dam

foundation of fill dam

③Foundation of permeable zone

- same shear strength as rock material
- Safe against piping caused by seepage flow
- no deformation of the embankment body.
- Remove loose parts of the ground
- Use riverbed gravel

①permeable material(zone)
②Semi-permeable material
③Waterproof(Impermeable) material



spillway installed on the ground

zone type

D6

(D96)fill dam

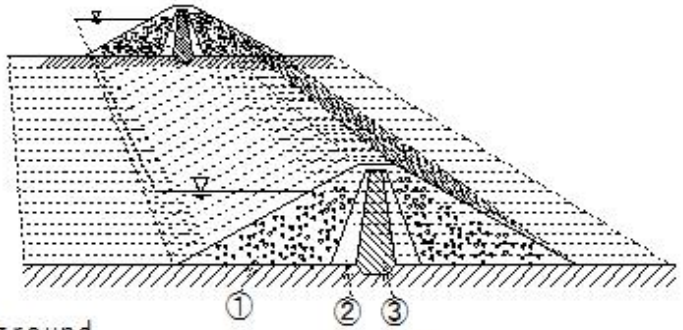
(D96)fill dam

fill dam

Weather conditions and filling

- Construction of core zone
- Easy to be affected by weather conditions

①permeable material(zone)
②Semi-permeable material
③Waterproof(Impermeable) material



spillway installed on the ground

zone type

D6

(D97)fill dam(test filling)

(D97)fill dam(test filling)

fill dam

test filling

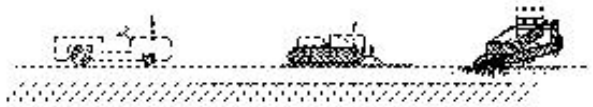
①On-site build-up test

・Design value of embankment material

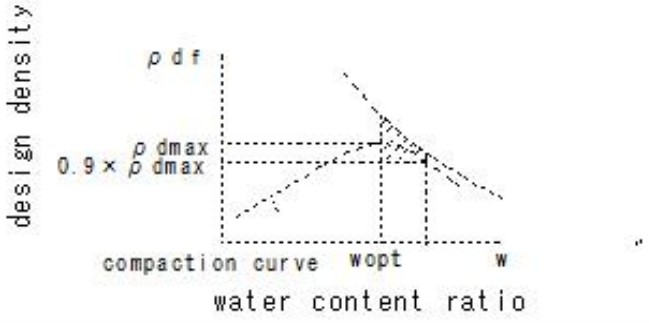
・Determination of construction moisture content

・design density

・Determine rational construction methods and
and construction management standards



・Determine the rolling number and unrolling thickness



E360

(D98)fill dam(test filling)

(D98)fill dam(test filling)

fill dam

test filling

②Compaction model

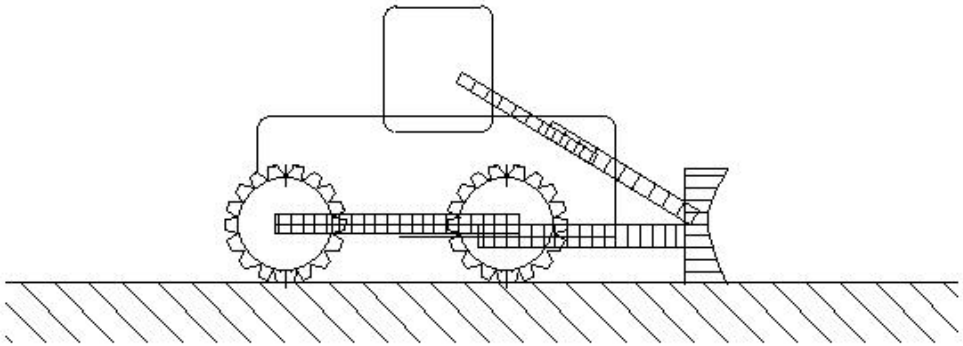
①Self-propelled tamping roller

・Crushing effect of rock fragments

・Mixing effect of materials

・Good familiarity with the next layer

・Used for viscous materials



①Self-propelled tamping roller

(D99)fill dam(test filling)

(D99)fill dam(test filling)

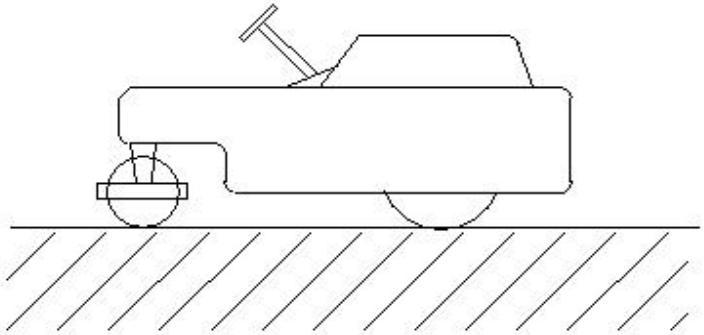
fill dam

test filling

②Compaction model

②Vibration roller

・Compaction of non-cohesive soil



vibrating roller

E240

(D100)fill dam(test filling)

(D100)fill dam(test filling)

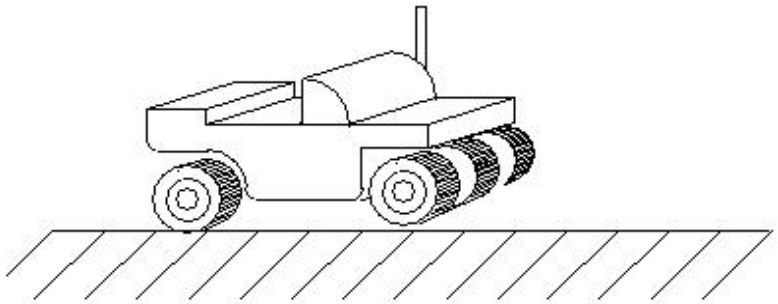
fill dam

test filling

②Compaction model

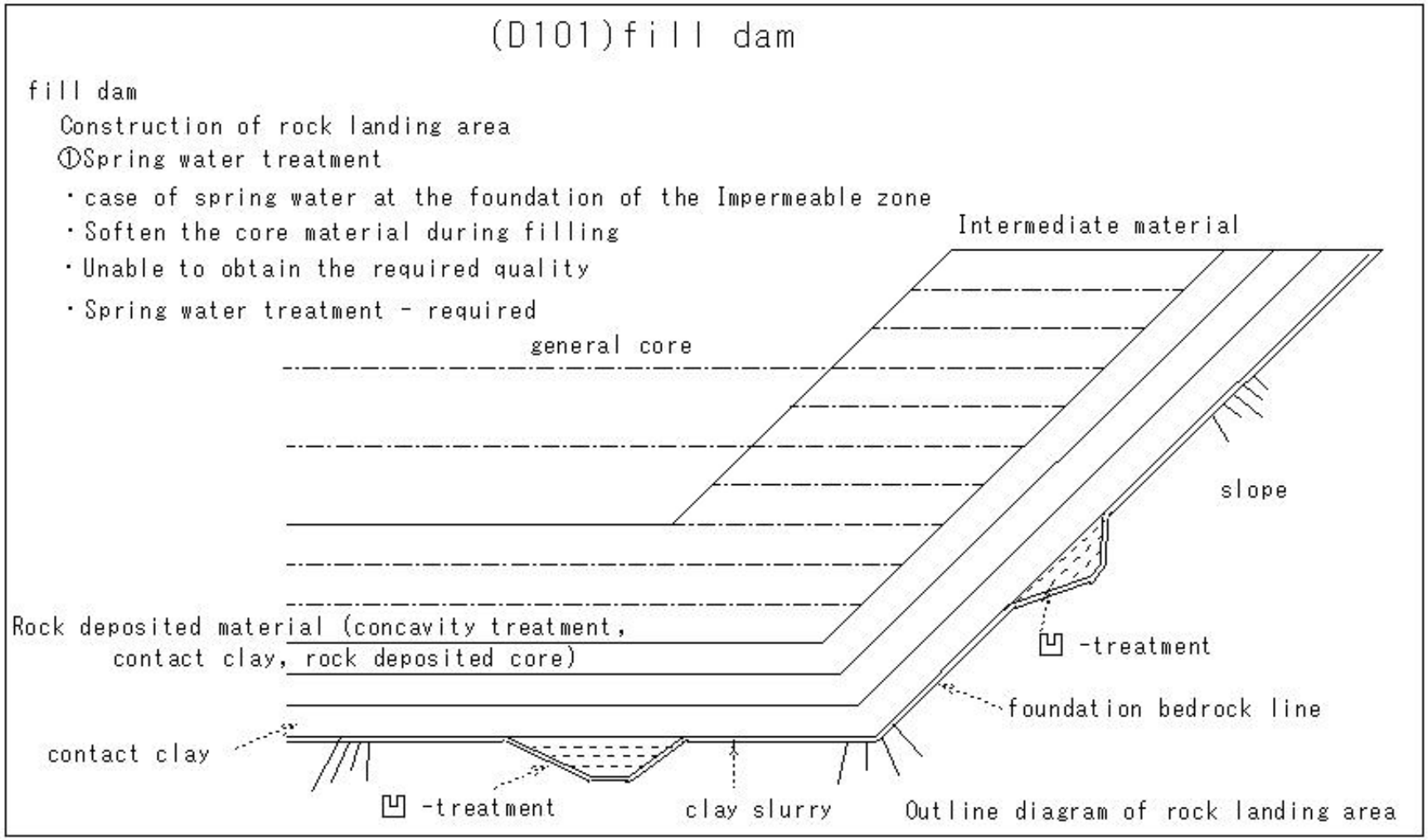
③Tire roller

- Suitable for fine-grained materials
- Low compaction effect to deep parts
- Can also handle slightly high water content ratios



③Tire roller

(D101)fill dam



(D102)fill dam

(D102)fill dam

fill dam

Construction of rock landing area

②Treatment of rock surface

・For the rock landing surface in the water-blocking zone

①Bedrock cleaning

②Open joint crack treatment

③Chipping of concrete surfaces such as corridors

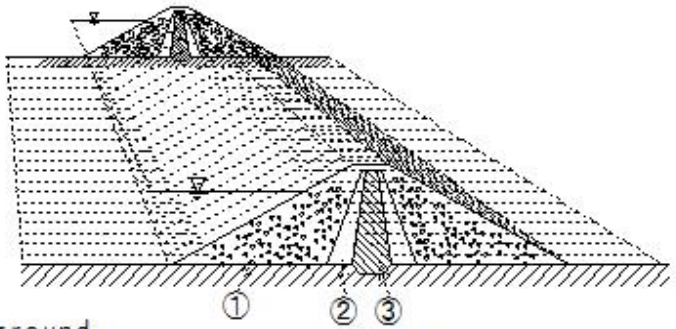
④Water treatment on bedrock and concrete surfaces

①permeable material

②Semi-permeable material

③Waterproof(Impermeable) material

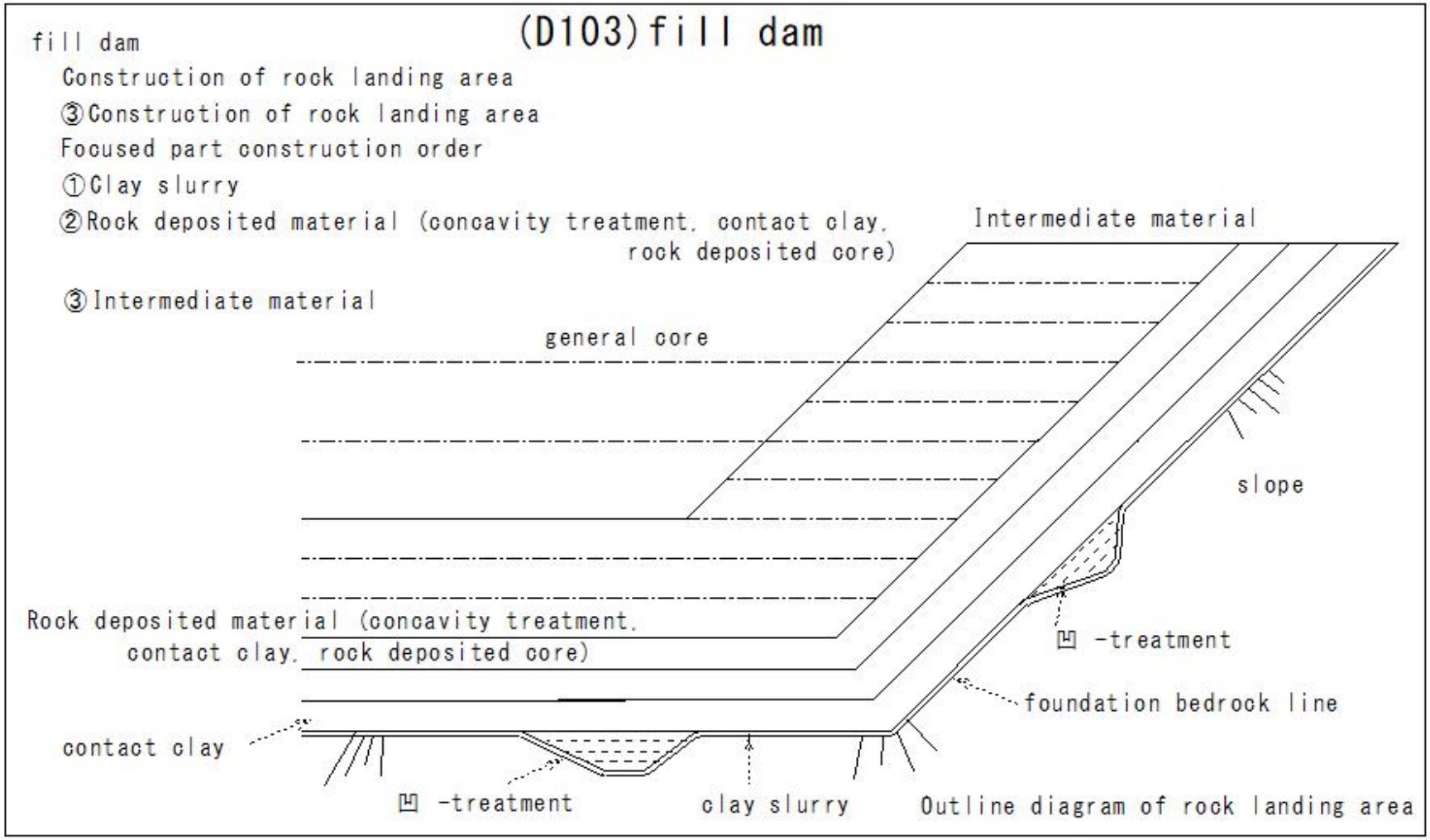
③Impermeable material



spillway installed on the ground

zone type

(D103)fill dam



(D104)fill dam

(D104)fill dam

fill dam

Build-up of Impermeable zone

①Unrolling

・Continuous dumping at appropriate intervals

・thickness (20-30cm) using a bulldozer

・Evenly in the dam axis direction

・Spread horizontally

・Unwinding

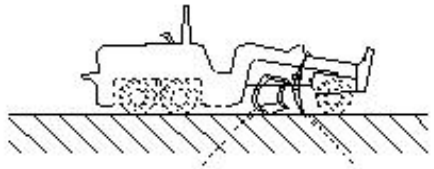
・Rake the surface layer of the compacted layer

Stir it up with a scarifier, etc., and spread out the next one.

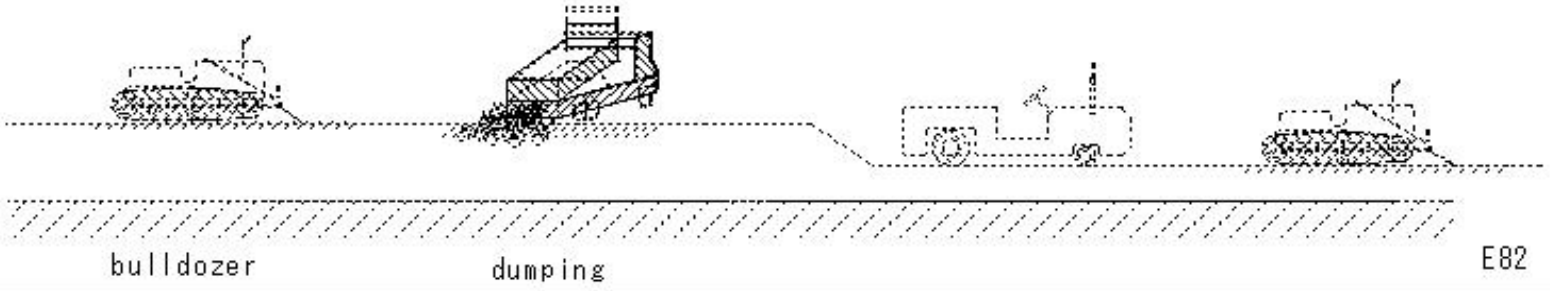
・case of the surface of the compaction layer is excessively dry or wet

・Remove this part

・Alternatively, stir it up, water it, aerate it, sprinkle the next layer.

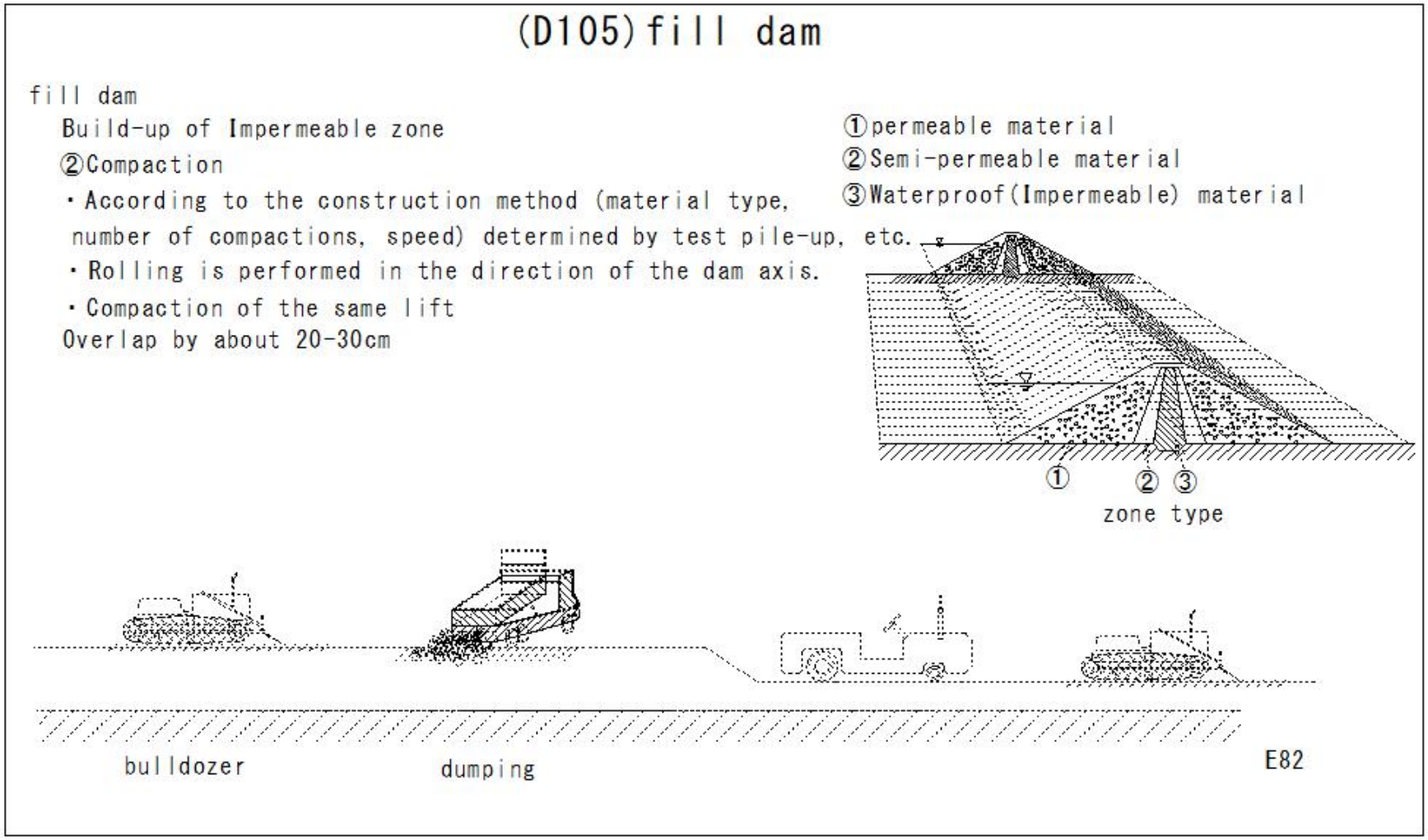


E356

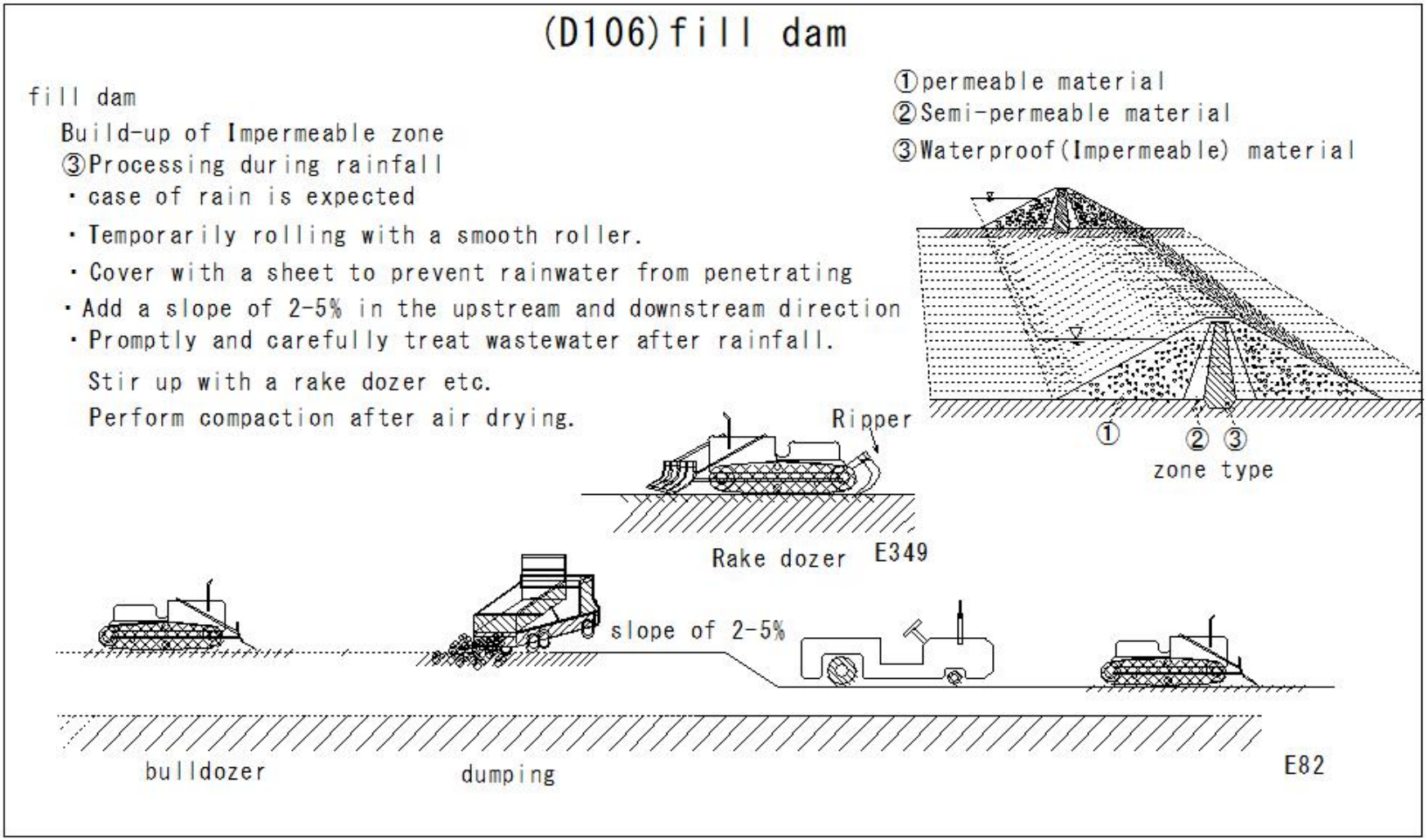


E82

(D105)fill dam



(D106)fill dam



(D107)fill dam

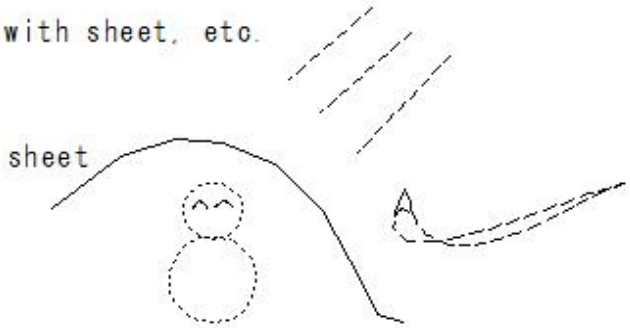
(D107)fill dam

fill dam

Build-up of Impermeable zone

④Overwintering treatment

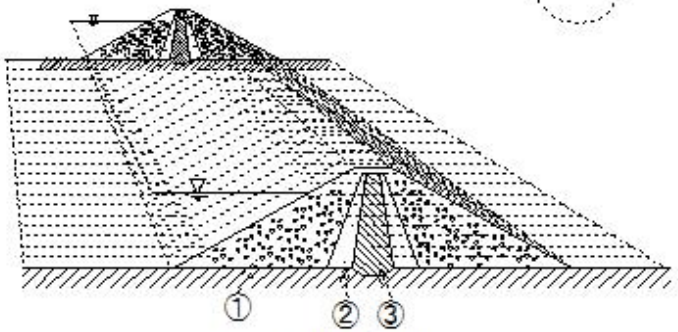
- Cold region: Suspension of filling for a long period of time during winter
- Prevents core from freezing, prevents water from entering during snow melting
- Protect the core
- Protective material (core material, lock material) Cover with sheet, etc.



①permeable material

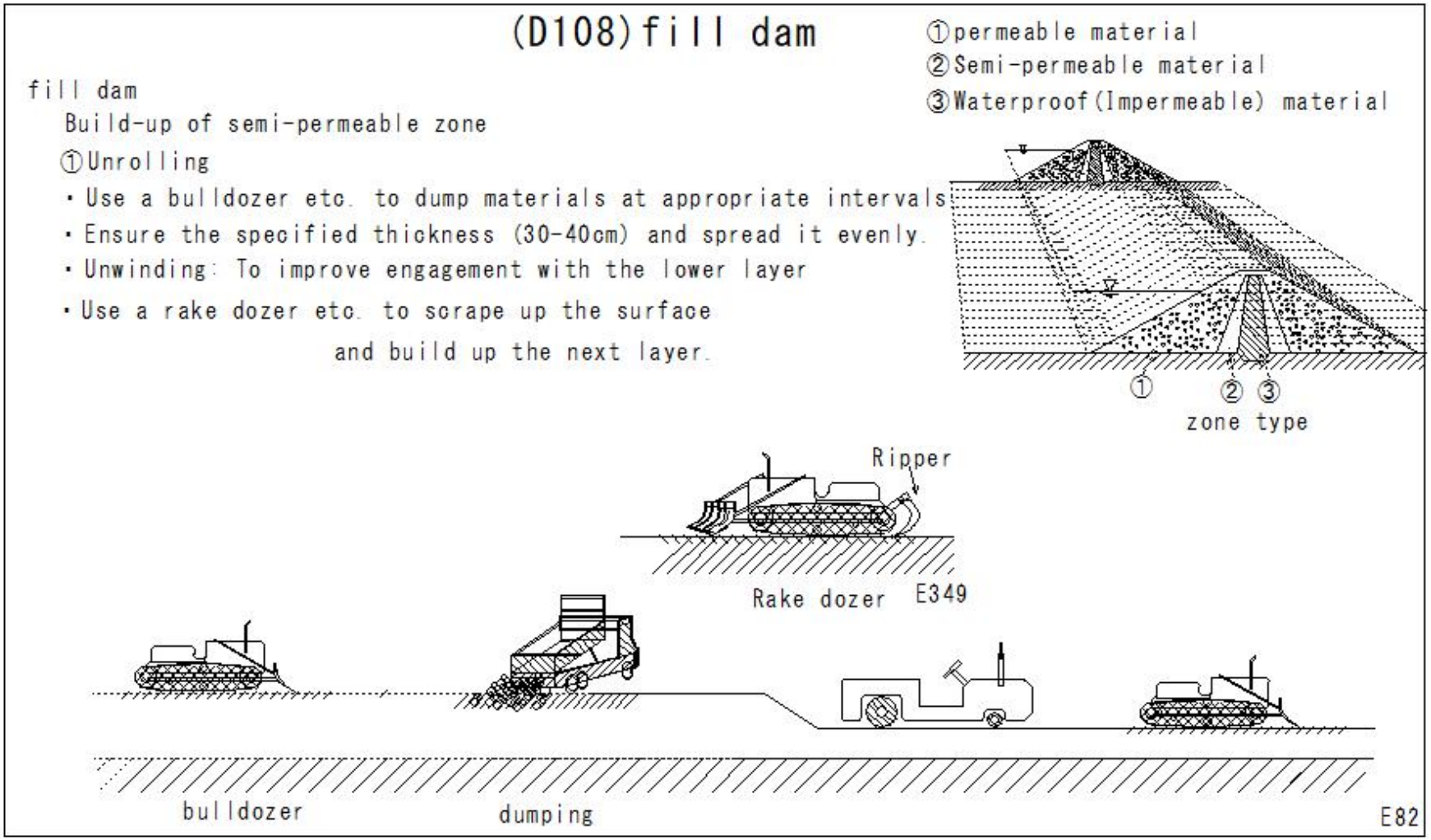
②Semi-permeable material

③Waterproof(Impermeable) material

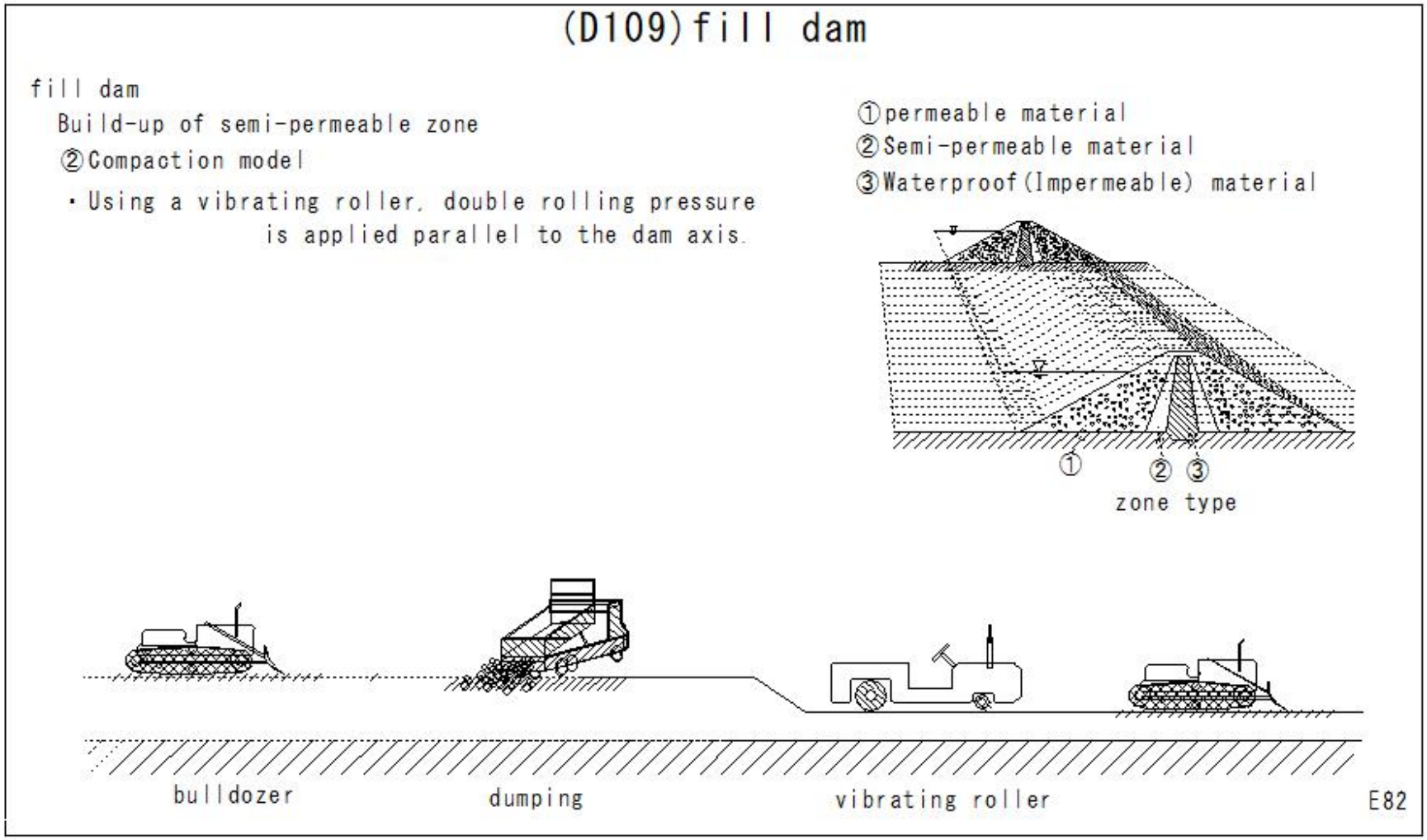


zone type

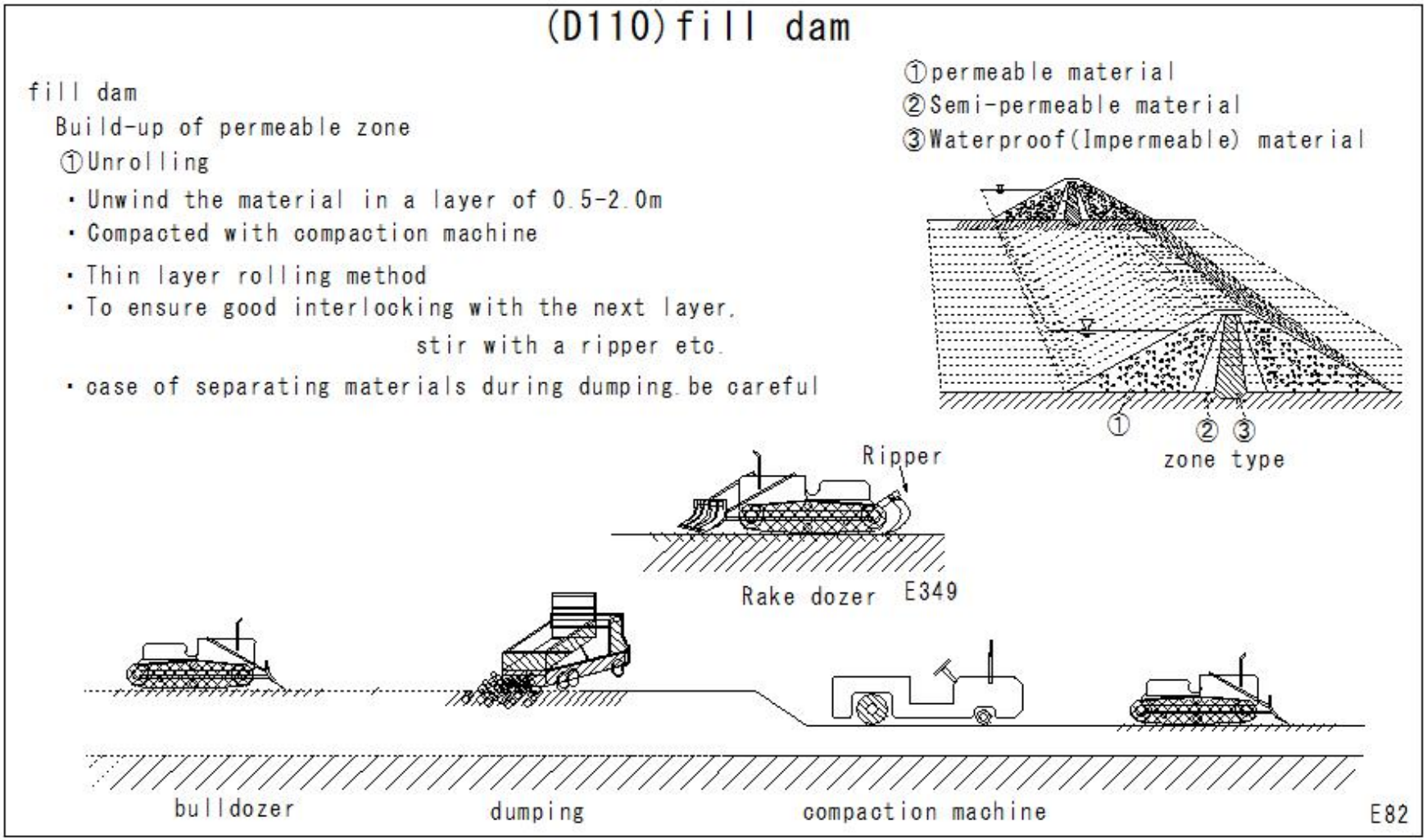
(D108)fill dam



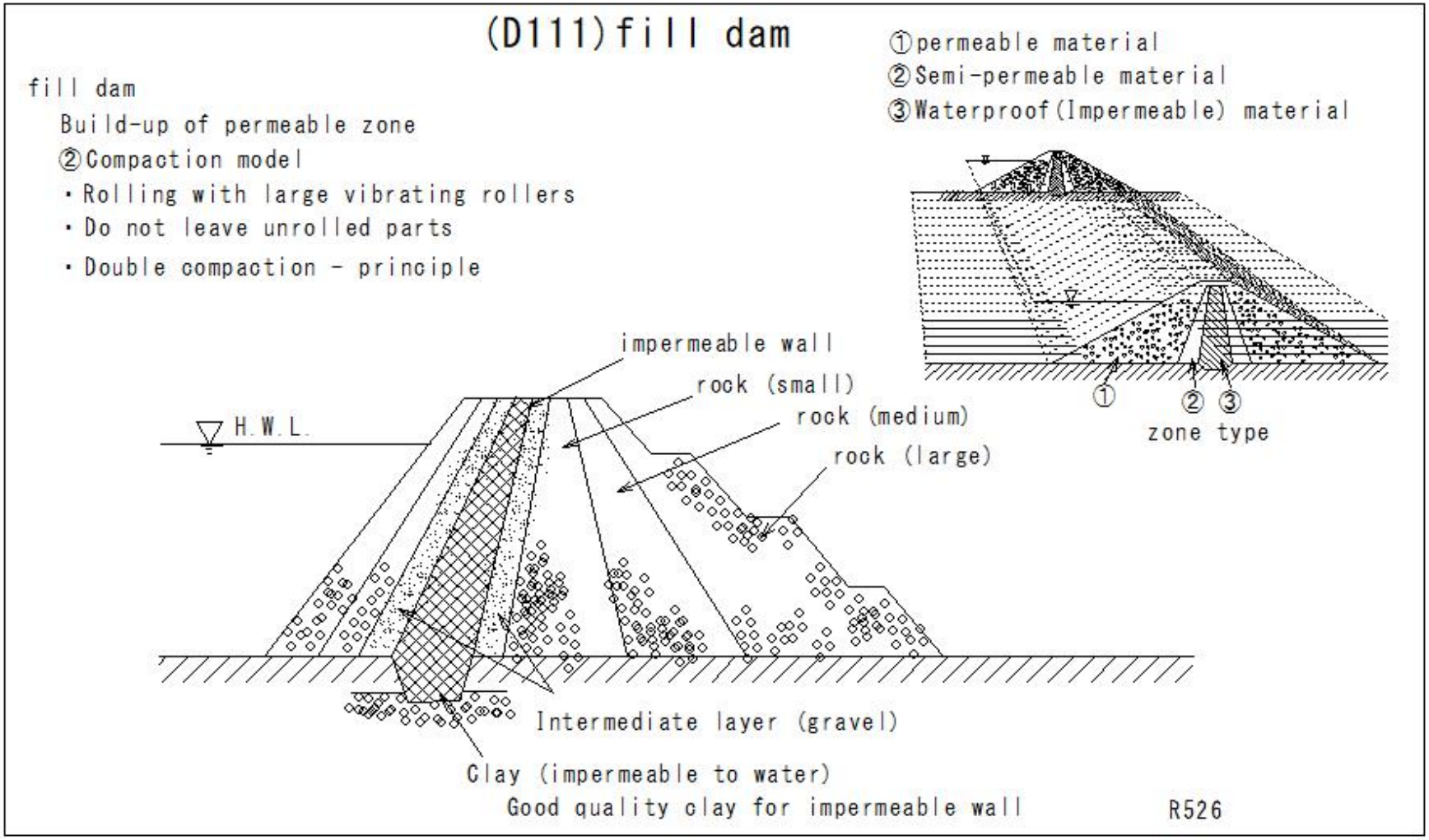
(D109)fill dam



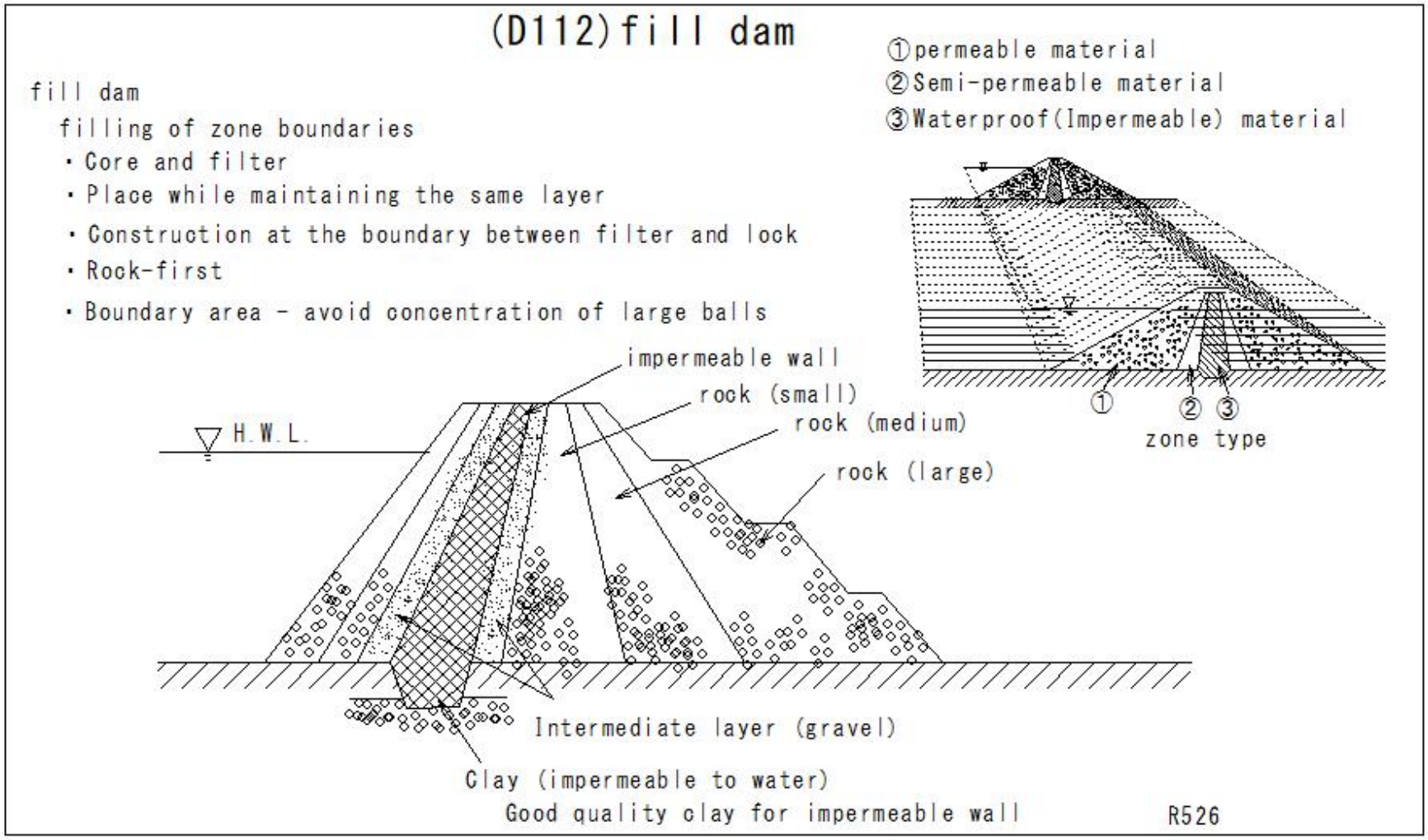
(D110)fill dam



(D111)fill dam



(D112)fill dam



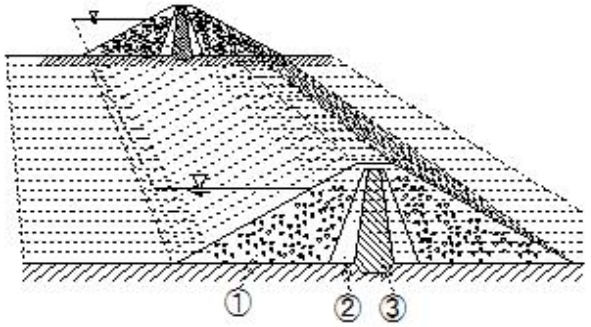
(D113)fill dam

fill dam

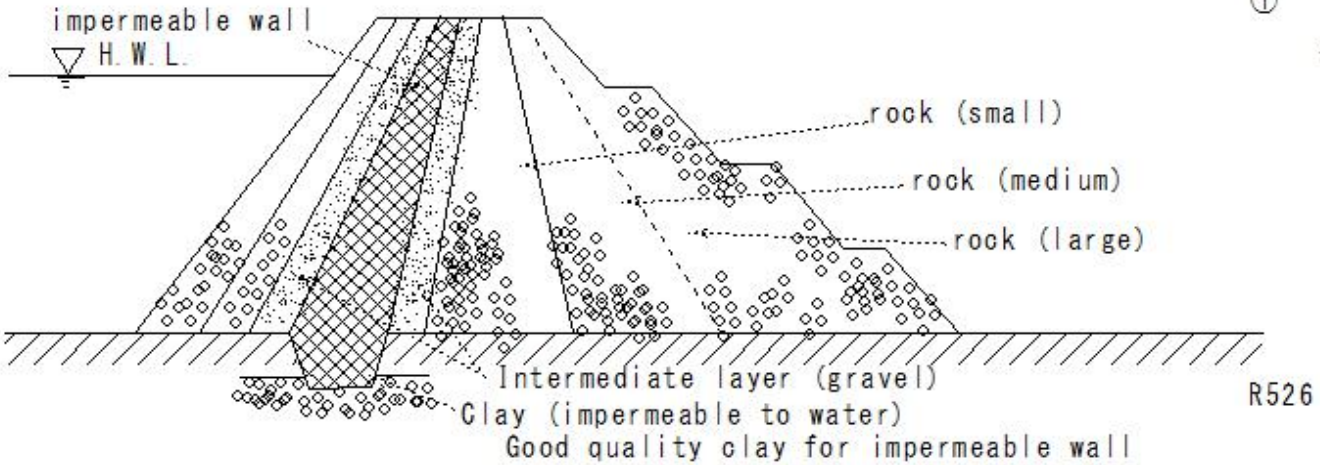
(D113)fill dam

Slope protection work
- Upstream side of the dam
- Wave erosion prevention
- Prevention of washing out
- Preventing weathering of the dam surface layer
- Prevention of fine graining
- Upstream and downstream surfaces: Slope protection work, riprap, and vegetation construction.
- Riprap material: Sufficient particle size, weight, and durability

①permeable material
②Semi-permeable material
③Waterproof(Impermeable) material

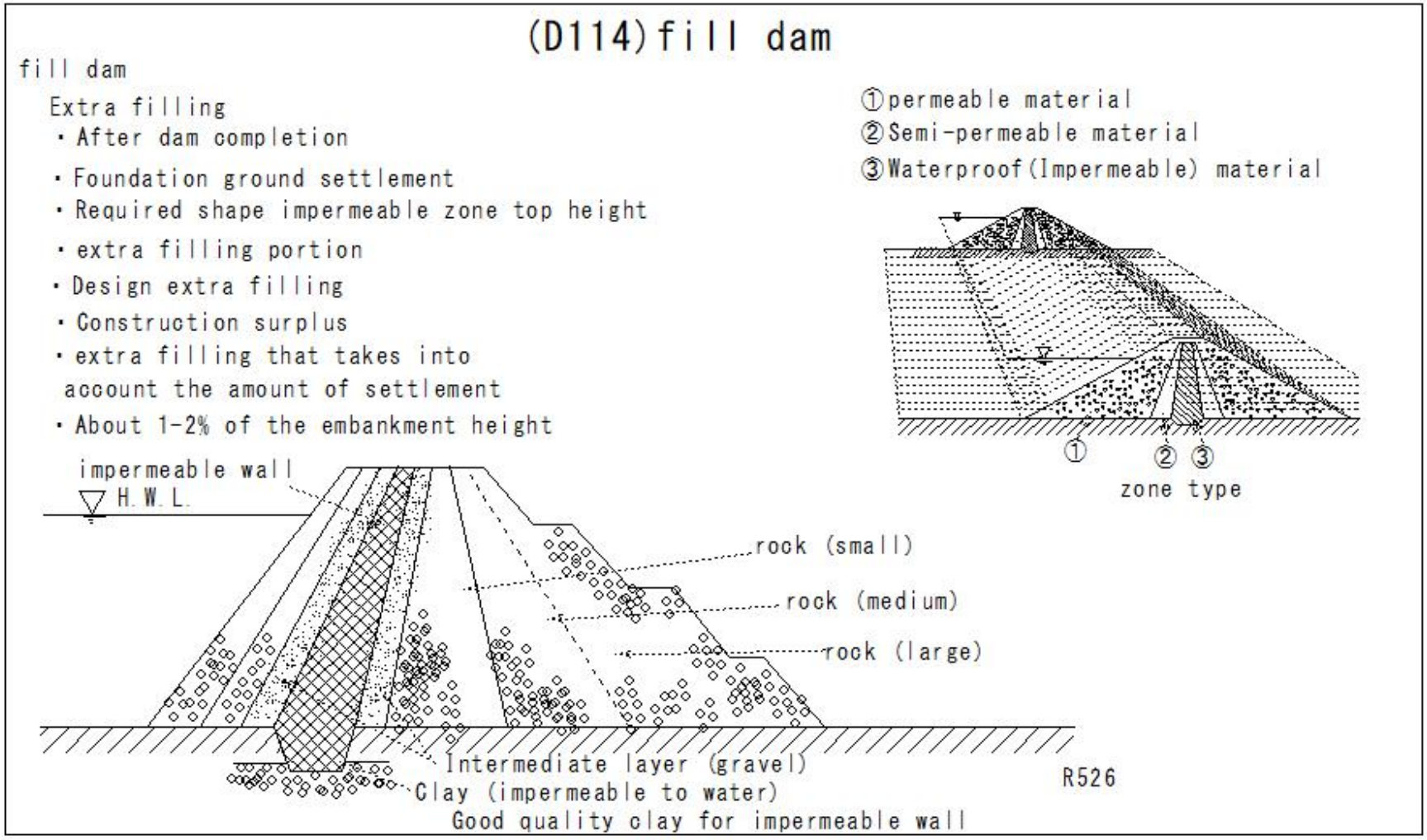


zone type

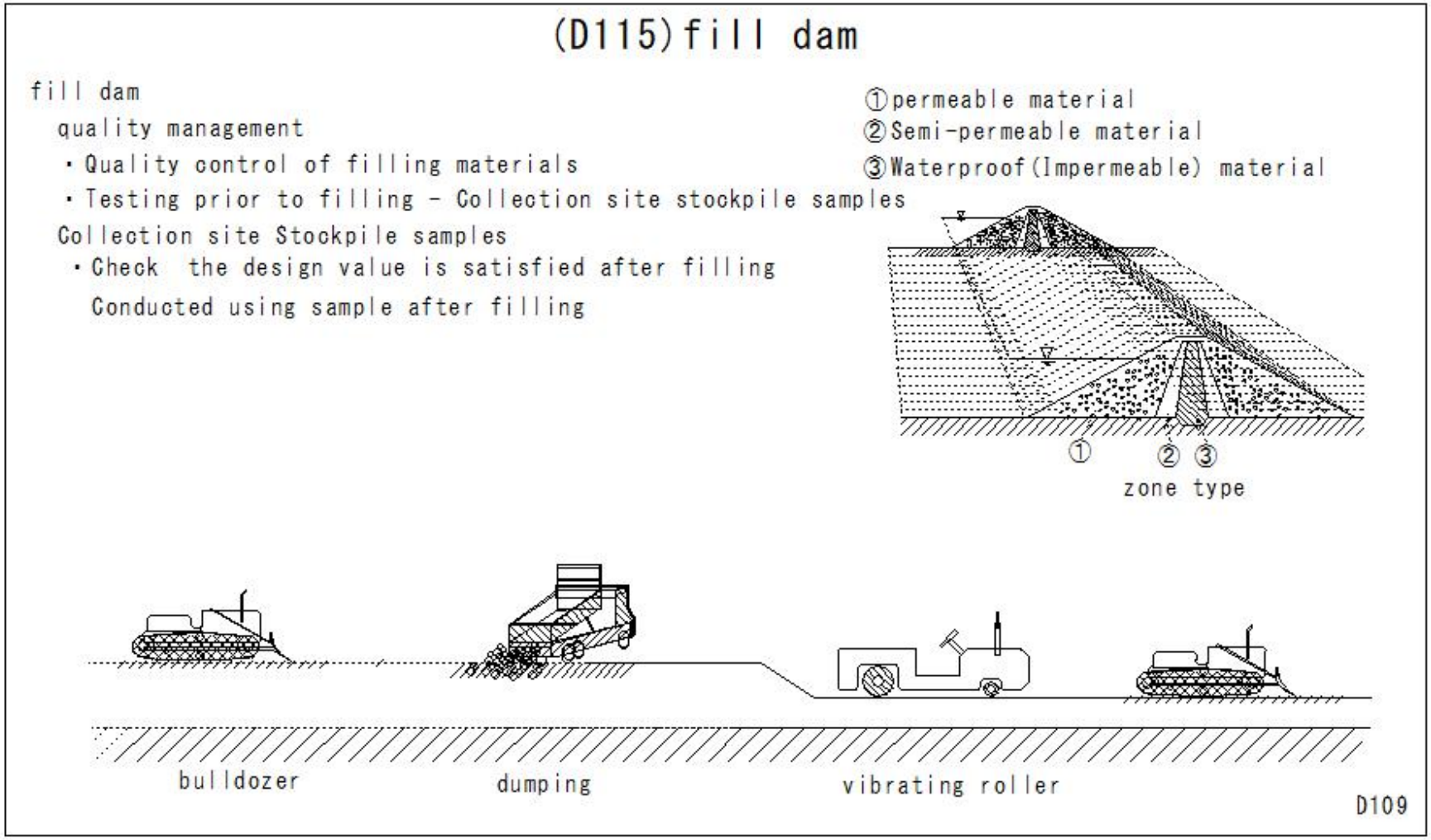


R526

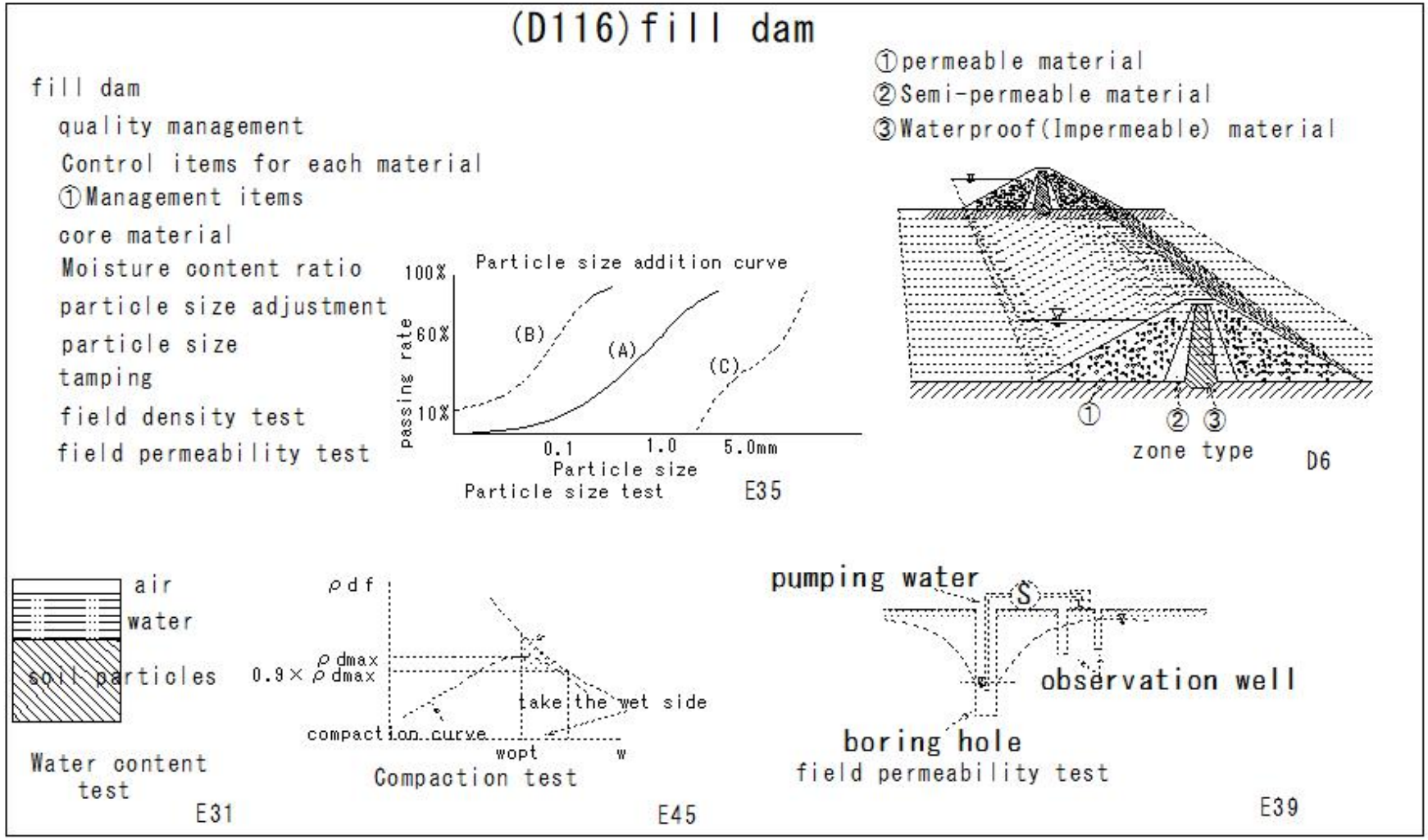
(D114)fill dam



(D115)fill dam



(D116)fill dam



(D117)fill dam

(D117) fill dam

①permeable material
②Semi-permeable material
③Waterproof(Impermeable) material

fill dam

quality management

Control items for each material

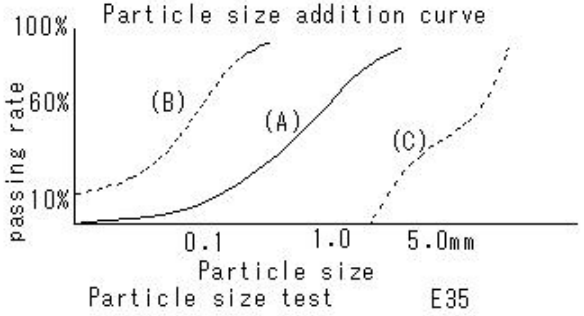
①Management items

Filter material

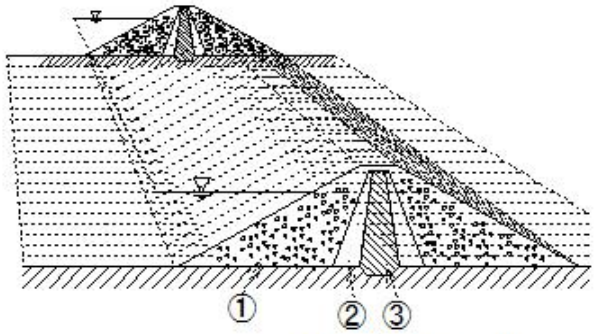
particle size test

field density test

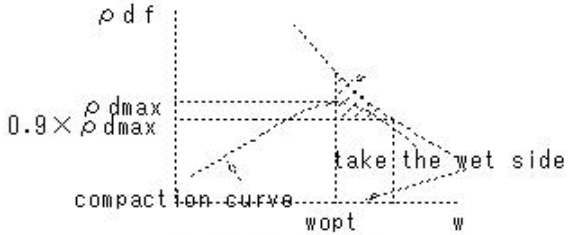
field permeability test



Particle size test E35

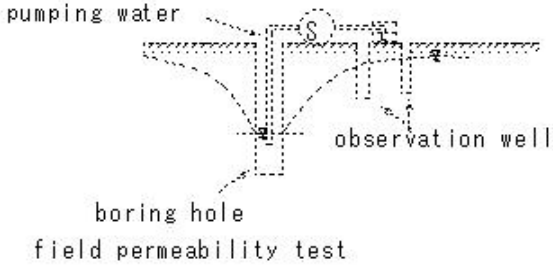


zone type D6



Compaction test

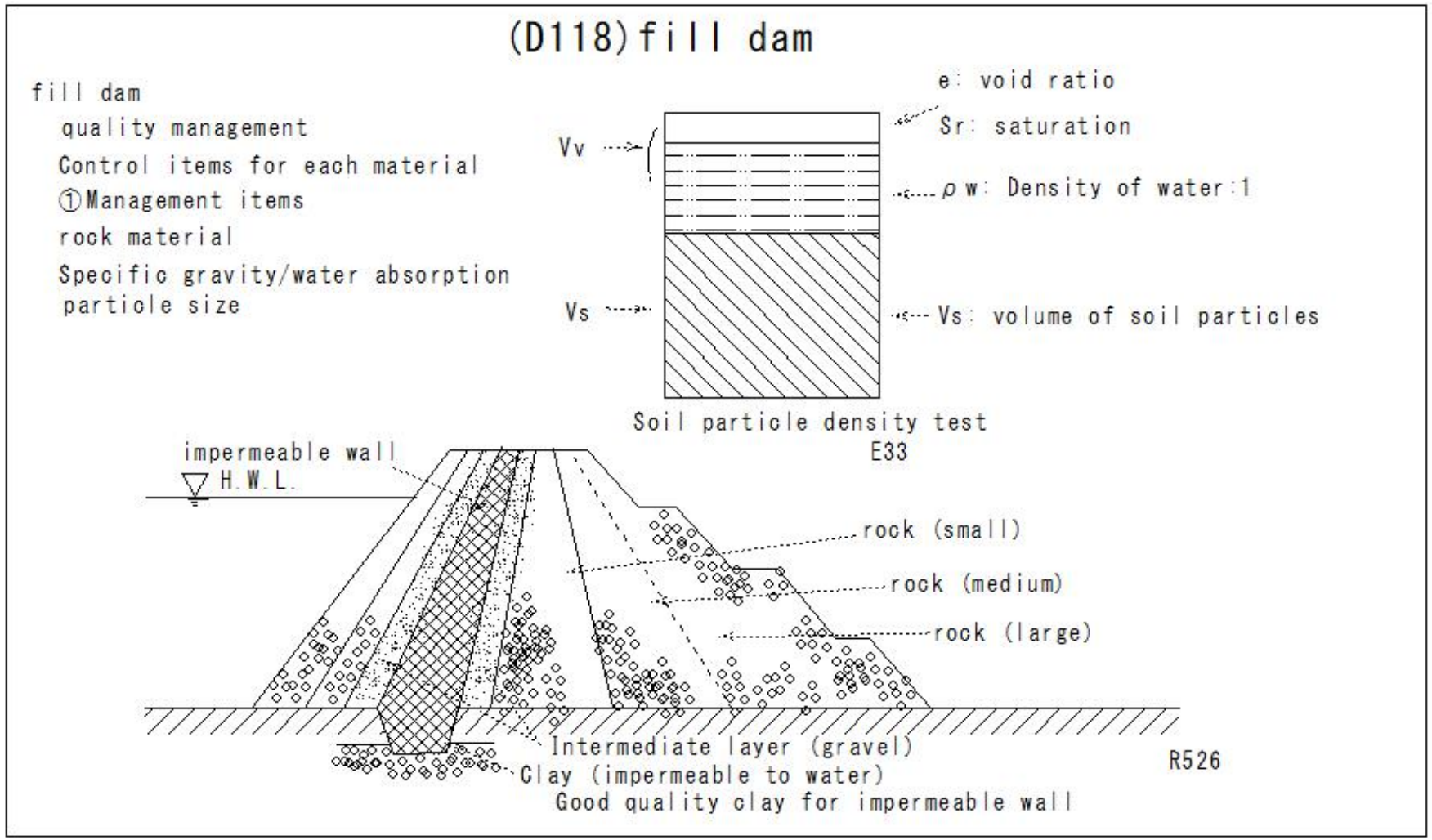
E45



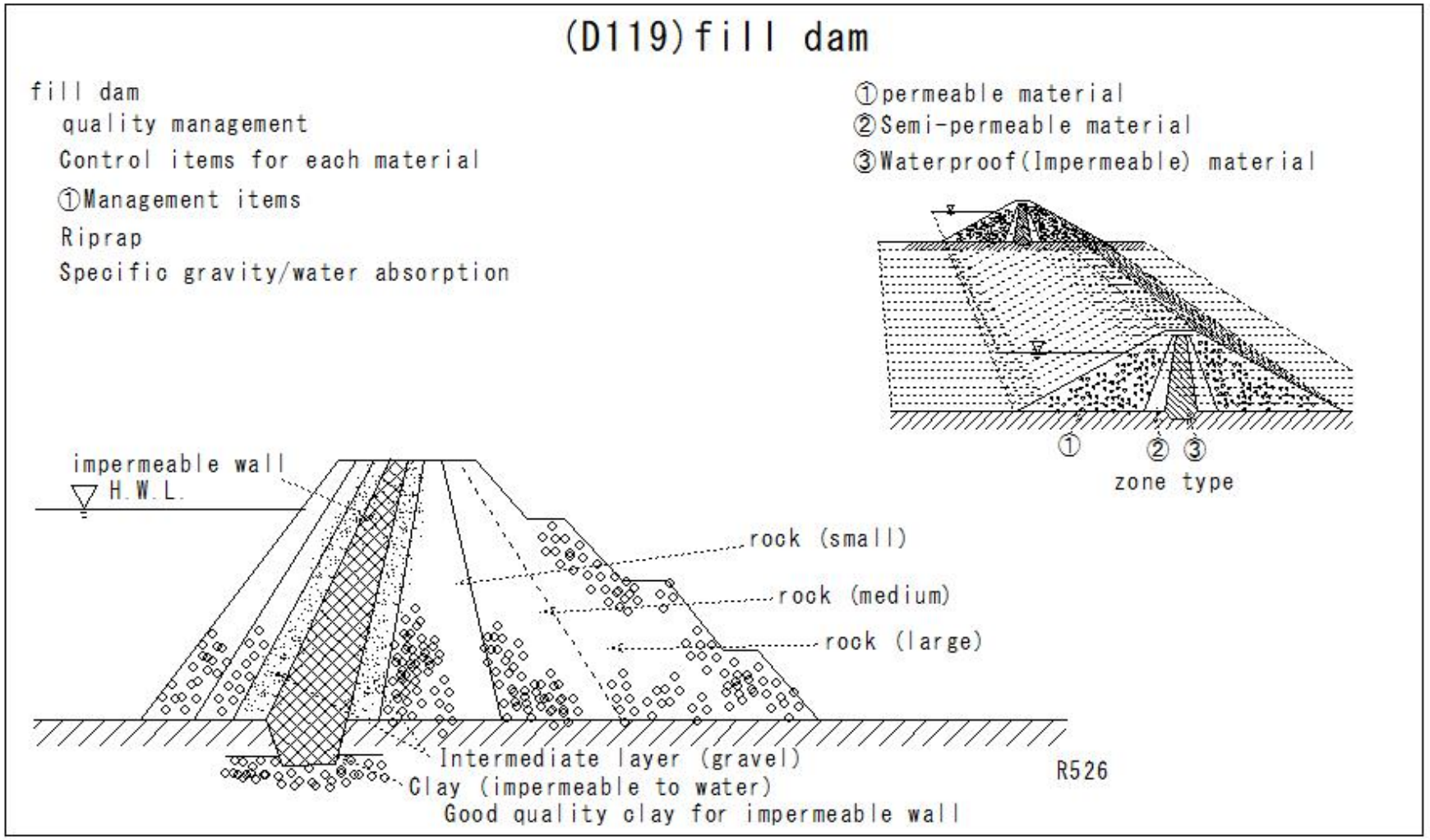
field permeability test

E39

(D118)fill dam



(D119)fill dam



(D120)fill dam

(D120)fill dam

fill dam

quality management

②Management standards

①Water content ratio

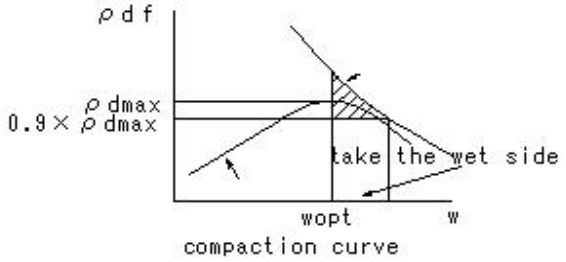
Optimal water content ratio (Wopt) 1-2% Minimum

Minimum Permeability coefficient on wet side

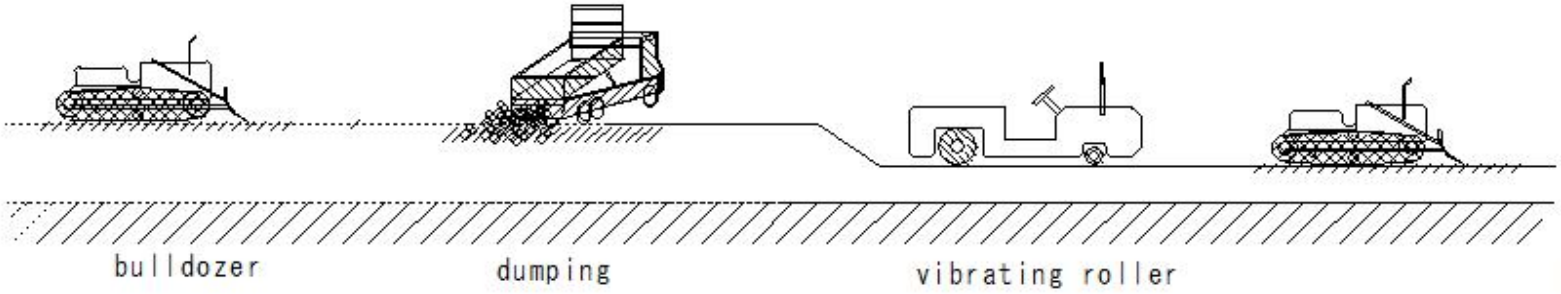
Material filled up on the wet side -

less prone to cracking

・Standard value Wopt±0－+3%

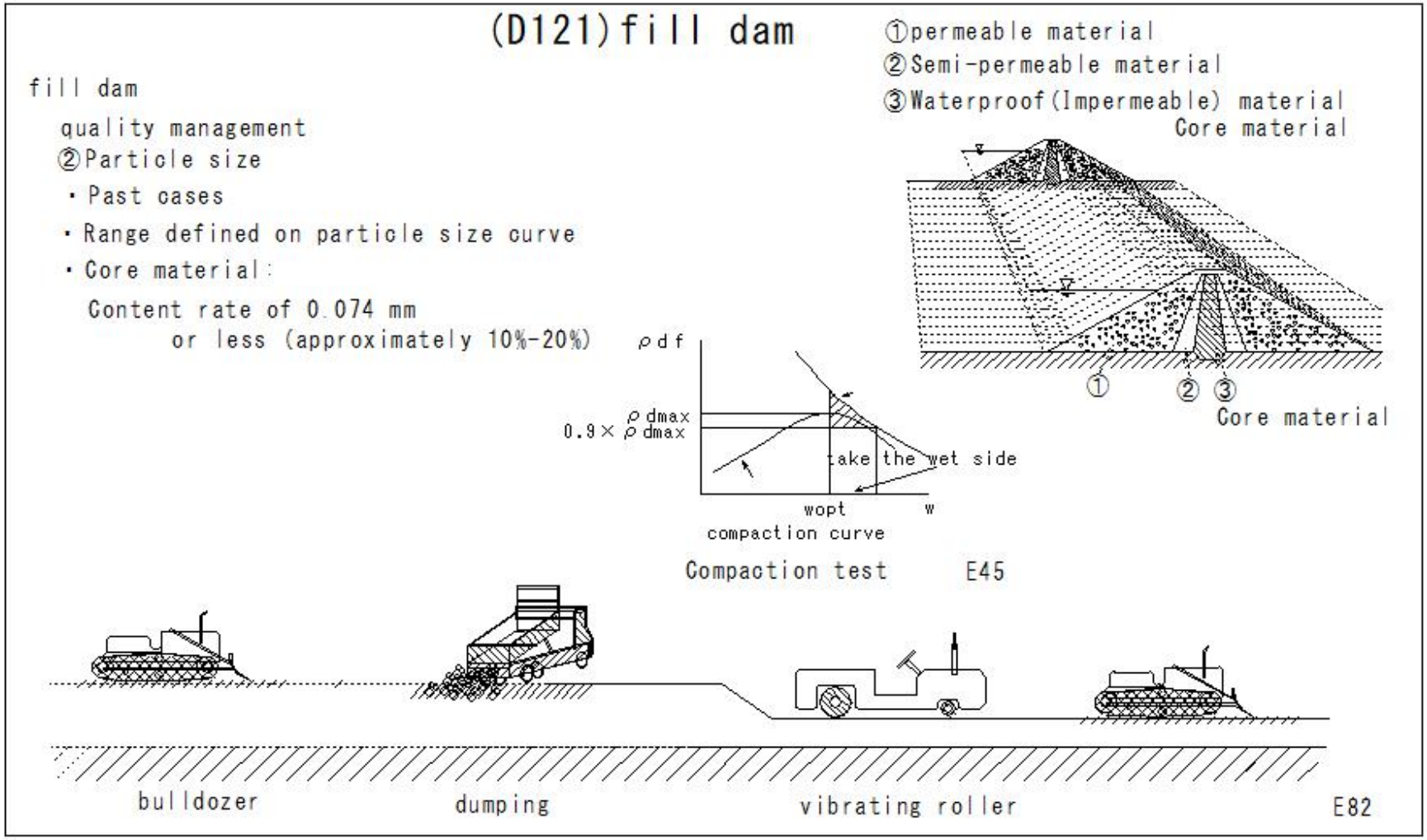


Compaction test E45

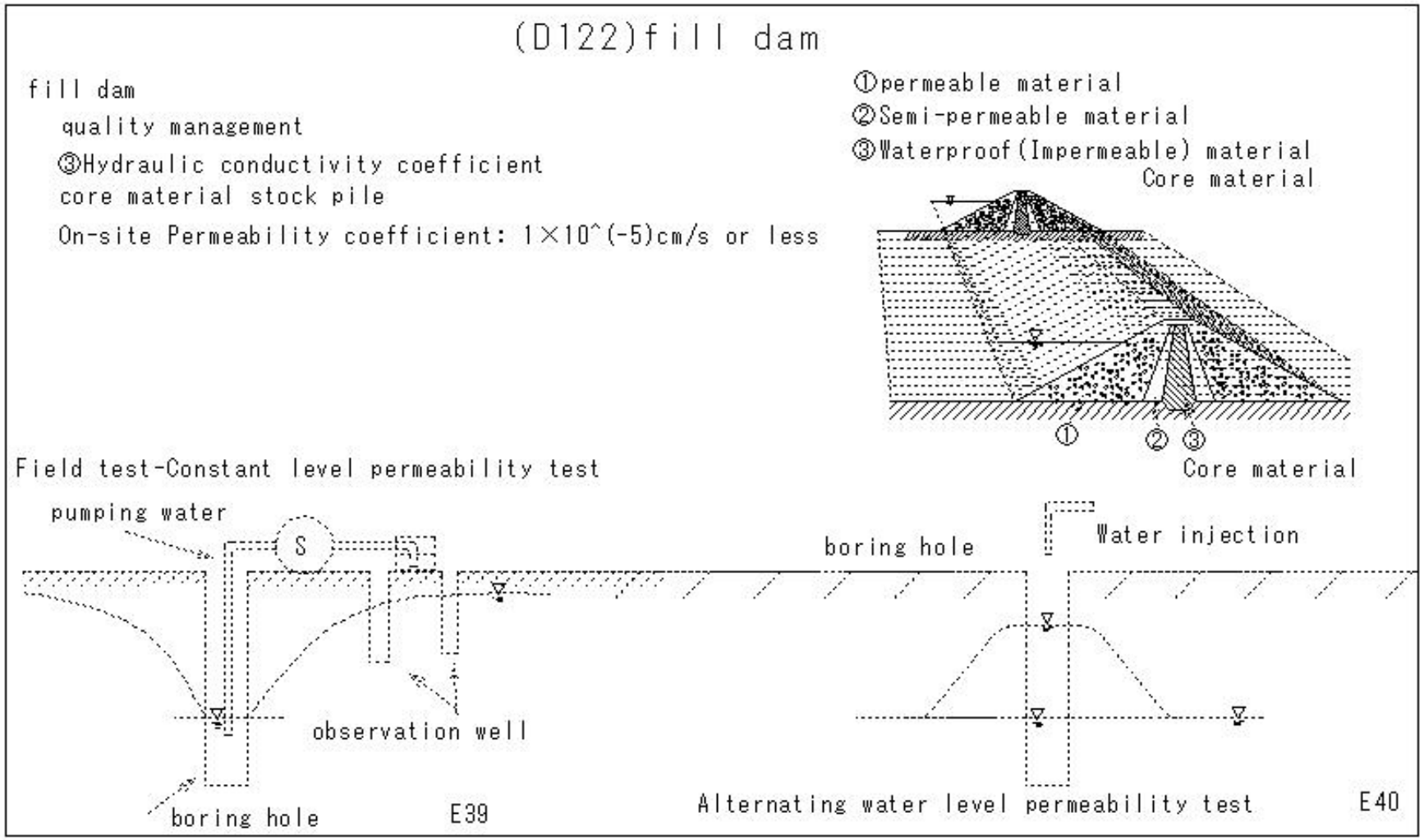


E82

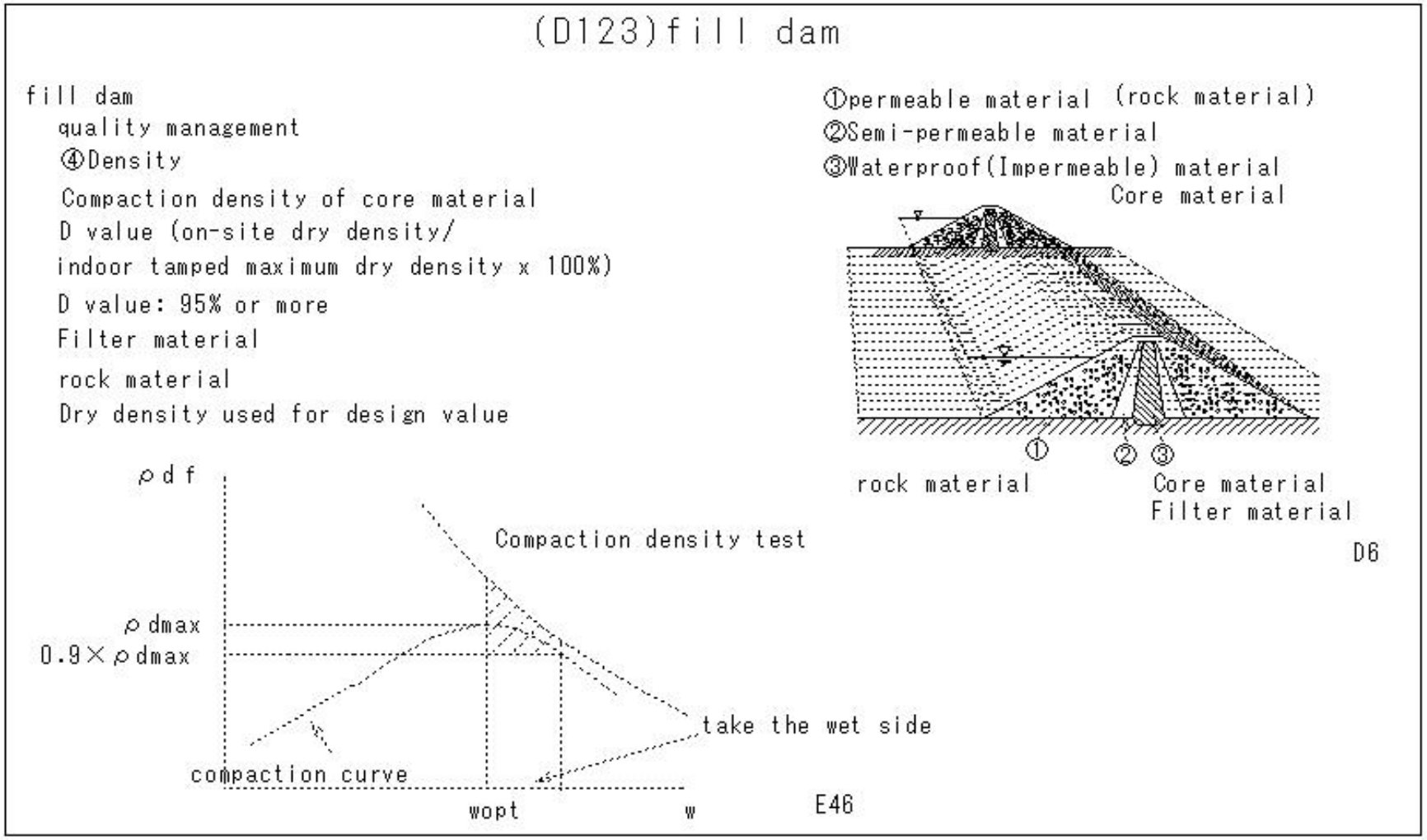
(D121)fill dam



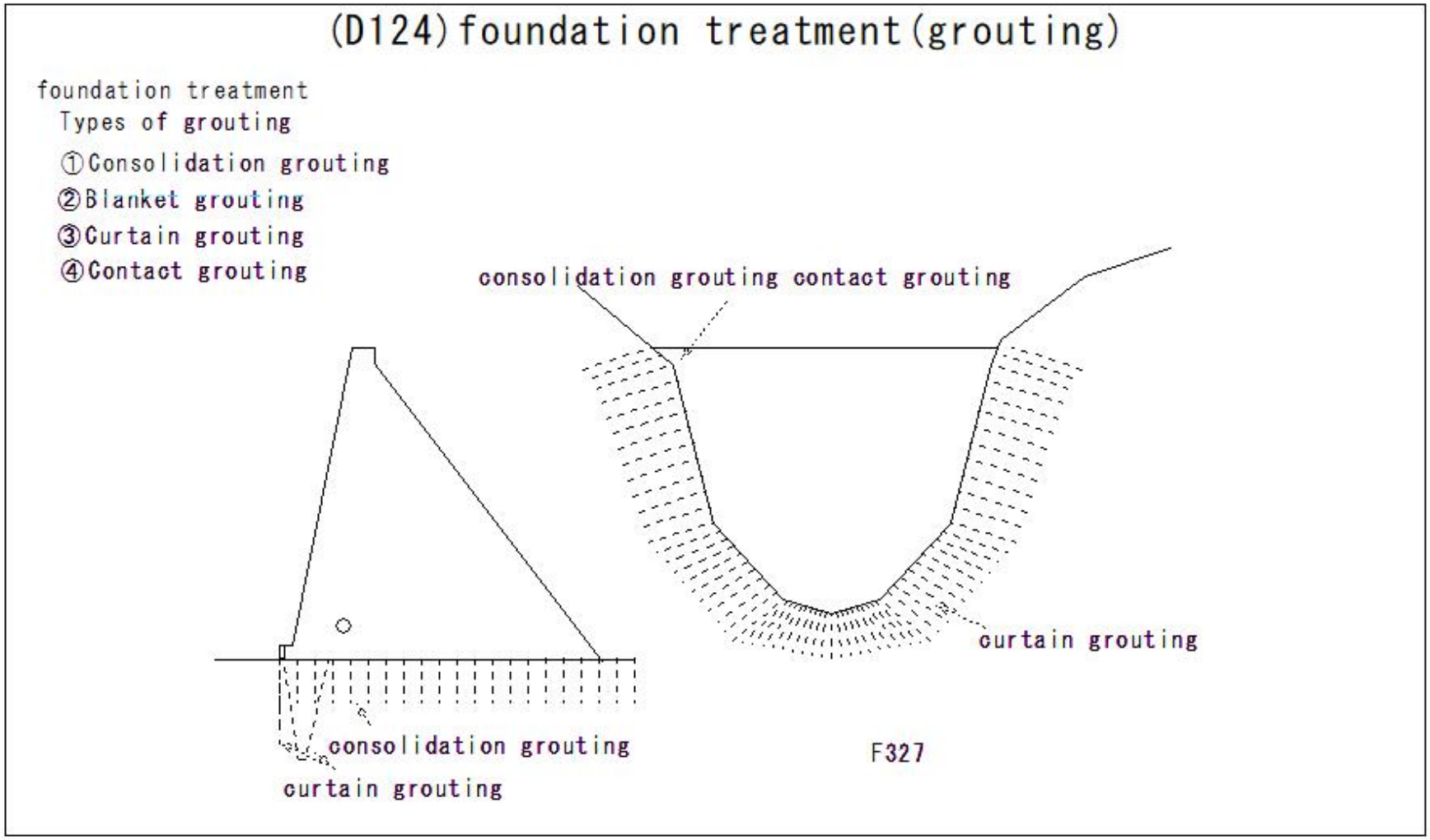
(D122)fill dam



(D123)fill dam



(D124)foundation treatment(grouting)



(D125)foundation treatment(grouting)

(D125) foundation treatment (grouting)

foundation treatment

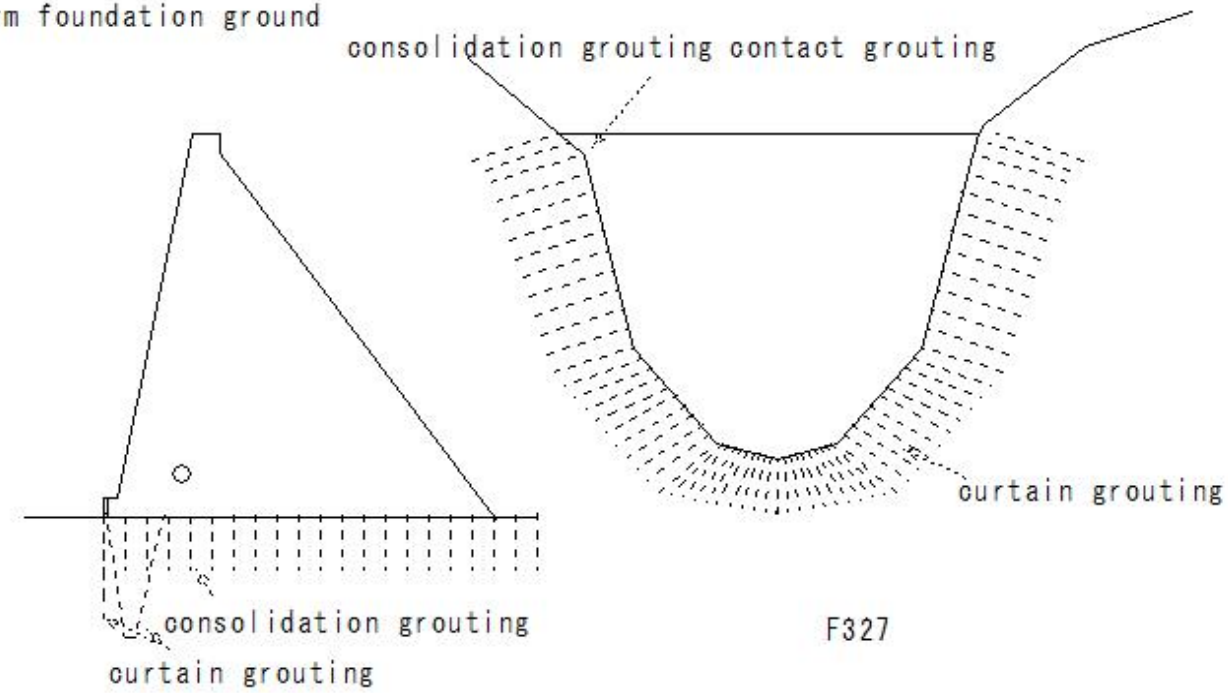
①Consolidation grouting

①Purpose

・Concrete dam embankment Fill dam spillway

Suppresses seepage flow near the contact area with the foundation ground

Uniform foundation ground



F327

(D126)foundation treatment(grouting)

(D126)foundation treatment(grouting)

foundation treatment

①Consolidation grouting

②Improvement target value

Gravity concrete dam approximately 5-10Lu

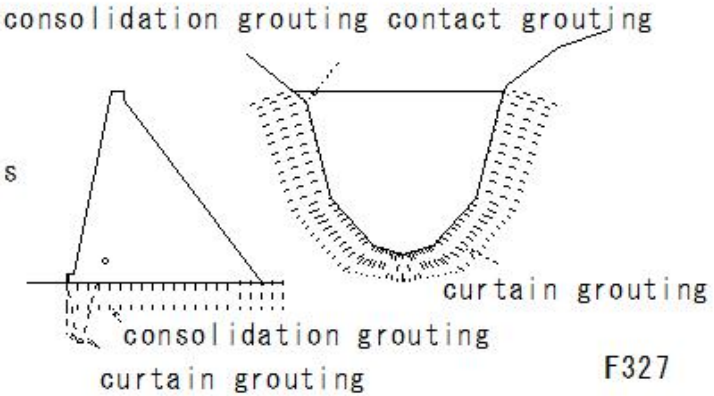
Arch type concrete dam approximately 2-5Lu

Lu: Lugeon value: evaluates the permeability of rock mass

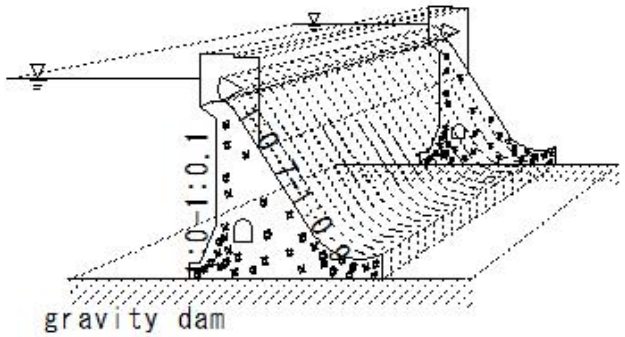
Under injection pressure of 10kgf/cm2

Defined as the number of liters of water

injected per minute per meter of hole length

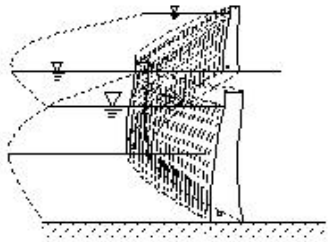


F327



gravity dam

D3



Arch dam

D4

(D127)Basic treatment(grouting)

(D127)foundation treatment(grouting)

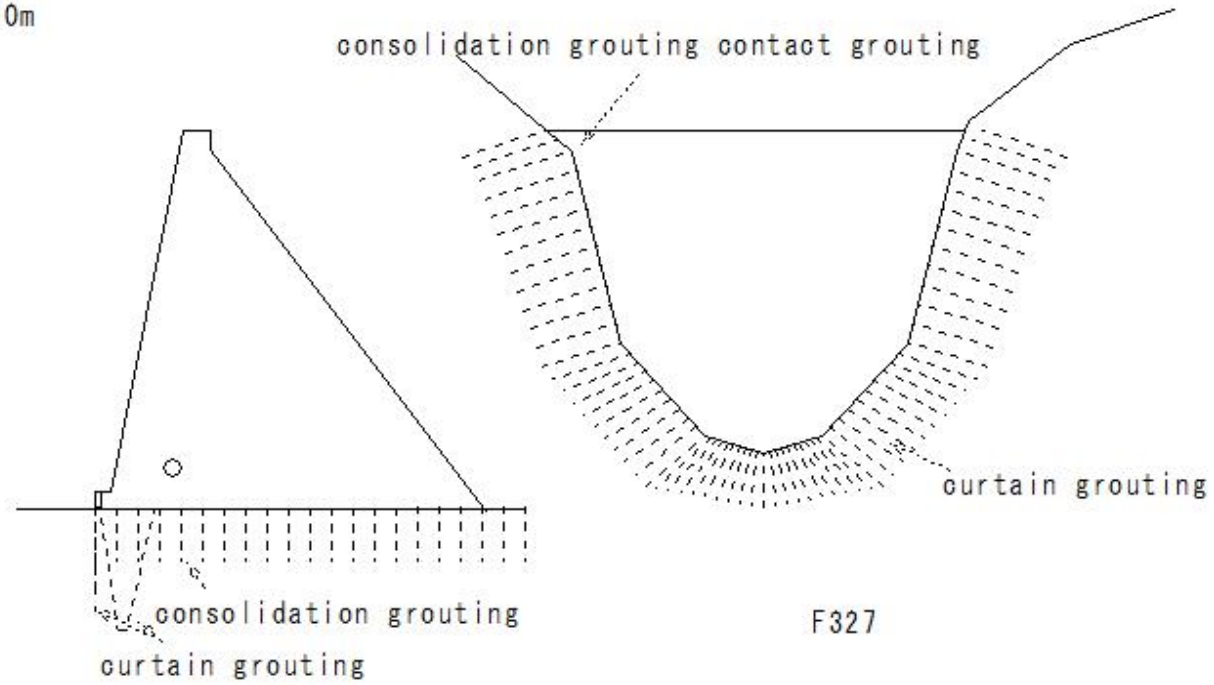
foundation treatment

①Consolidation grouting

③Construction area

Entire area of concrete dam site

Depth 5-10m



(D128)foundation treatment(grouting)

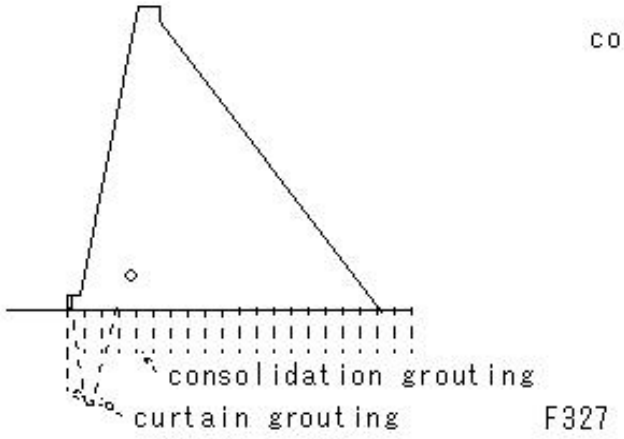
(D128)foundation treatment(grouting)

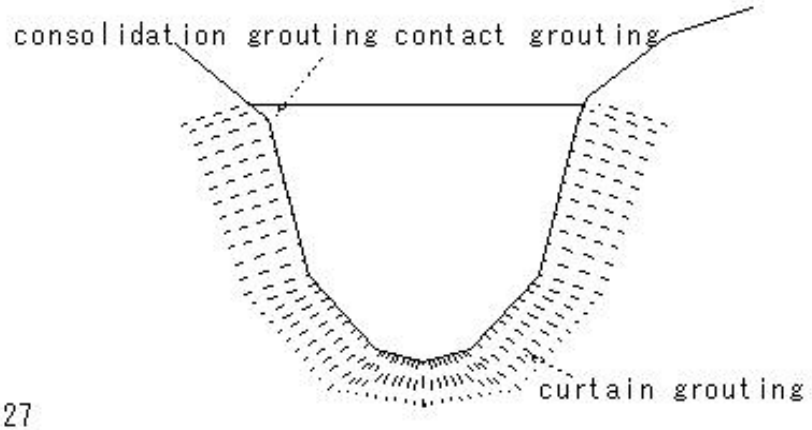
foundation treatment

①Consolidation grouting

④Construction period

- Bedrock - good, no leaks etc.
- Final excavation (about 50cm) left
- Construction directly from the rock surface
- case of a leak occurs
- case of displacement occurs in the bedrock
- Constructed after pouring several lifts of concrete for the main body





F327

(D129)foundation treatment(grouting)

(D129)foundation treatment(grouting)

foundation treatment

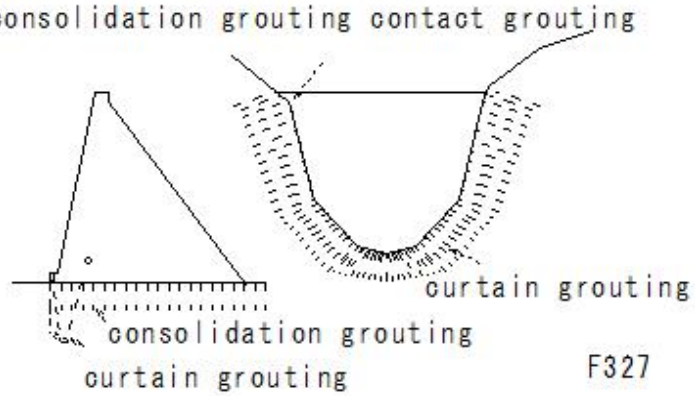
① Consolidation grouting

⑤Injection pressure

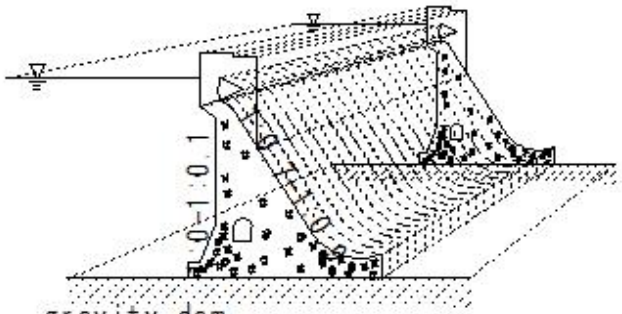
・3-5kgf/cm2

・Arch type concrete dam

Secondary consolidation grouting 5-10kgf/m2

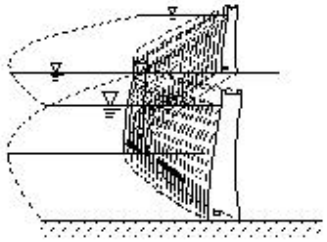


F327



gravity dam

D3



Arch dam

D4

(D130)foundation treatment(grouting)

(D130)foundation treatment(grouting)

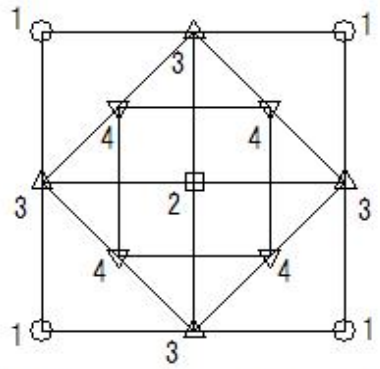
foundation treatment

①Consolidation grouting

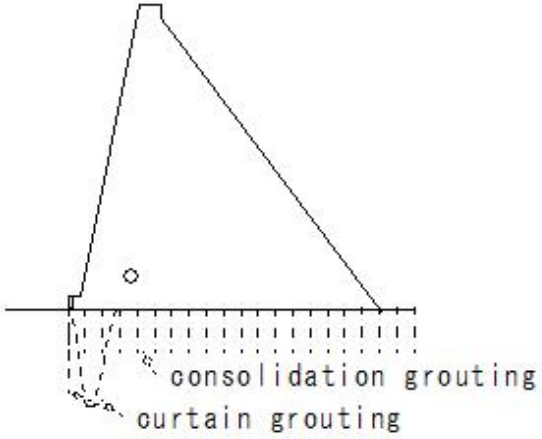
⑥Hole arrangement

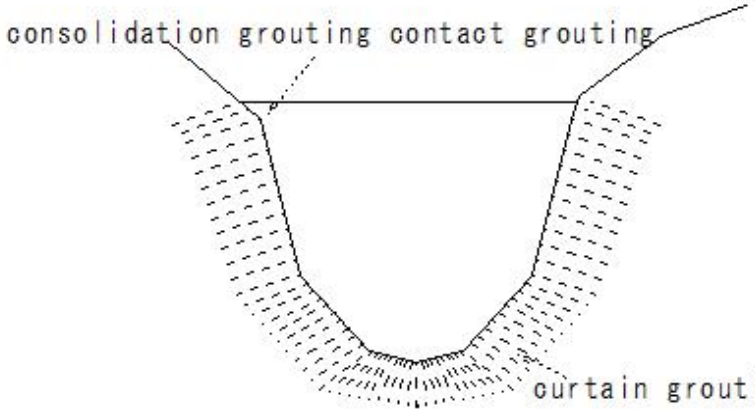
・Lattice shape

・drilling hole spacing 5m



Drilling layout diagram





F327

(D131)foundation treatment(grouting)

(D131)foundation treatment(grouting)

foundation treatment

②Blanket grouting

①Purpose

fill dam

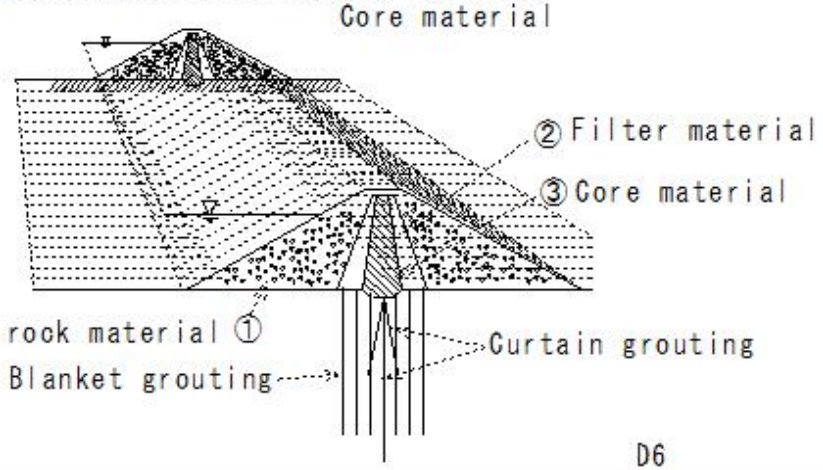
・By suppressing seepage flow near the contact area between the core rock landing area of the fill dam and the foundation ground.

・Suppression of leakage of impermeable material of embankment body and piping of foundation ground

①permeable material (rock material)

②Semi-permeable material

③Waterproof(Impermeable) material



D6

(D132)foundation treatment(grouting)

(D132)foundation treatment(grouting)

foundation treatment

fill dam

②Blanket grouting

②Improvement target value

Approximately 5-10Lu

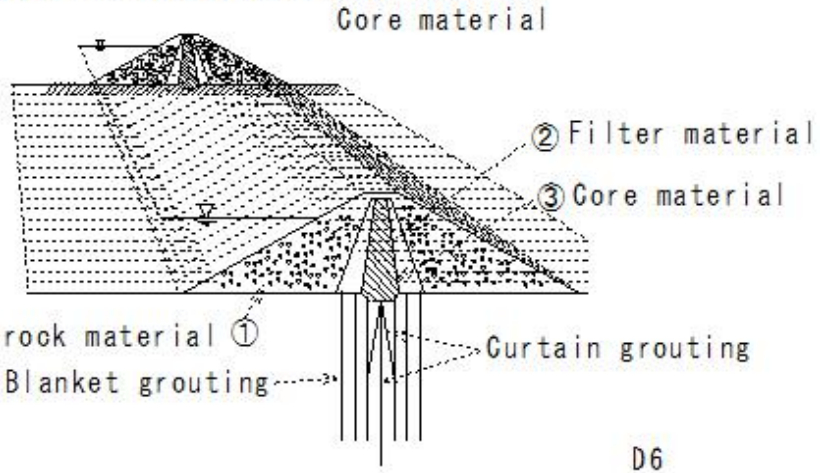
・By suppressing seepage flow near the contact area between the core rock landing area of the fill dam and the foundation ground.

・Suppression of leakage of impermeable material of embankment body and piping of foundation ground

①permeable material (rock material)

②Semi-permeable material

③Waterproof(Impermeable) material



D6

(D133)foundation treatment(grouting)

(D133)foundation treatment(grouting)

foundation treatment

fill dam

②Blanket grouting

③Construction scope

・Entire core area ・Depth 5-10m

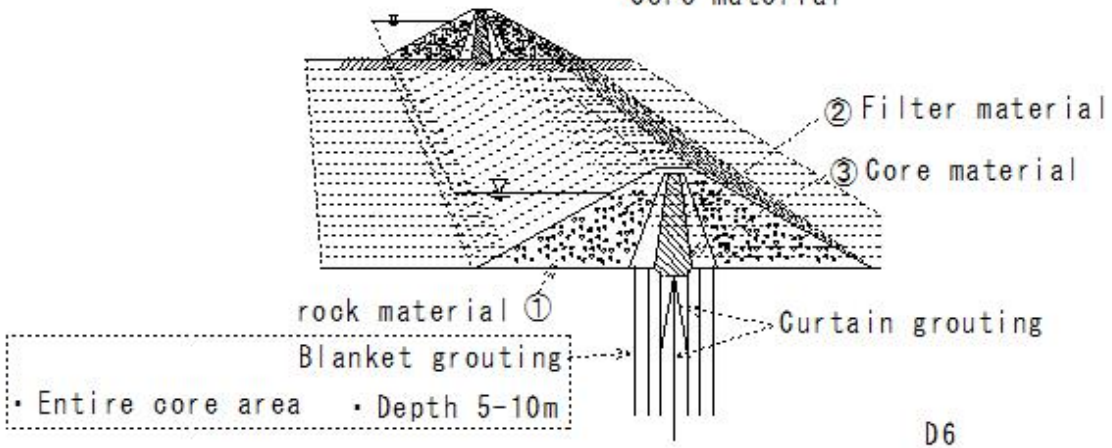
・By suppressing seepage flow near the contact area between the core rock landing area of the fill dam and the foundation ground.

・Suppression of leakage of impermeable material of embankment body and piping of foundation ground

①permeable material (rock material)

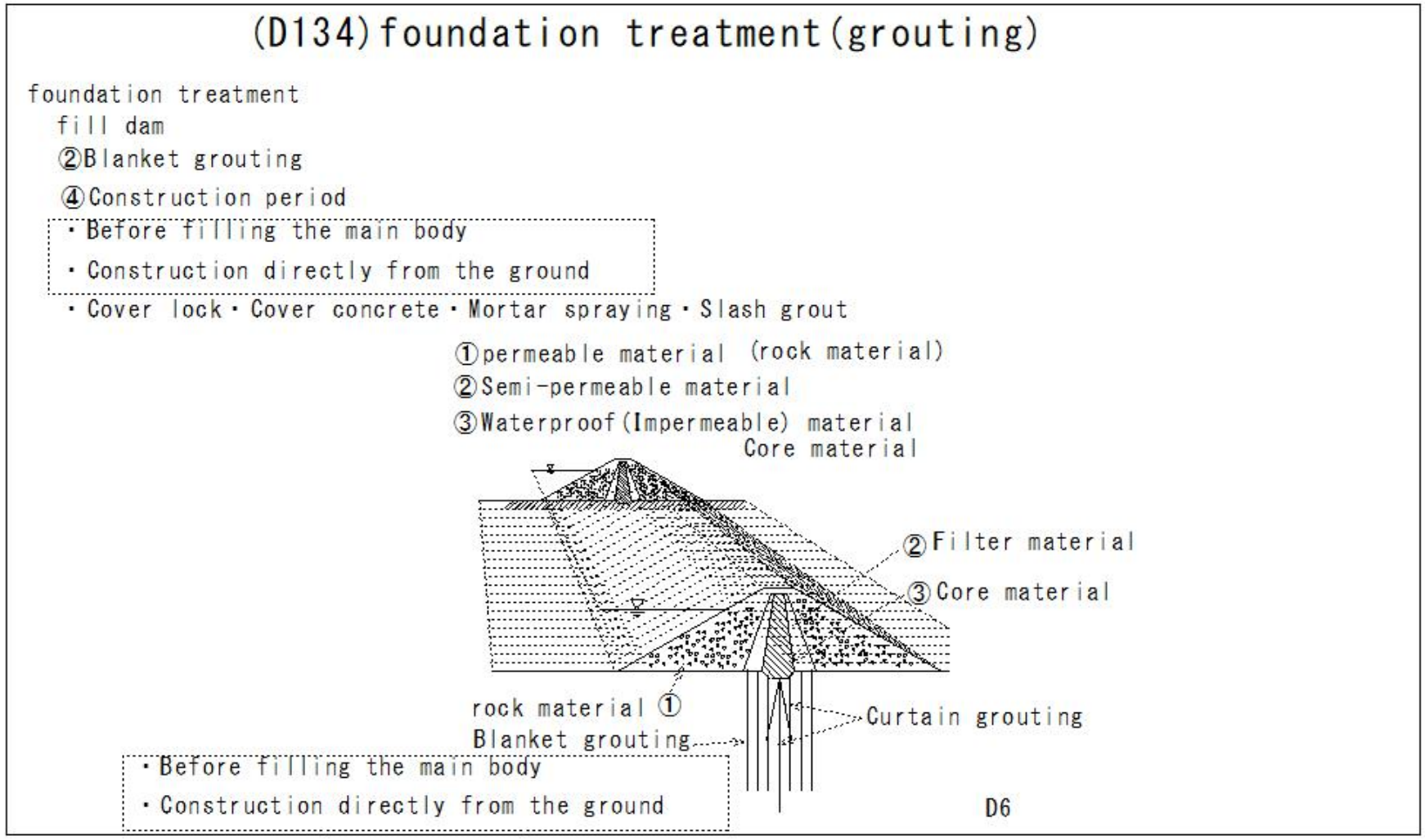
②Semi-permeable material

③Waterproof(Impermeable) material



D6

(D134)foundation treatment(grouting)



(D135)foundation treatment(grouting)

(D135)foundation treatment(grouting)

foundation treatment

fill dam

②Blanket grouting

⑤Injection pressure

・3kgf/cm2

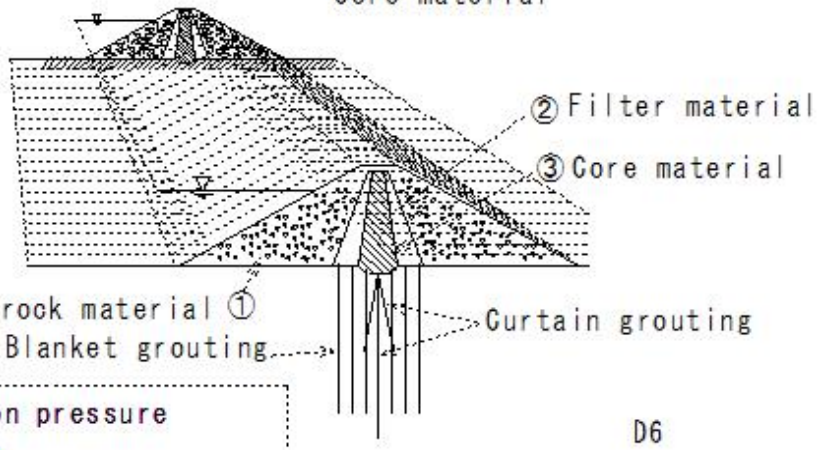
・For soft rock 1-2kgf/cm2

①permeable material (rock material)

②Semi-permeable material

③Waterproof(Impermeable) material

Core material



⑤Injection pressure

・3kgf/cm2

・For soft rock 1-2kgf/cm2

D6

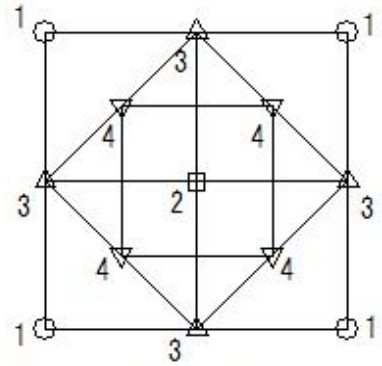
(D136)foundation treatment(grouting)

(D136)foundation treatment(grouting)

foundation treatment

fill dam

②Blanket grouting



Drilling layout diagram

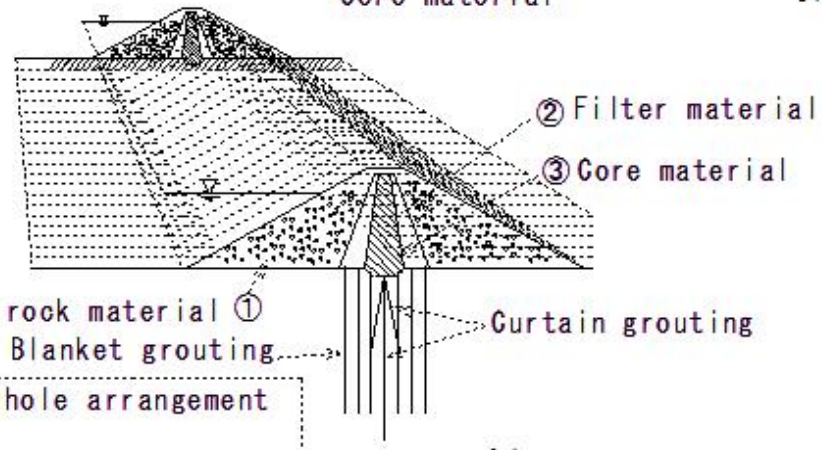
D129

①permeable material (rock material)

②Semi-permeable material

③Waterproof(Impermeable) material

Core material



⑥drilling hole arrangement

・2.5-3m

D6

(D137)foundation treatment(grouting)

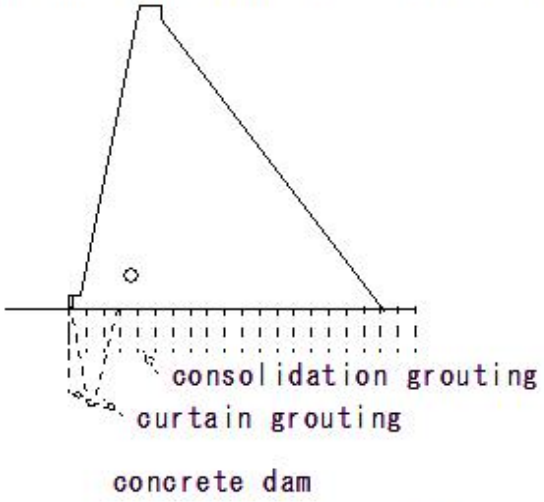
(D137)foundation treatment(grouting)

foundation treatment

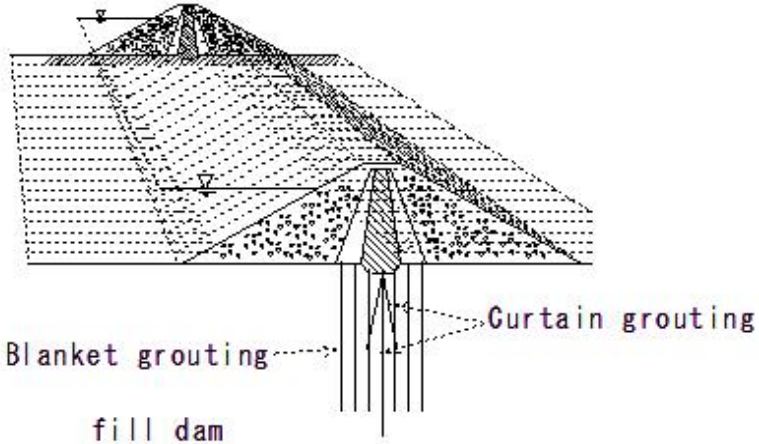
③Curtain grouting

①Purpose

- Prevents infiltration and outflow of stored water
- Prevent piping in the foundation ground
- Contact surface between concrete dam body and foundation ground
- Reduce uplift force
- Outside of embankment type - rim grouting



D130



D131

(D138)foundation treatment(grouting)

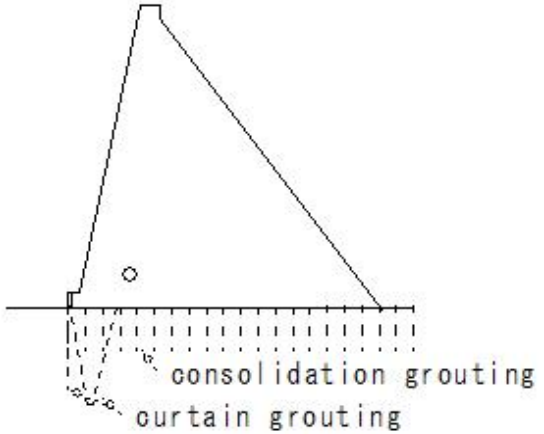
(D138)foundation treatment(grouting)

foundation treatment

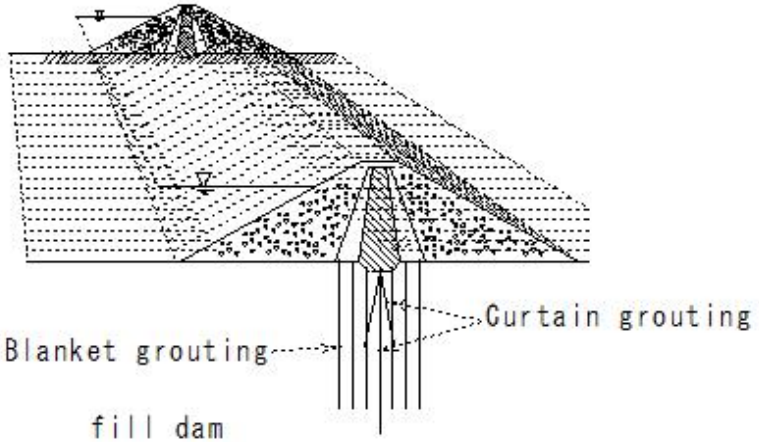
③Curtain grouting

②Improvement target value

- Concrete dam
  Approximately 1-2 Lu
- fill dam
  Approximately 2-5Lu



concrete dam
Approximately 1-2 Lu



fill dam
Approximately 2-5Lu

D137

(D139)foundation treatment(grouting)

(D139)foundation treatment(grouting)

foundation treatment

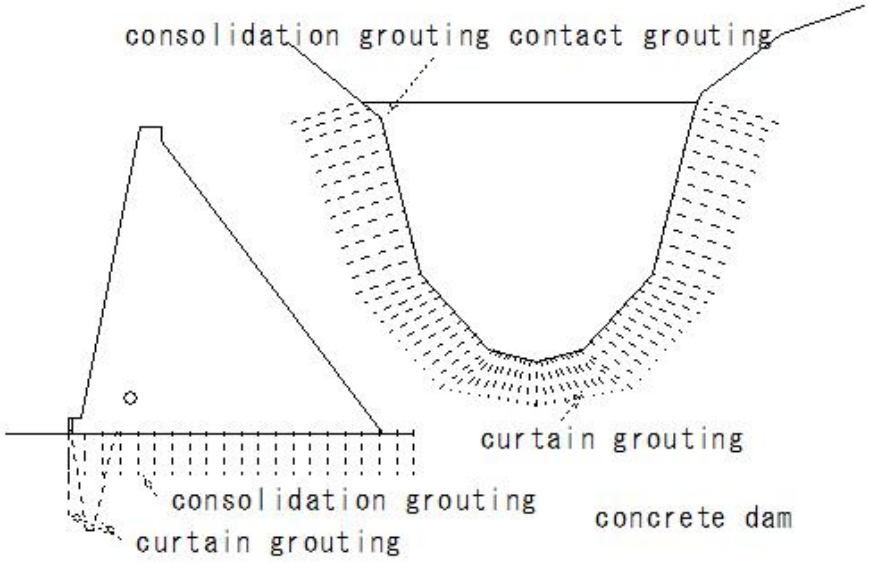
③Curtain grouting

③Construction scope

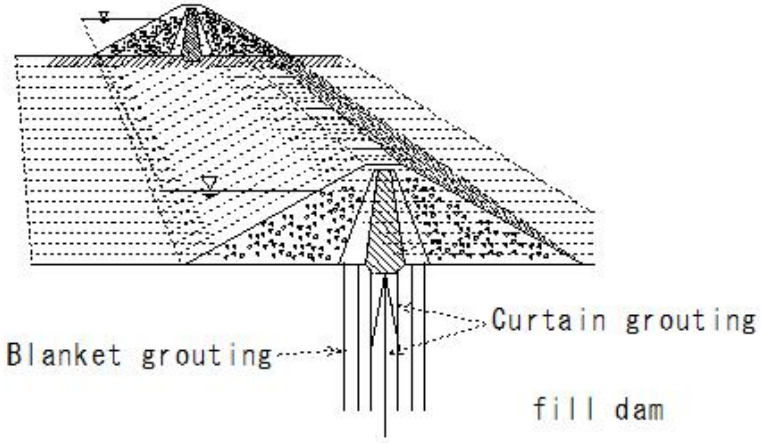
①The depth at which the Lugeon value of the foundation ground reaches the improvement target value

②Range where the underground water level of the ground intersects with the surcharge water level

③Dam height

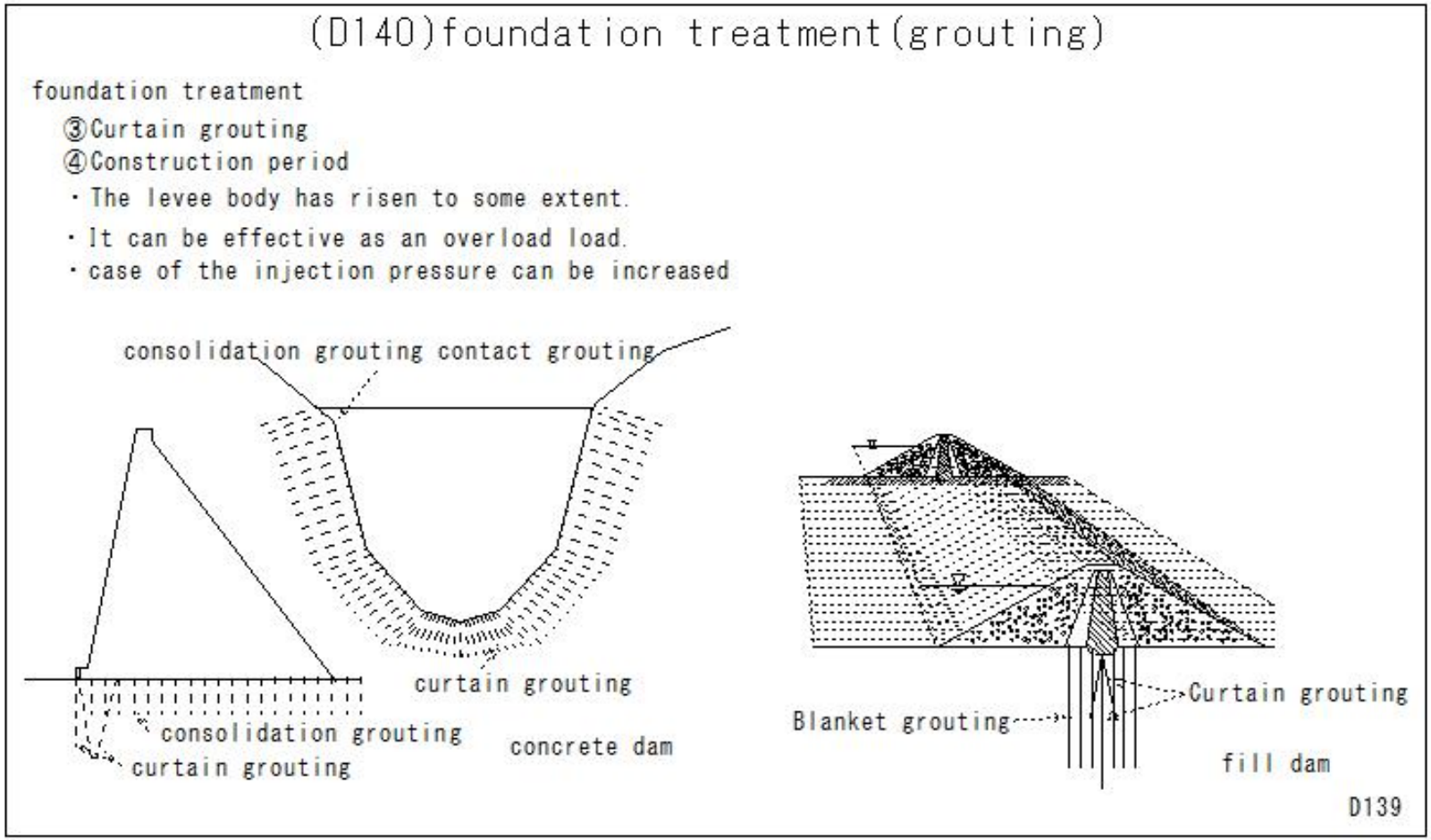


D130



D138

(D140)foundation treatment(grouting)



(D141)foundation treatment(grouting)

(D141)foundation treatment(grouting)

foundation treatment

③Curtain grouting

⑤Construction location

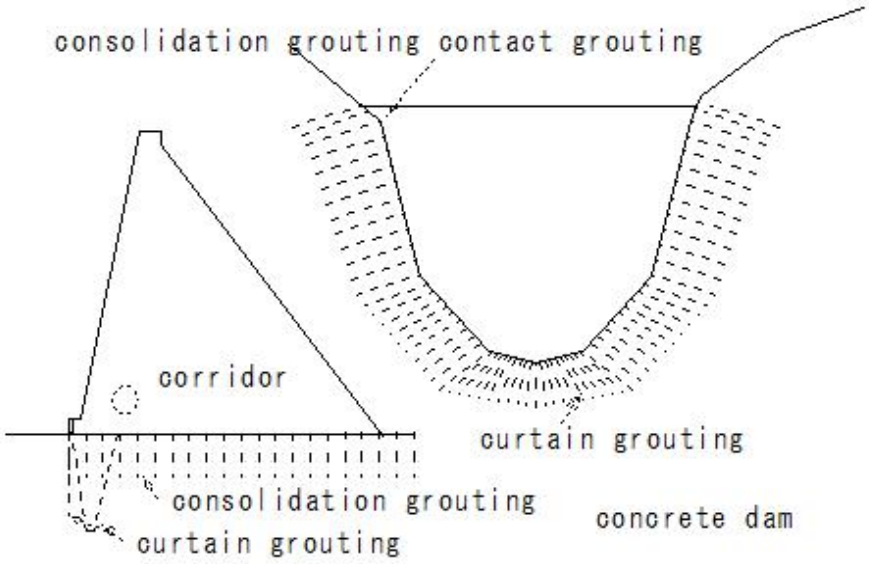
①Concrete dam

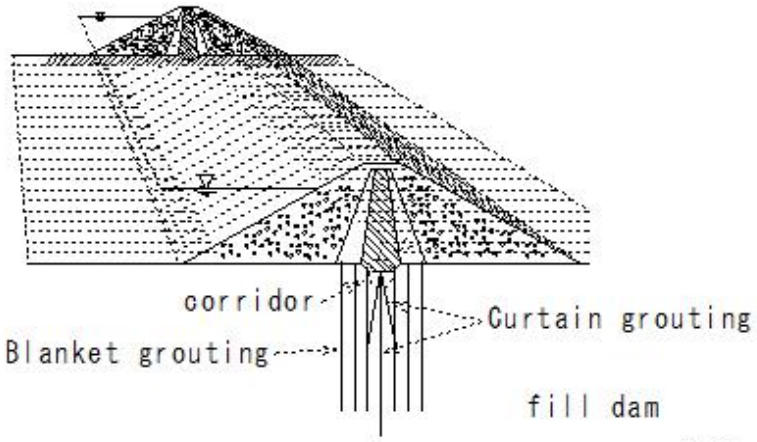
・Footing on the upstream side of the embankment body

Construction from inside the corridor

②fill dam

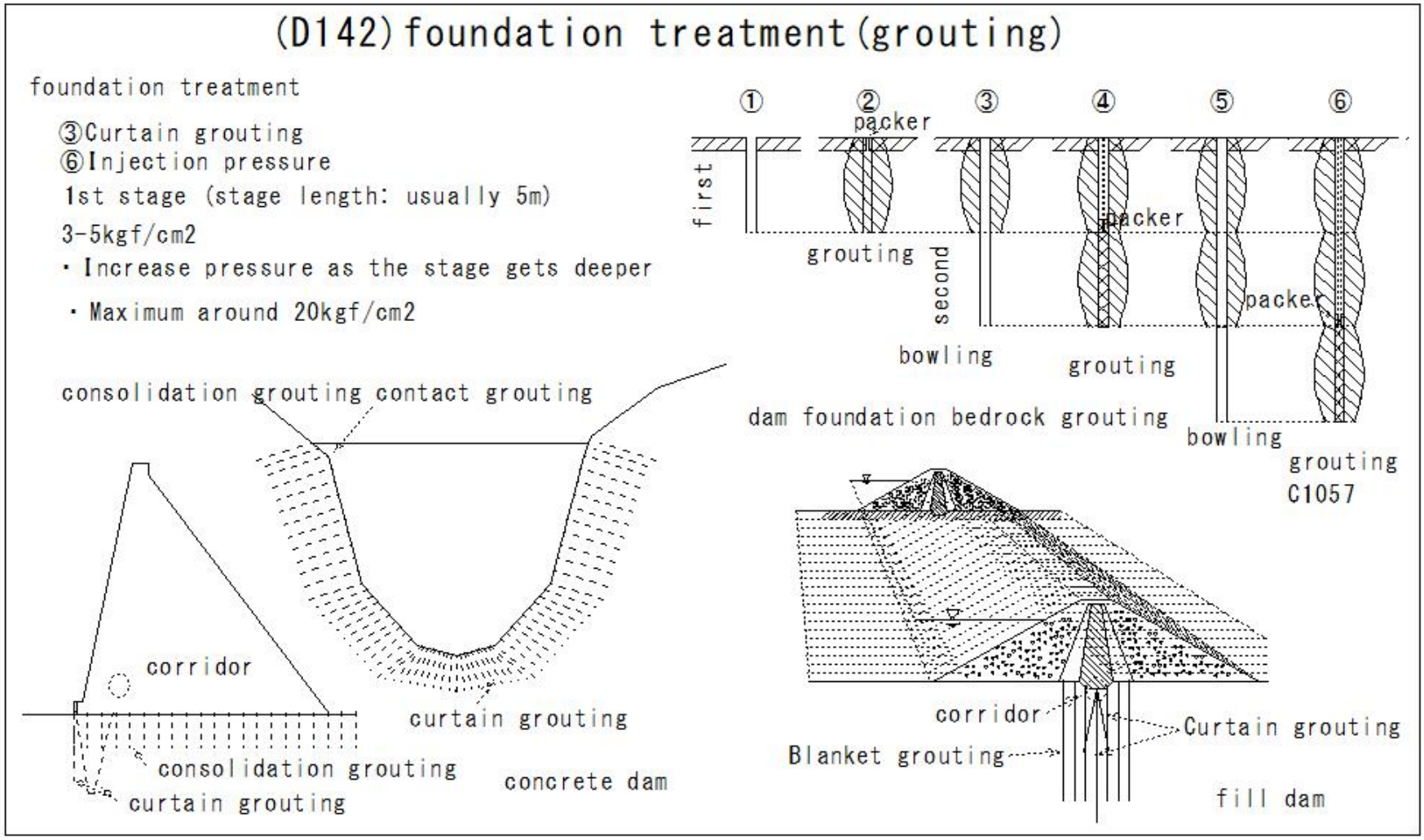
・Construction from inside the corridor





D139

(D142)foundation treatment(grouting)



(D143)foundation treatment(grouting)

(D143) foundation treatment (grouting)

foundation treatment

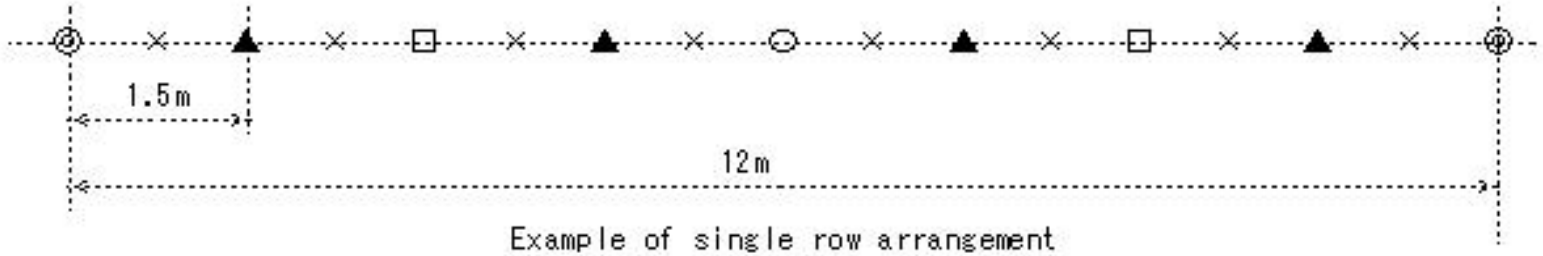
③Curtain grouting

⑦Hole arrangement and depth

①Number of construction rows

・Single row arrangement, multiple row arrangement

・Single row arrangement



Example of single row arrangement

◎: Pilot hole

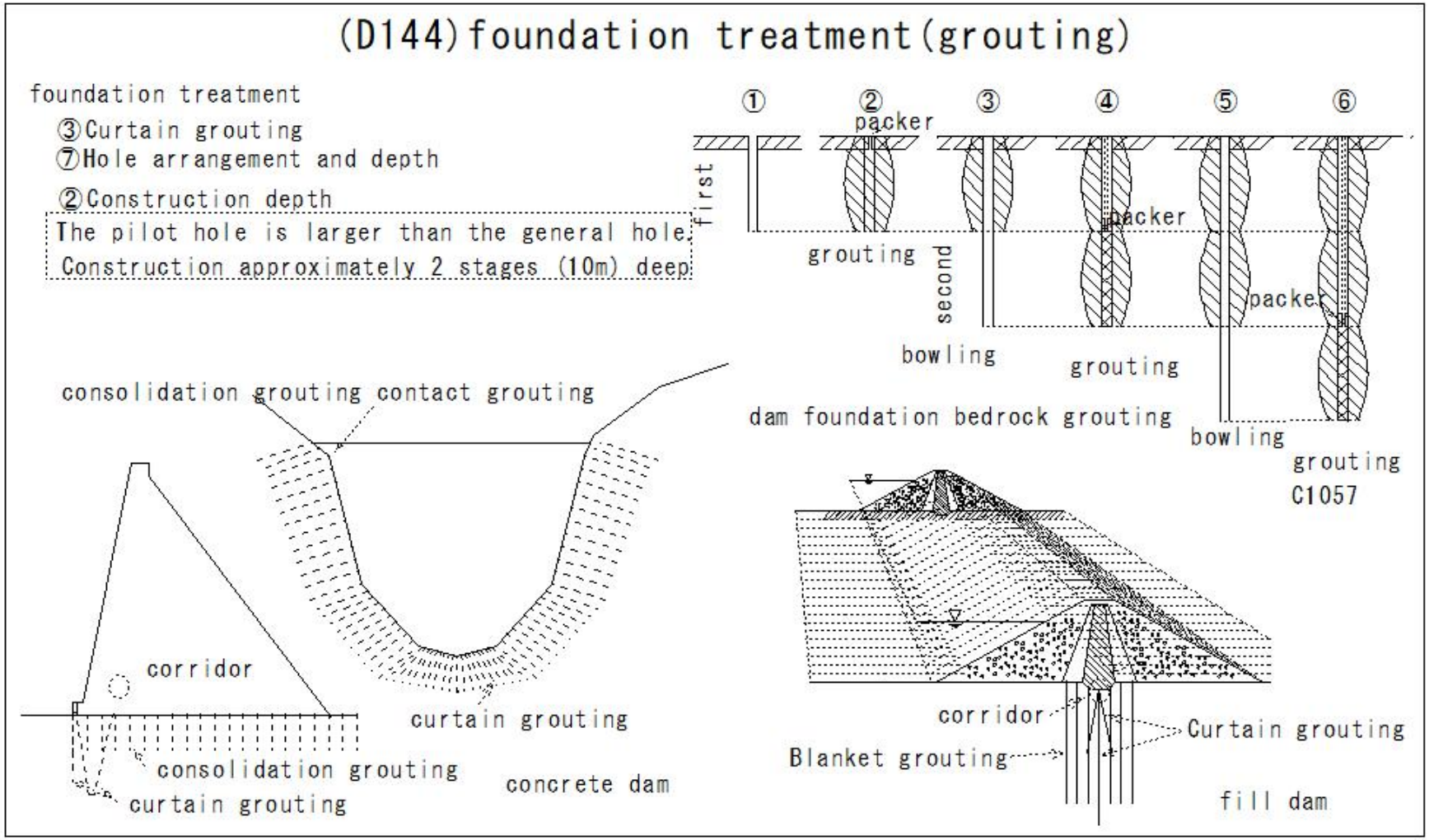
○: Primary hole

□: Secondary hole

▲: Tertiary hole

×: Additional hole

(D144)foundation treatment(grouting)



(D145)foundation treatment(grouting)

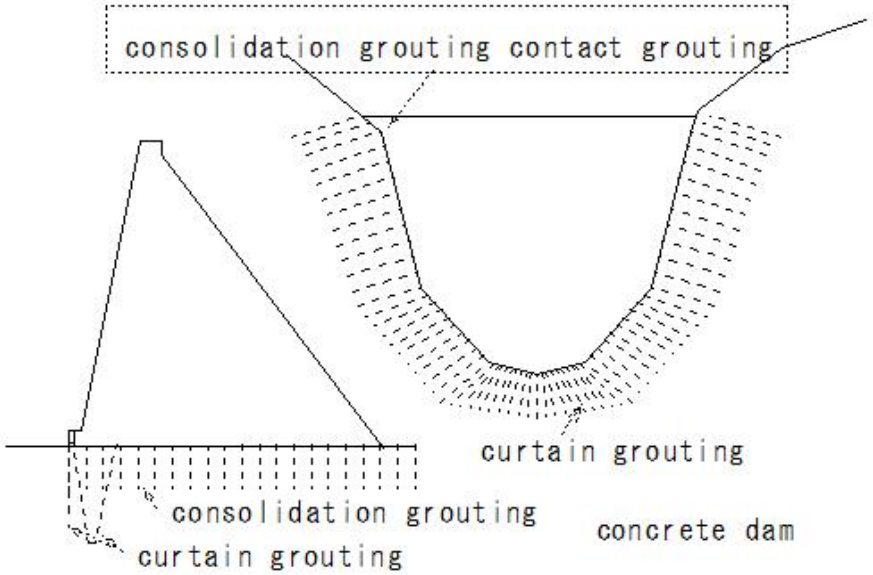
(D145)foundation treatment(grouting)

foundation treatment

④Contact grouting

①Concrete dam

contact grouting=consolidation grout



D139

(D146)foundation treatment(grouting)

(D146)foundation treatment(grouting)

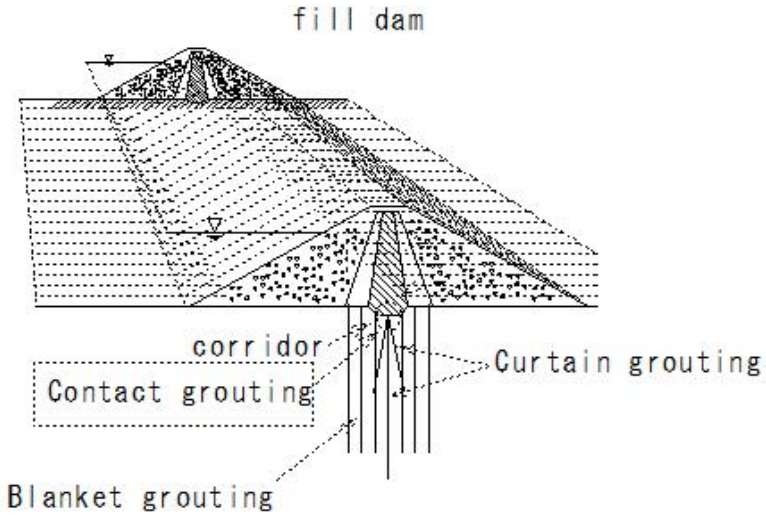
foundation treatment

②fill dam

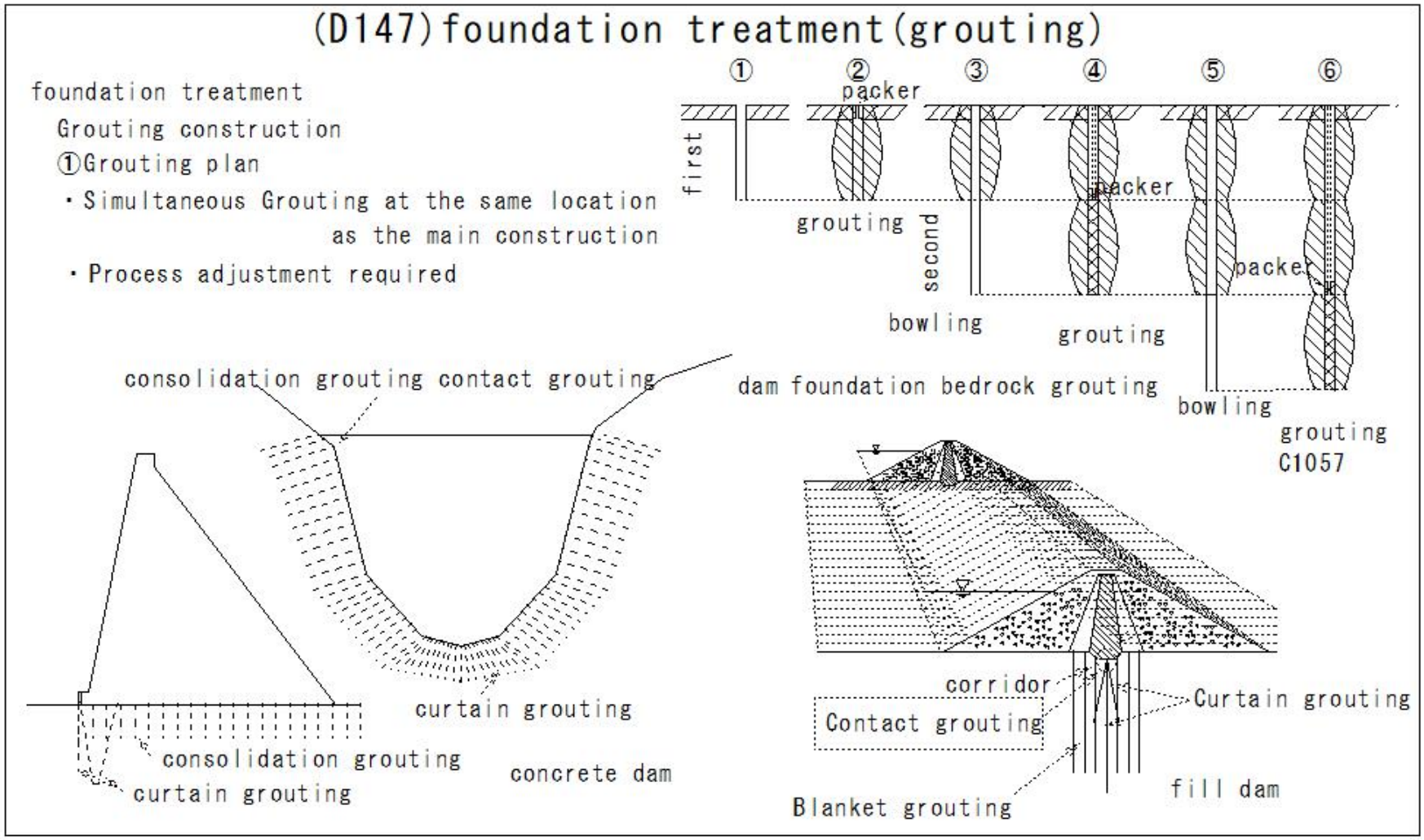
④Contact grouting

・Reinforcement of looseness around the corridor

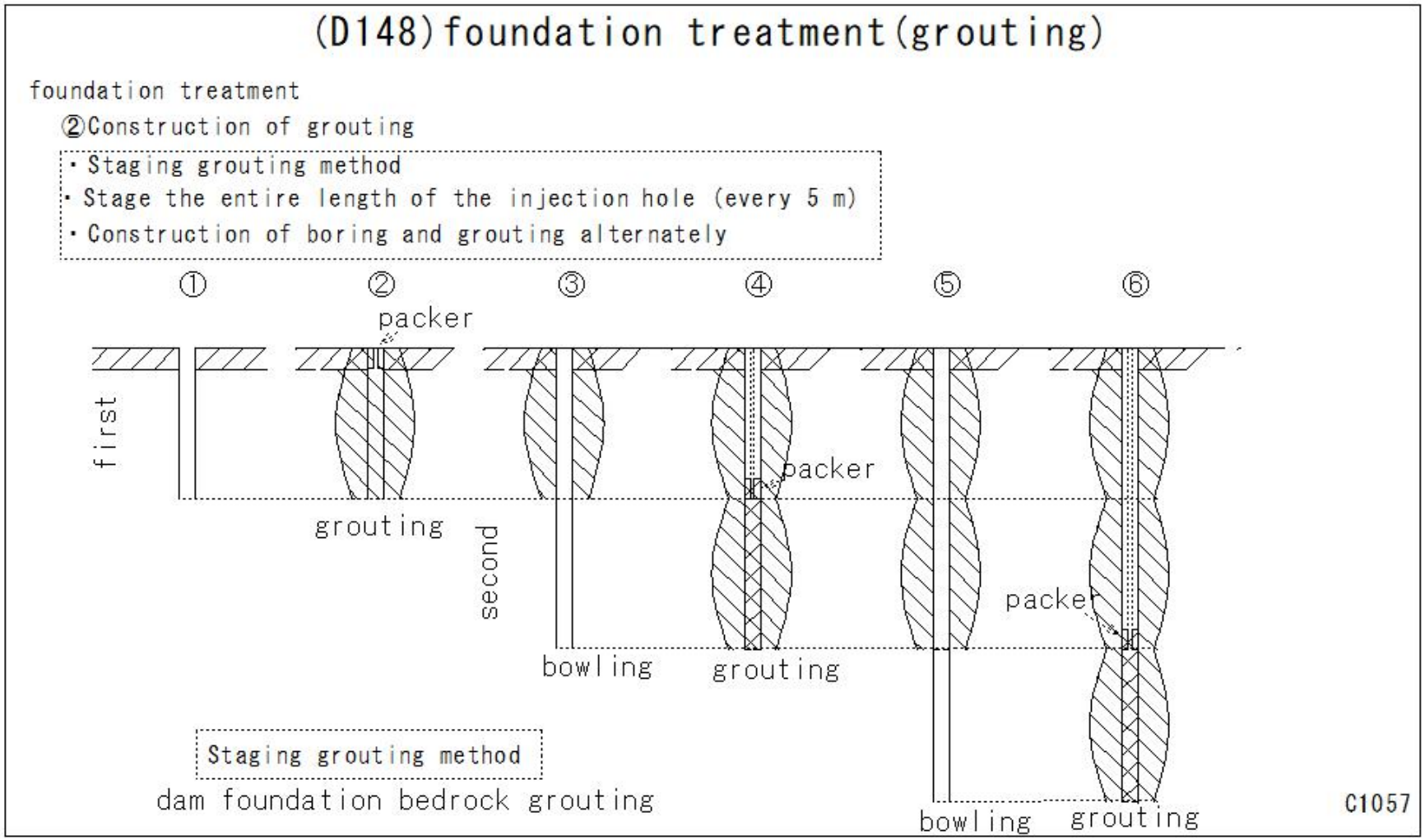
・Fill the gap between the corridor and the rock landing area



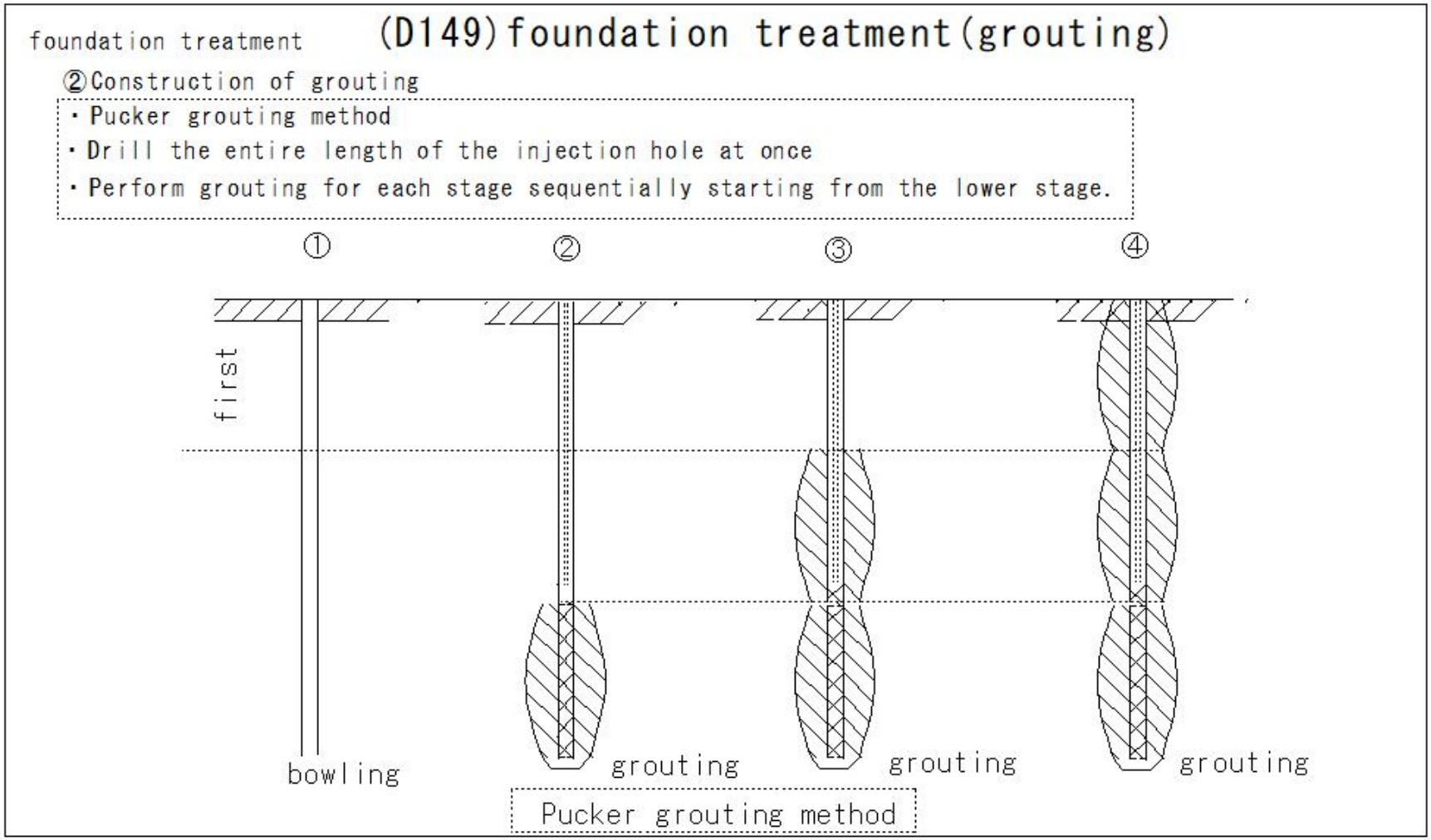
(D147)foundation treatment(grouting)



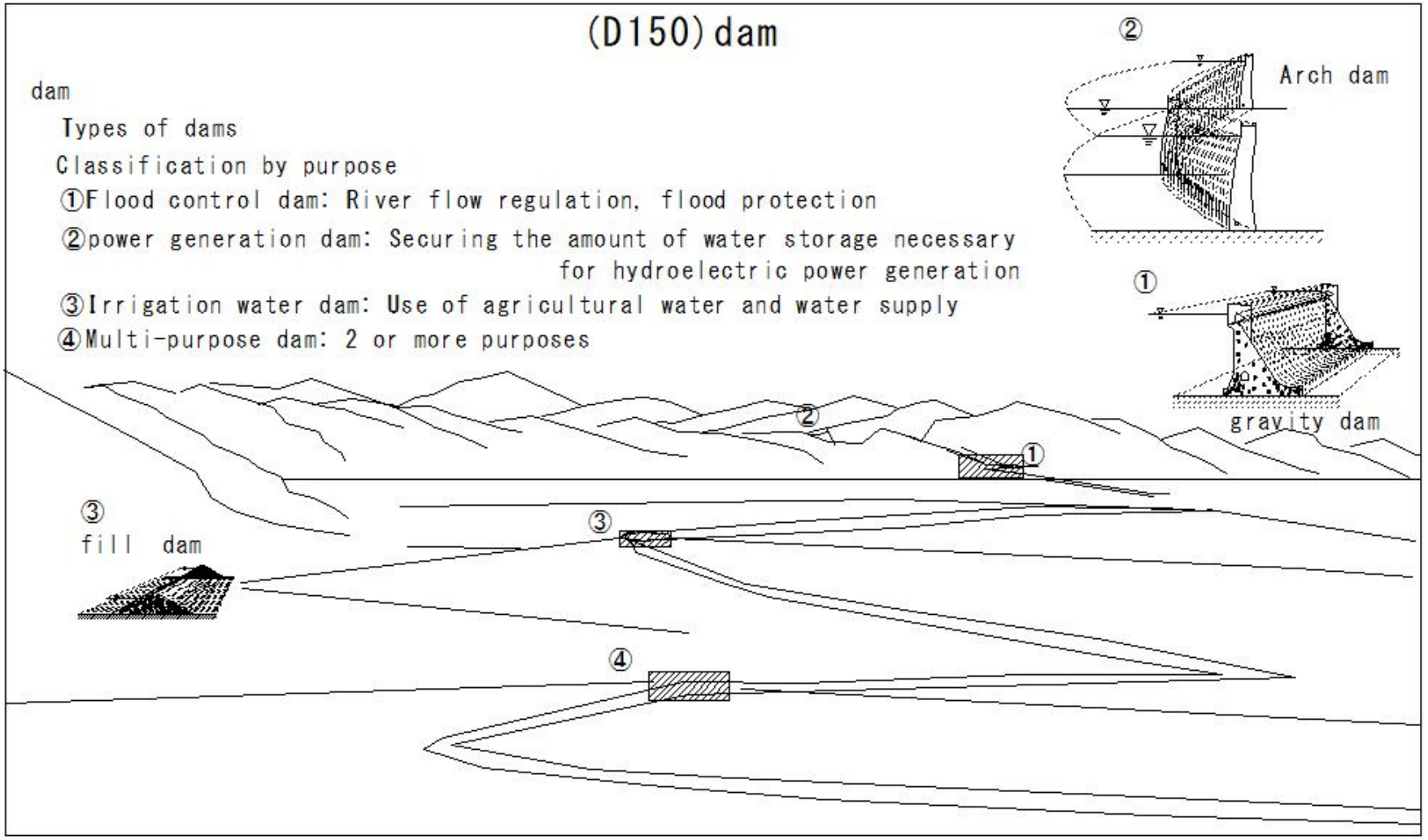
(D148)foundation treatment(grouting)



(D149)foundation treatment(grouting)



(D150)dam


(D150)dam
dam
Types of dams
Classification by purpose
①Flood control dam: River flow regulation, flood protection
②power generation dam: Securing the amount of water storage necessary for hydroelectric power generation
③Irrigation water dam: Use of agricultural water and water supply
④Multi-purpose dam: 2 or more purposes
②
Arch dam
①
gravity dam
②
①
③
③
fill dam
④

(D151)dam

(D151) dam

dam

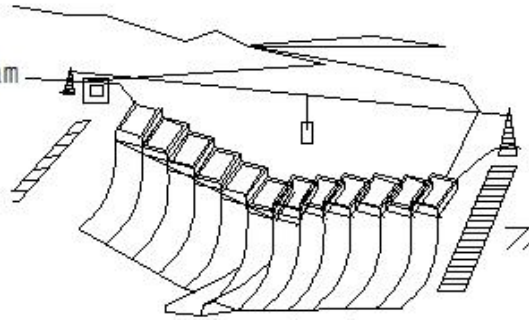
Types of dams

Materials used

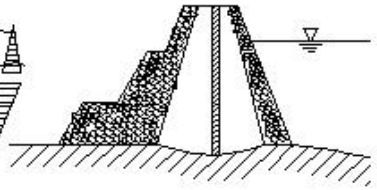
- concrete dam
- rockfill dam
- earth dam

Structural form

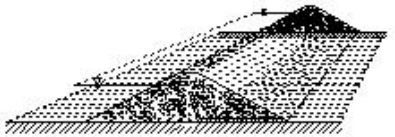
- gravity dam
- hollow gravity dam
- buttress dam
- arch dam



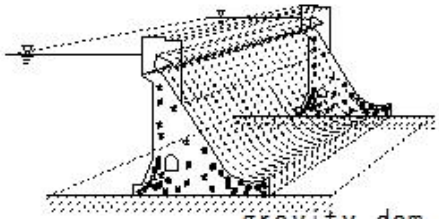
concrete dam



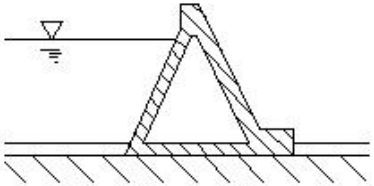
rockfill dam



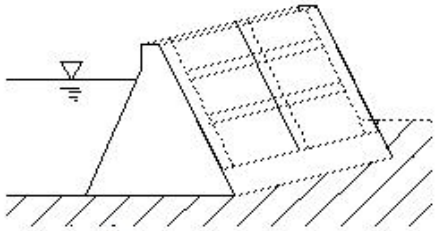
earth dam



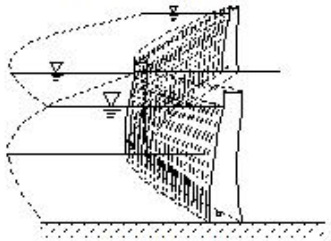
gravity dam



Hollow gravity dam

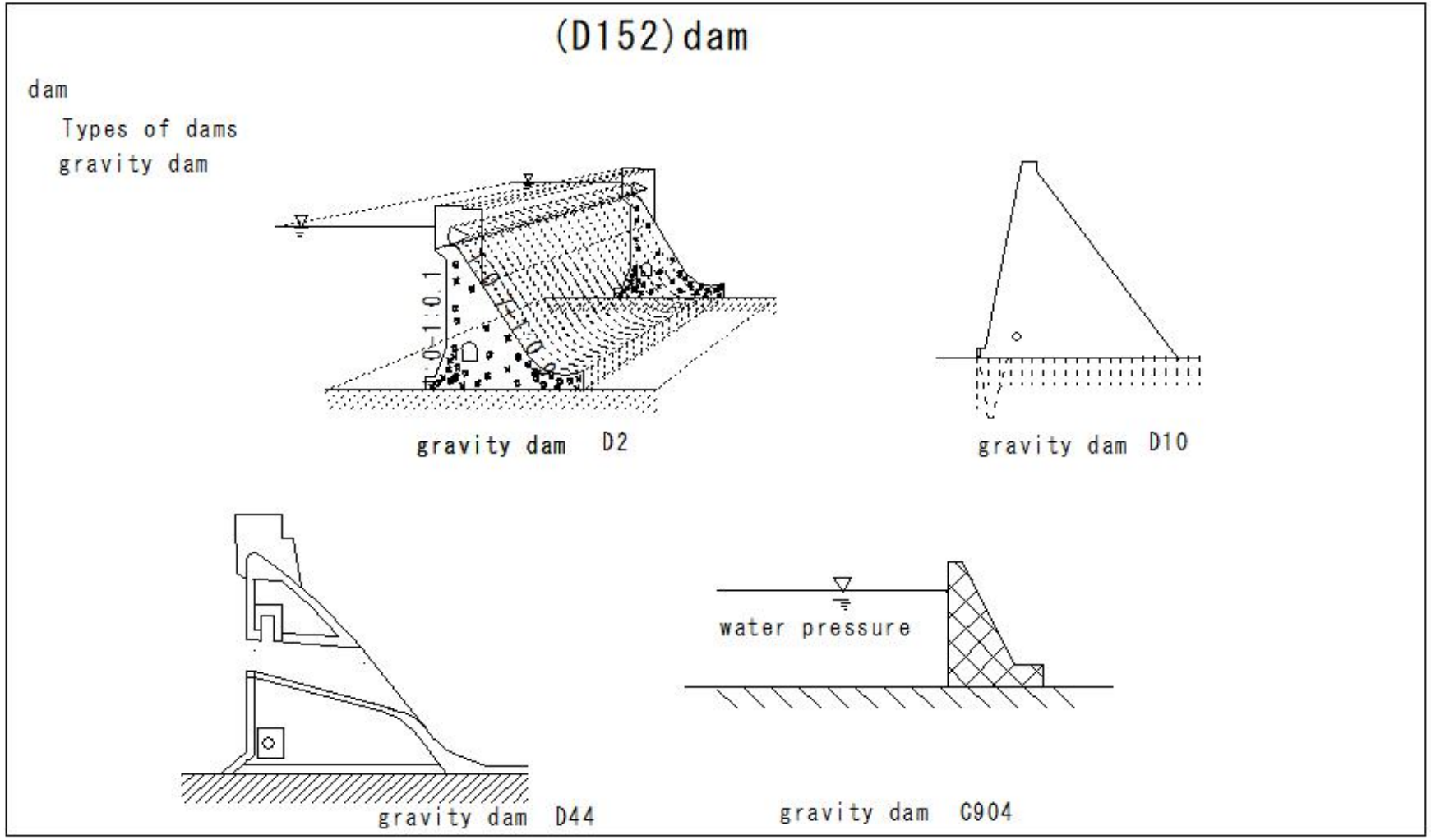


Buttress dam



Arch dam

(D152)dam


(D152)dam
dam
Types of dams
gravity dam
1:0.1
gravity dam D2
gravity dam D10
water pressure
gravity dam D44
gravity dam C904

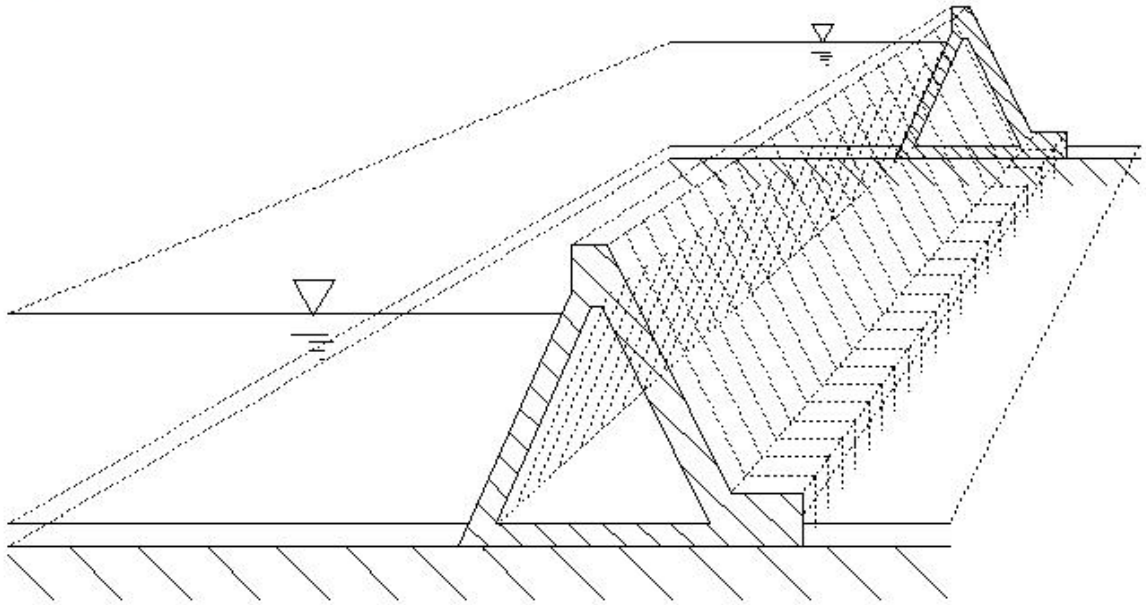
(D153)dam

(D153) dam

dam

Types of dams

hollow gravity dam



Hollow gravity dam

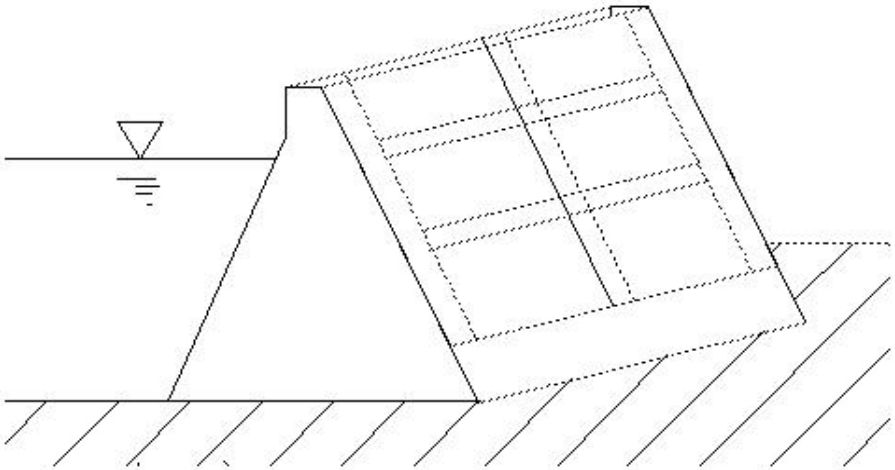
(D154)dam

(D154) dam

dam

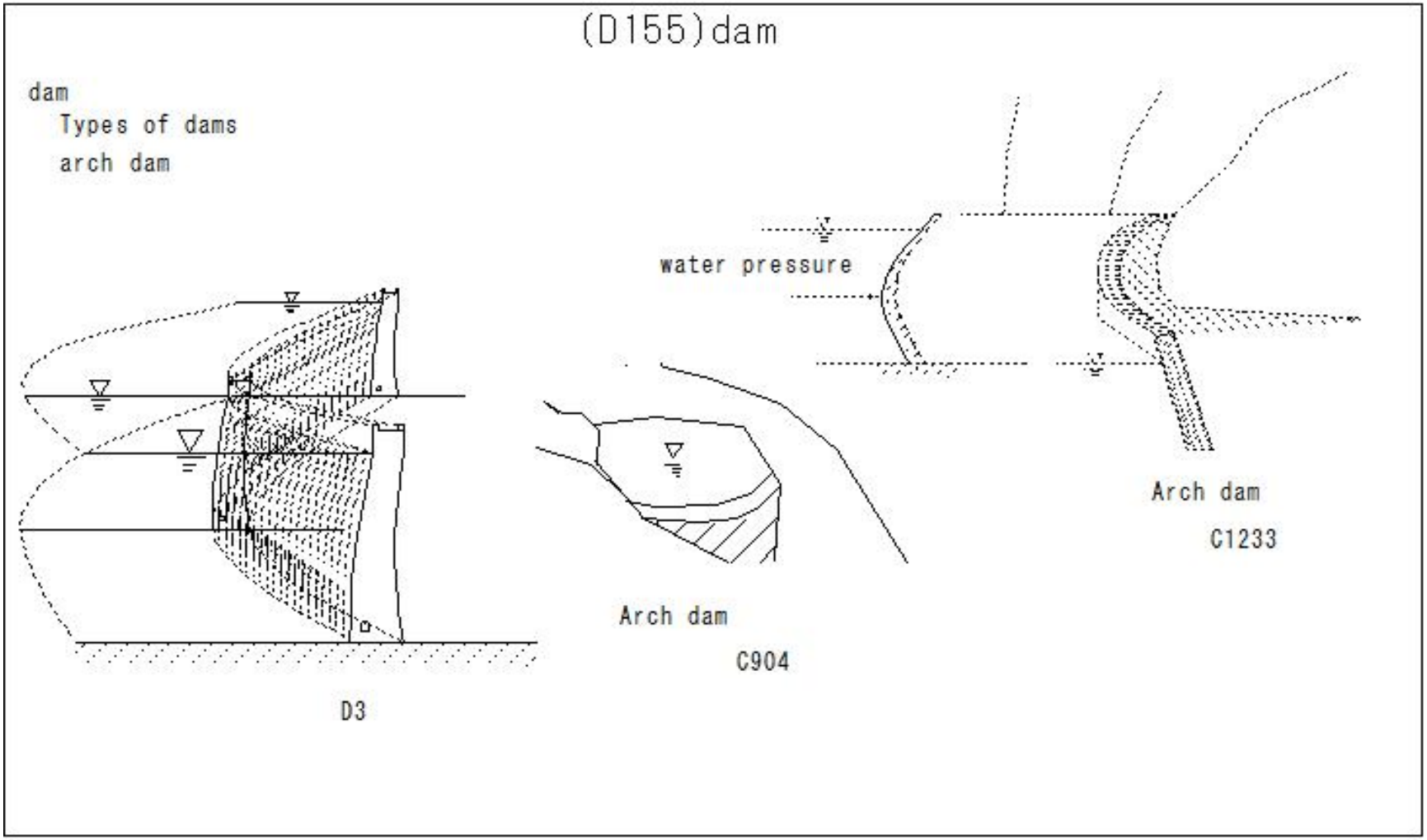
Types of dams

buttress dam

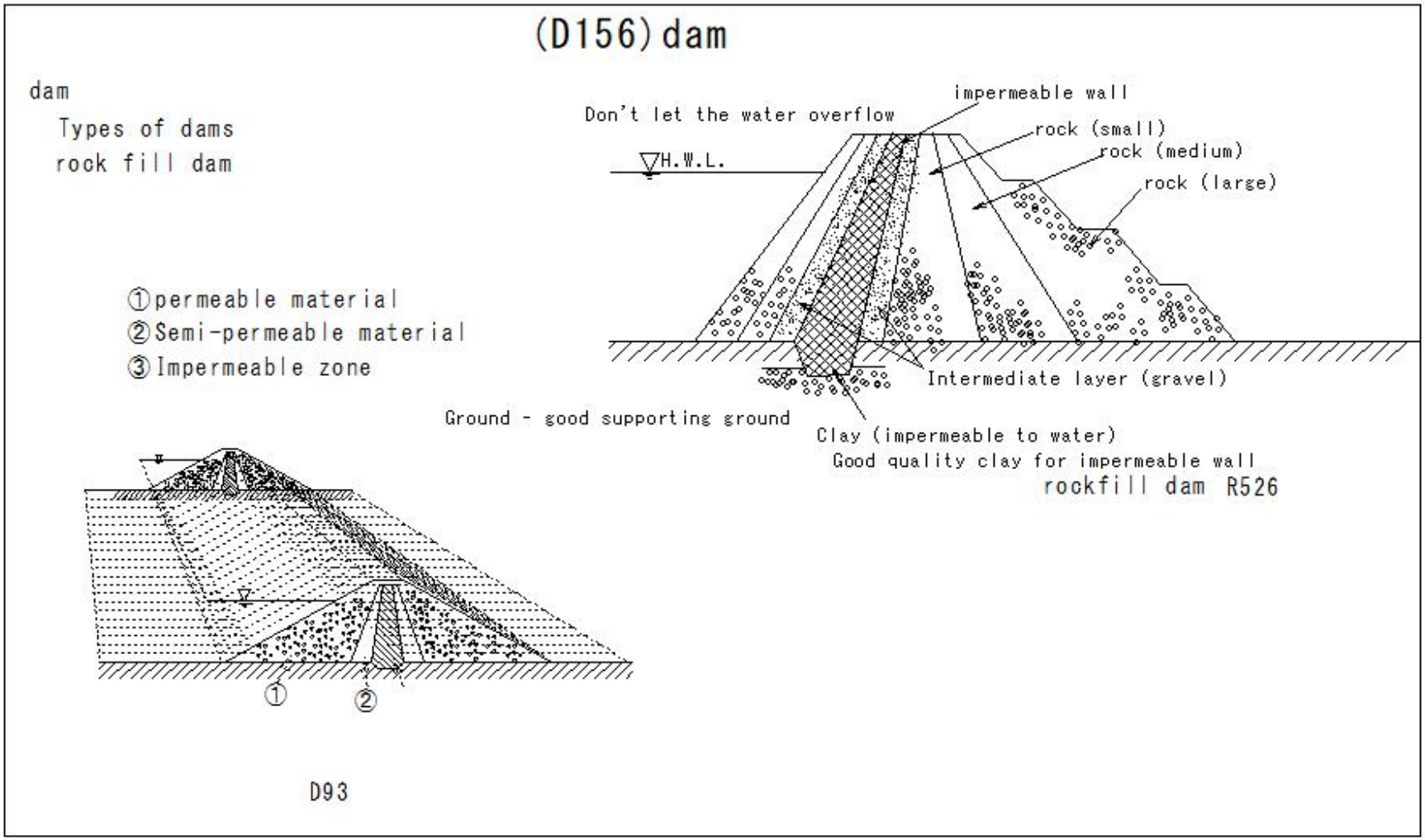


Buttress dam

(D155)dam


(D155)dam
dam
Types of dams
arch dam
water pressure
Arch dam
C1233
Arch dam
C904
D3

(D156)dam


(D156) dam
dam
Types of dams
rock fill dam
①permeable material
②Semi-permeable material
③Impermeable zone
Don't let the water overflow
impermeable wall
rock (small)
rock (medium)
rock (large)
▽H.W.L.
Intermediate layer (gravel)
Ground - good supporting ground
Clay (impermeable to water)
Good quality clay for impermeable wall
rockfill dam R526
①
②
D93

(D157)dam

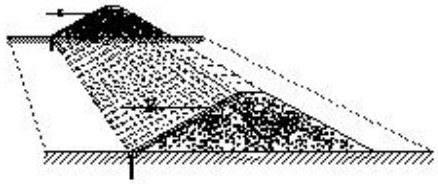
(D157)dam

dam

Types of dams

rock fill dam

Facing type dam(Surface impermeable)

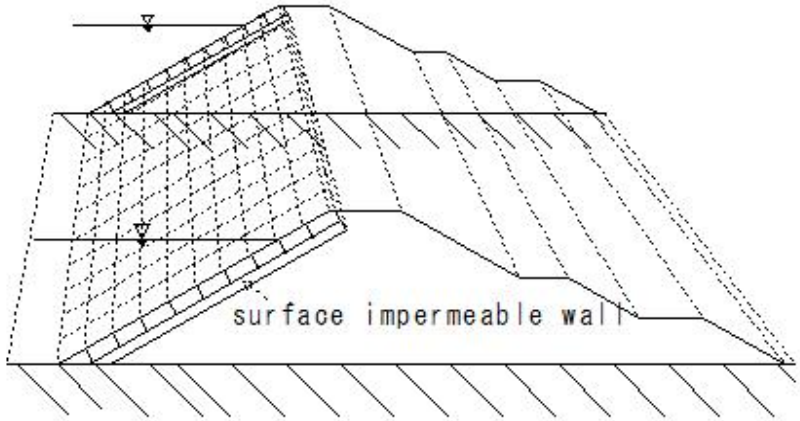


Surface impermeable wall type

R592

D4

rock fill dam



R474

(D158)dam

(D158)dam

dam

hydroelectric power

・Energy in water

・Continuously drops water from high places

・Convert into velocity and pressure energy

・How to generate electricity with a water turbine generator

①Clean natural environmental energy using the power of nature

②Equipment costs are high

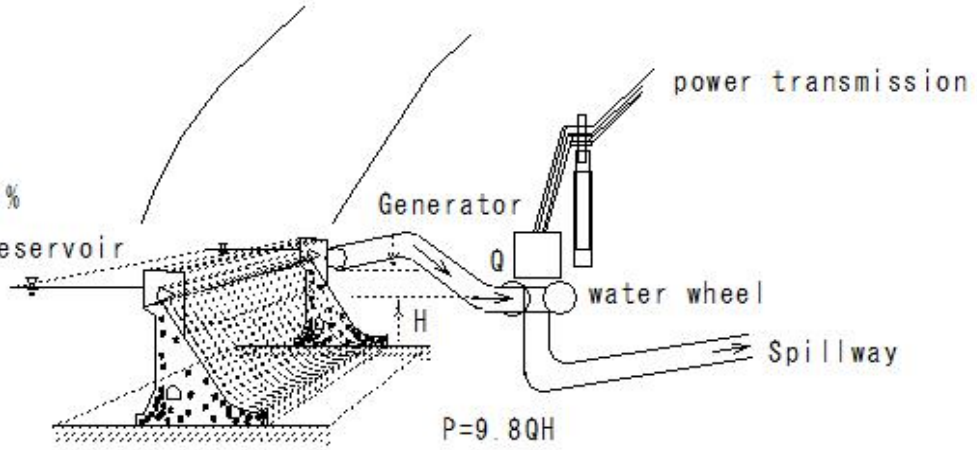
long service life

Operating costs are low

③Highly reliable technology

④High efficiency of 85-90%

Thermal power generation is 35-41%



hydroelectric power

(D159)dam

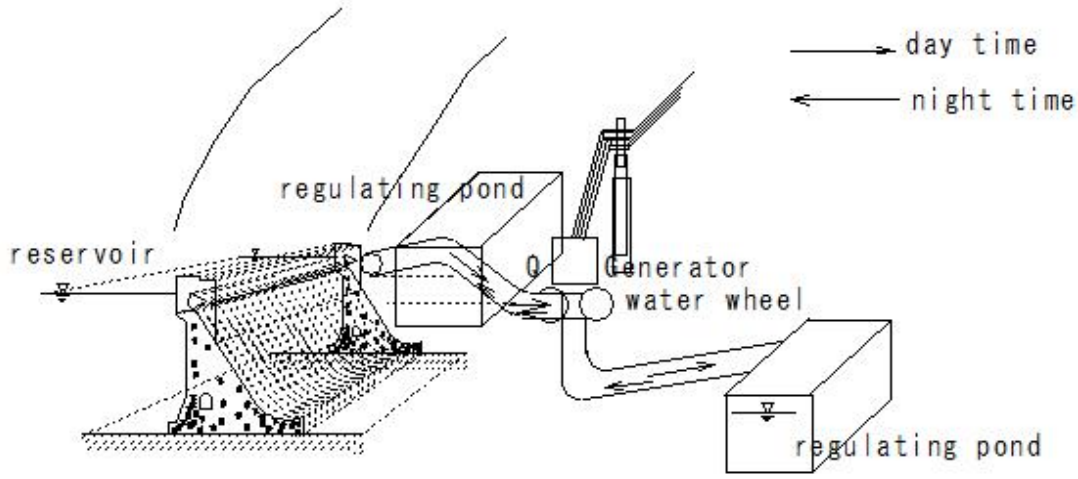
(D159)dam

dam

hydroelectric power

pumped storage power generation

- Nighttime during electricity demand is low
- Use surplus electricity to operate the pump
- Pump up and store water in a reservoir
- Generate electricity by discharging electricity during daytime peak hours



pumped storage power generation

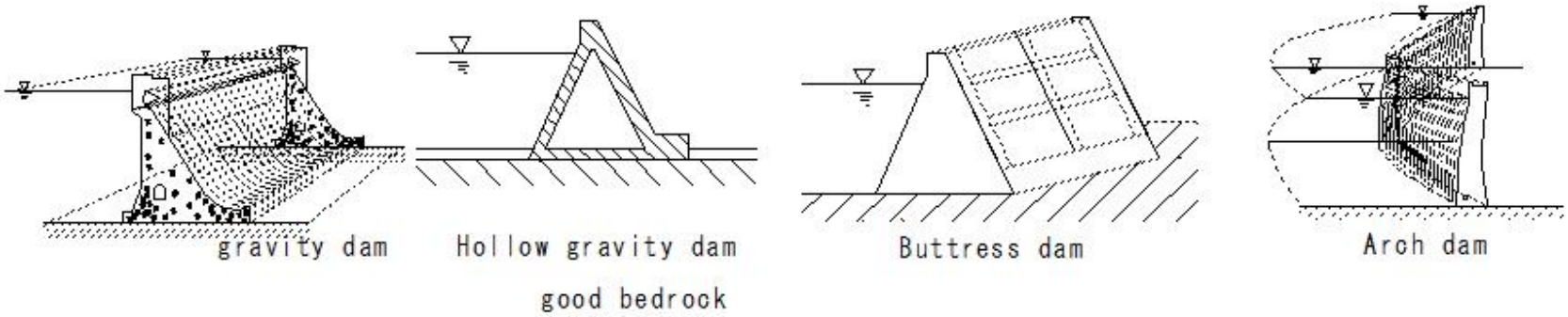
(D160)dam

(D160) dam

dam

concrete dam

・Requires good bedrock



D151

(D161)dam(Diversion works)

(D161)dam(Diversion works)

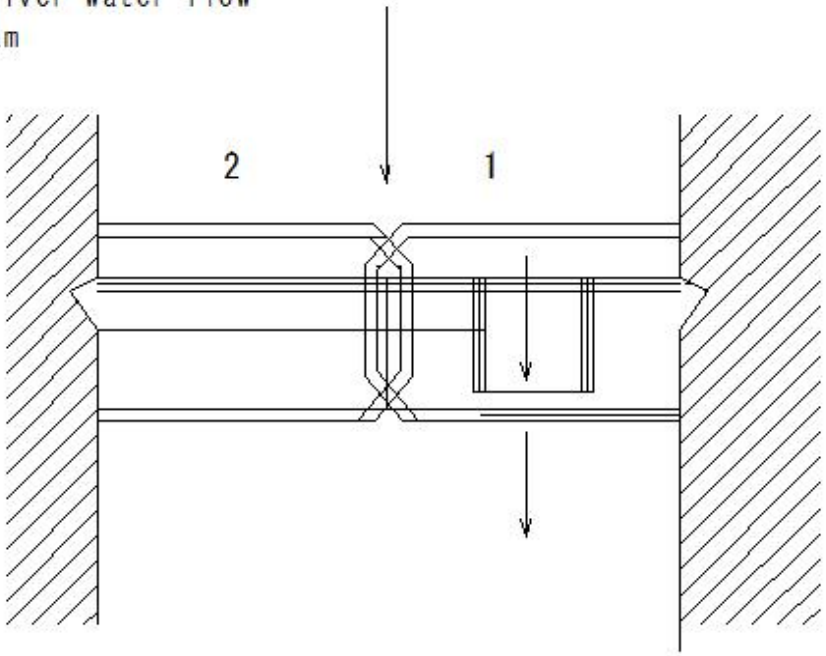
dam

・Diversion work

dam construction

・Temporarily close the river water flow

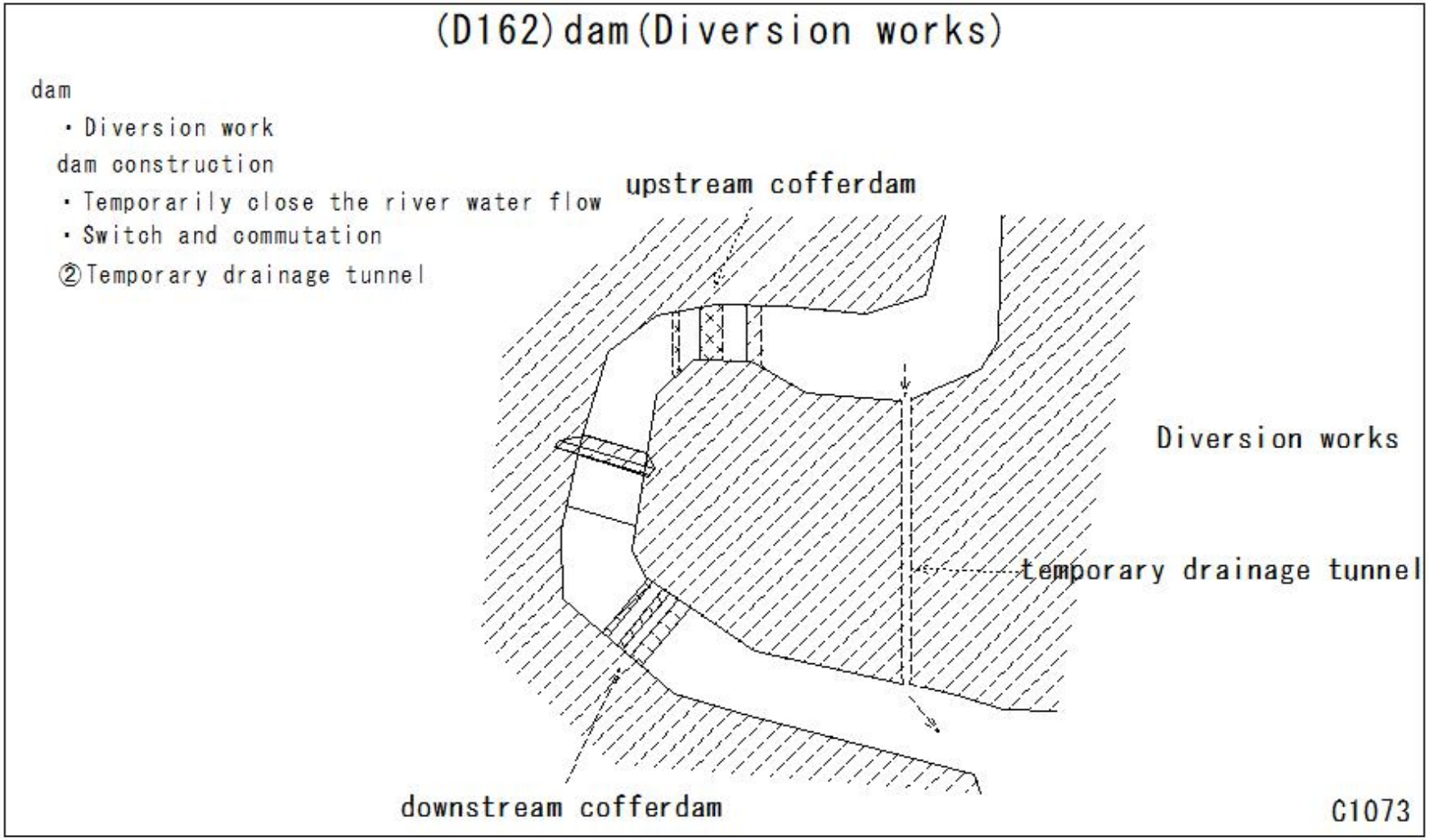
①half temporary cofferdam



Diversion works-Half cofferdam

C1074

(D162)dam(Diversion works)



(D163)dam(Diversion works)

(D163)dam(Diversion works)

dam

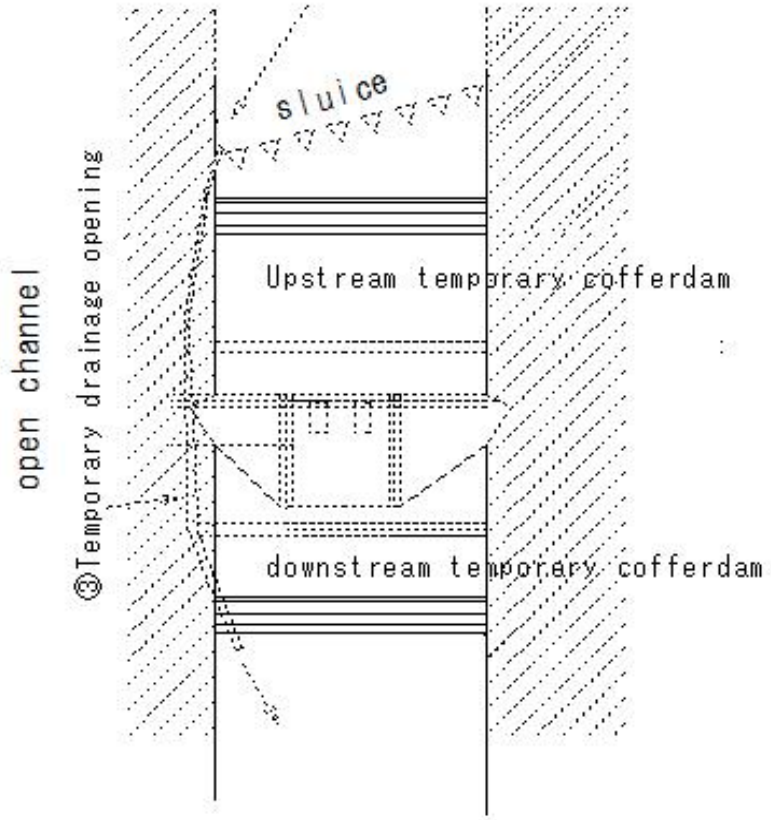
・Diversion work

dam construction

・Temporarily close the river water flow

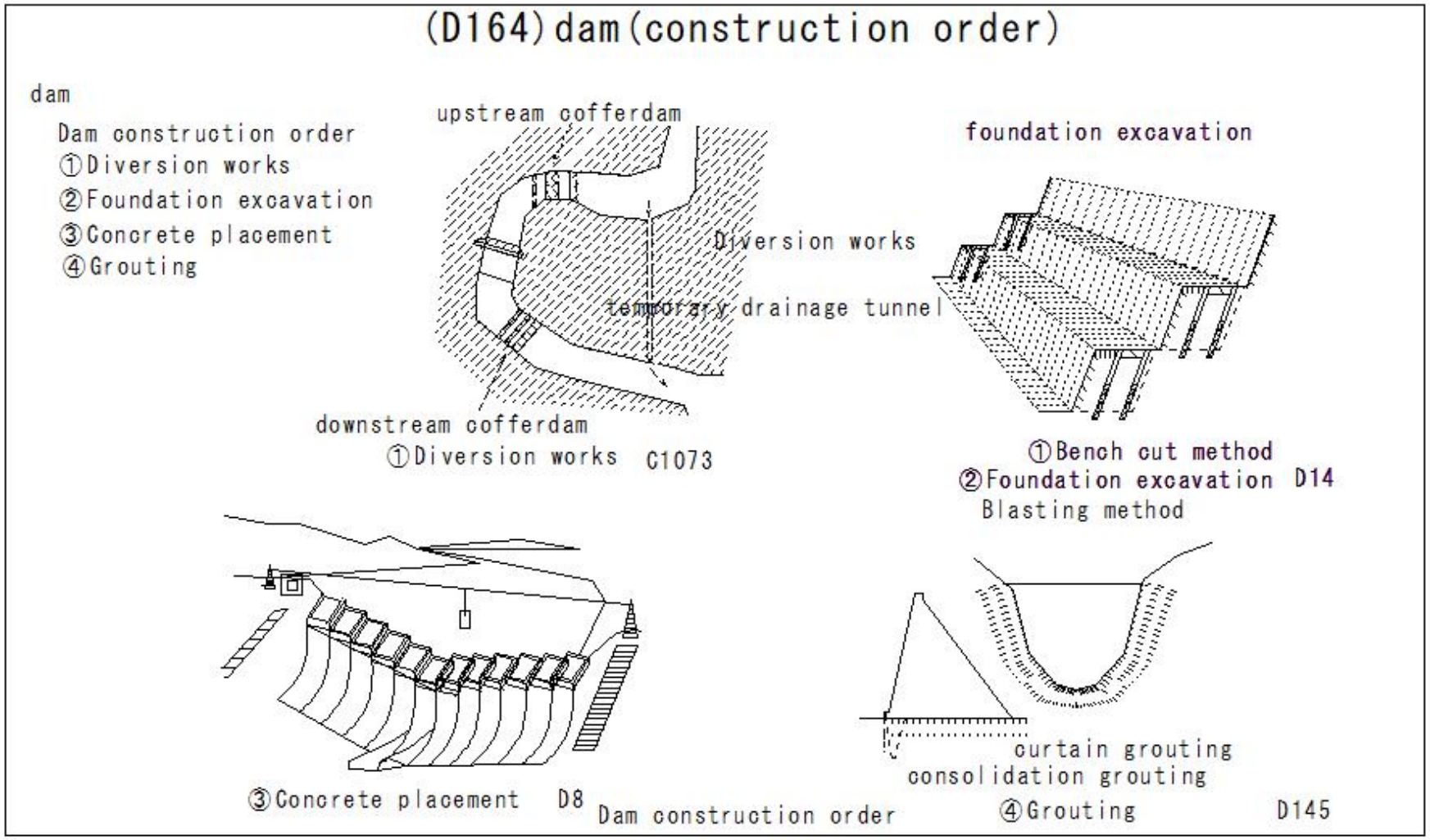
・Switch and commutation

③Temporary drainage opening

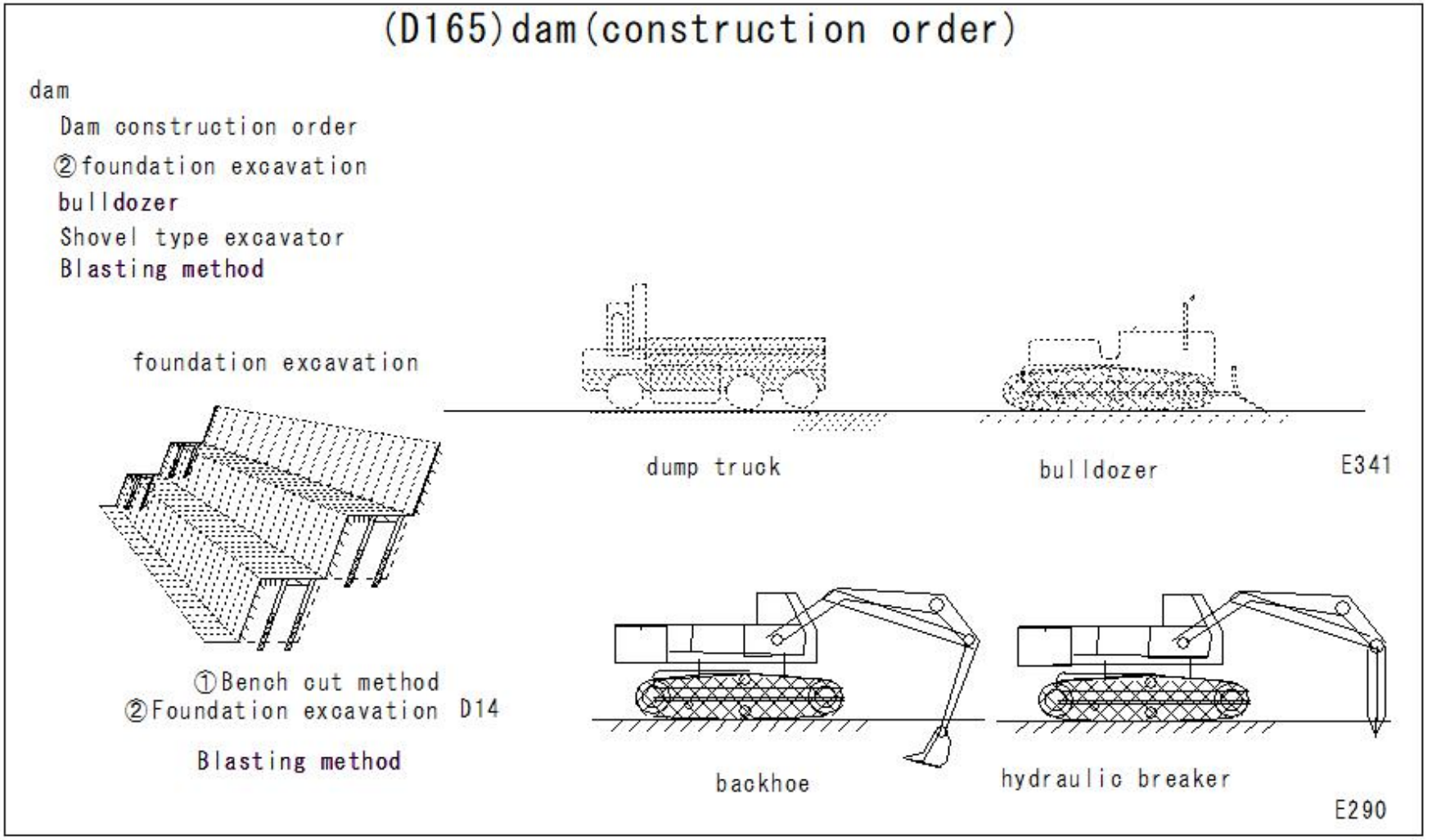


C1075

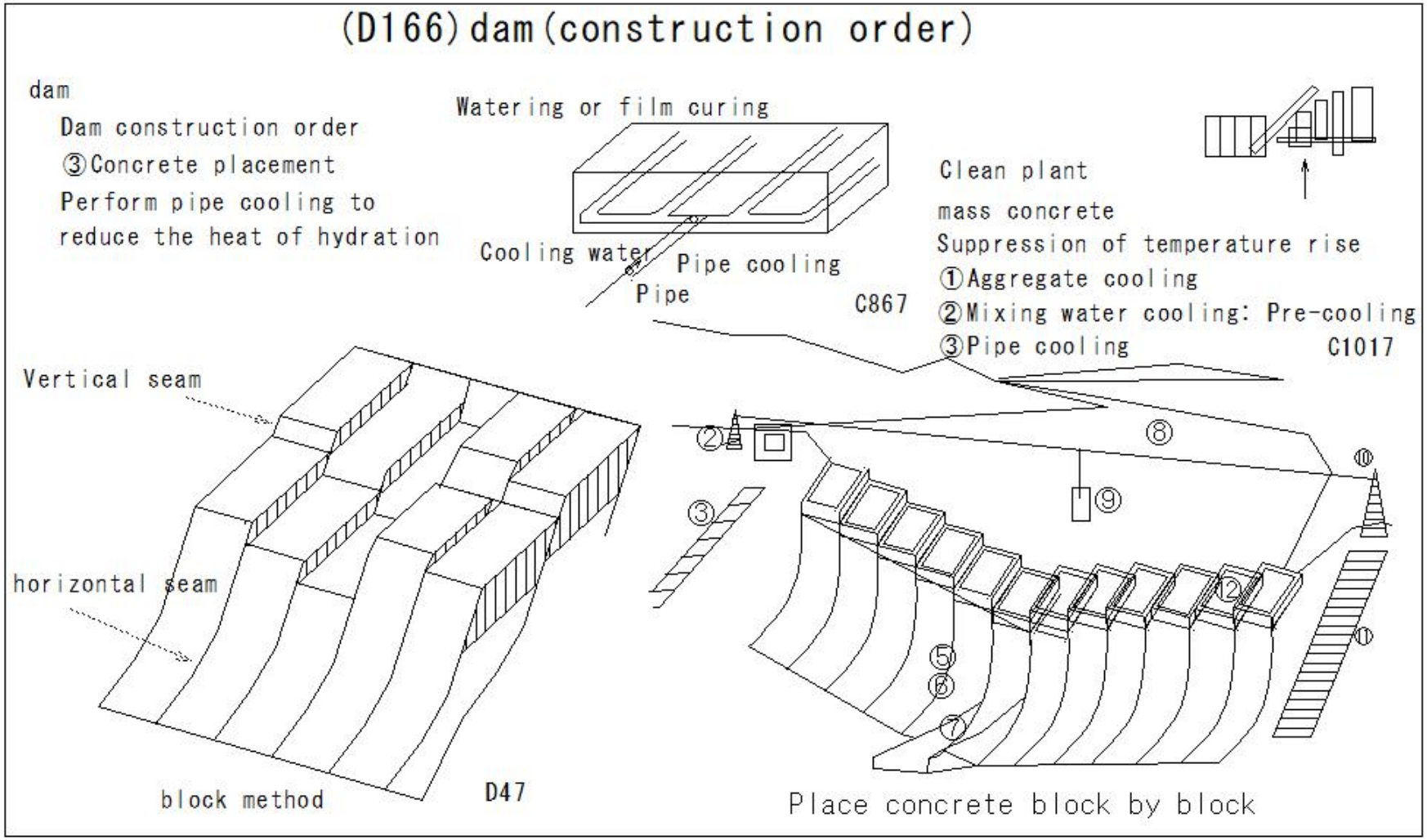
(D164)dam(construction order)



(D165)dam(construction order)



(D166)dam(construction order)



(D167)dam(construction order)

(D167)dam(construction order)

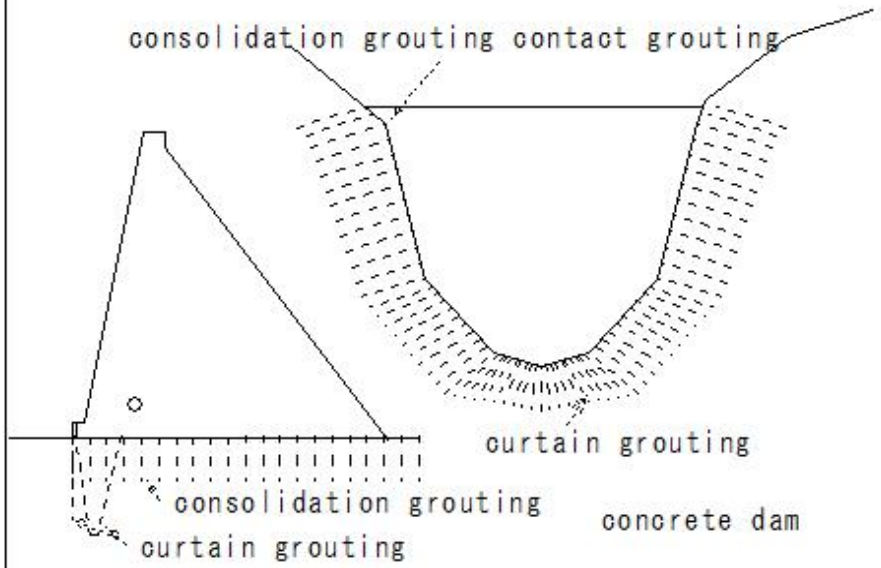
dam

Dam construction order

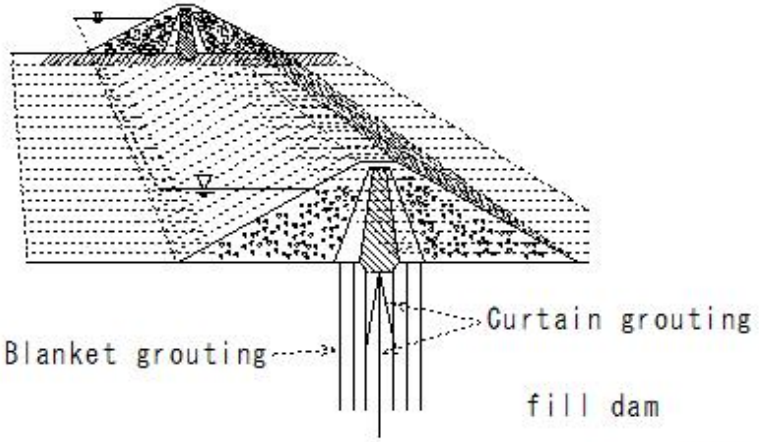
④Grouting

curtain grout

consolidation grout



D130



D138

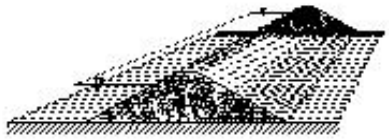
(D168)dam(fill dam)

(D168)dam(fill dam)

fill dam

fill dam

①Earth dam that evenly fills impermeable earth and sand

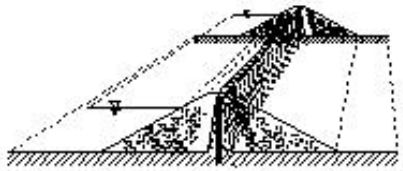


Uniform type

R591

Surface impermeable wall type

R592

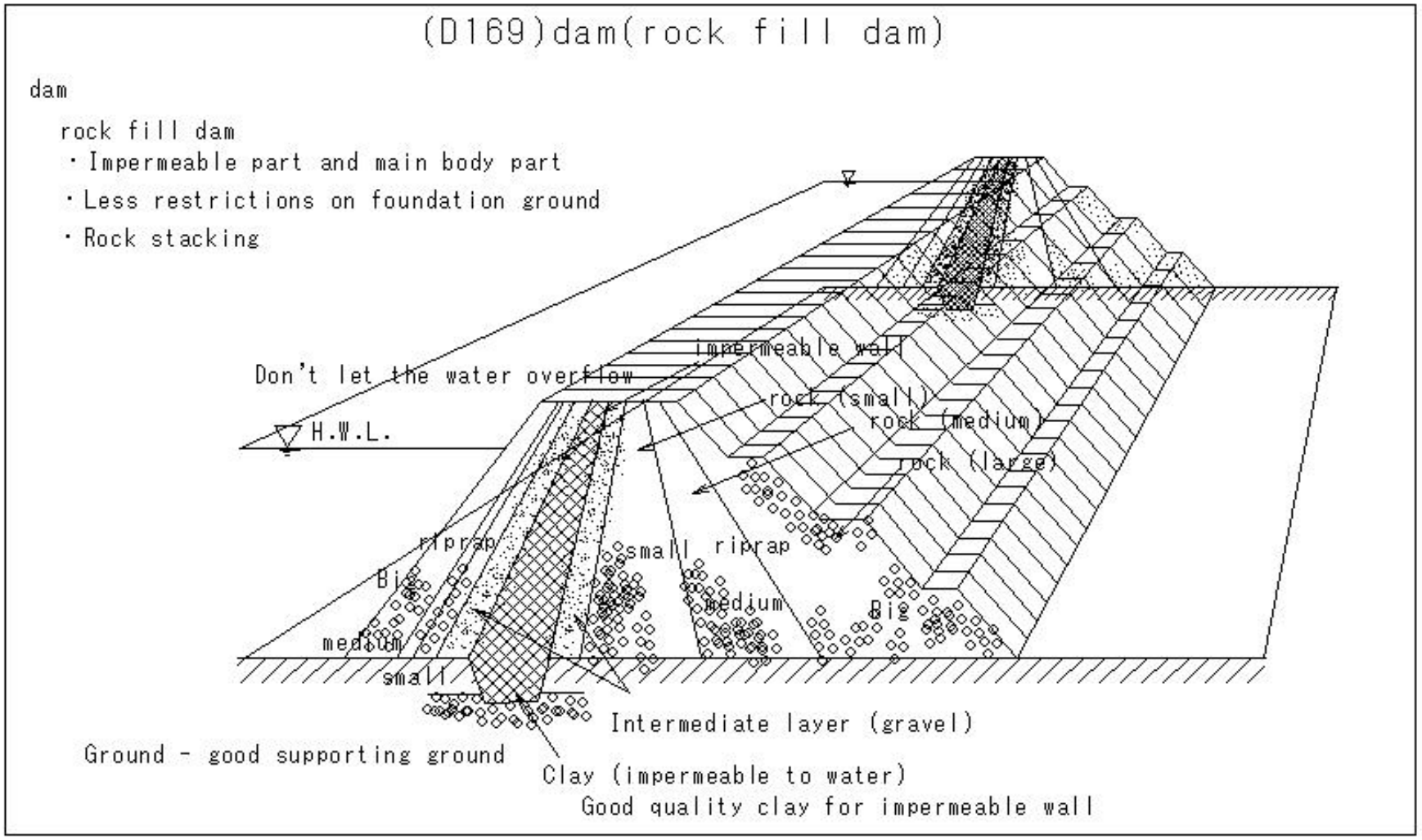


artificial material core

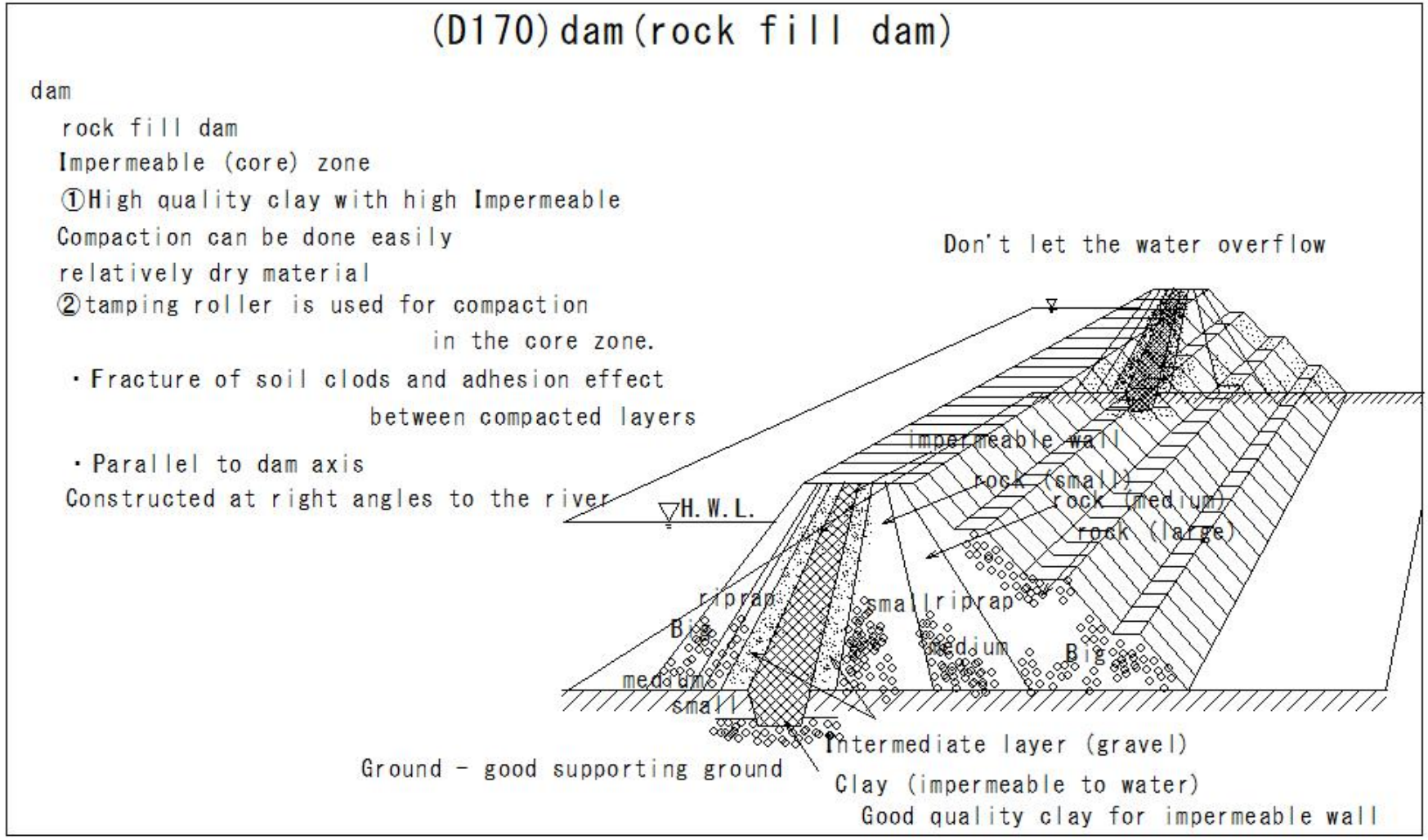
R593

D4

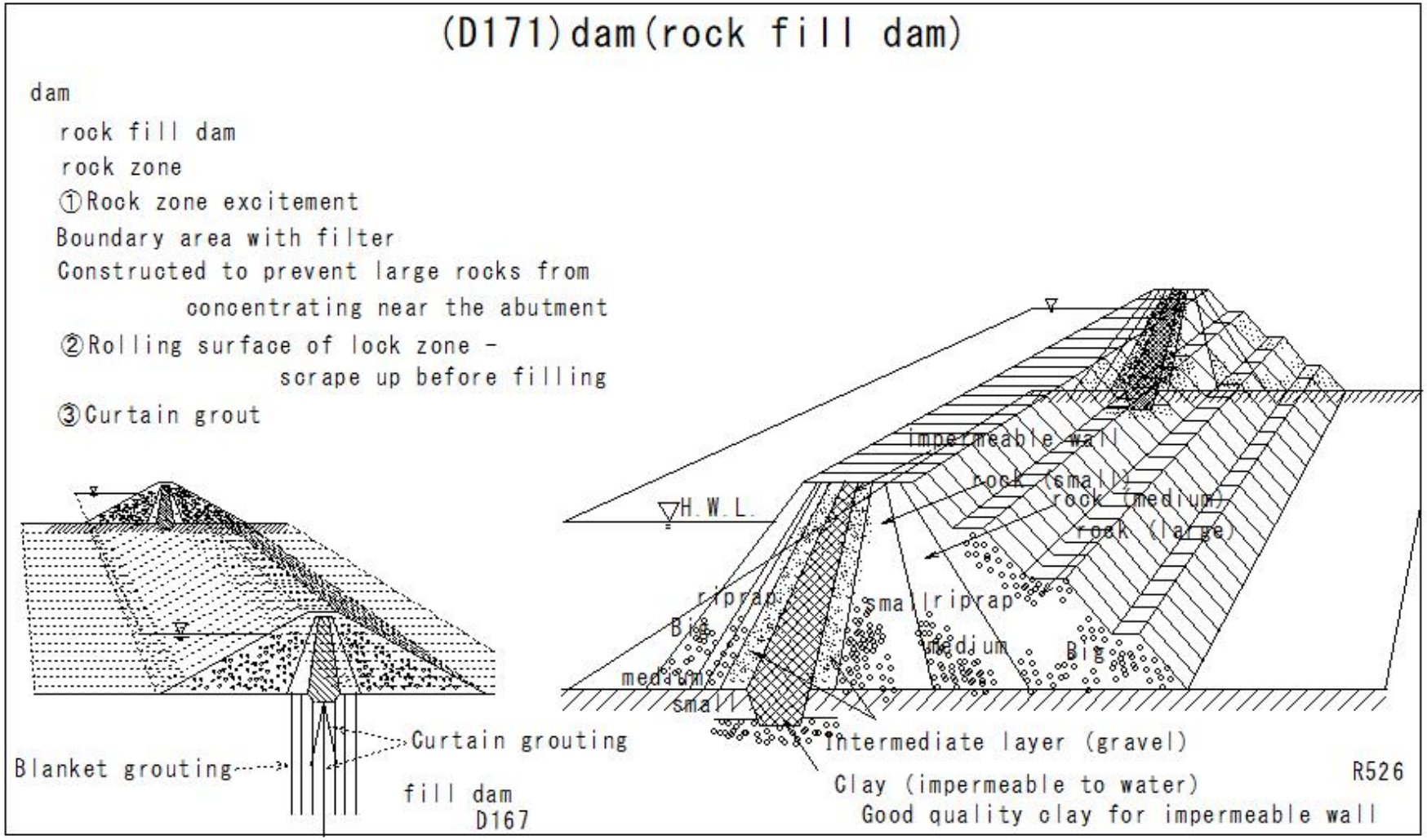
(D169)dam(rock fill dam)



(D170)dam(rock fill dam)



(D171)dam(rock fill dam)



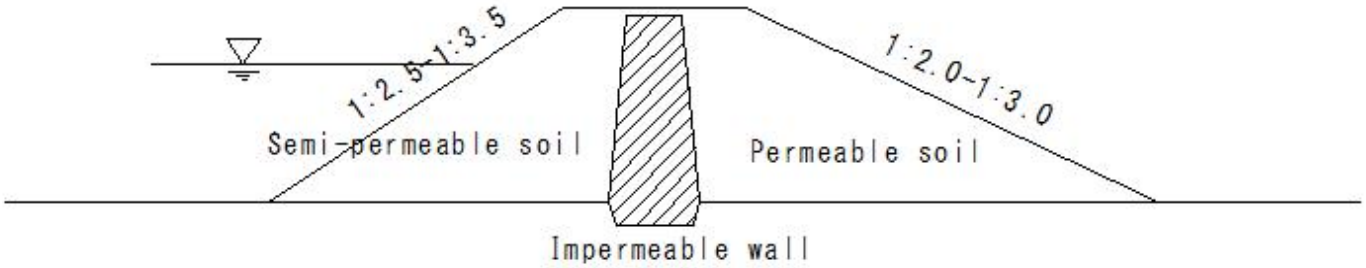
(D172)dam(earth dam)

(D172)dam(earth dam)

earth dam

Embankment body is soil

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



・Central impermeable wall type

・For imperviousness, carefully compact the sticky soil.

・Reinforced concrete using steel plates, etc.

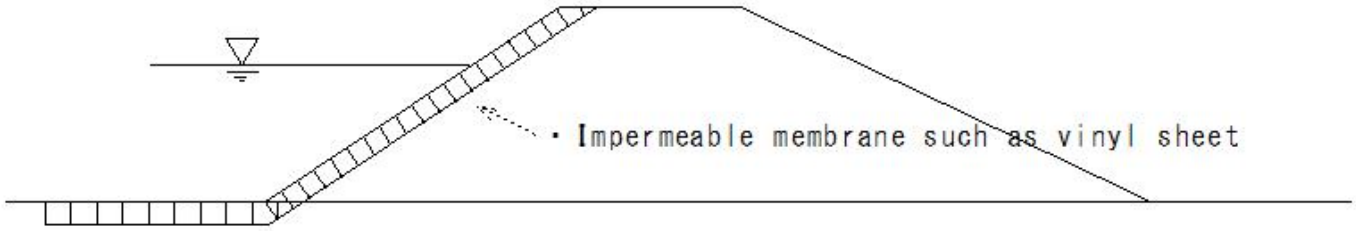
(D173)dam(earth dam)

(D173)dam(earth dam)

earth dam

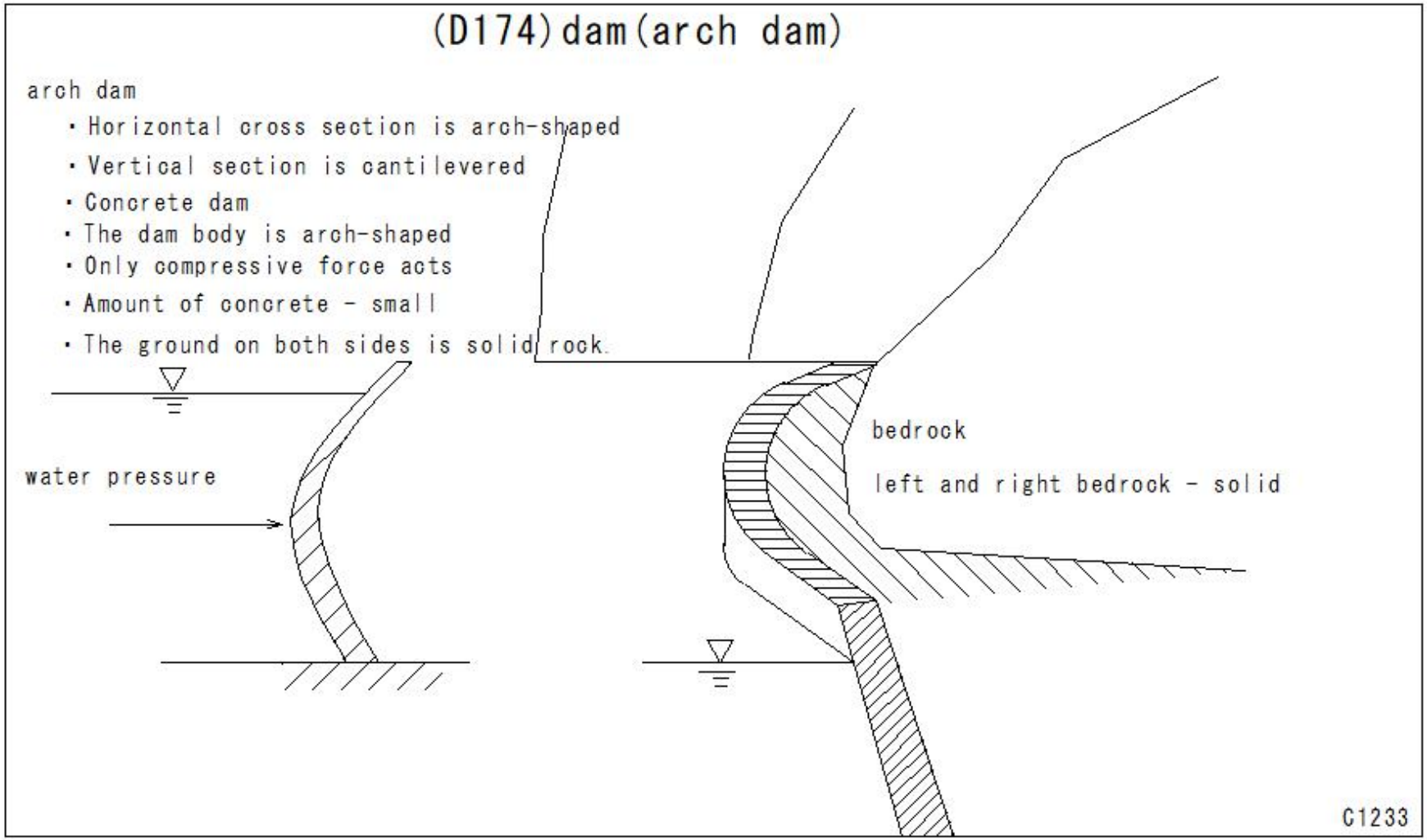
Embankment body is soil

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

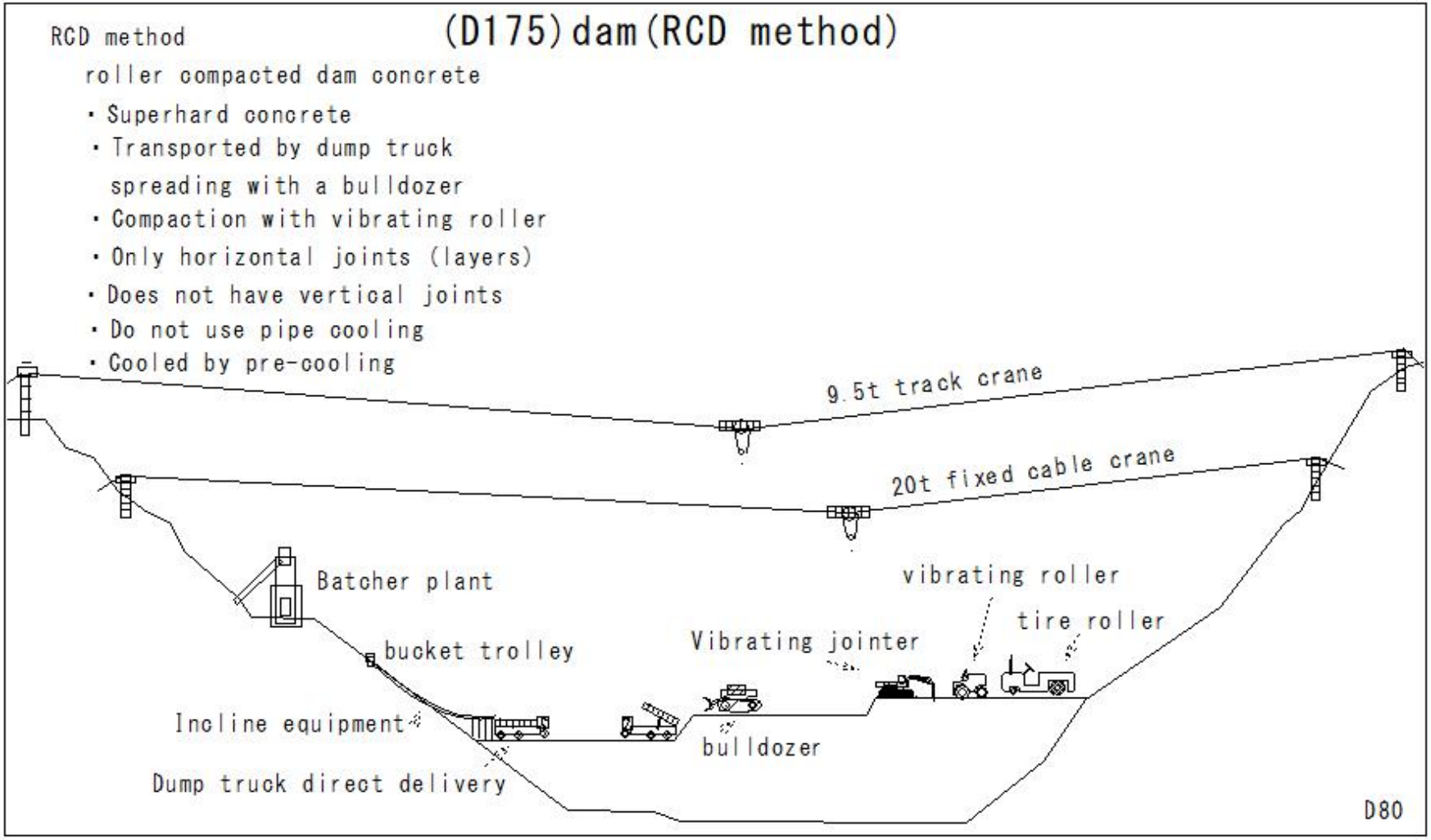


・Front impermeable wall type

(D174)dam(arch dam)



(D175)dam(RCD method)



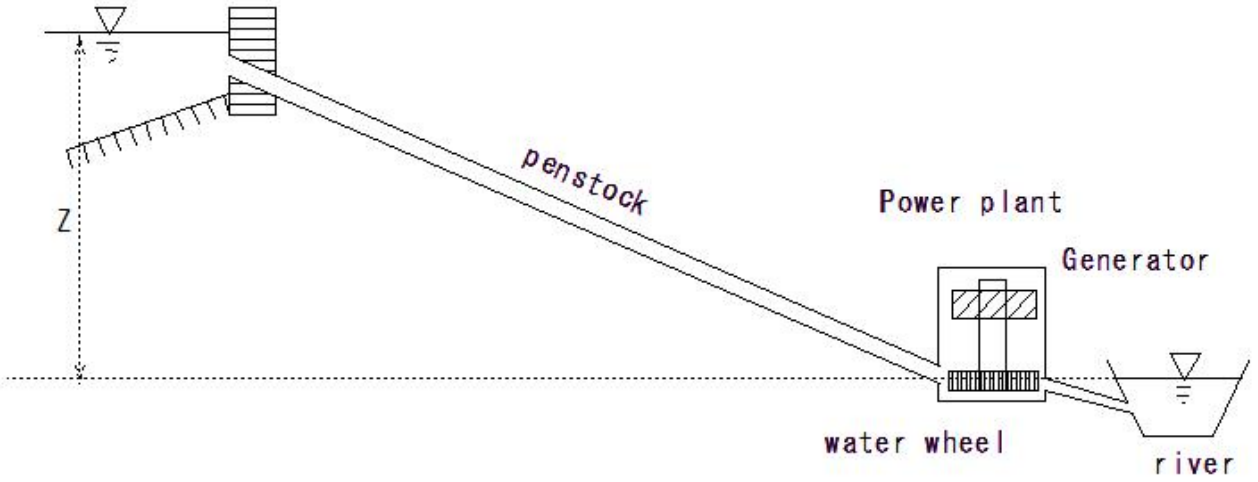
(D176)dam(potential head)

(D176)dam(potential head)

potential head

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

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



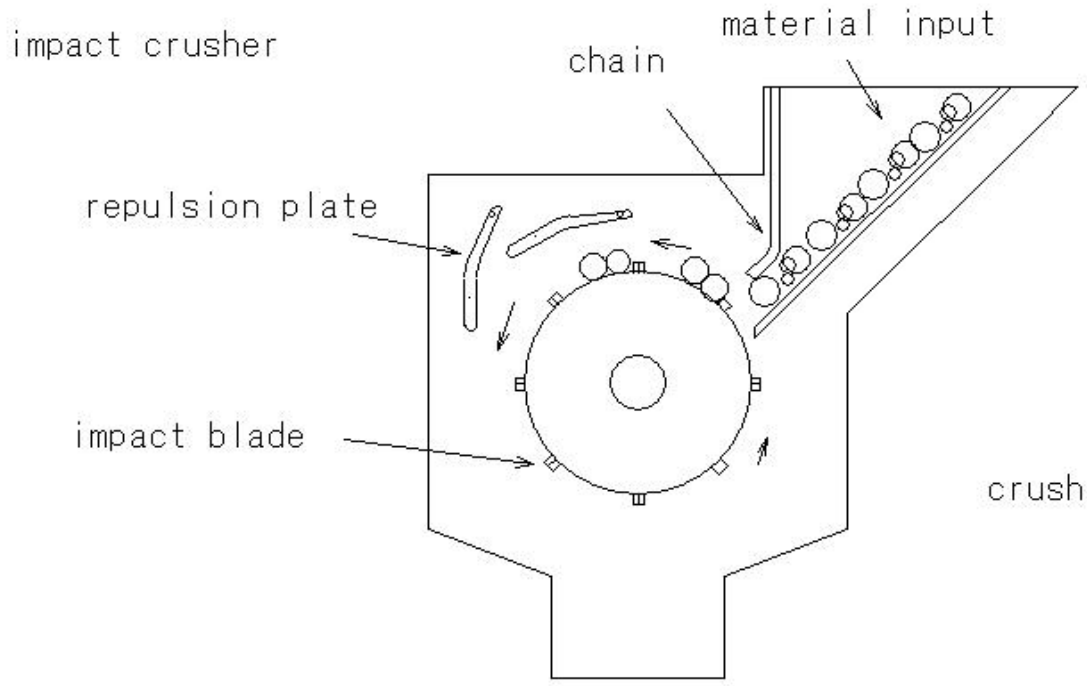
Z : (potential head) (m) Total head in hydropower generation

(D177)impact crusher

(D177) impact crusher

impact crusher

・Crush rocks at high speed by impact



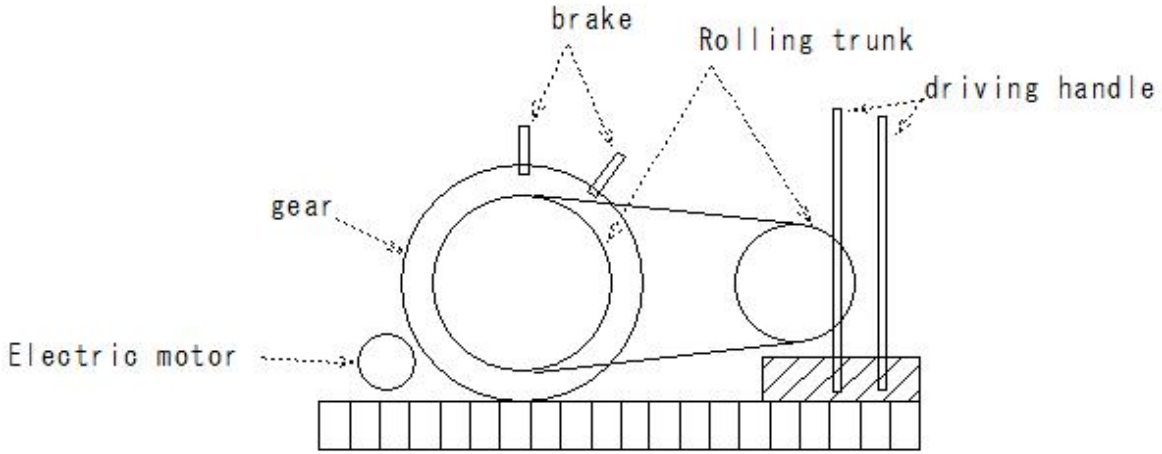
c1252

(D178)winch

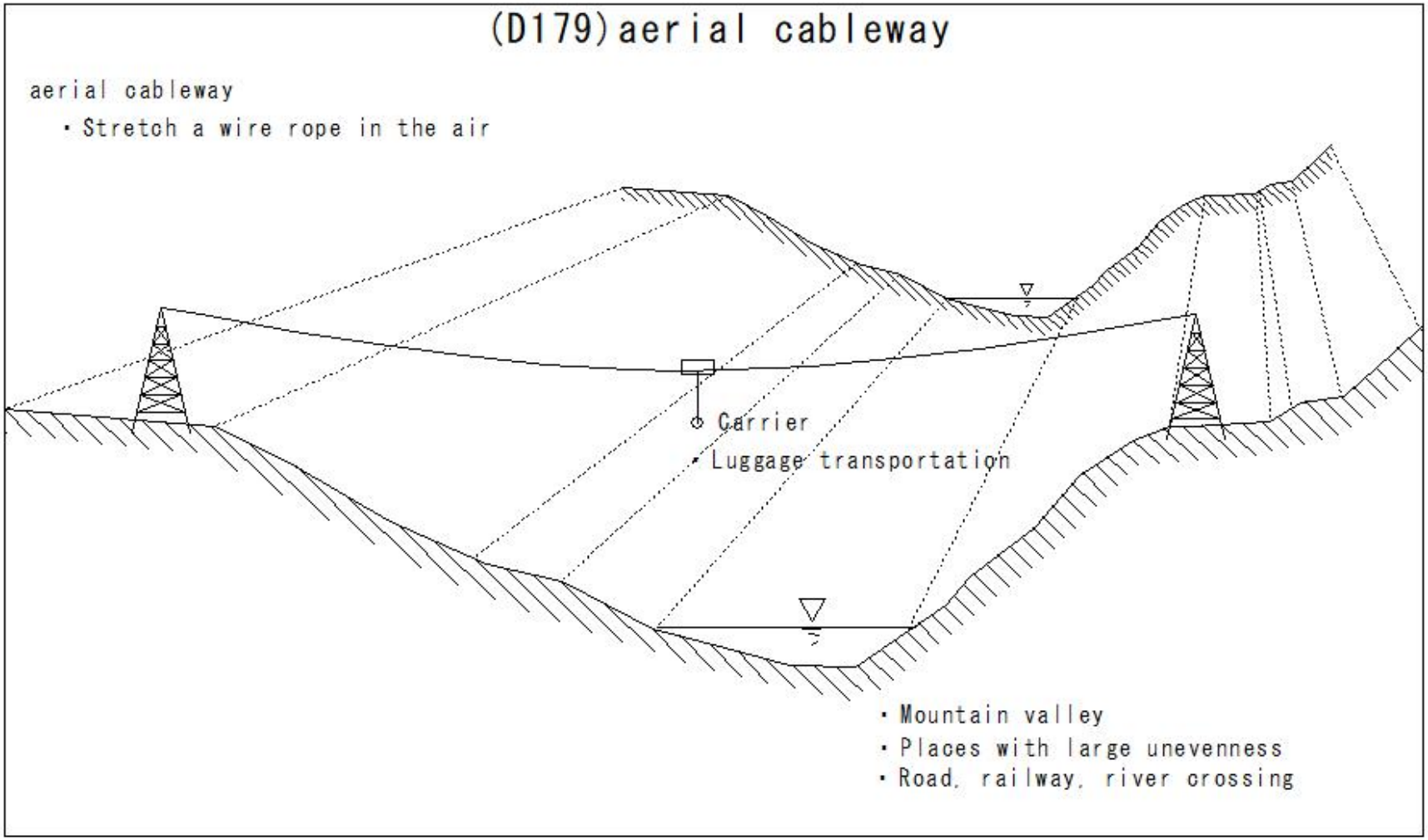
(D178)winch

winch

- Wire rope
- Lift up the load
- Pulling



(D179)aerial cableway



(D180)design flood discharge

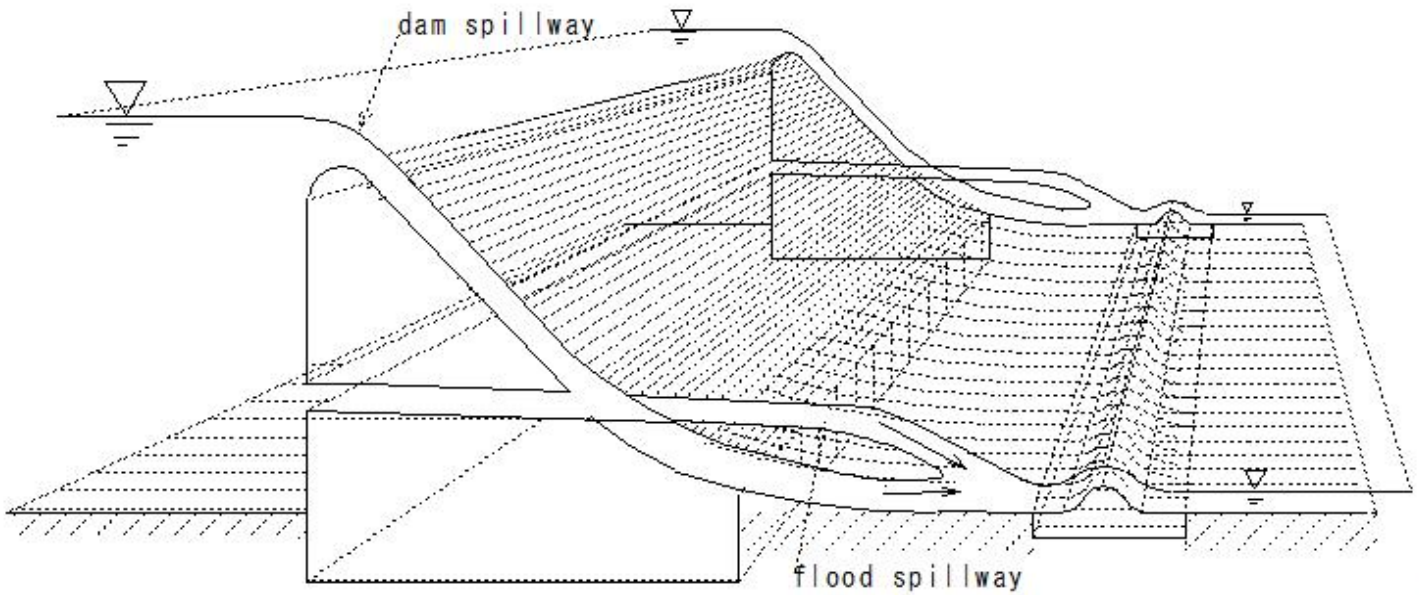
(D180)design flood discharge

design flood discharge

used in dam design

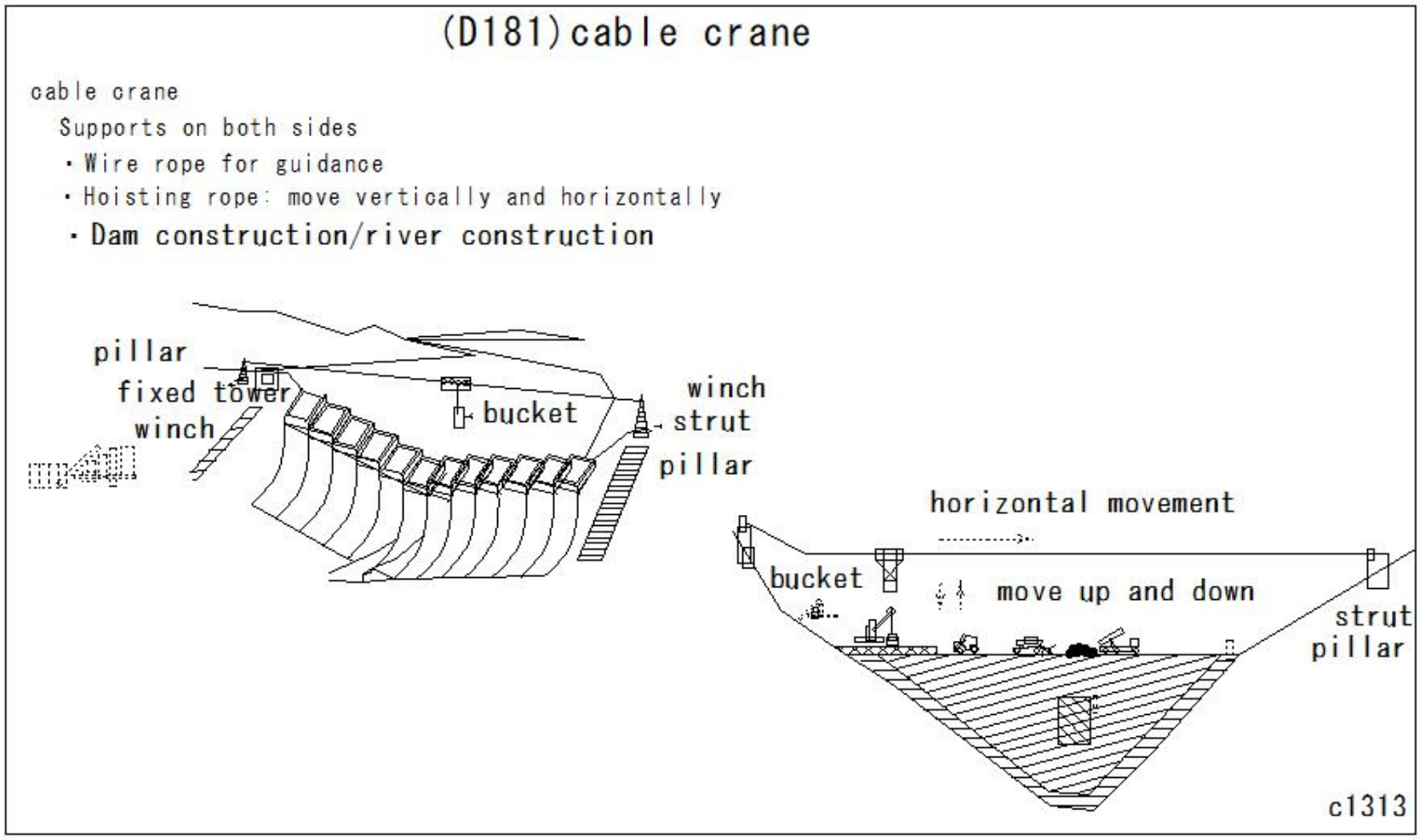
- Concrete dam probability: flood volume that occurs once in 100 years
- Flood dam probability: flood volume that occurs once every 200 years
- Dam spillway

Designed for safe flow　Designed to be safely swept away by a spillway



R352

(D181)cable crane

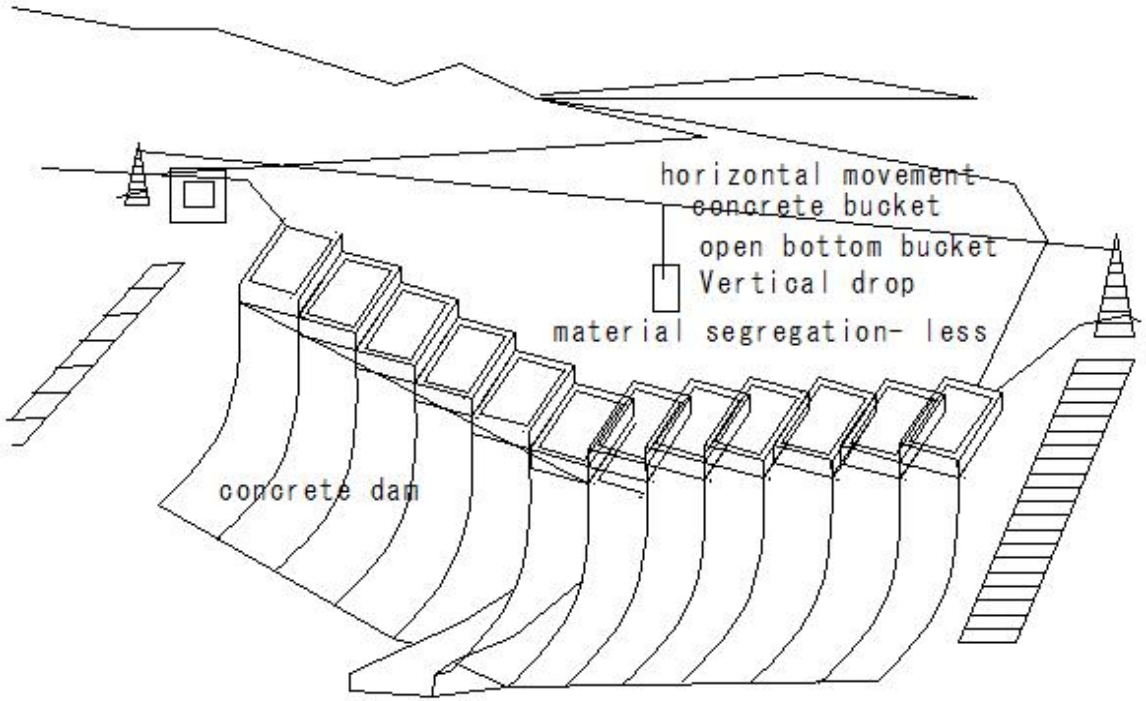


(D182)concrete bucket

(D182)concrete bucket

concrete bucket

- Transport the concrete to the pouring position while lifting it with a crane
- Dam construction: placing using a crane



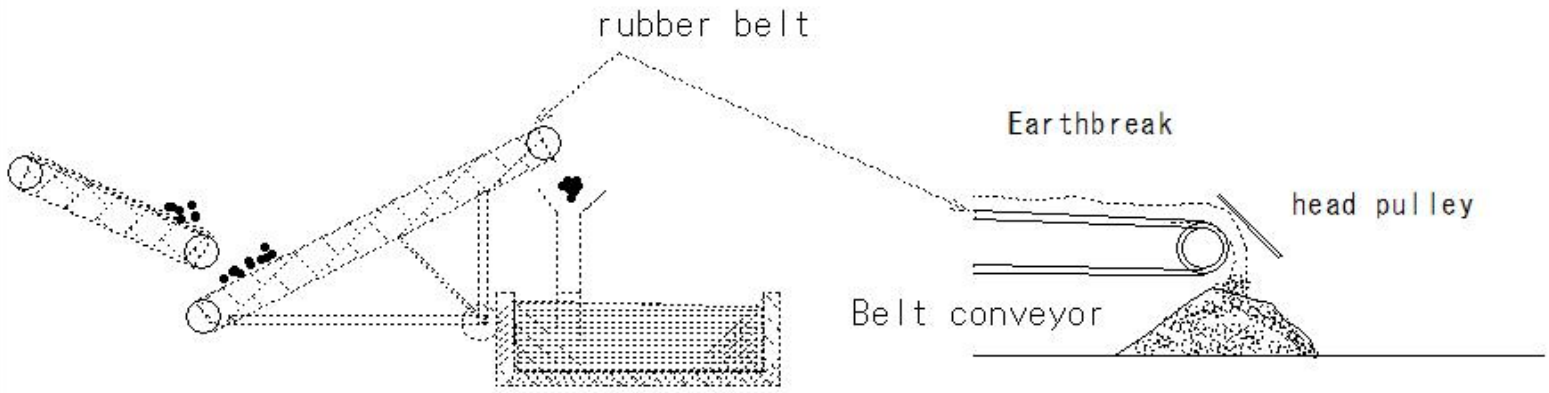
c1322

(D183)conveyor

(D183)conveyor

Conveyor

- From low to high places
- From high places to low places
- Materials Earth and sand, concrete, aggregate - Continuously transported belt conveyor



Continuous transport equipment

c1329

(D184)crusher

(D184)crusher

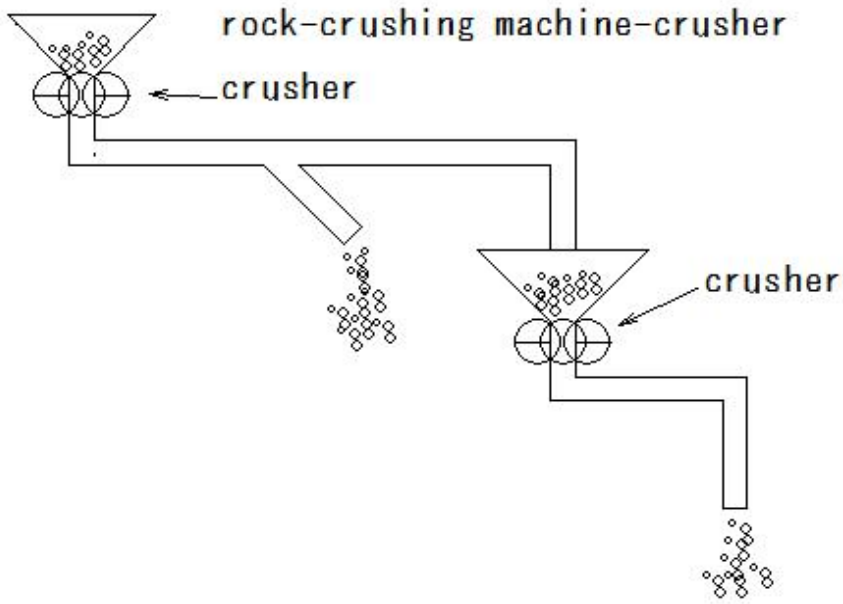
crusher

- A machine that crushes rocks into the required size: Crusher
- Large rough stone - coarse crusher - medium crusher - crusher

Crusher: Jaw crusher, gyratory crusher

Intermediate crusher: Cone crusher, impact crusher, hammer crusher, hydro cone crusher

Grinding machine: rod mill



c1330

(D185)surge-tank

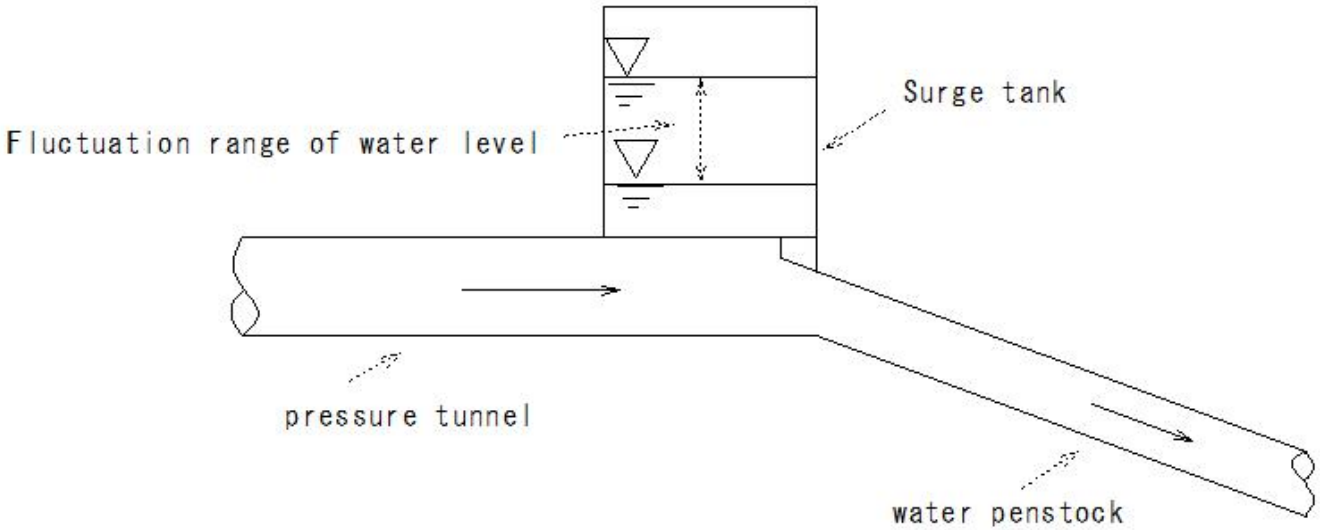
(D185)surge-tank

surge-tank

Dam waterway power plant

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

Fluctuation range of water level

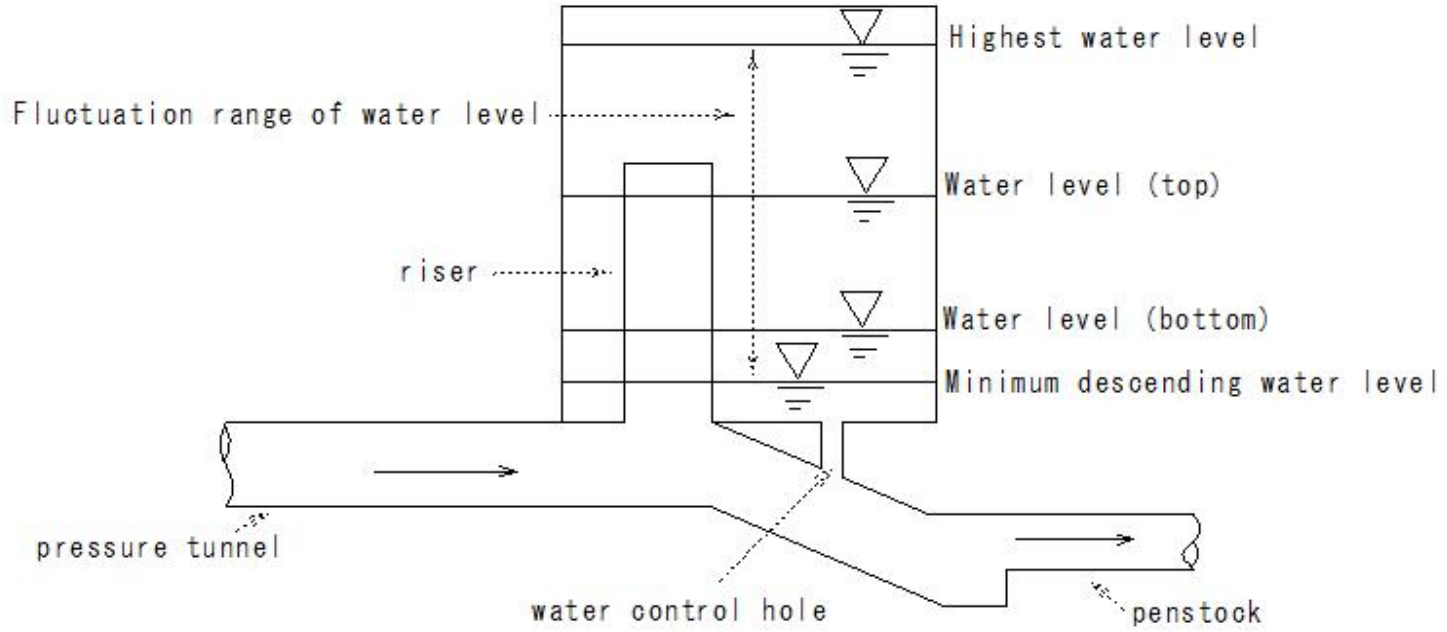


(D186) differential surge-tank

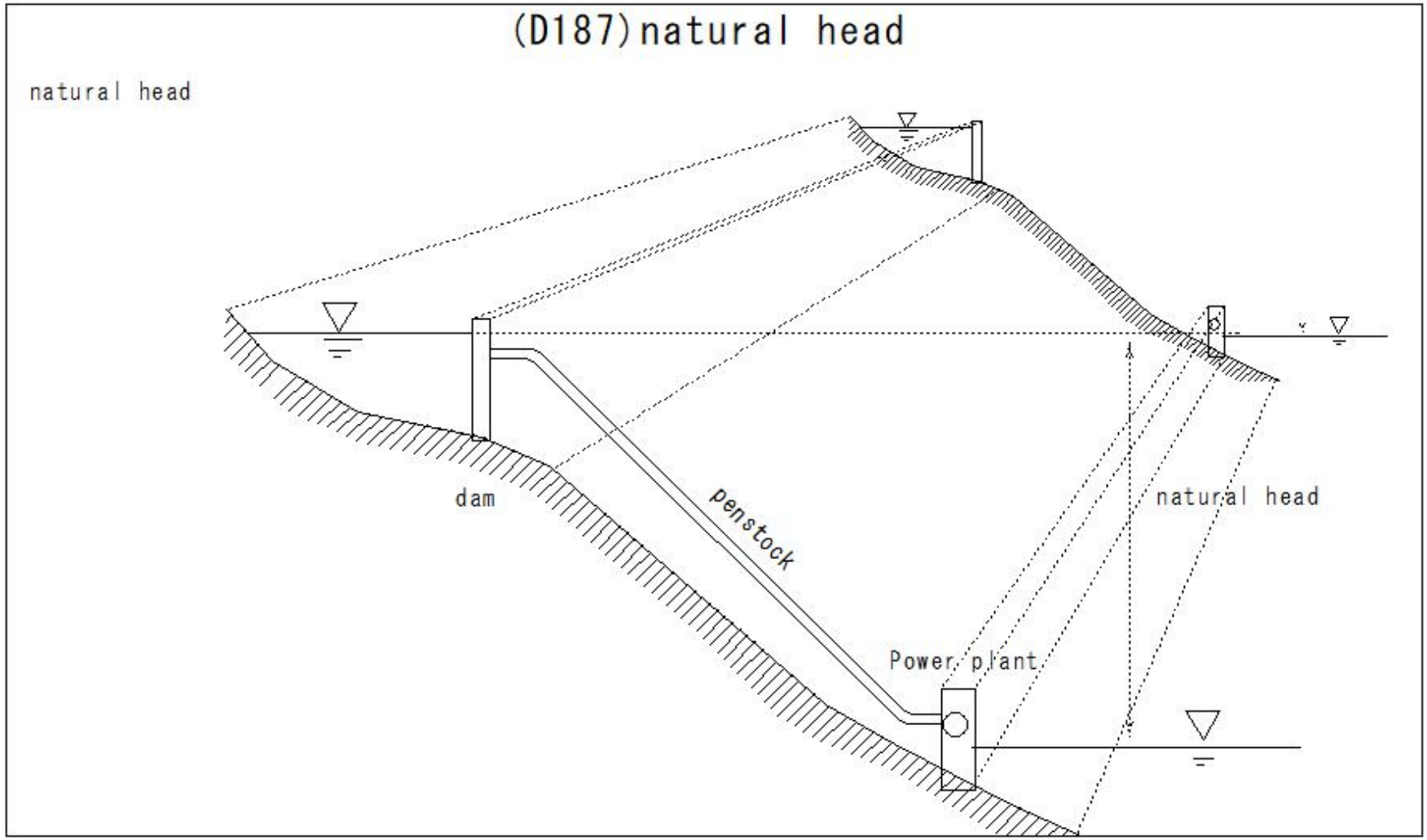
(D186) differential surge-tank

differential surge tank

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



(D187)natural head



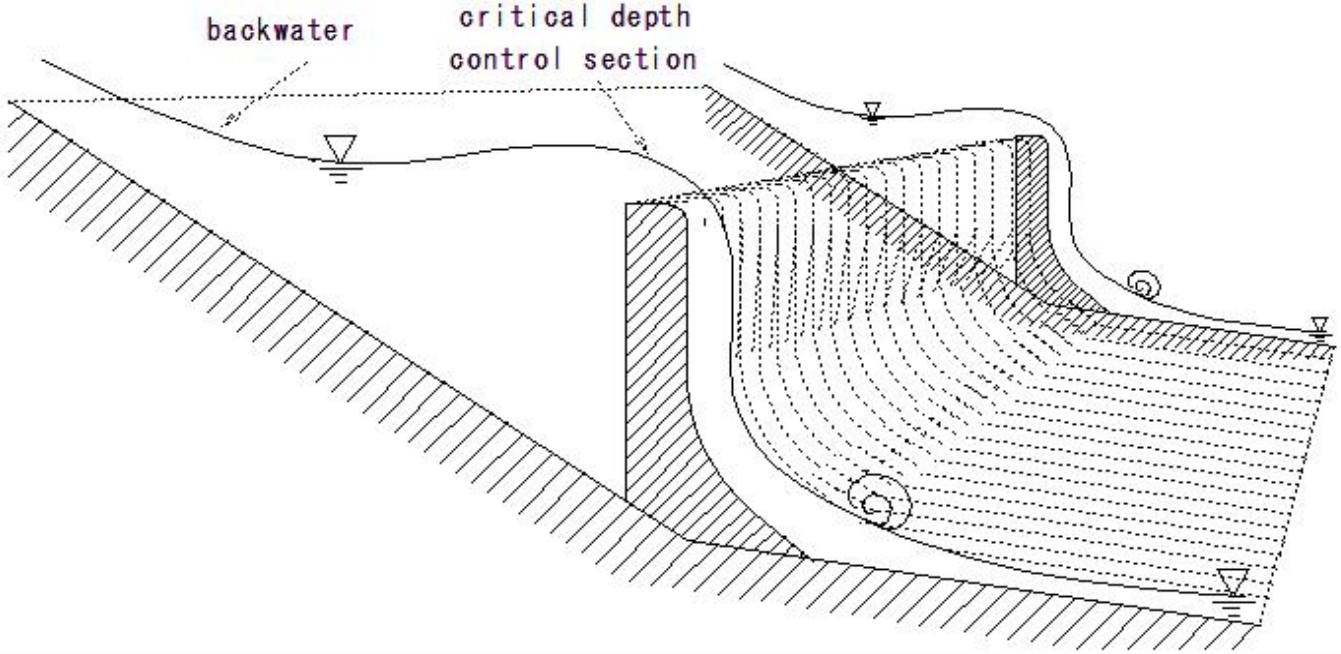
(D188)control section

(D188)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.



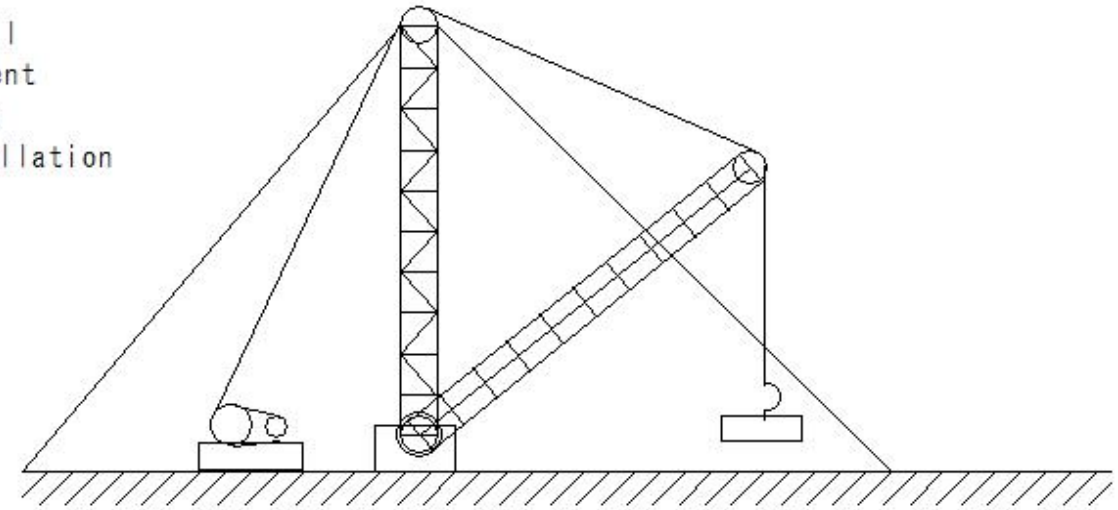
r360

(D189)jib crane

(D189) jib crane

jib crane

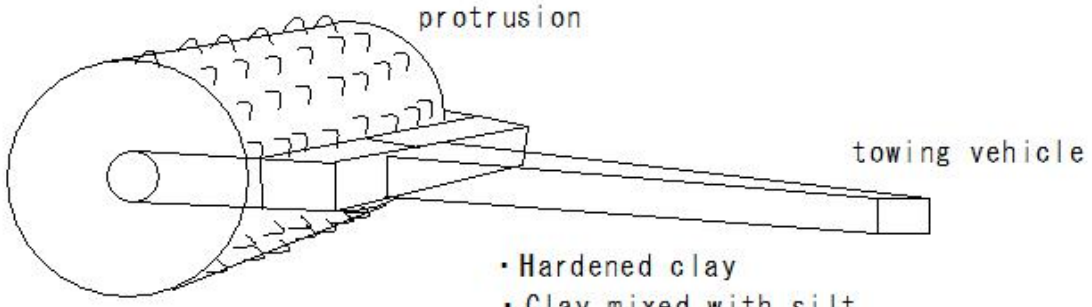
- Erection machinery
- Disassembly/assembly - Easy
- Handling - Easy
- Inexpensive
- Occupied area - small
- Dam concrete placement
- Bank protection work
- Concrete block installation



(D190)sheeps-foot roller

(D190)sheeps-foot roller

sheeps-foot roller
tamping roller
・Steel drum

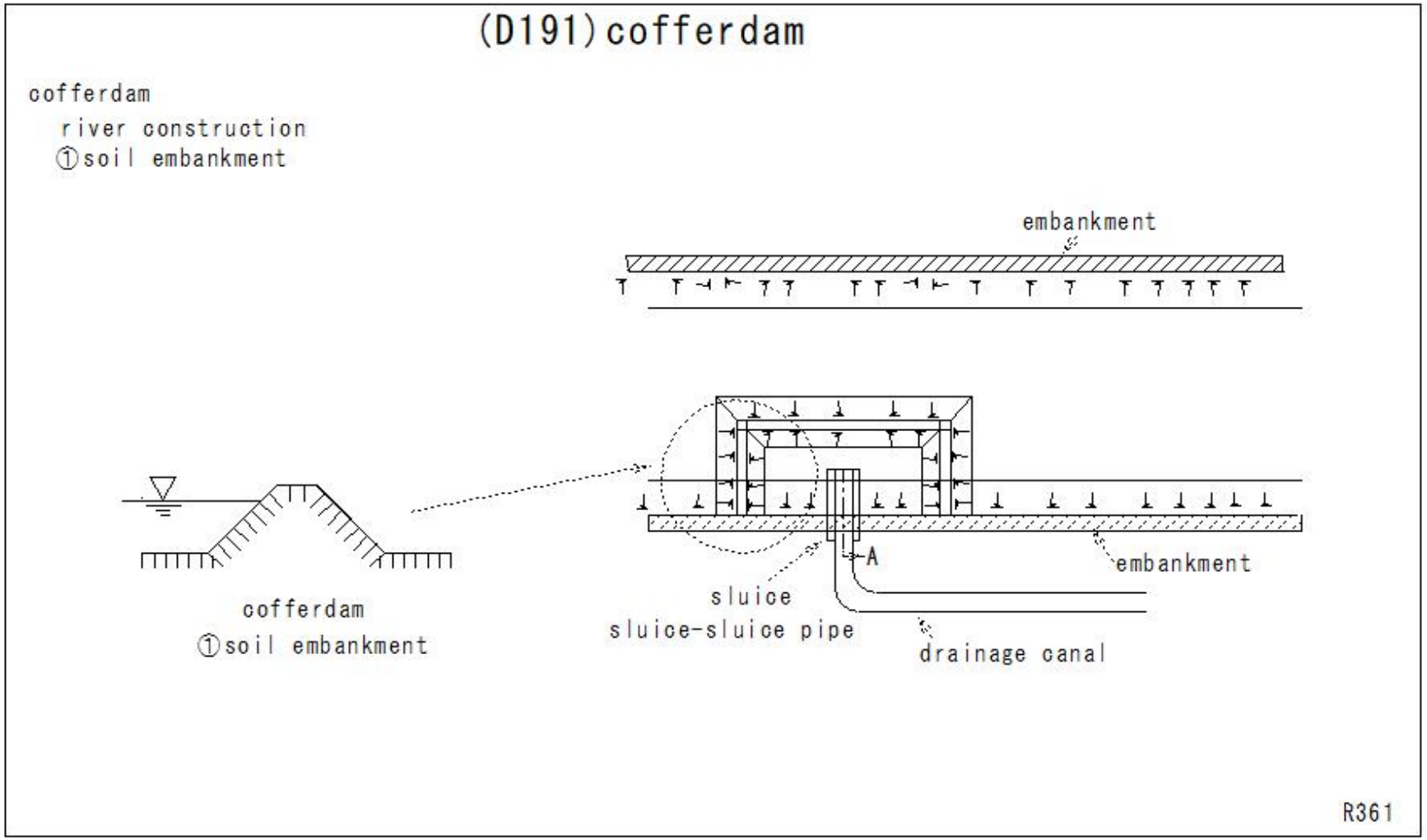


・Hardened clay
・Clay mixed with silt
・Compaction

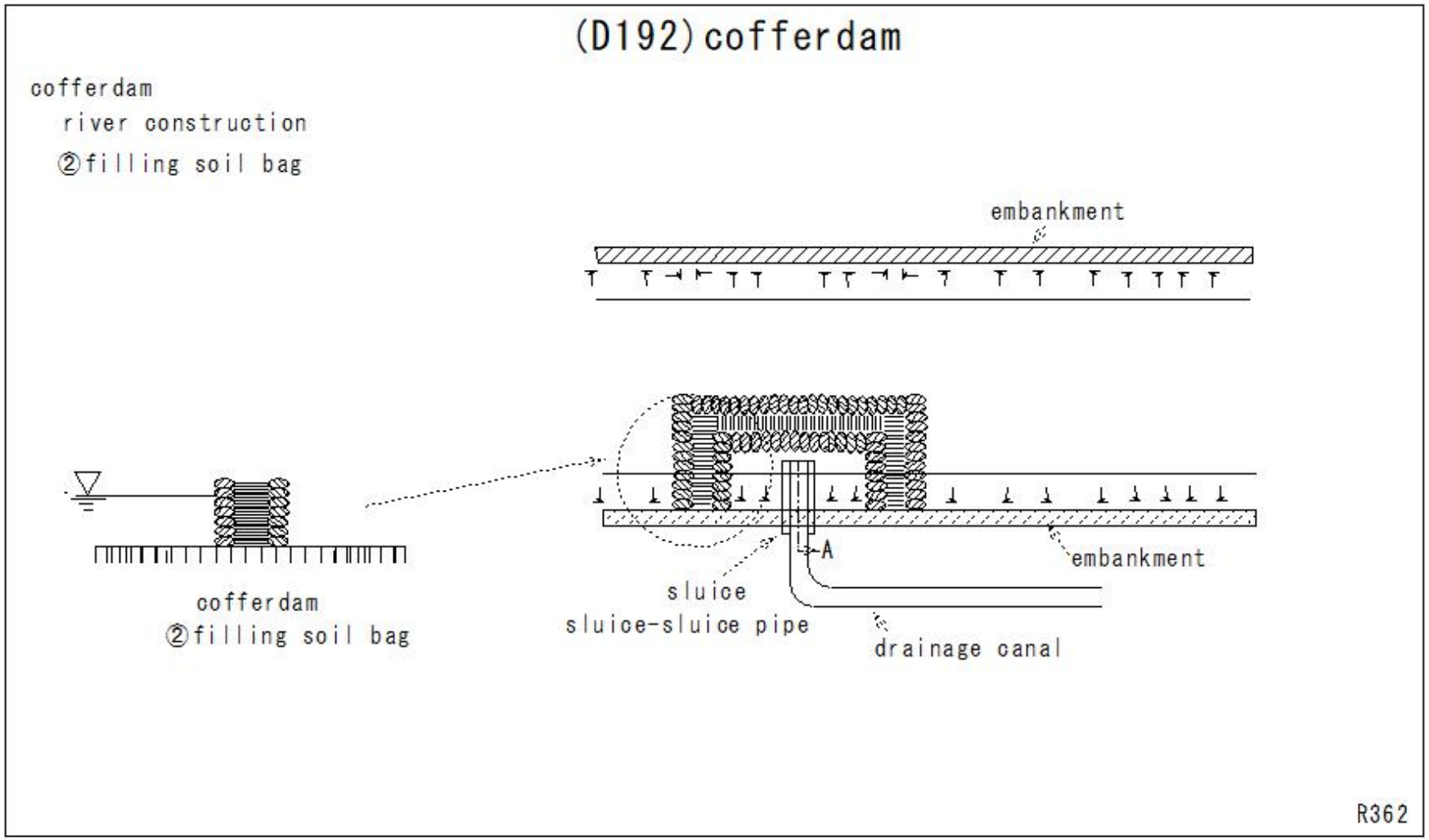
Tamping roller

e363

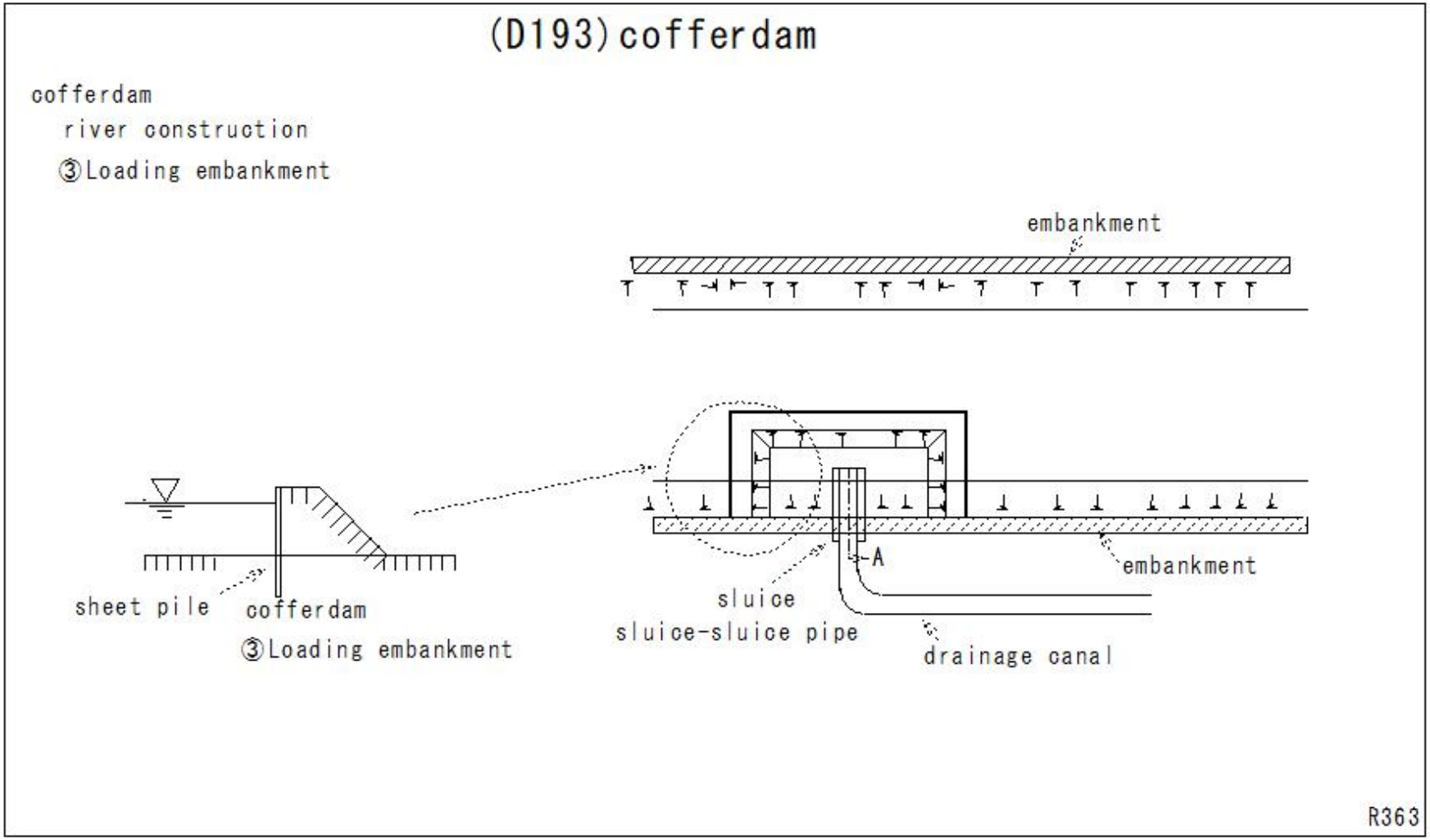
(D191)cofferdam



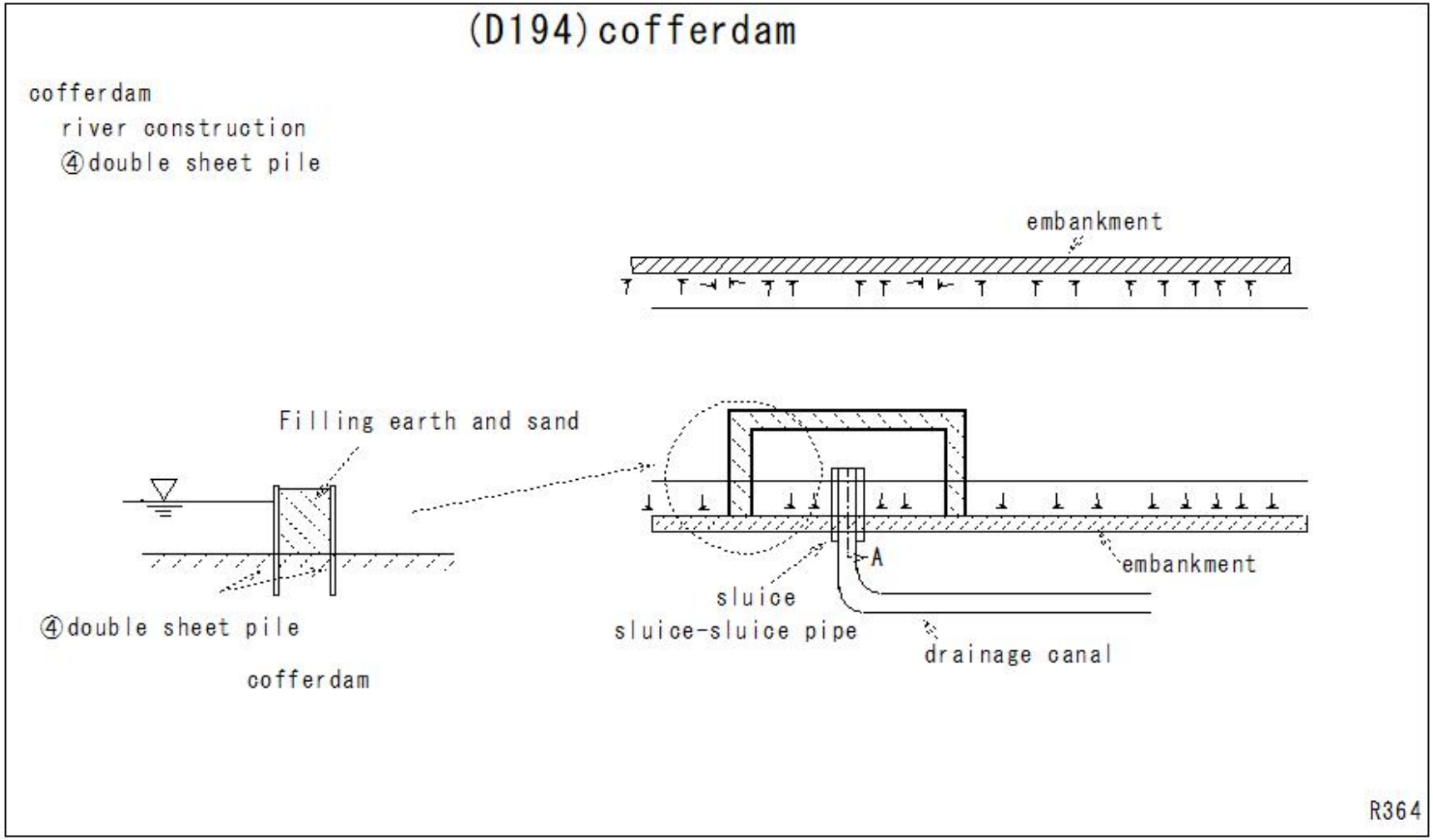
(D192)cofferdam



(D193)cofferdam



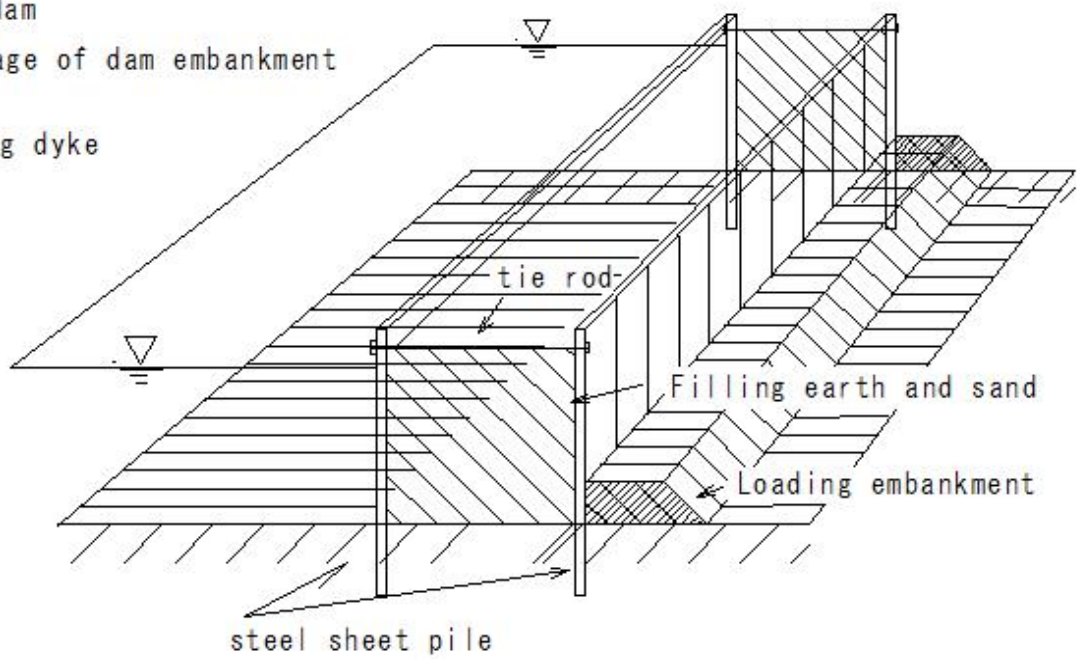
(D194)cofferdam



(D195)closing dyke

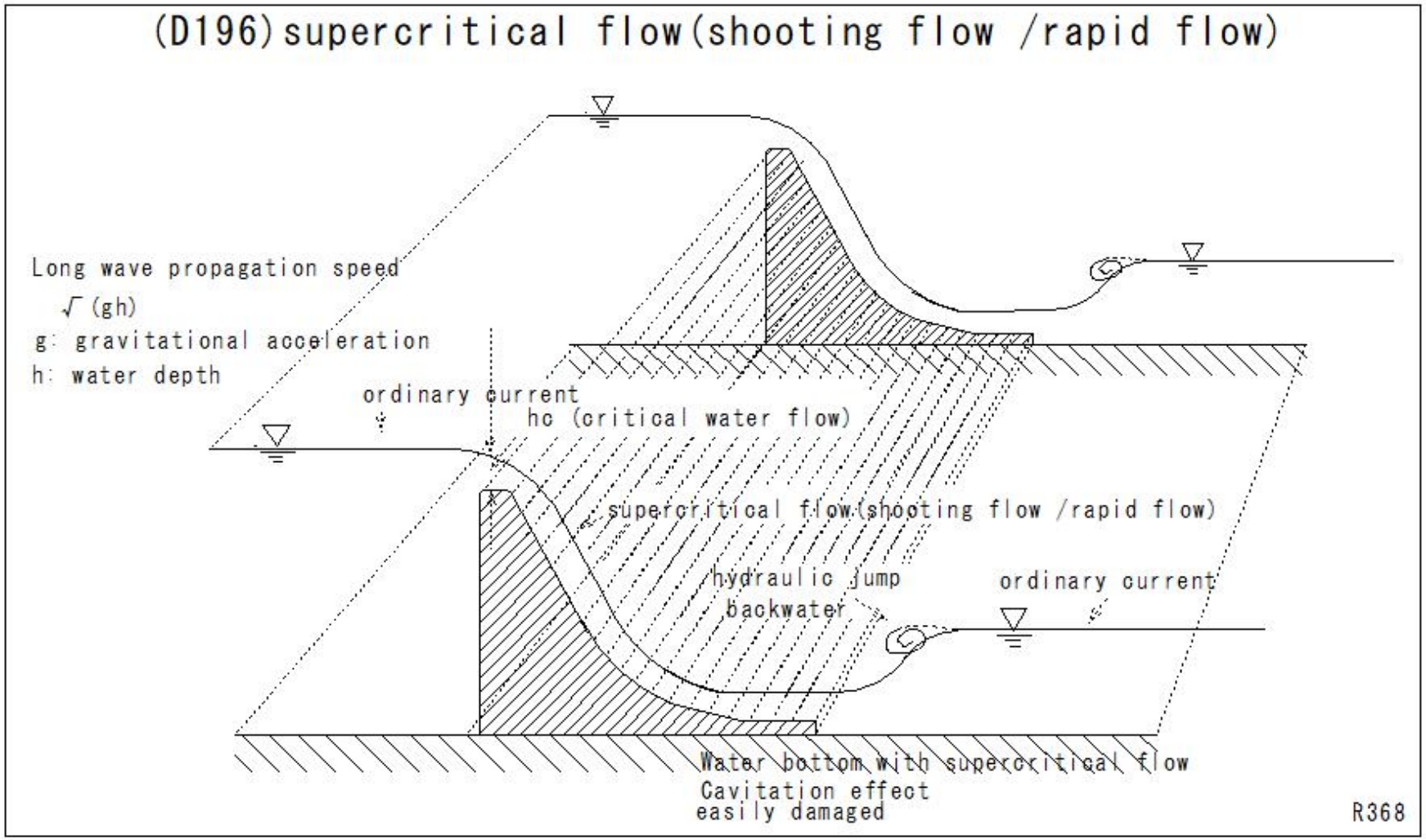
(D195)closing dyke

closing dyke
Changing the waterway
Tributary river cofferdam
Purpose of water stoppage of dam embankment
river cross section
Steel sheet pile closing dyke

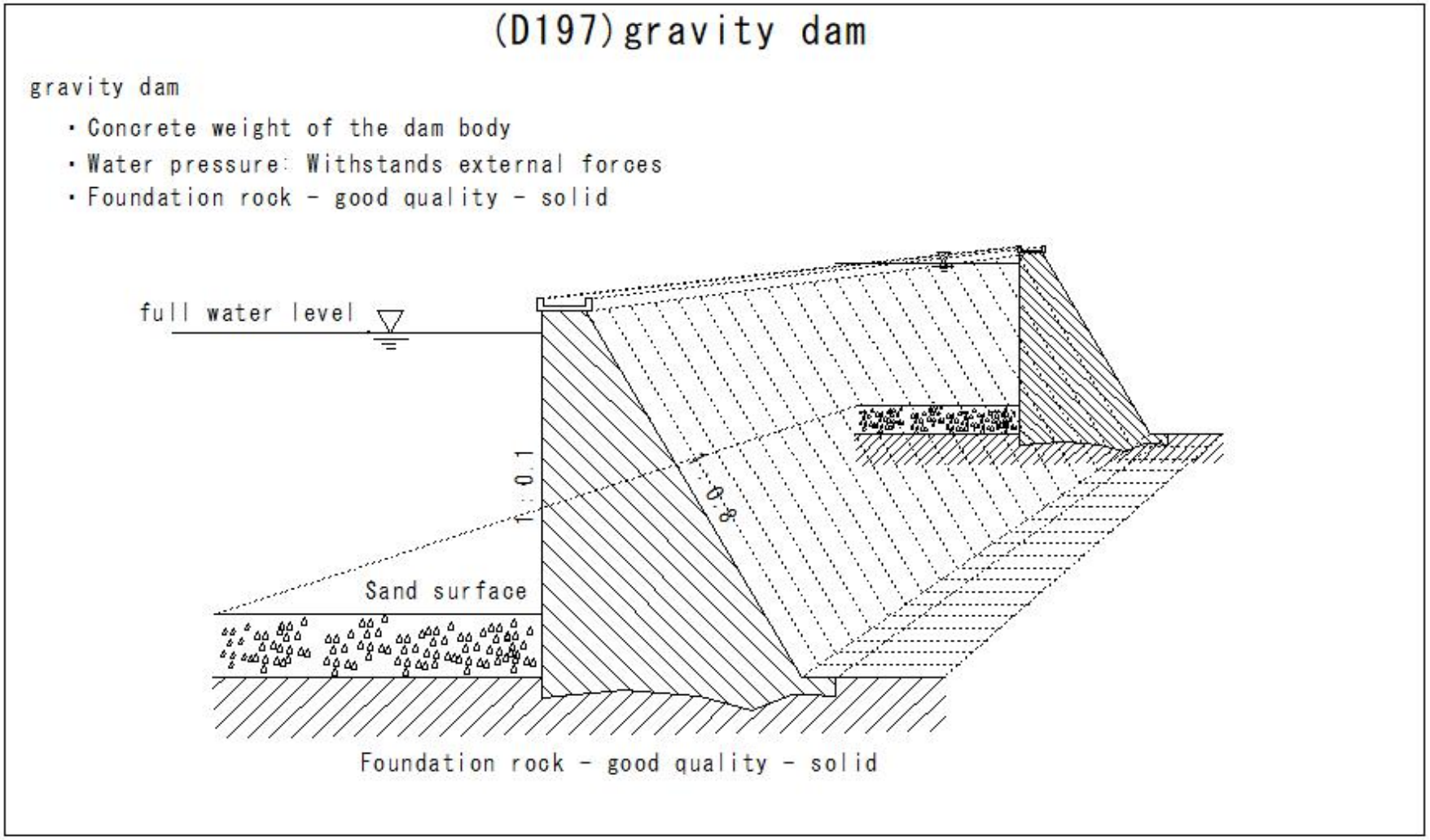


R365

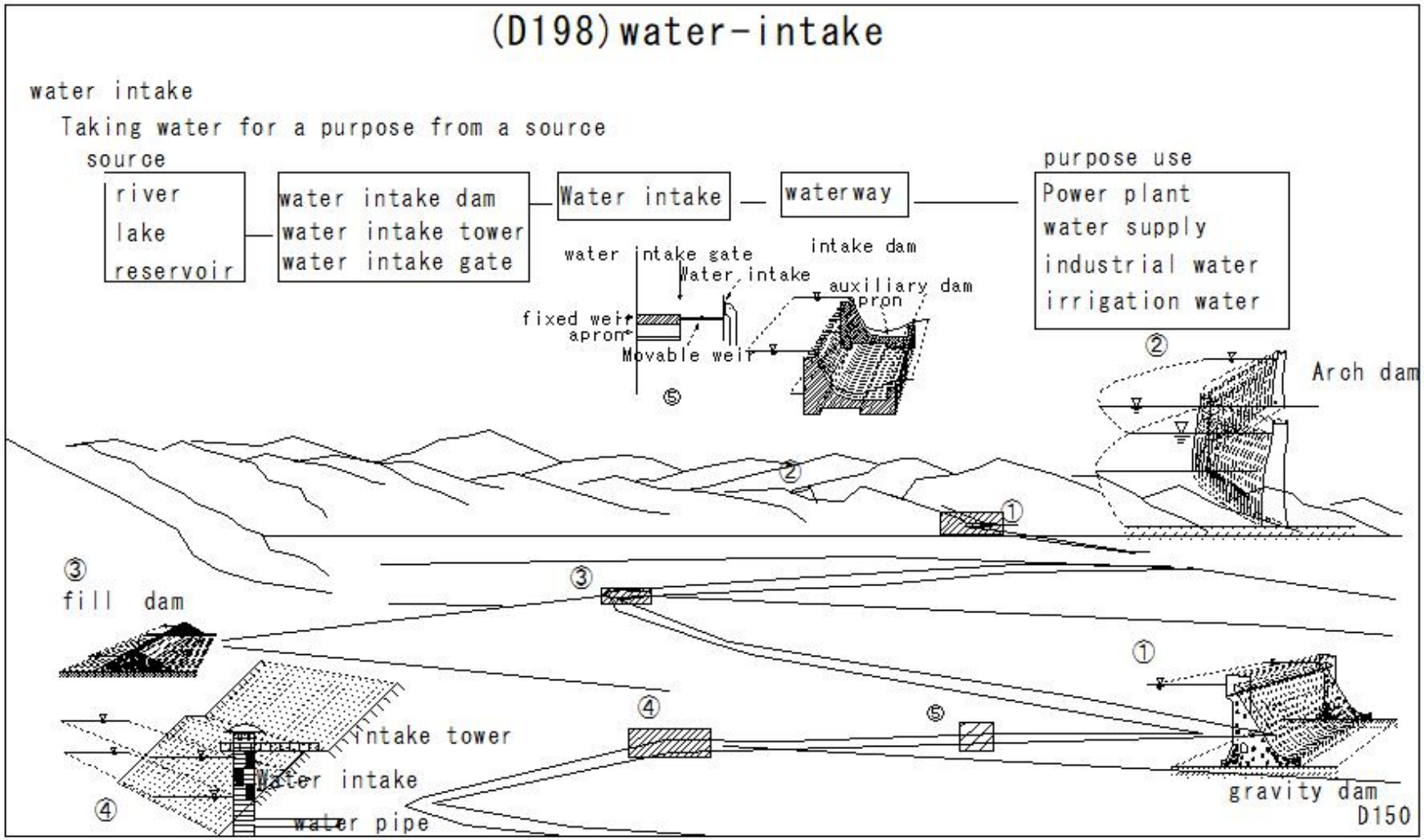
(D196)supercritical flow(shooting flow /rapid flow)



(D197)gravity dam



(D198)water-intake

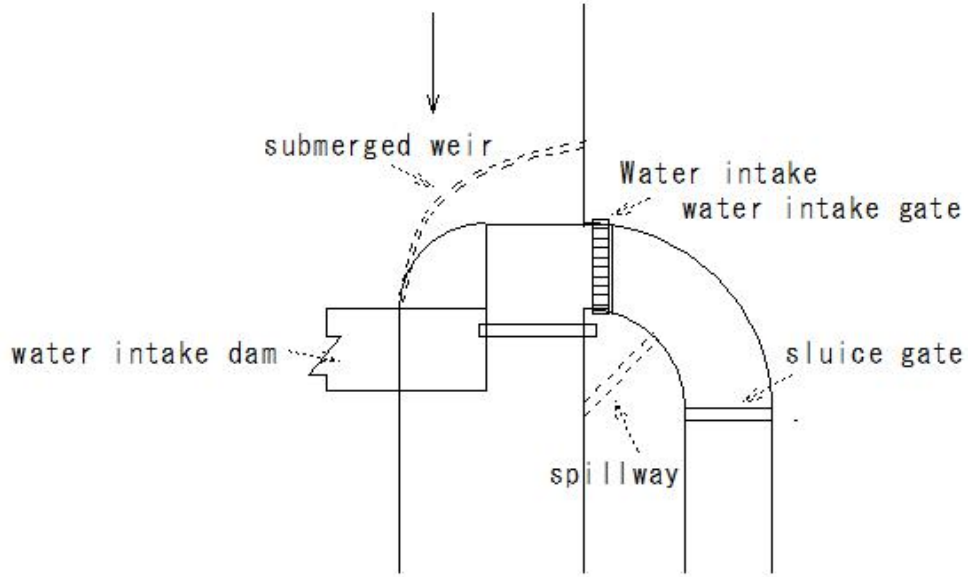


(D199)intake

(D199)intake

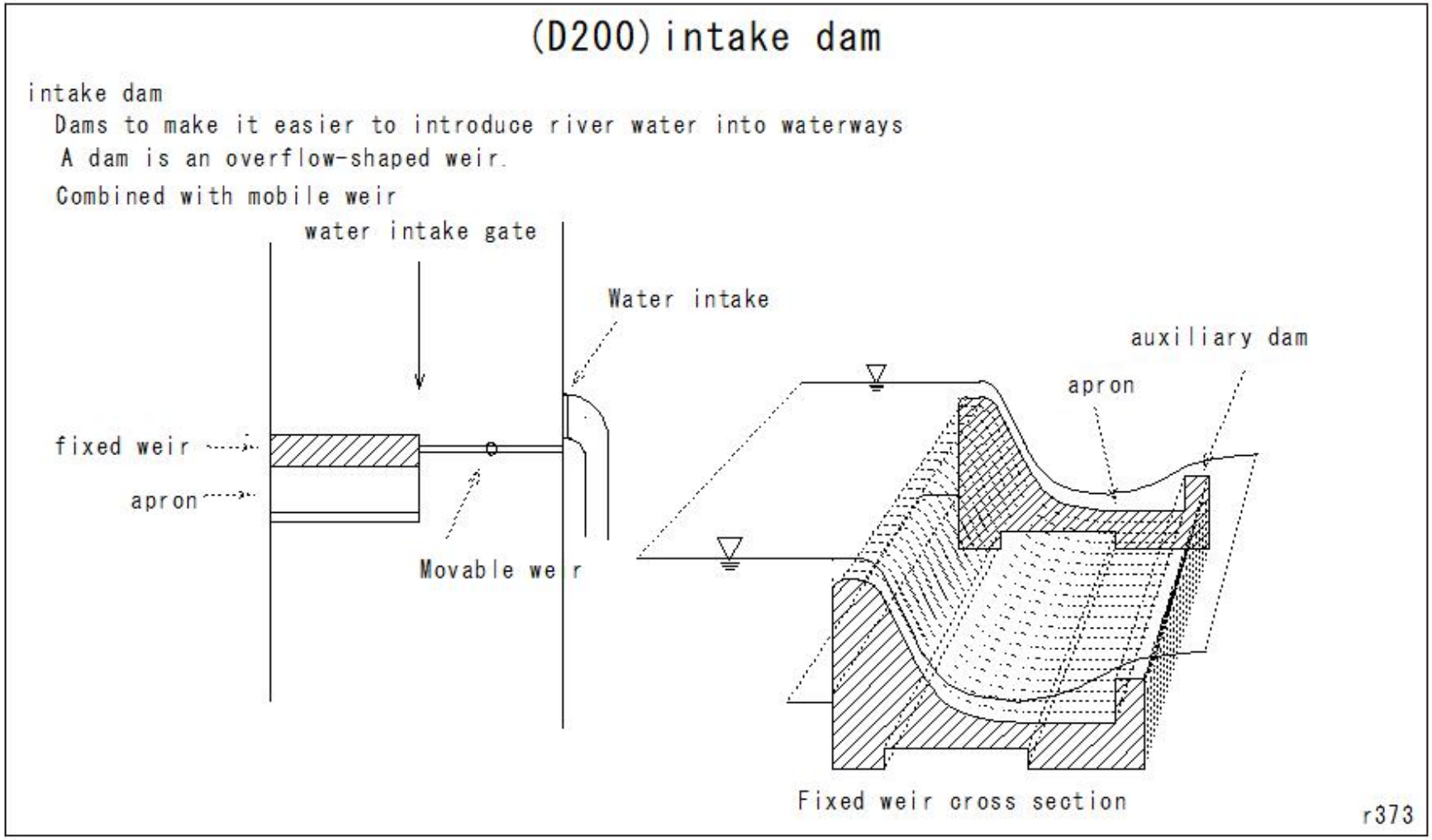
intake

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



r372

(D200)intake dam



(D201)intake dam

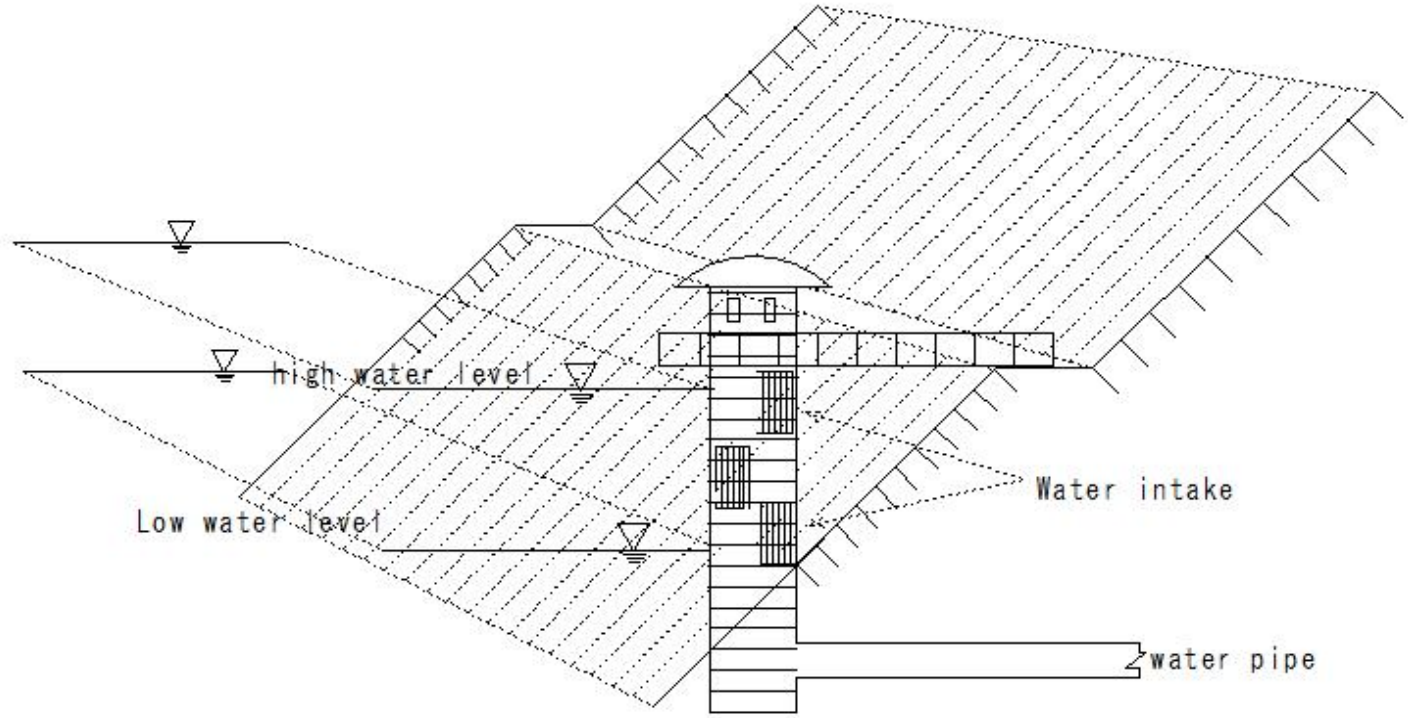
(D201) intake dam

intake tower

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

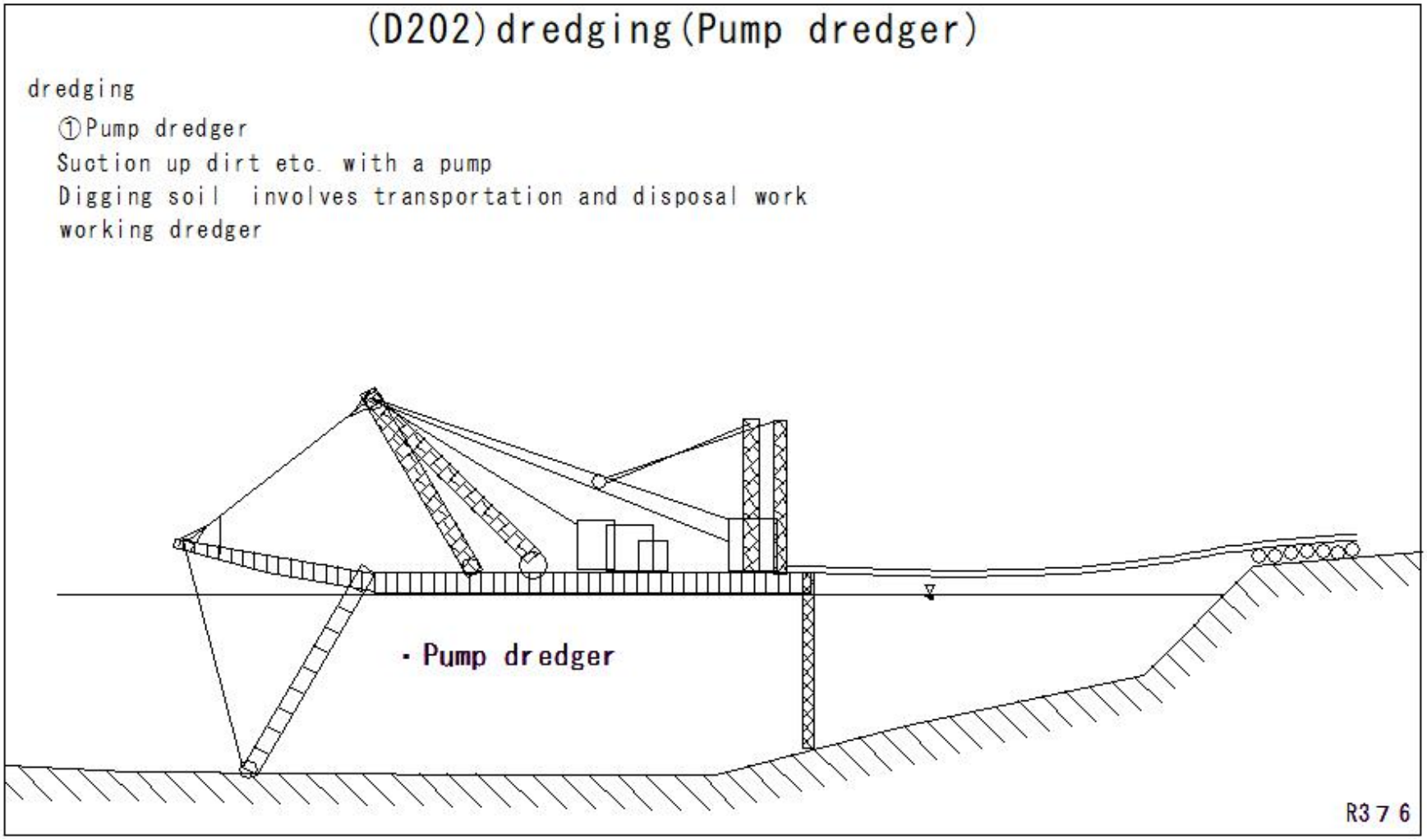
A tower built underwater

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

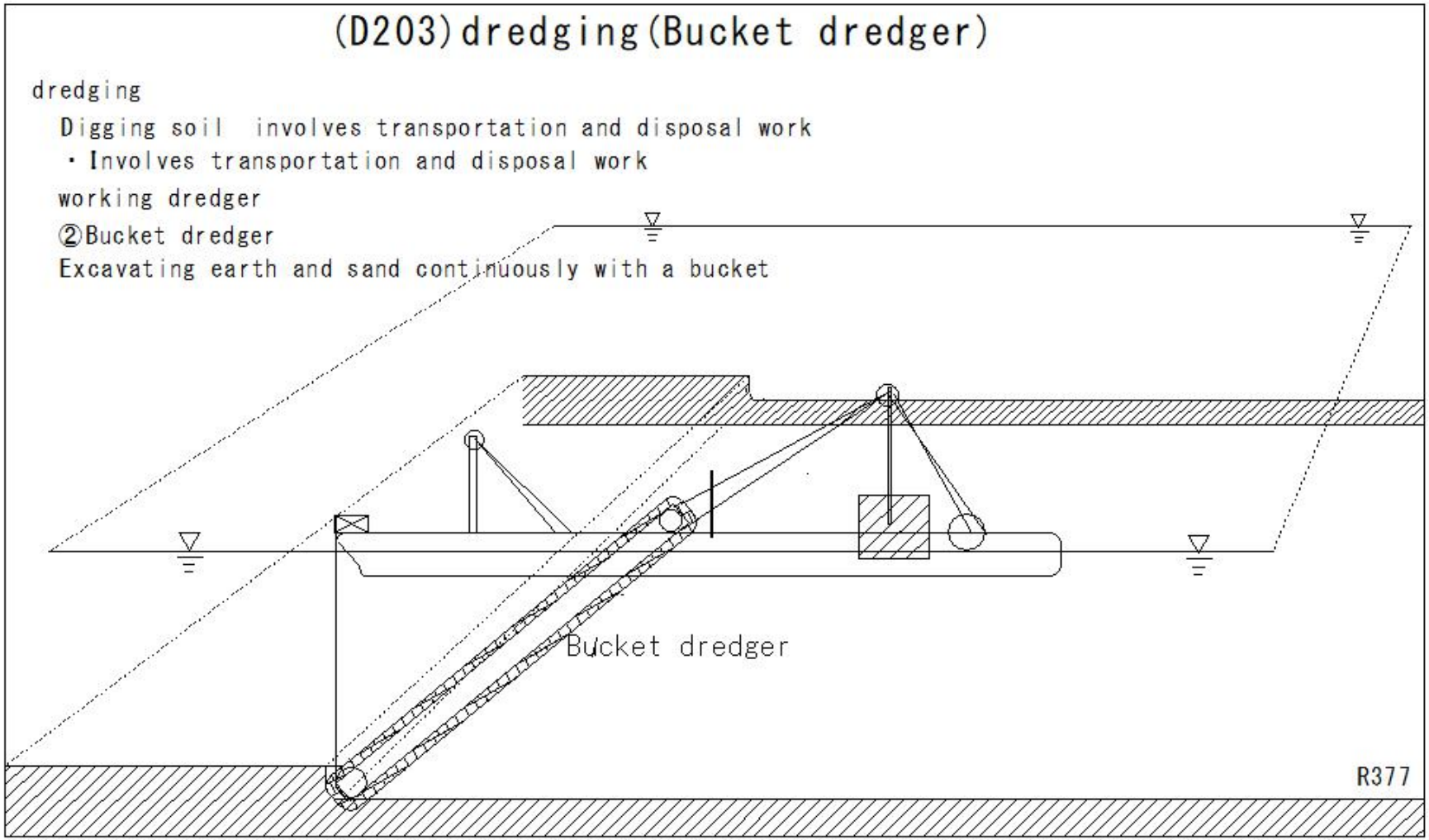


r374

(D202)dredging(Pump dredger)



(D203)dredging(Bucket dredger)



(D204)dredging(Grab dredger)

(D204)dredging(Grab dredger)

grab dredger

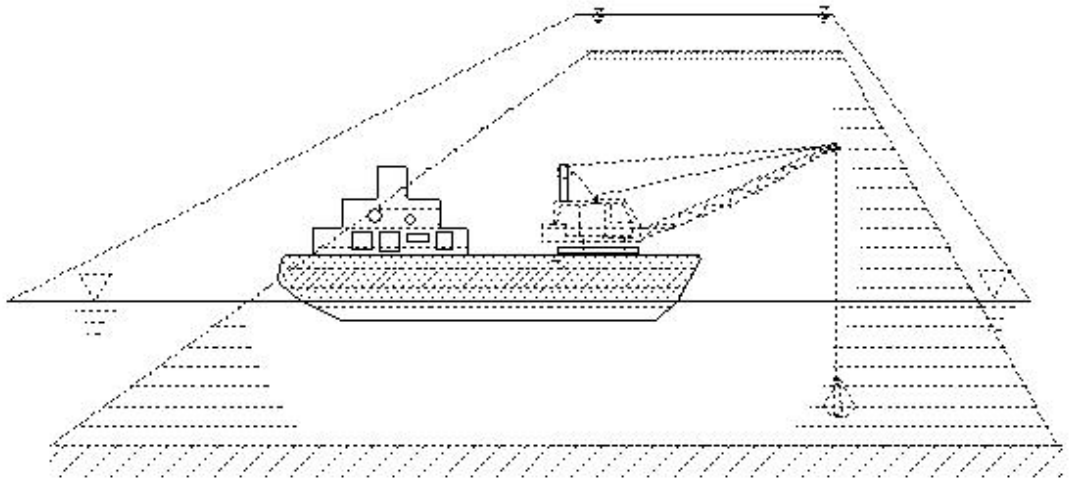
Digging soil involves transportation and disposal work

・Involves transportation and disposal work

working dredger

③Grab dredger

excavating with a grab bucket



Grab dredger

R378

(D205)dredging(Dipper dredger)

(D205)dredging(Dipper dredger)

dredging

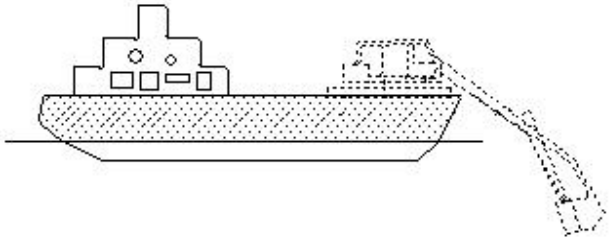
Digging soil involves transportation and disposal work

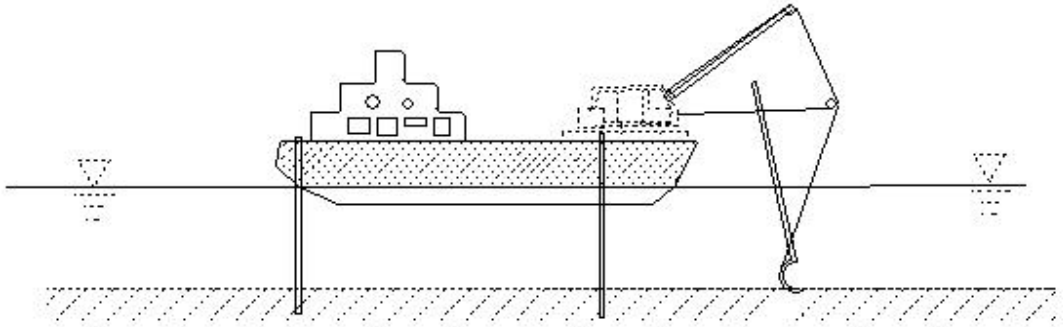
・Involves transportation and disposal work

working dredger

④Dipper dredger

Excavating hard soil with a dipper

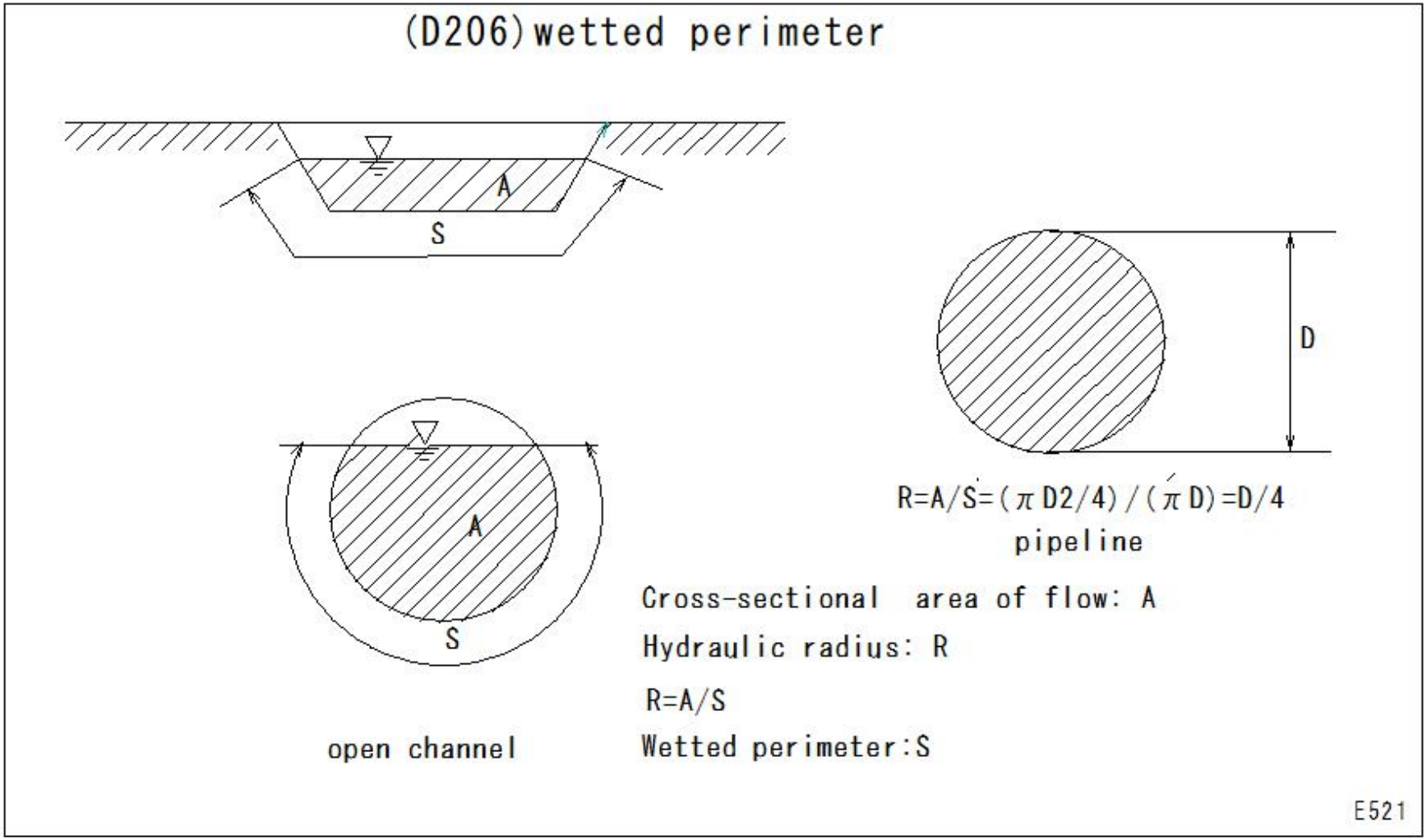




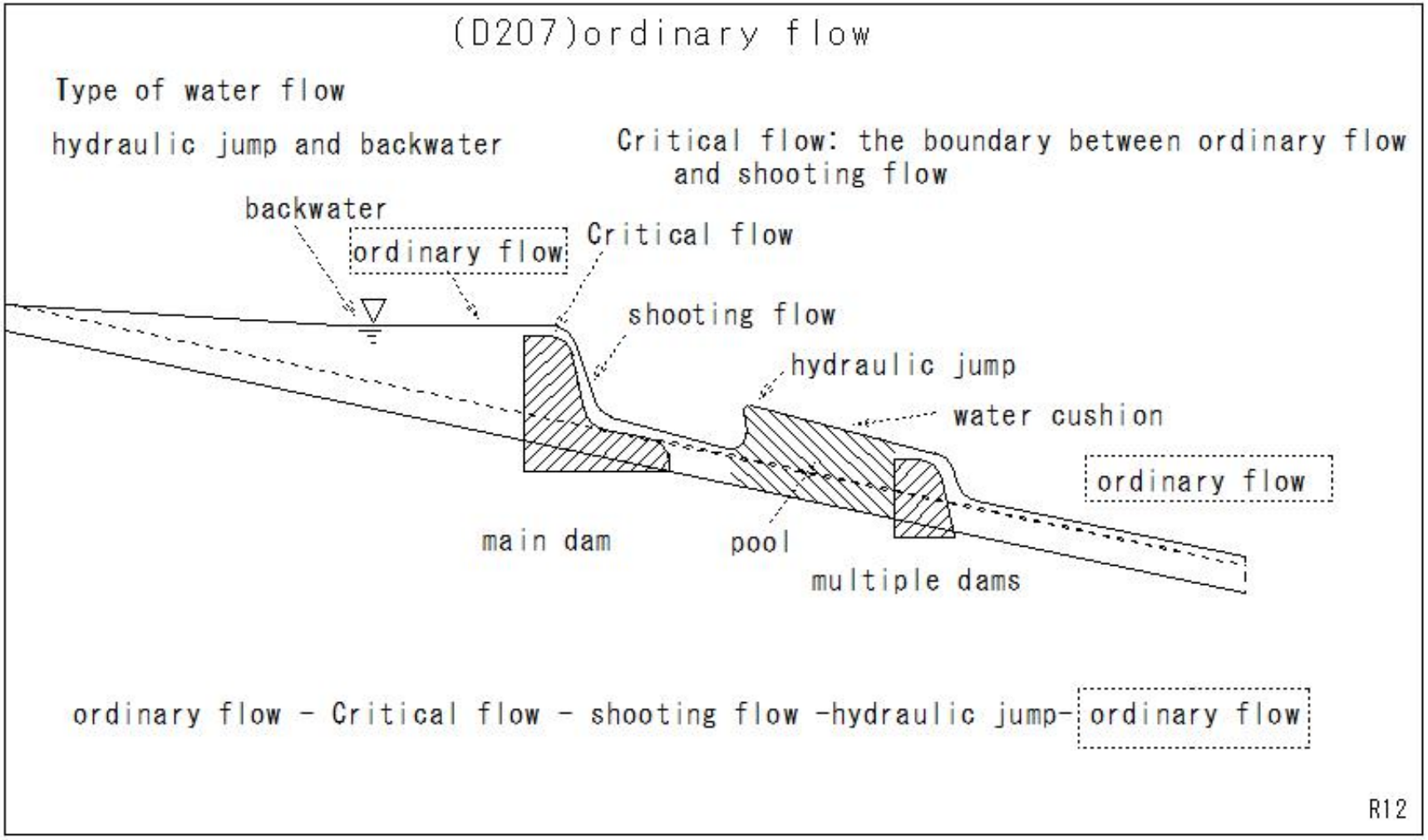
Dipper dredger

R378

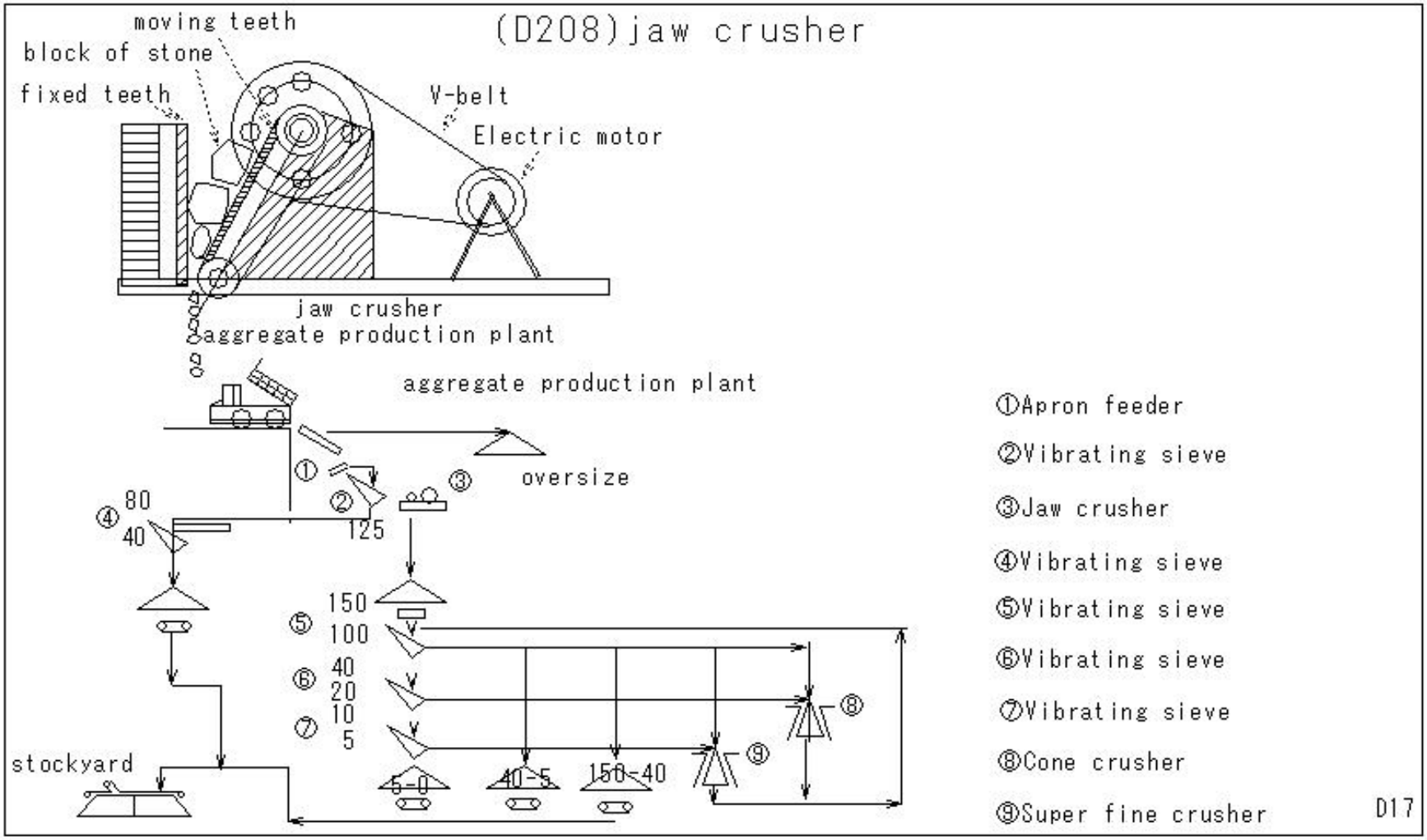
(D206)wetted perimeter



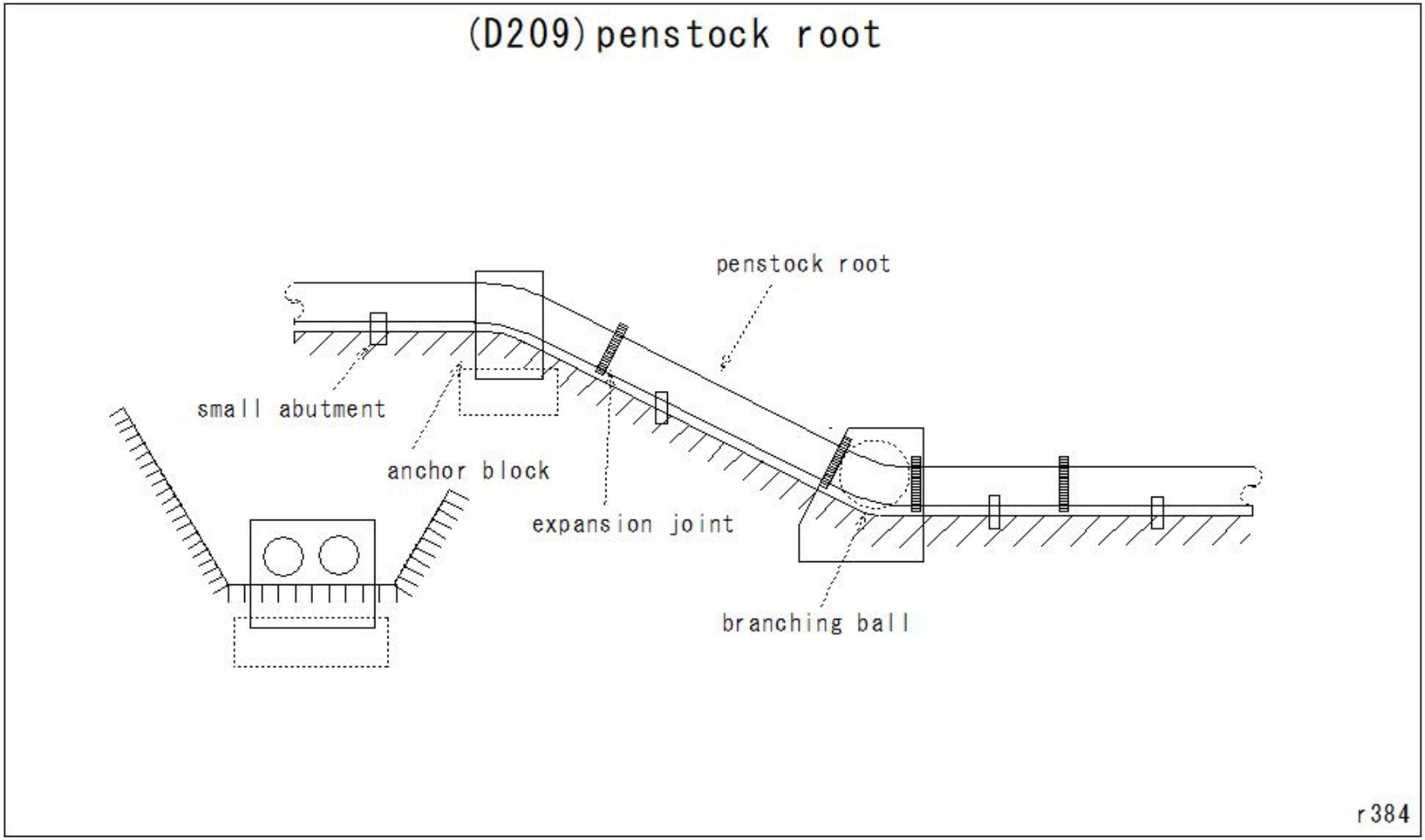
(D207)ordinary flow



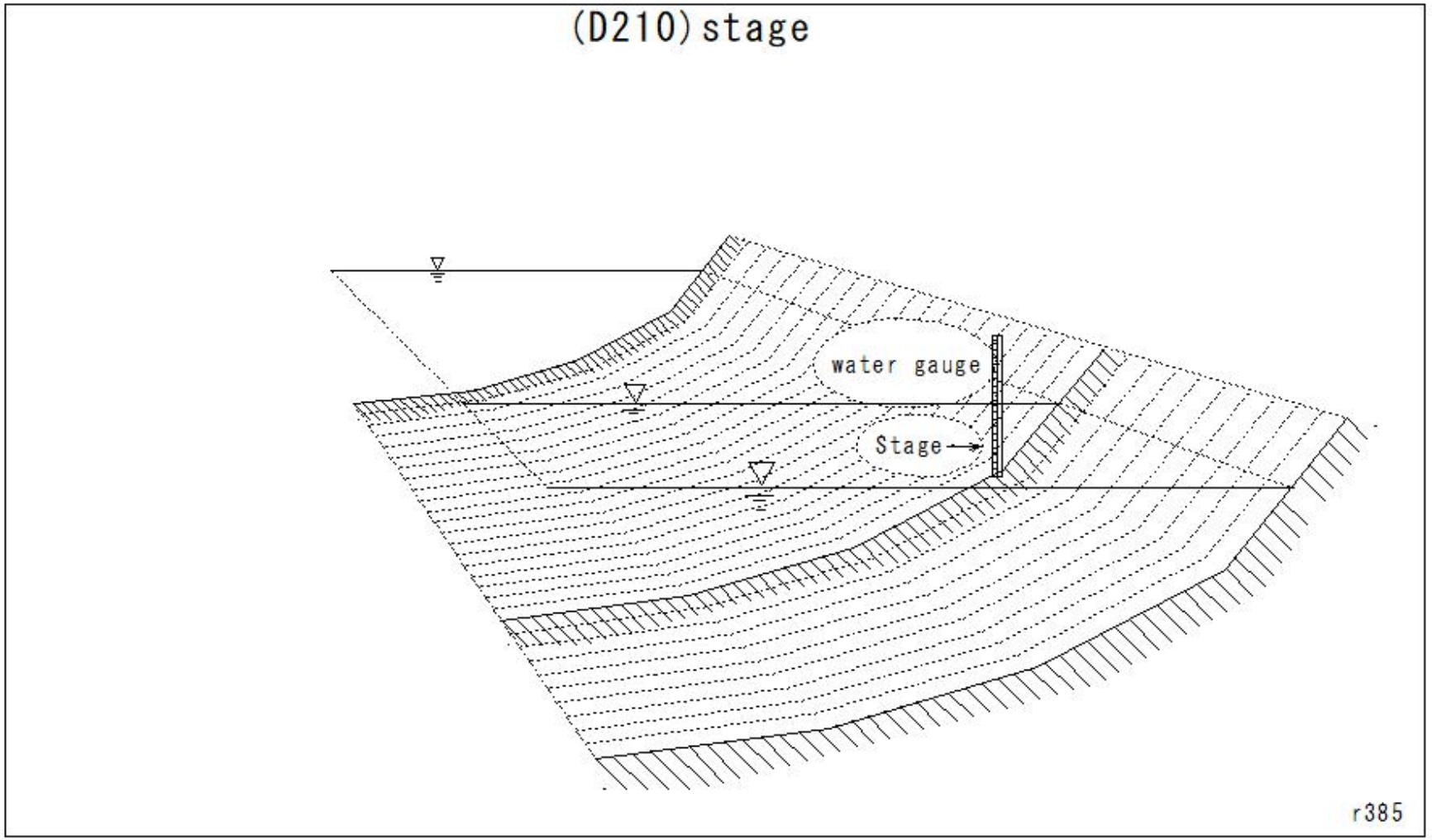
(D208)jaw crusher



(D209)penstock root



(D210)stage



(D211)water-level recorder

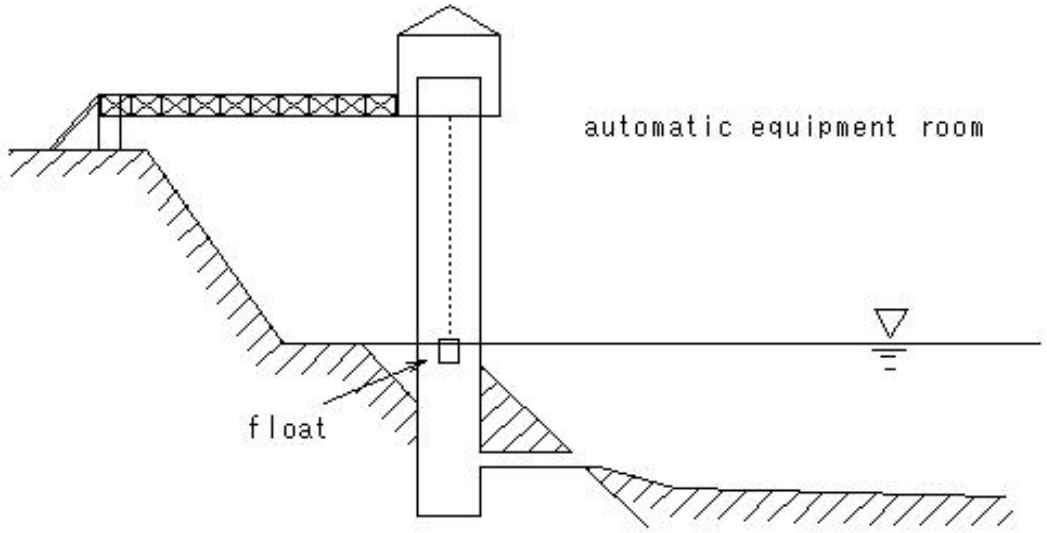
(D211)water-level recorder

water-level recorder

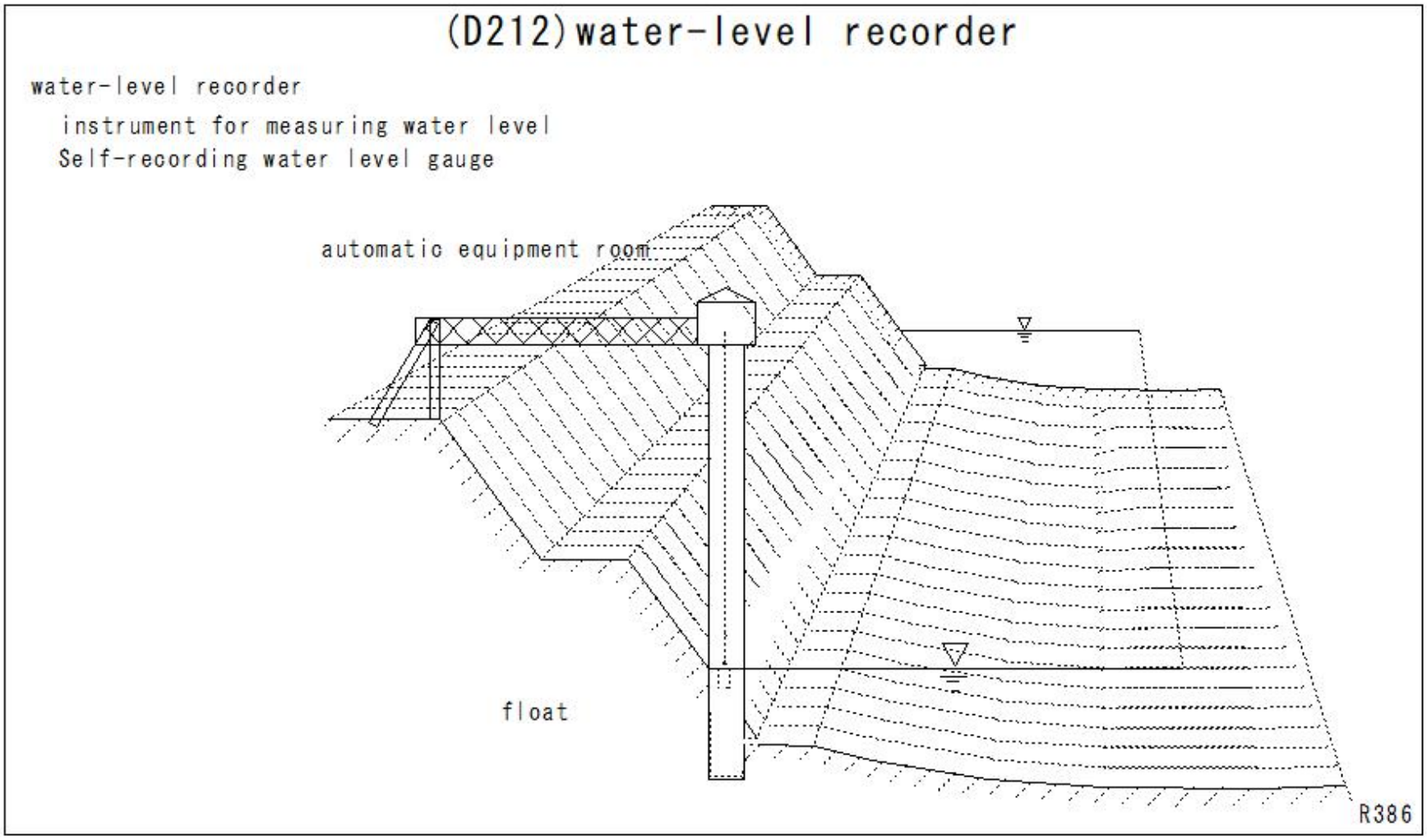
water level gauge

nstrument for measuring water level

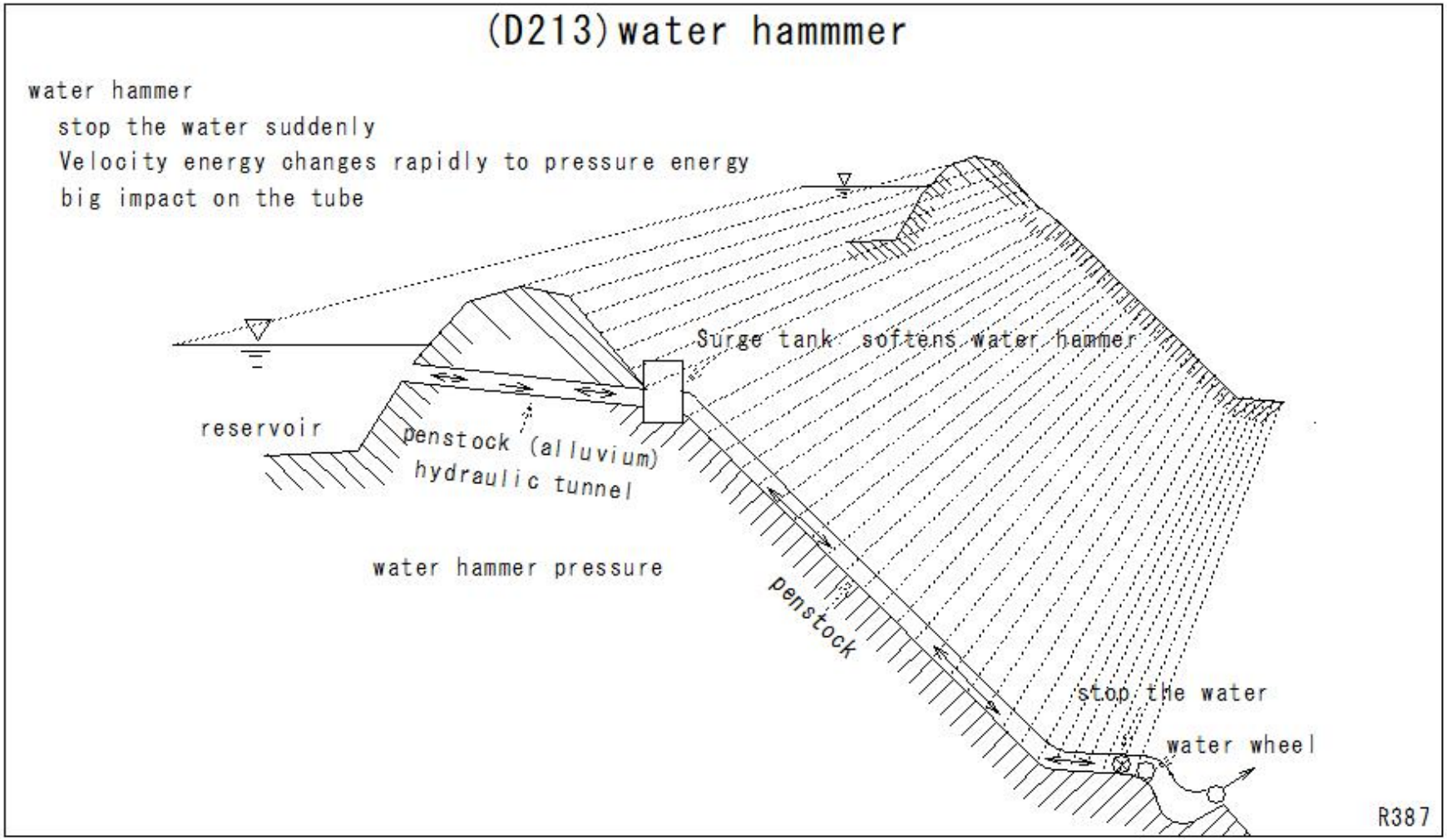
Self-recording water level gauge



(D212)water-level recorder



(D213)water hammmer

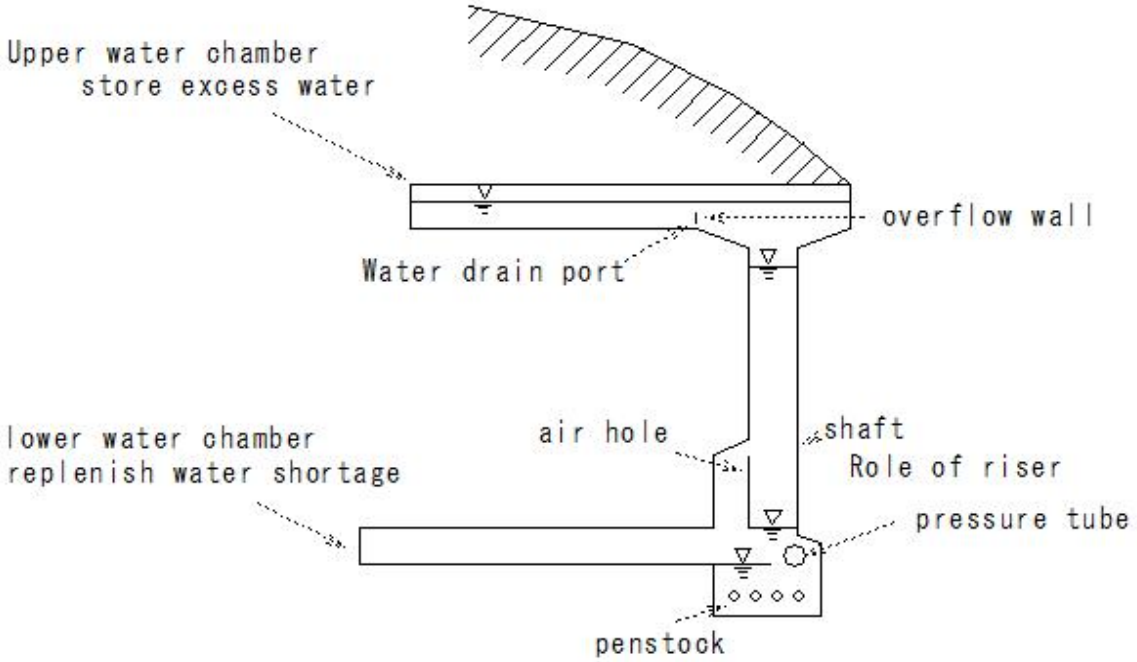


(D214)chamber surge tank

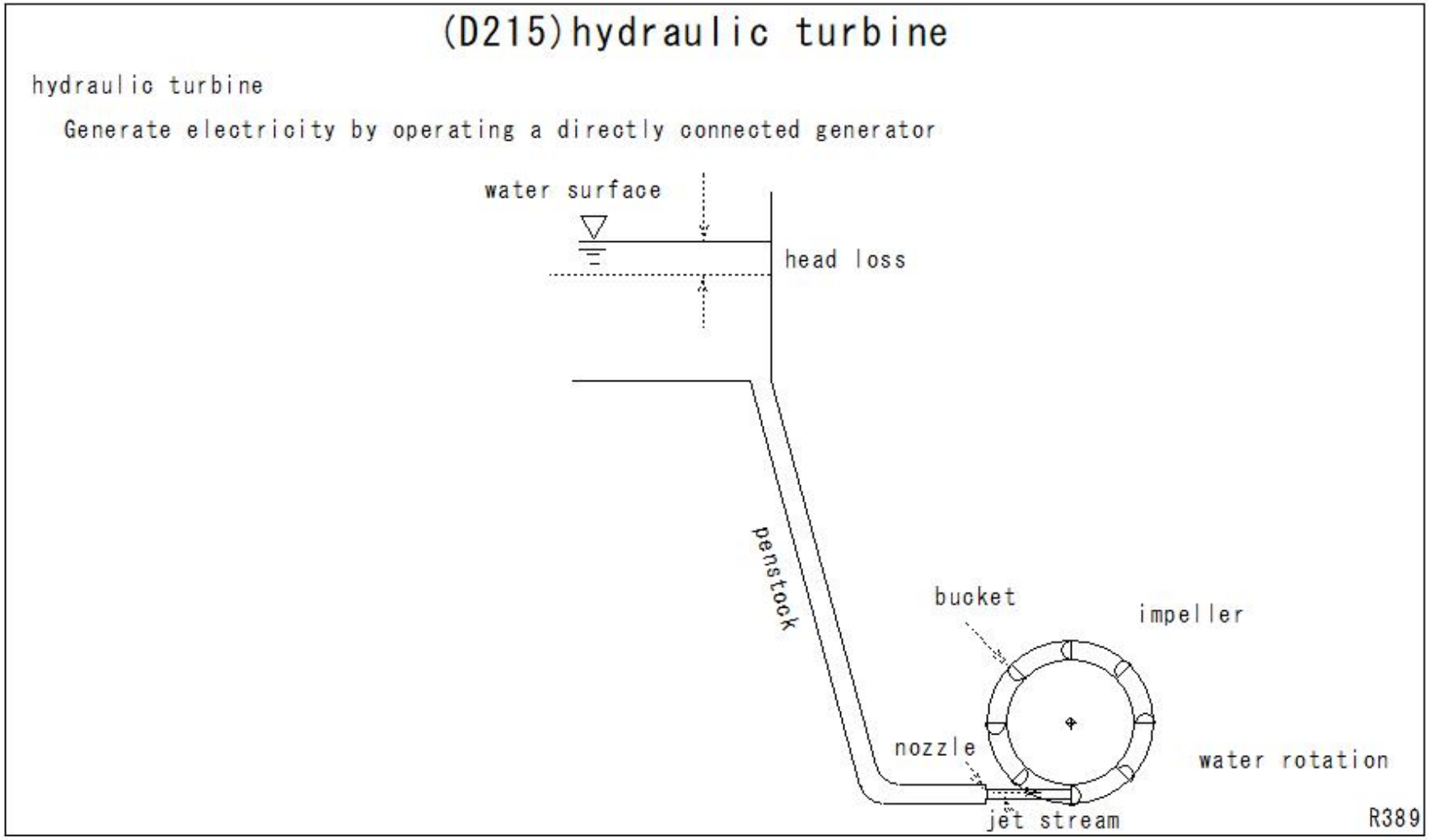
(D214)chamber surge tank

chamber surge tank

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



(D215)hydraulic turbine



(D216)efficiency of hydraulic turbine

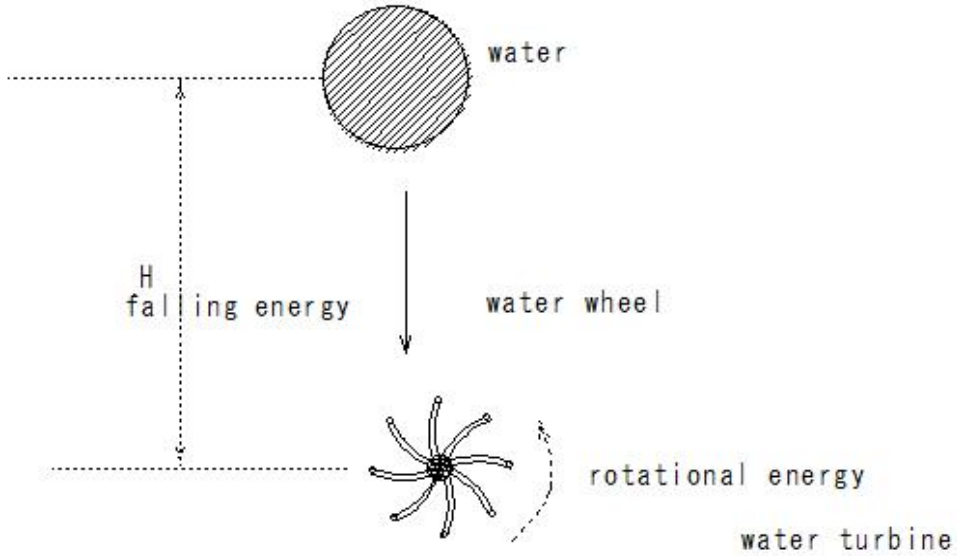
(D216)efficiency of hydraulic turbine

efficiency of hydraulic turbine

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

water energy rotational energy

Degree - Efficiency of a water wheel



(D217)gate

(D217) gate

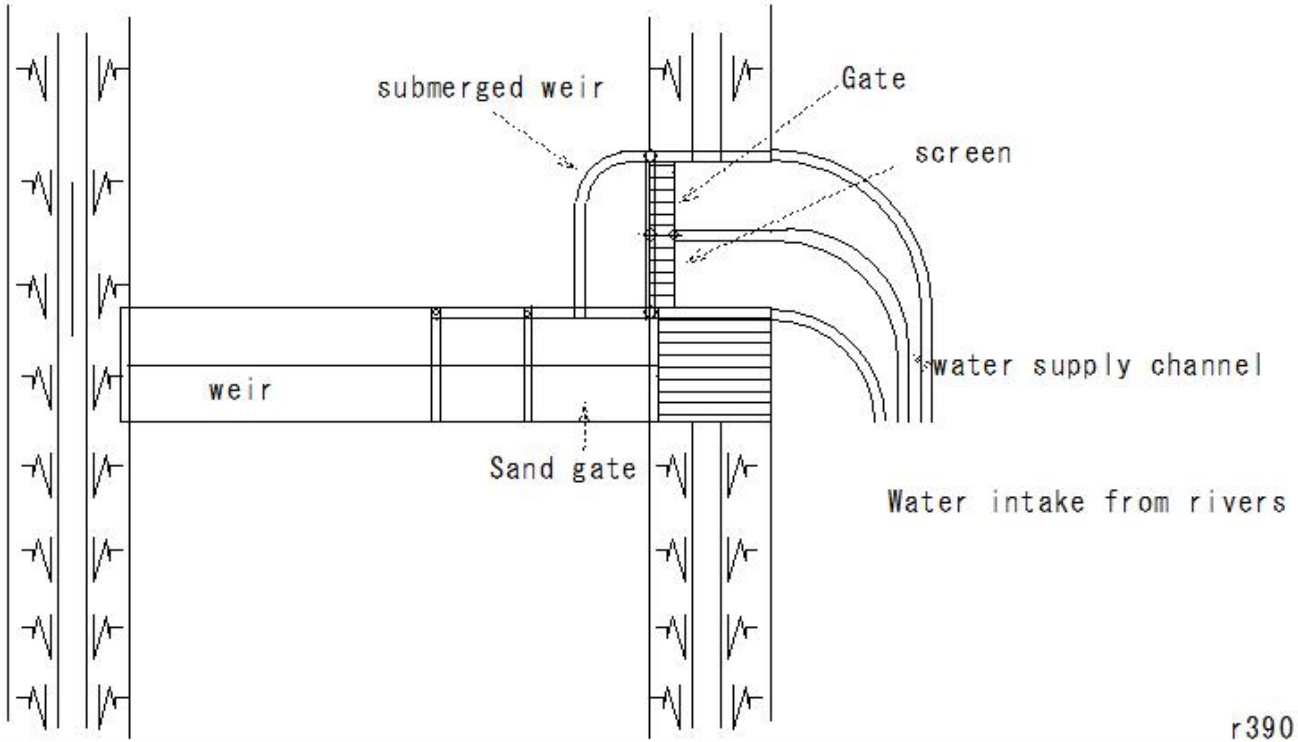
gate

discharge adjustment

water intake

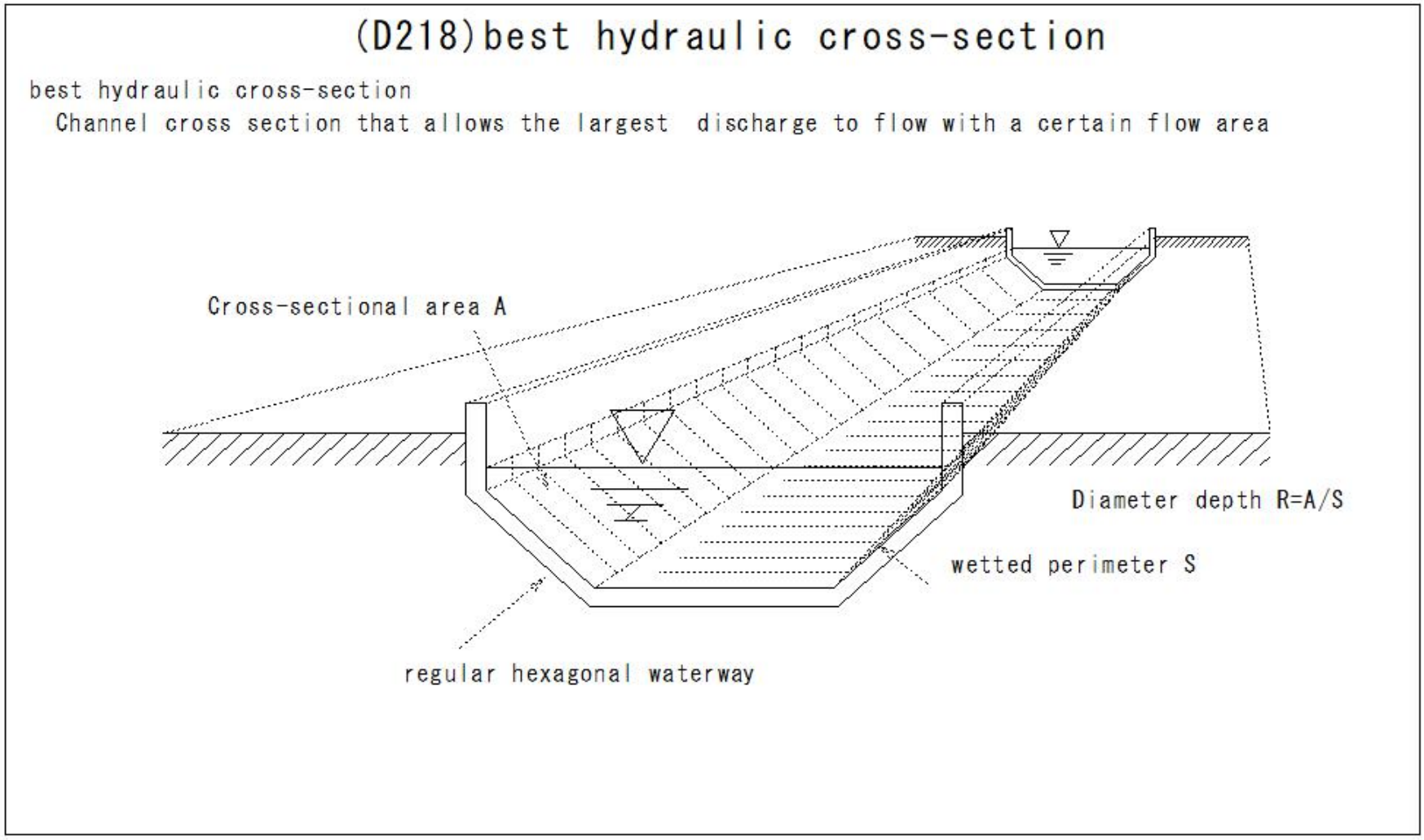
for ship navigation

Movable doors installed across rivers, canals, and embankments

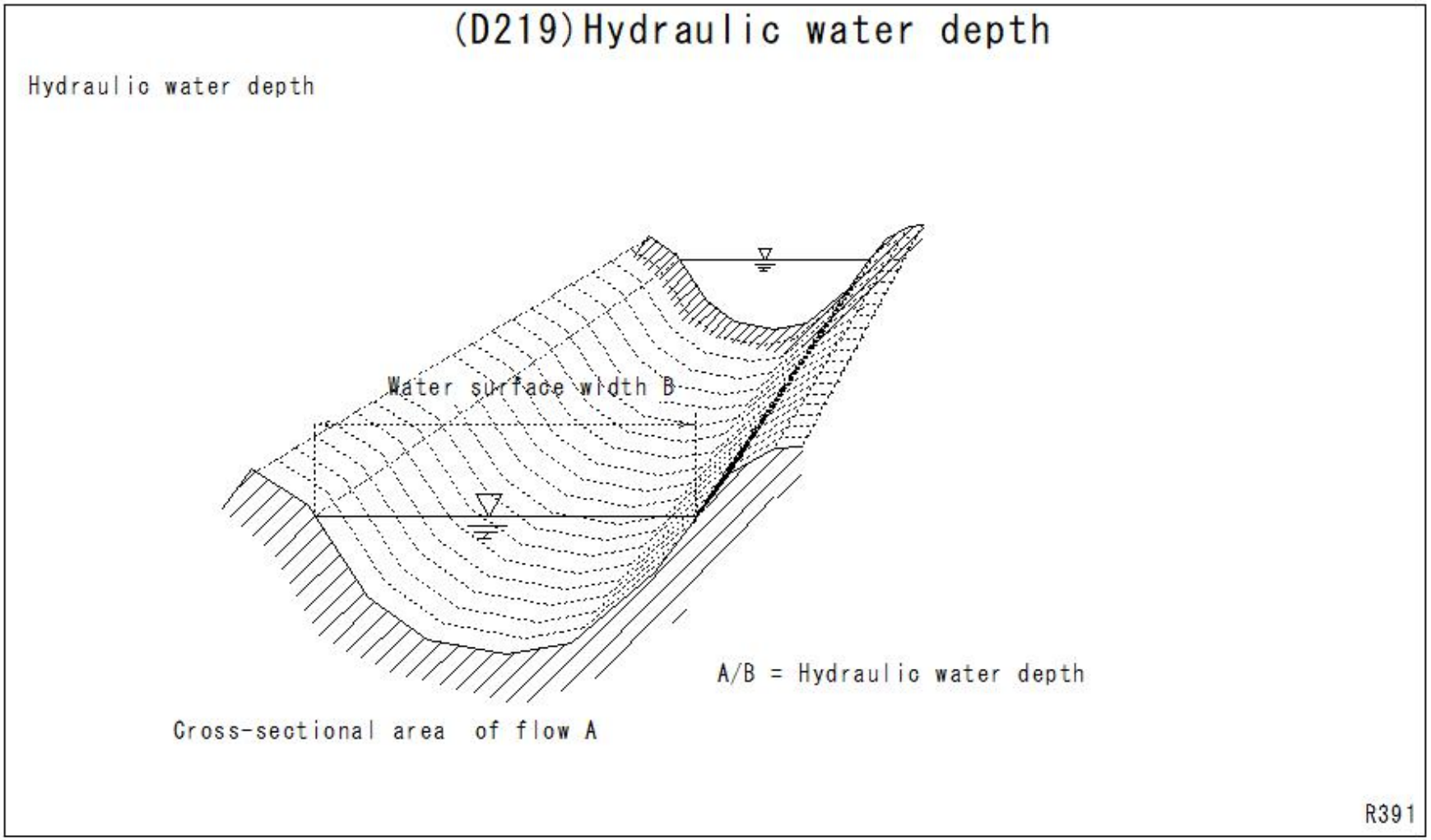


r390

(D218)best hydraulic cross-section



(D219)Hydraulic water depth



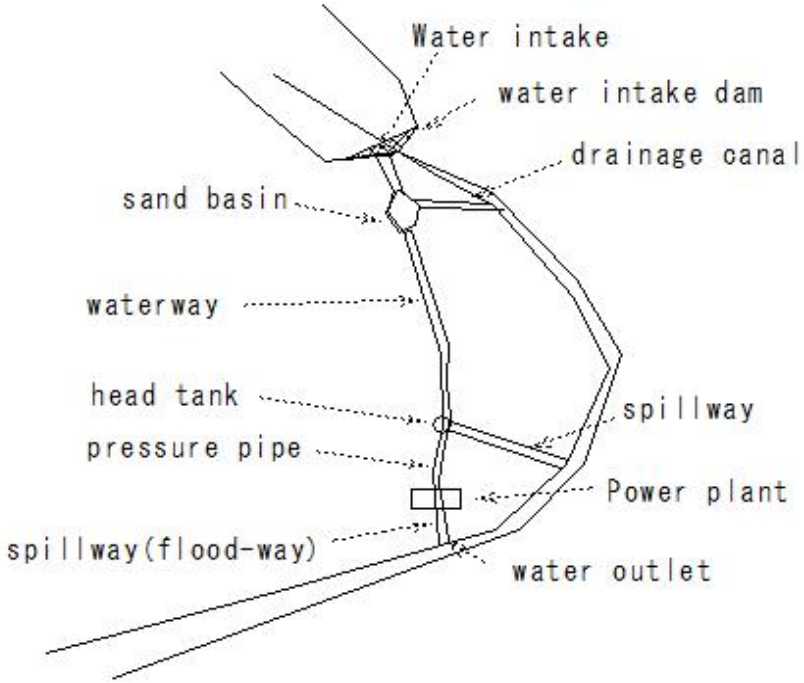
(D220)conduct type water power

(D220)conduct type water power

conduct type water power

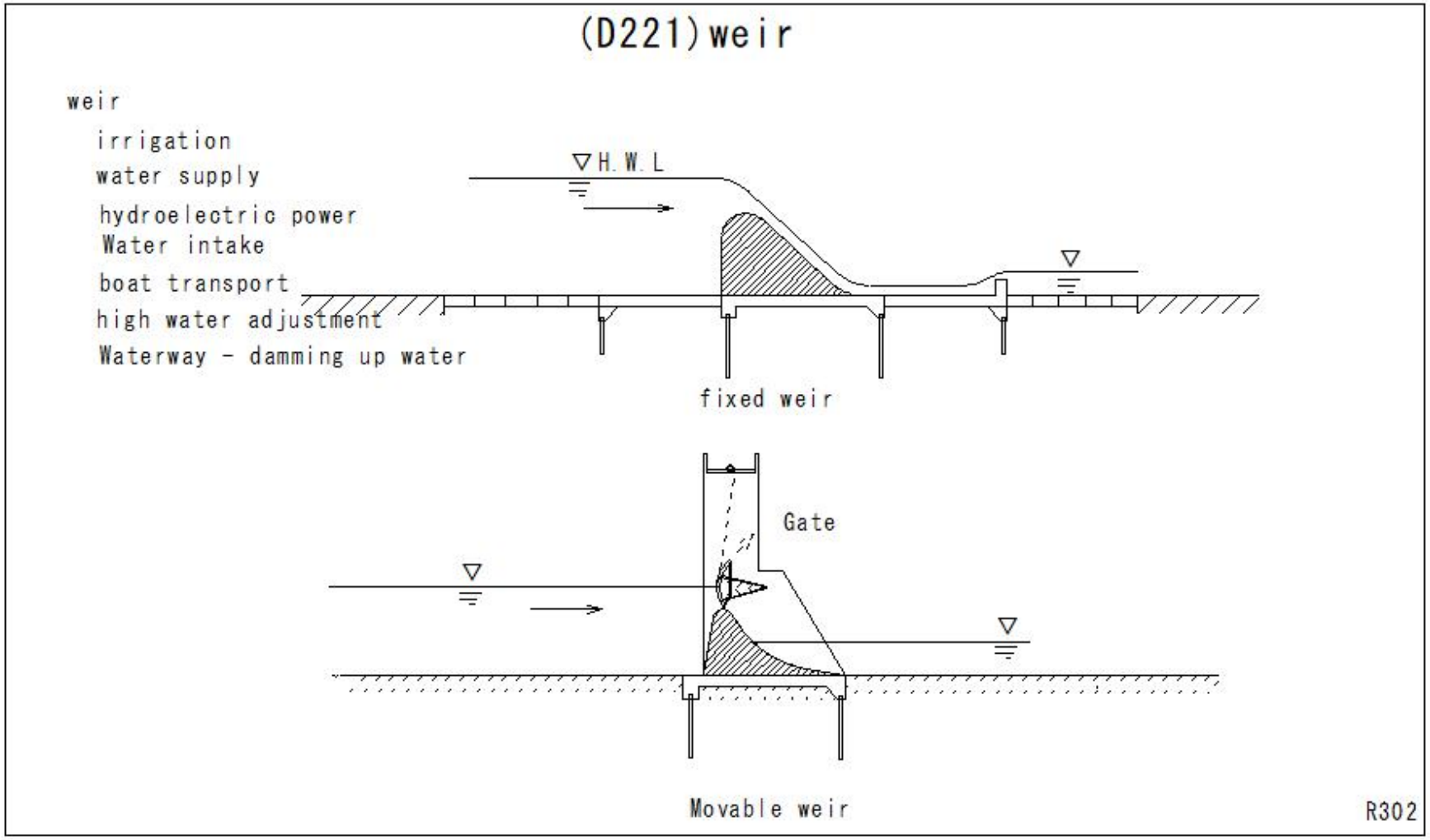
Guide river water through a channel to a point where a large head can be obtained.

Generate electricity by dropping it down with a pressure tube

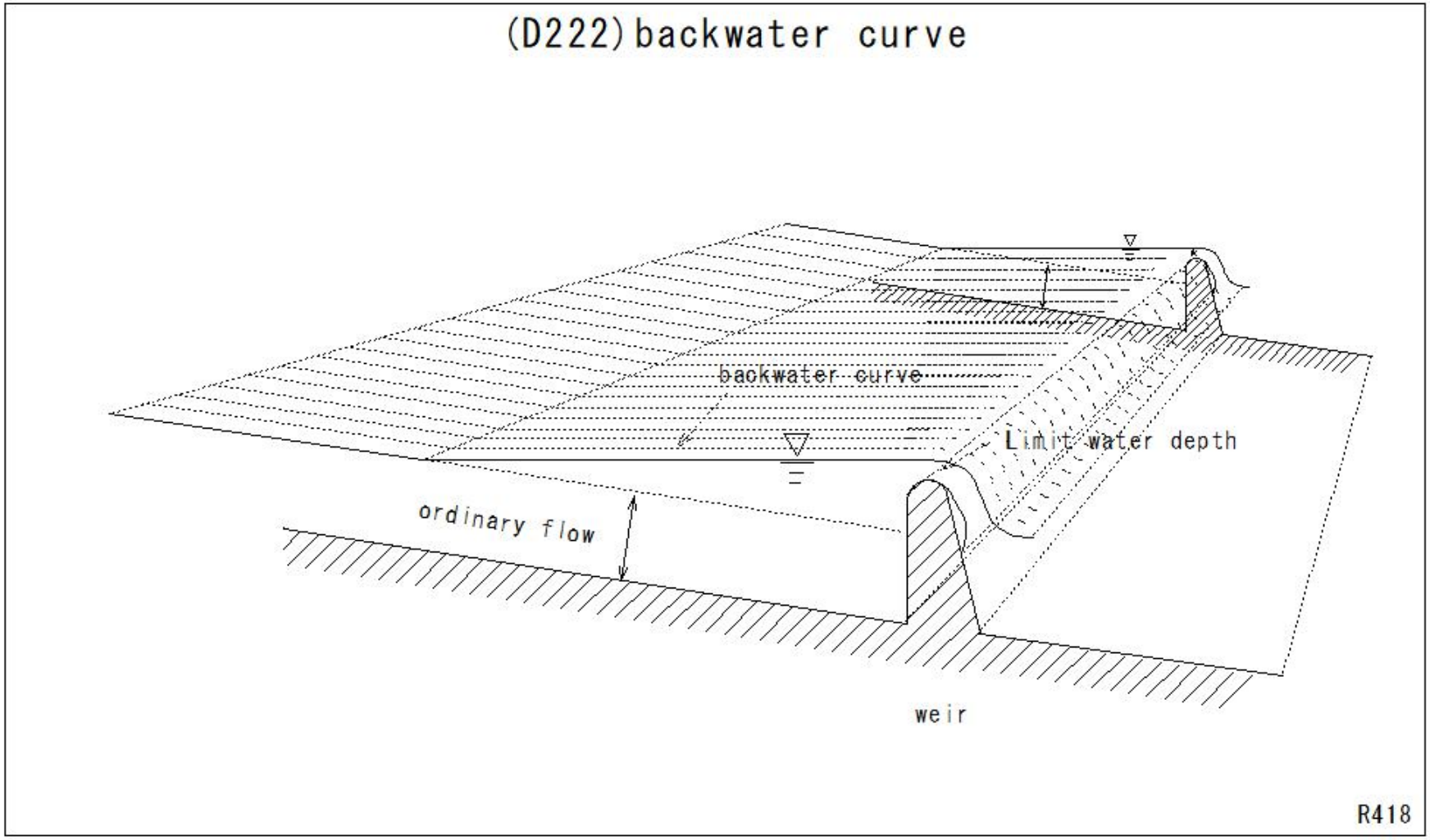


R392

(D221)weir


(D221)weir
weir
irrigation
water supply
hydroelectric power
Water intake
boat transport
high water adjustment
Waterway - damming up water
▽H.W.L
▽
fixed weir
Gate
▽
▽
Movable weir
R302

(D222)backwater curve



(D223)hollow gravity dam

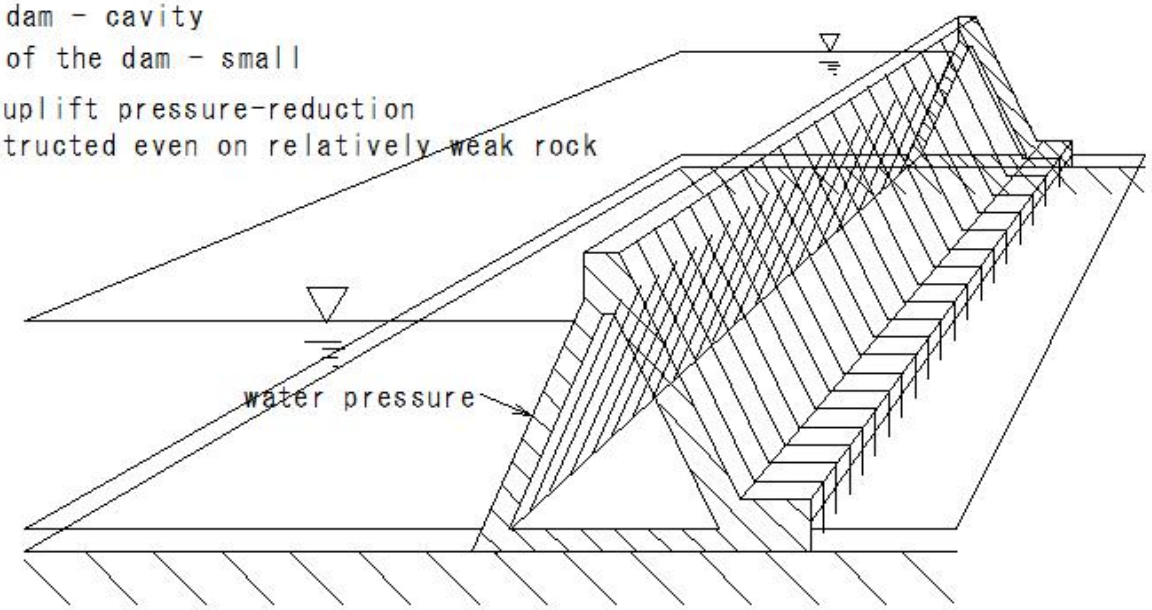
(D223)hollow gravity dam

dam

Types of dams

hollow gravity dam

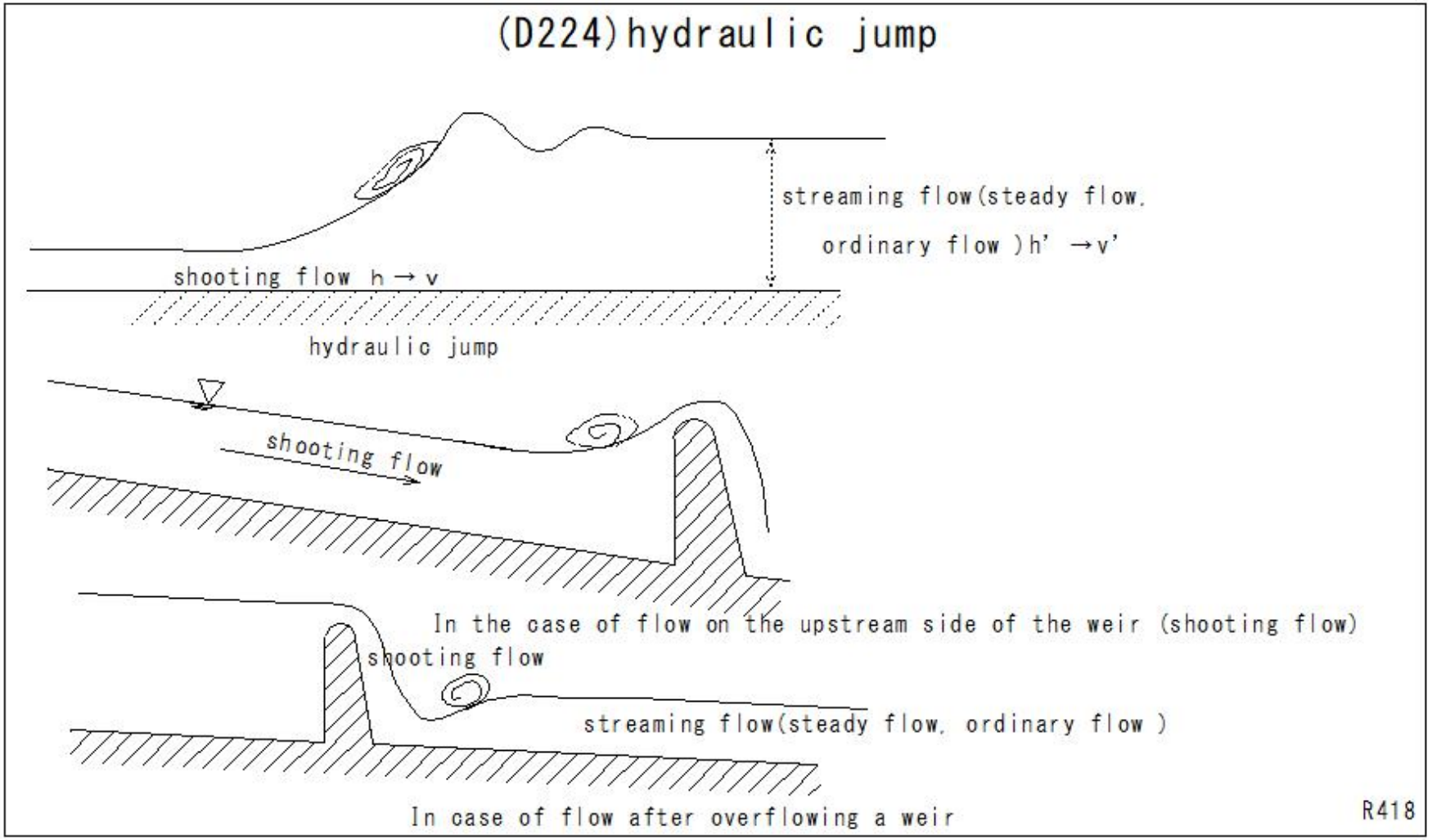
- Inside the dam - cavity
- The weight of the dam - small
- Structural-uplift pressure-reduction
- Can be constructed even on relatively weak rock



Hollow gravity dam

D153

(D224)hydraulic jump

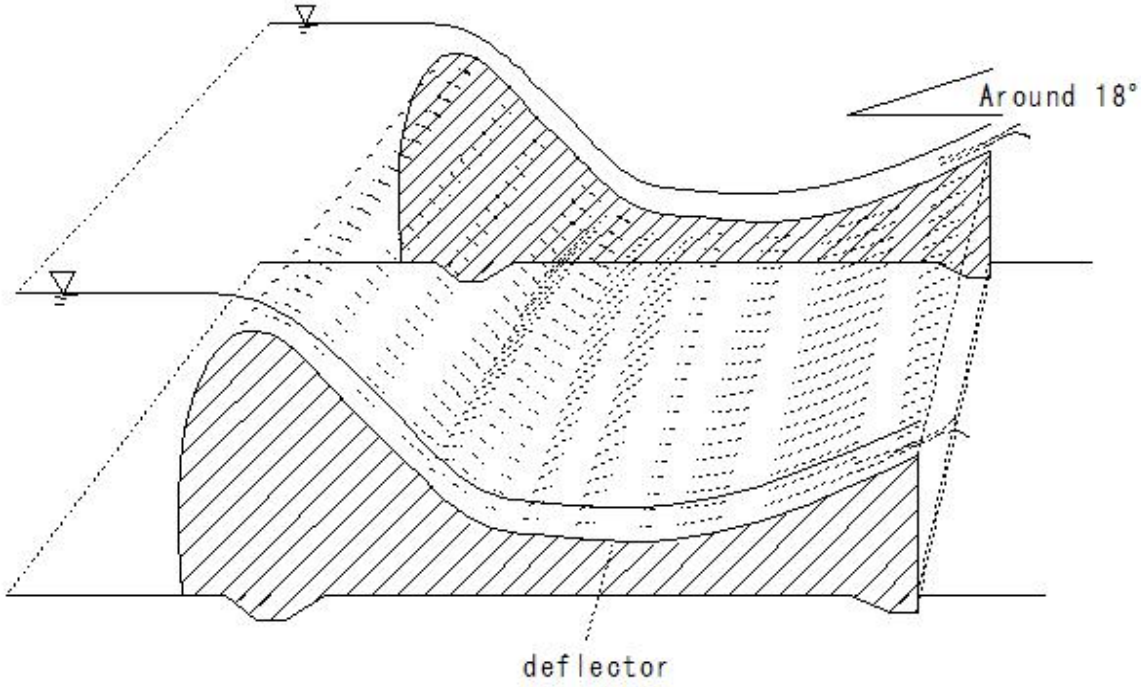


(D225)deflector

(D225)deflector

deflector

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



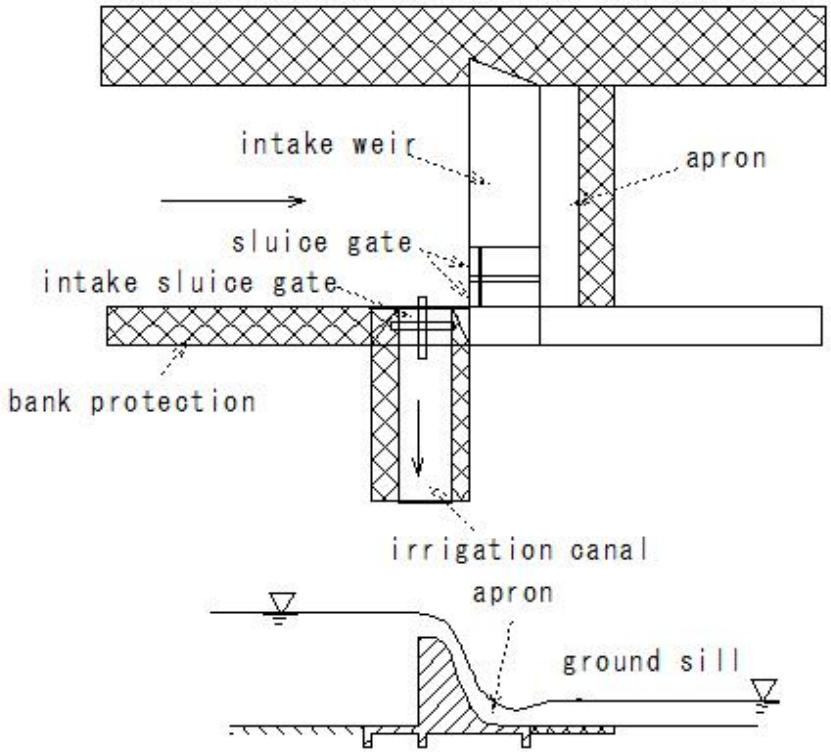
R435

(D226)head works

(D226)head works

weir(head works)

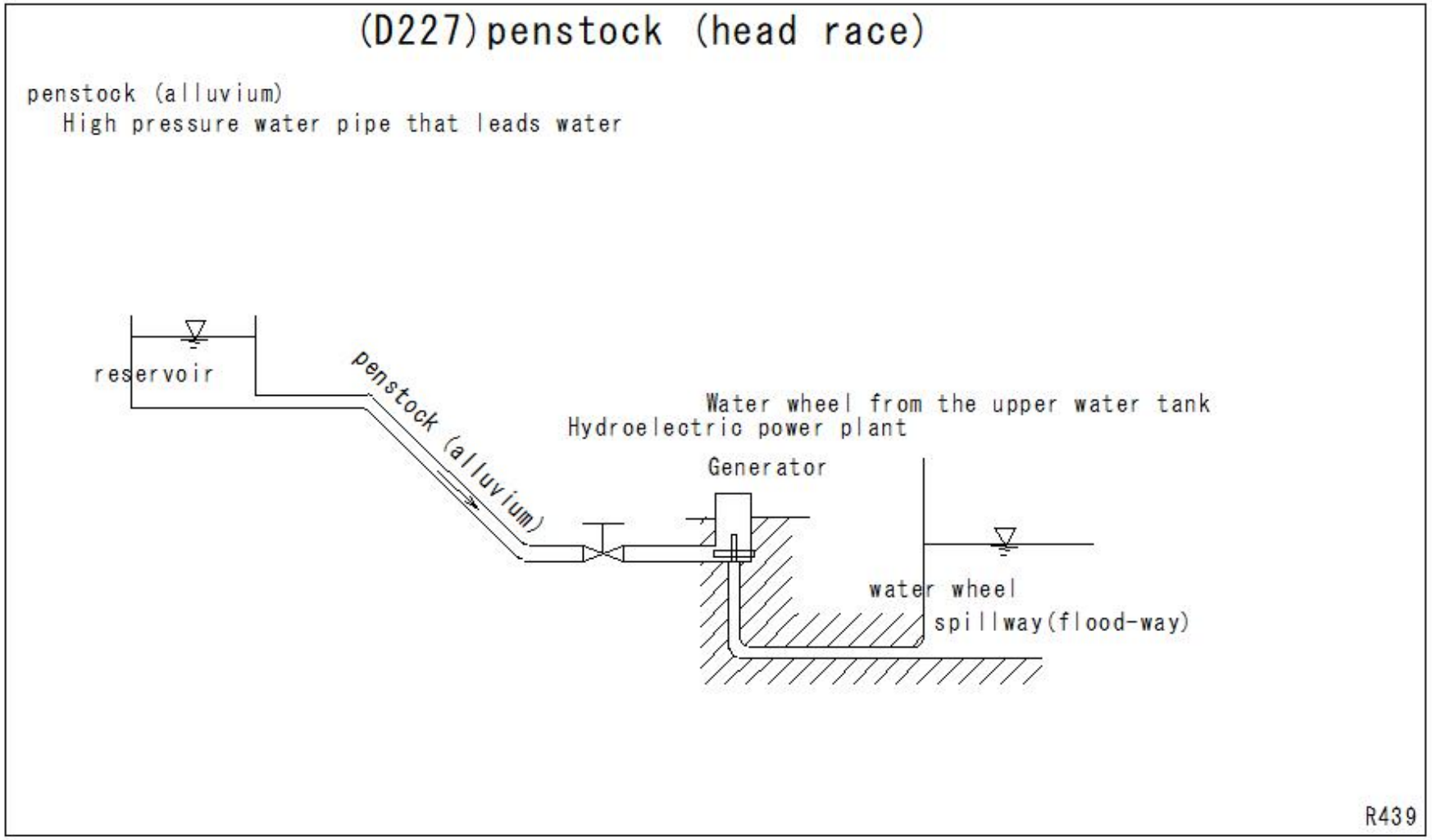
Facilities that draw water from lakes, rivers, etc. to irrigation canals



Weir cross section

R438

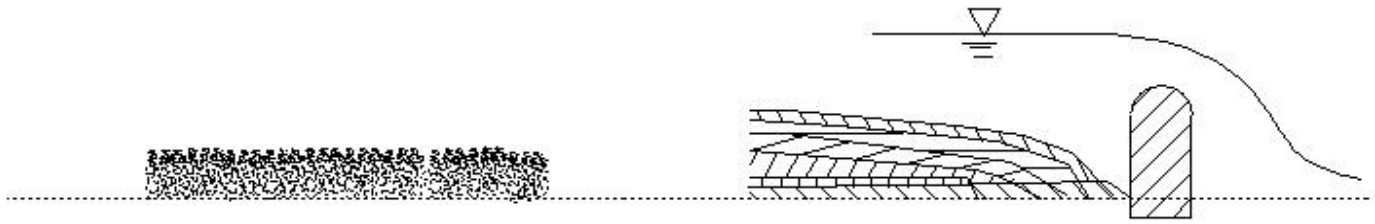
(D227)penstock (head race)



(D228)sediment settling

(D228)sediment settling

sediment settling
- Water flow
- Stationary soil pressure
- Sediment in water - precipitation

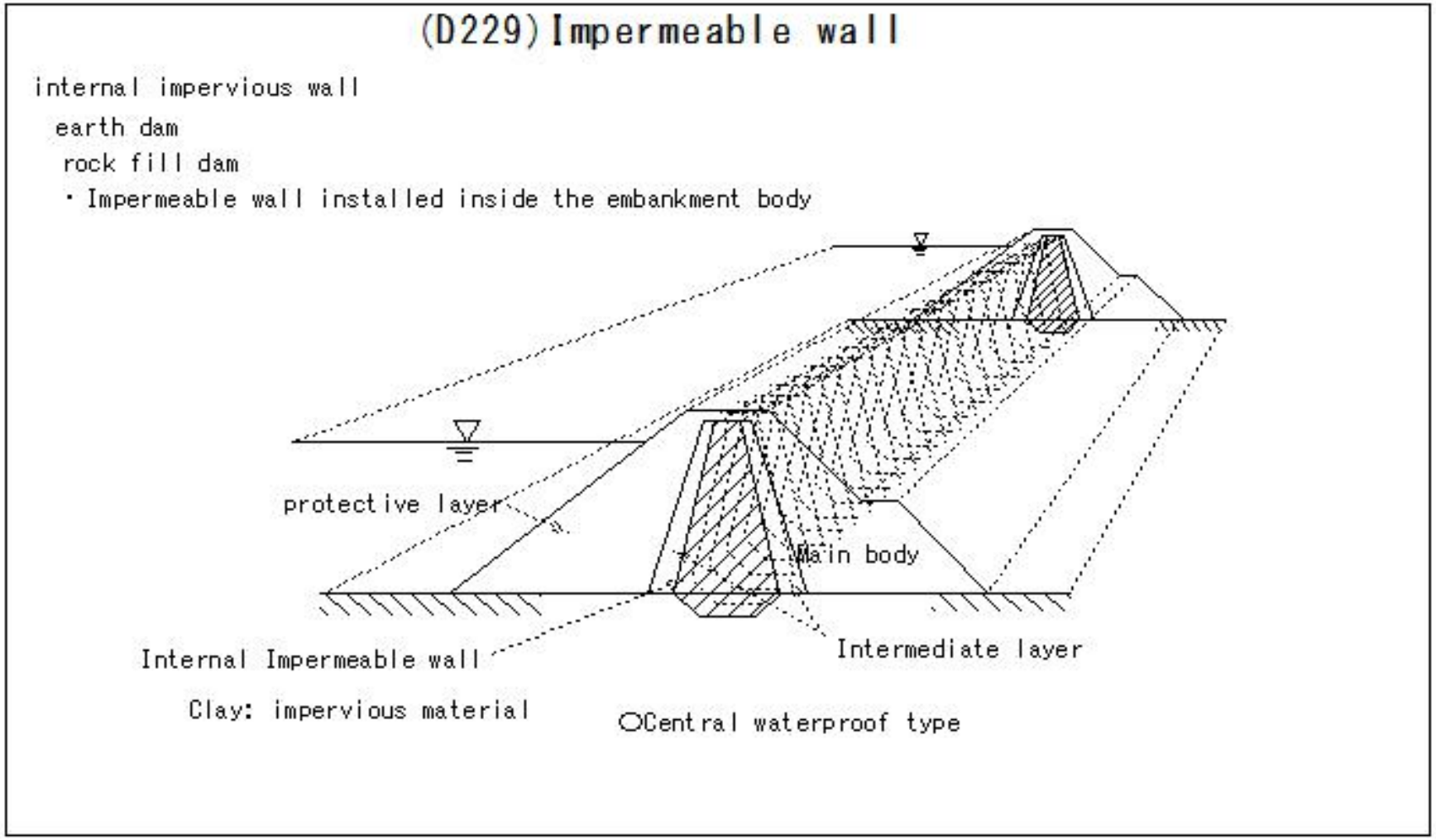


Precipitation in still water
The lower layer has a larger particle size

The tip is attached to the dam
Deposition

E580

(D229)internal impervious wall



(D230)internal impervious wall

(D230) internal impervious wall

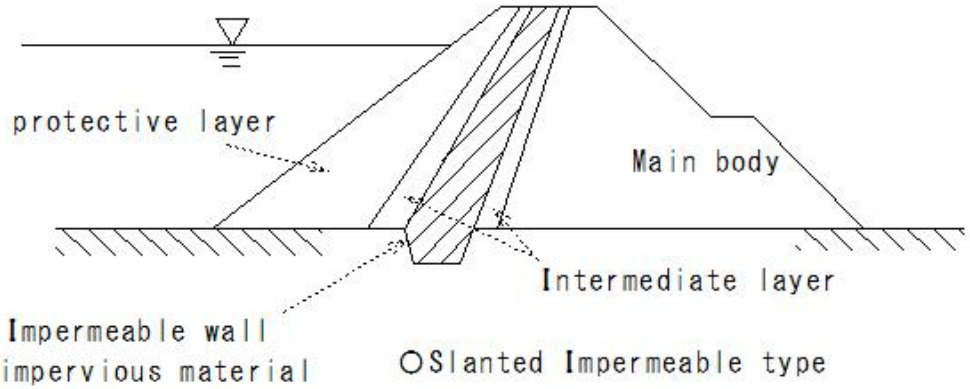
internal impervious wall

earth dam

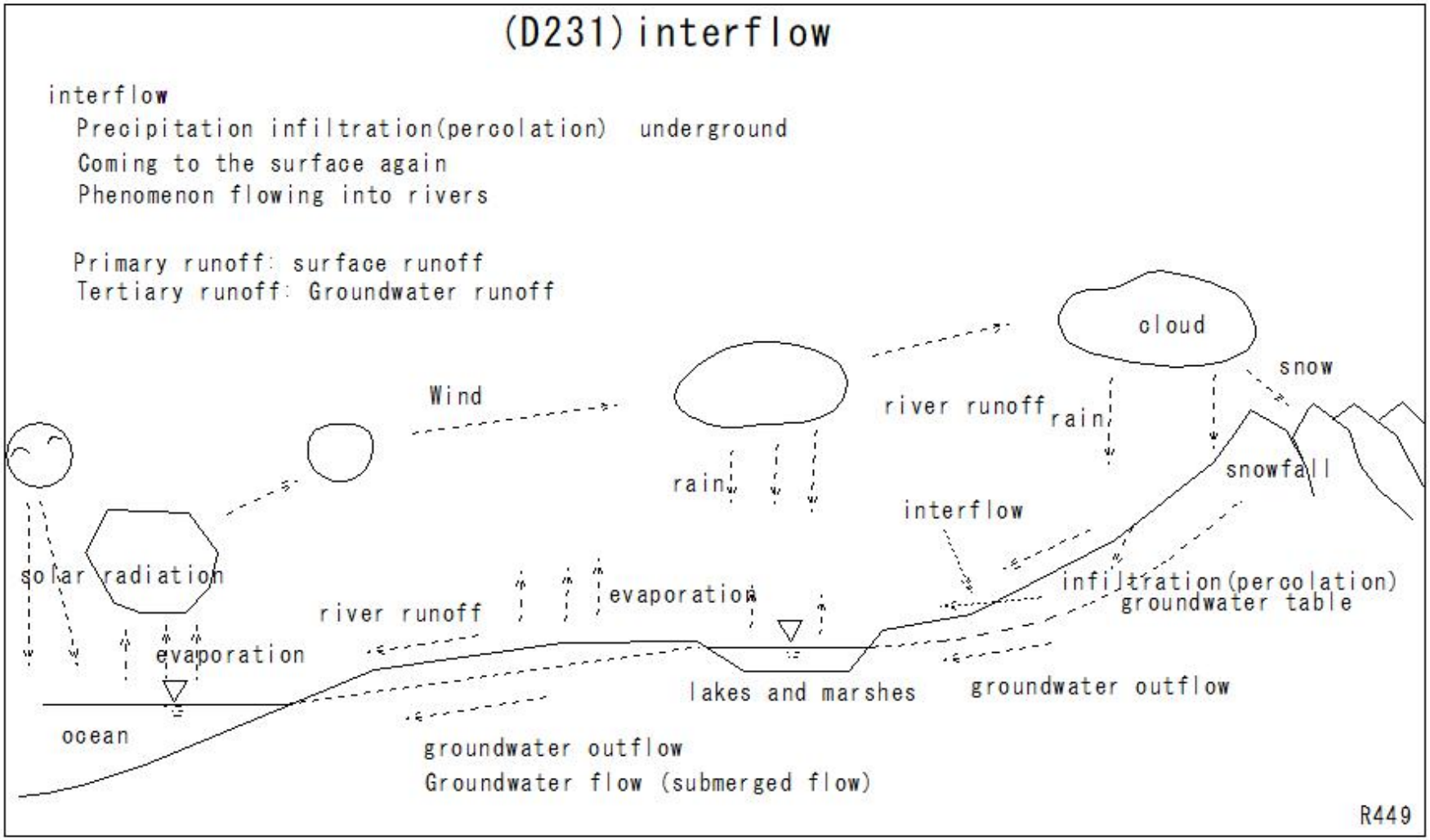
rock fill dam

・Impermeable wall installed inside the embankment body

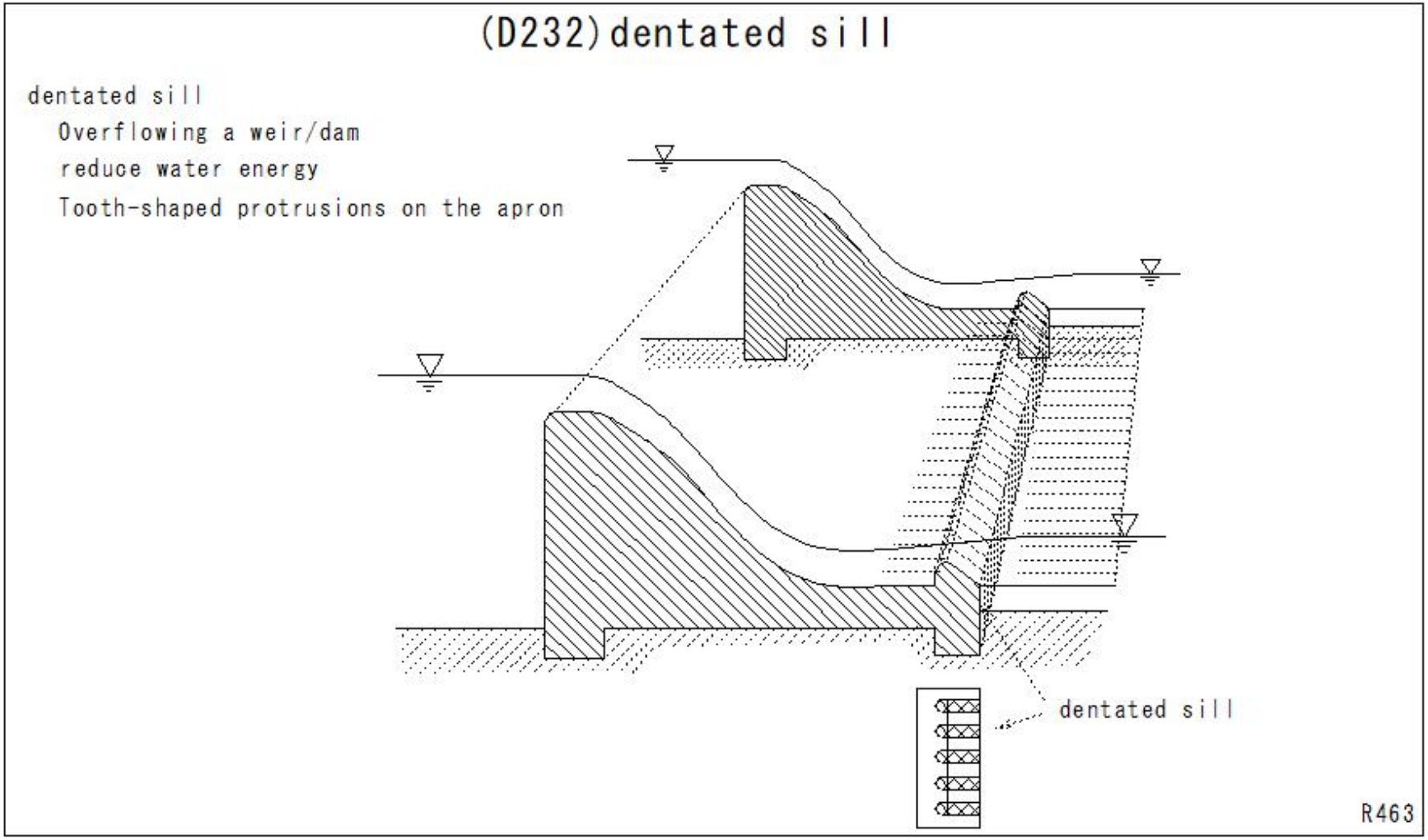
○Slanted Impermeable type



(D231)interflow



(D232)dentated sill



(D233)sharp crested weir

(D233) sharp crested weir

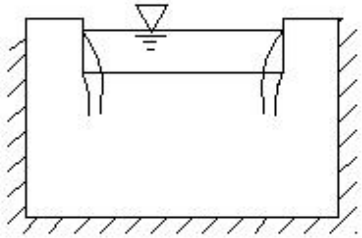
sharp crested weir

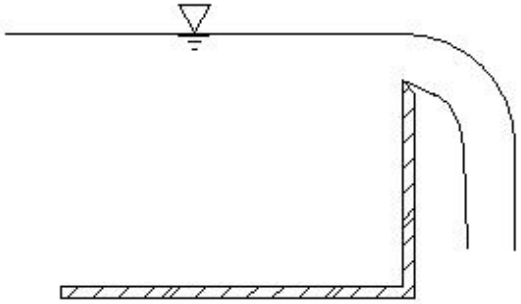
The overflow part is sharp.

blade shaped weir: Stable nap

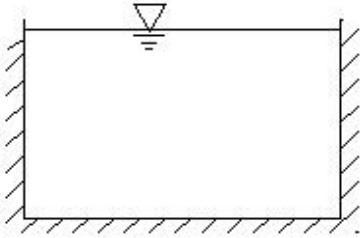
Easily measure overflow depth

Open channel flow measurement

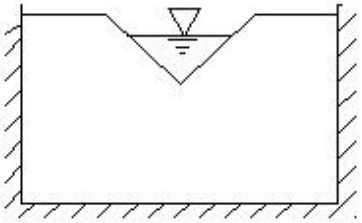




square cough



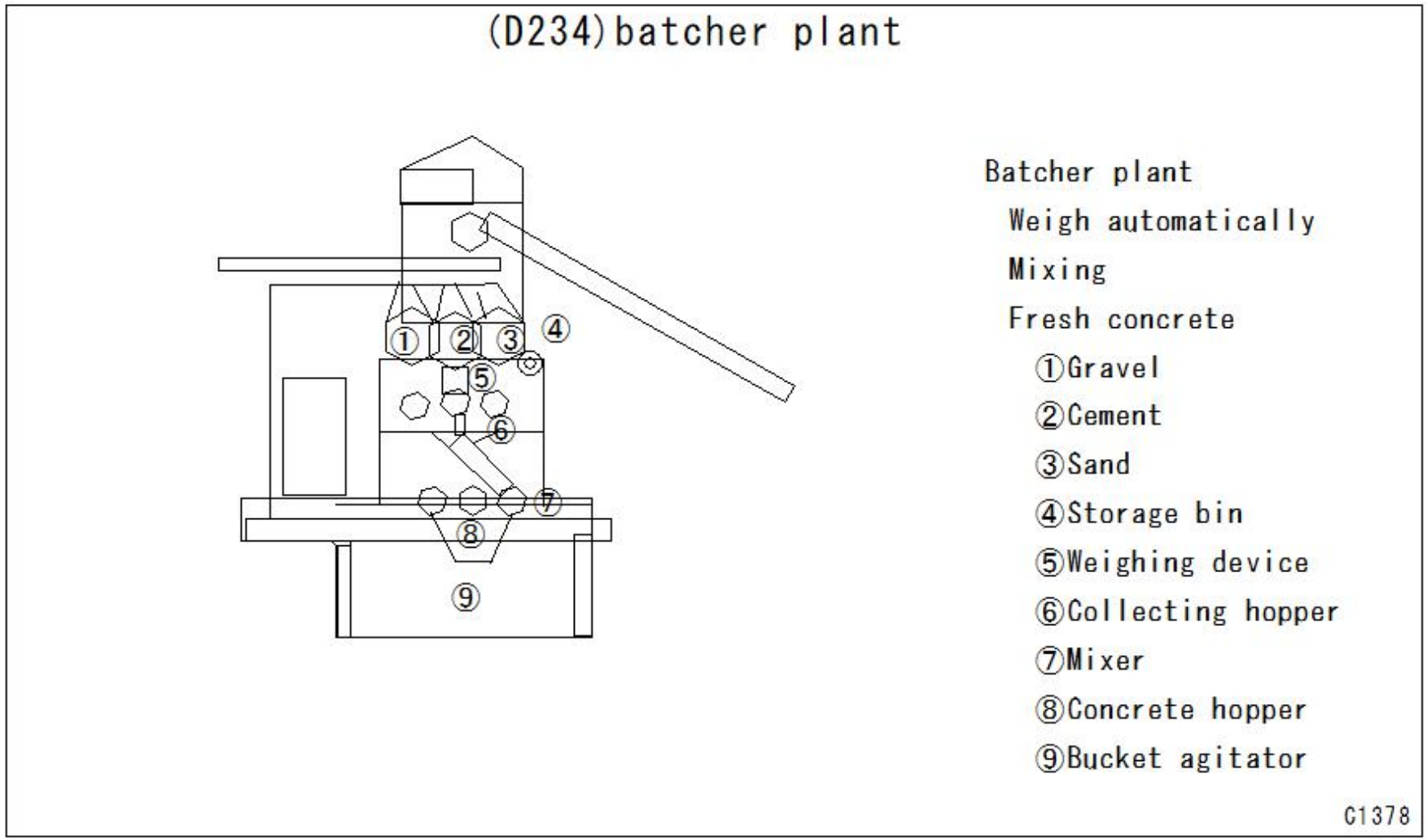
full width weir



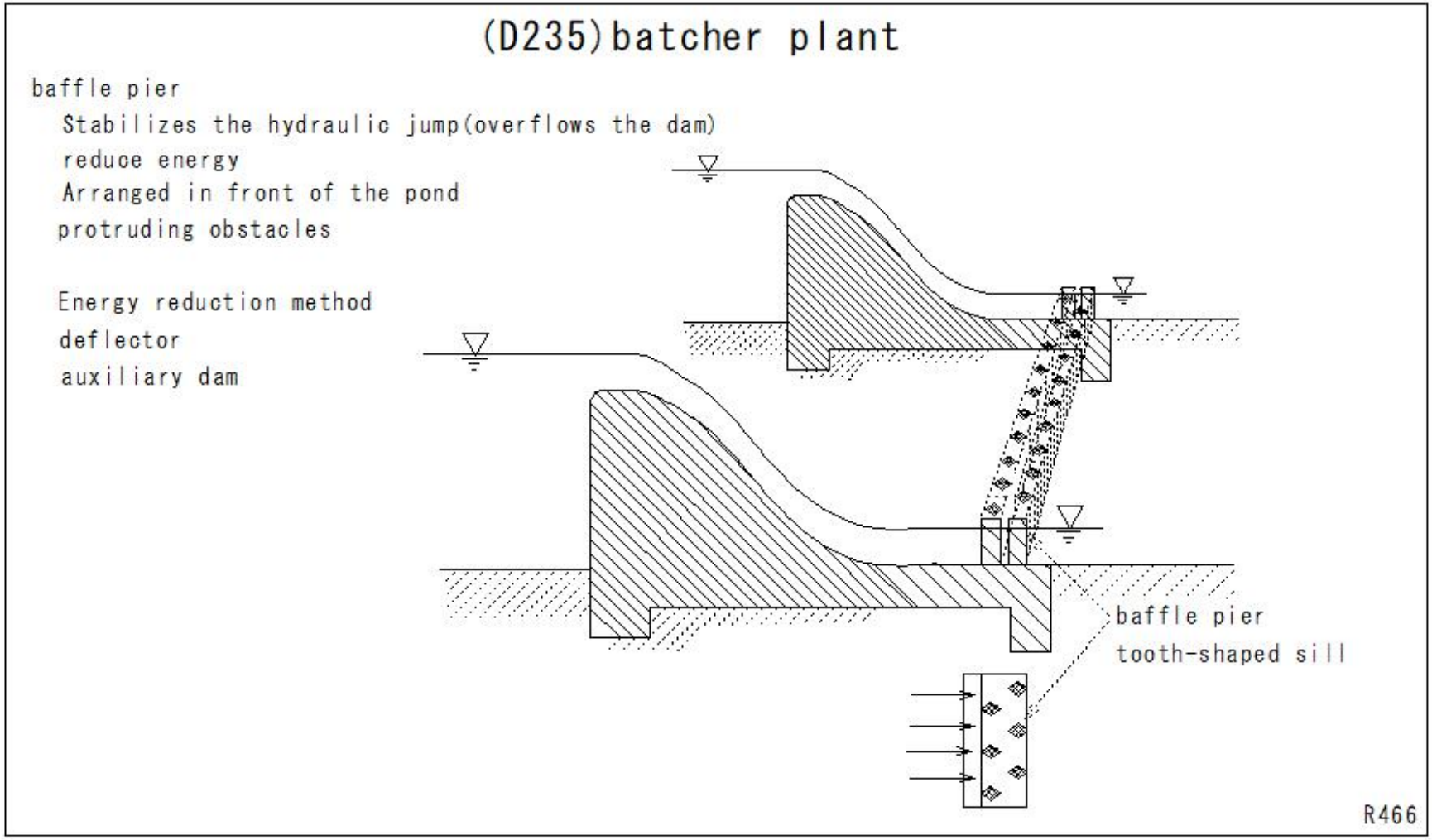
triangular weir

R464

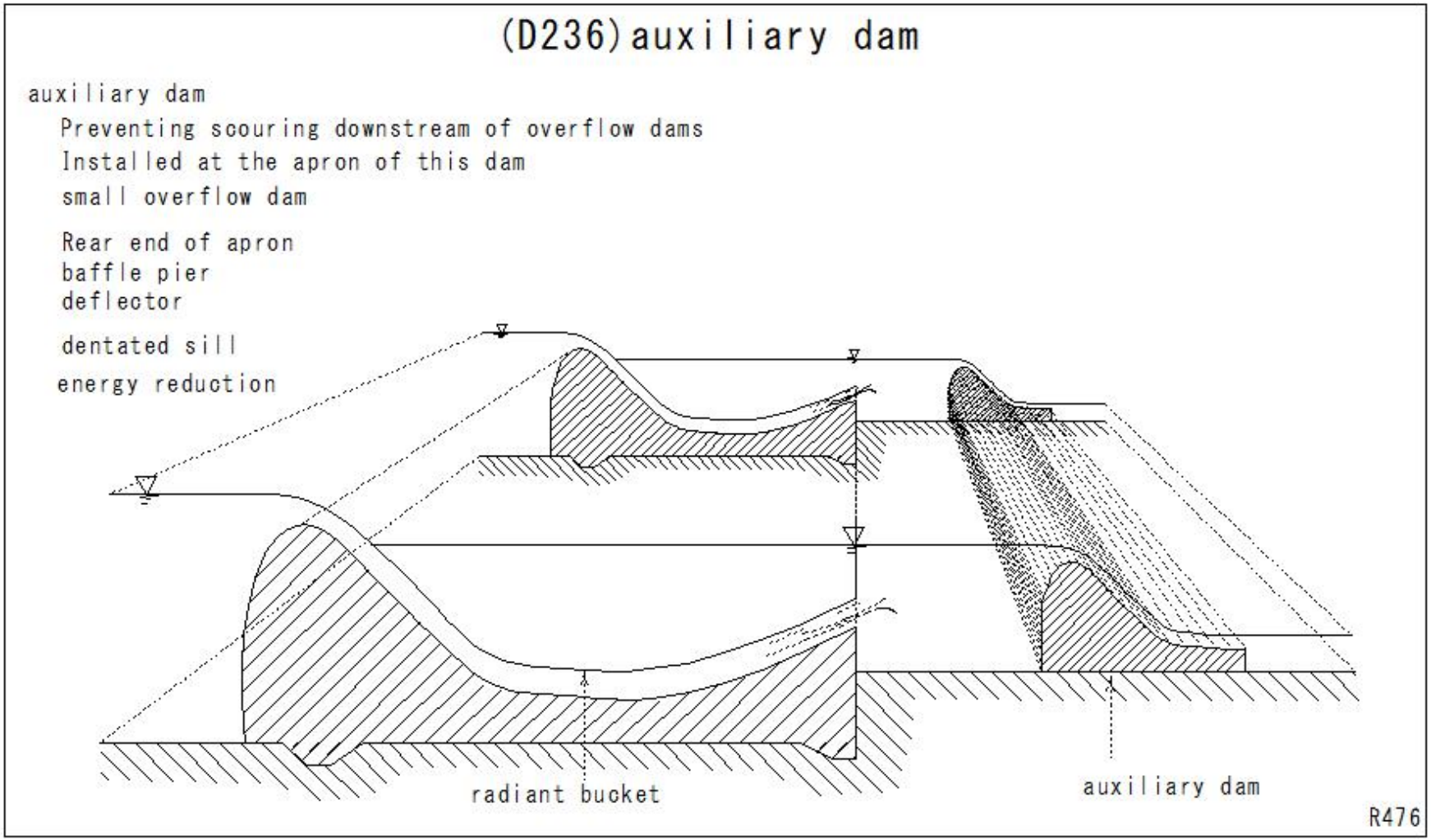
(D234)batcher plant



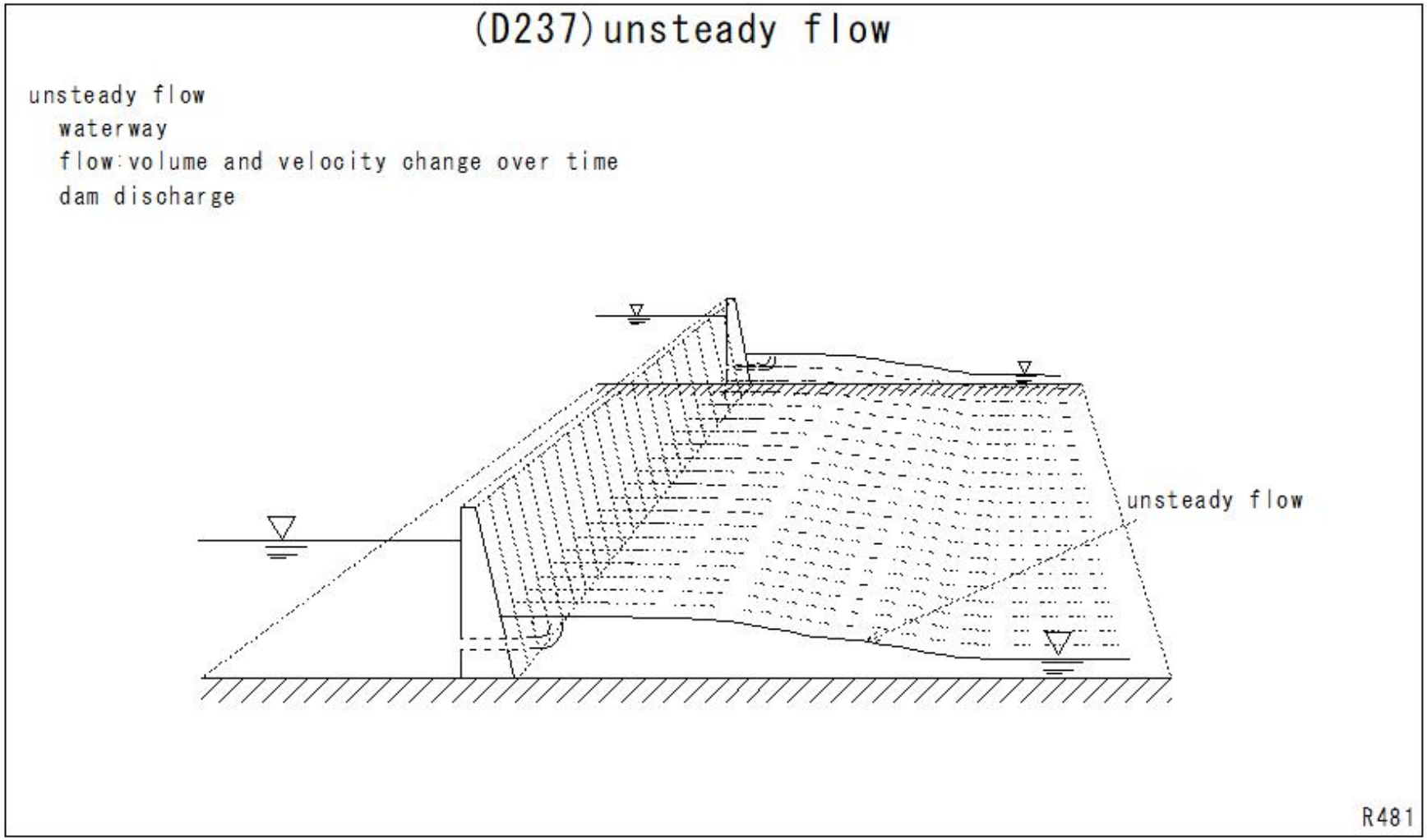
(D235)batcher plant



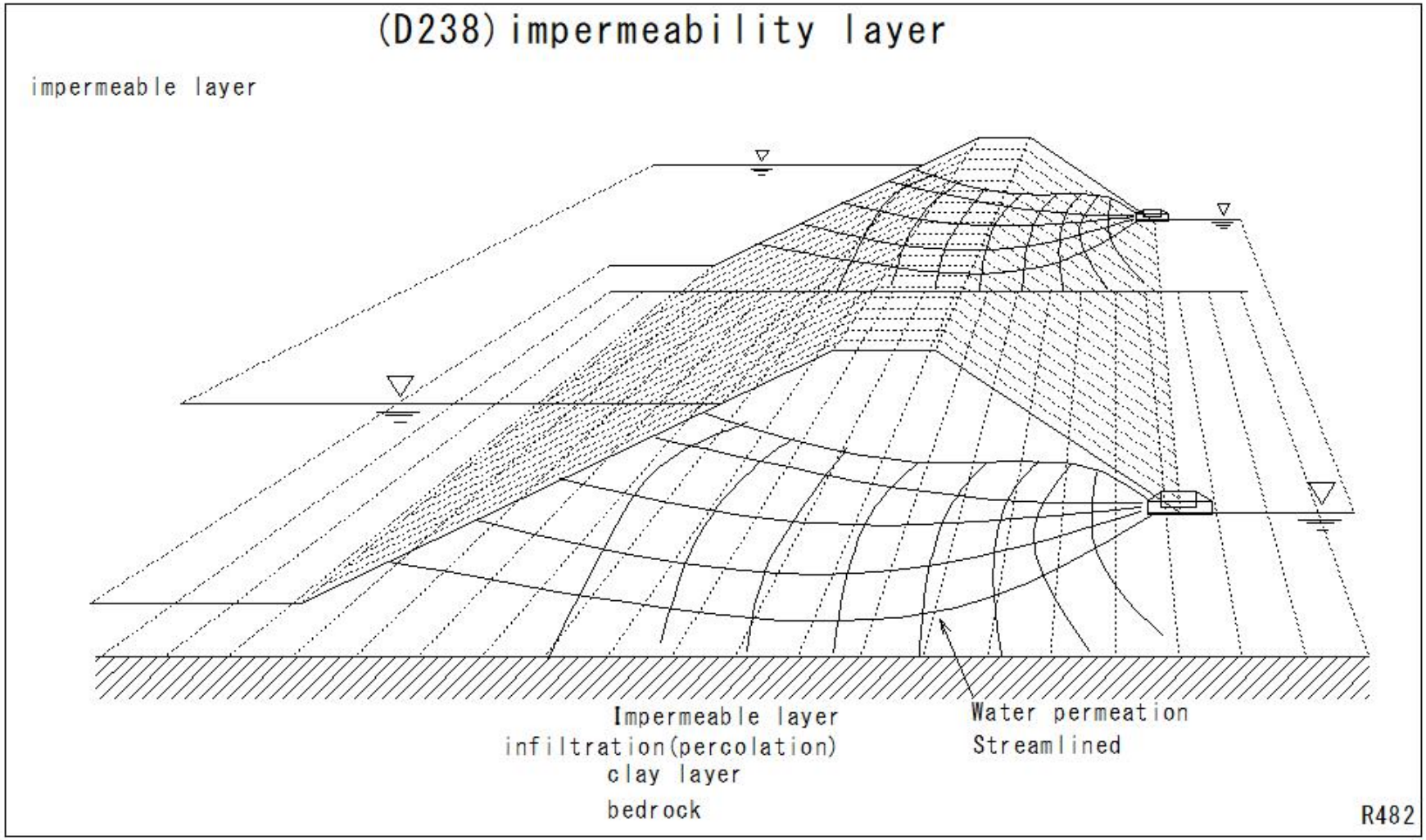
(D236)auxiliary dam



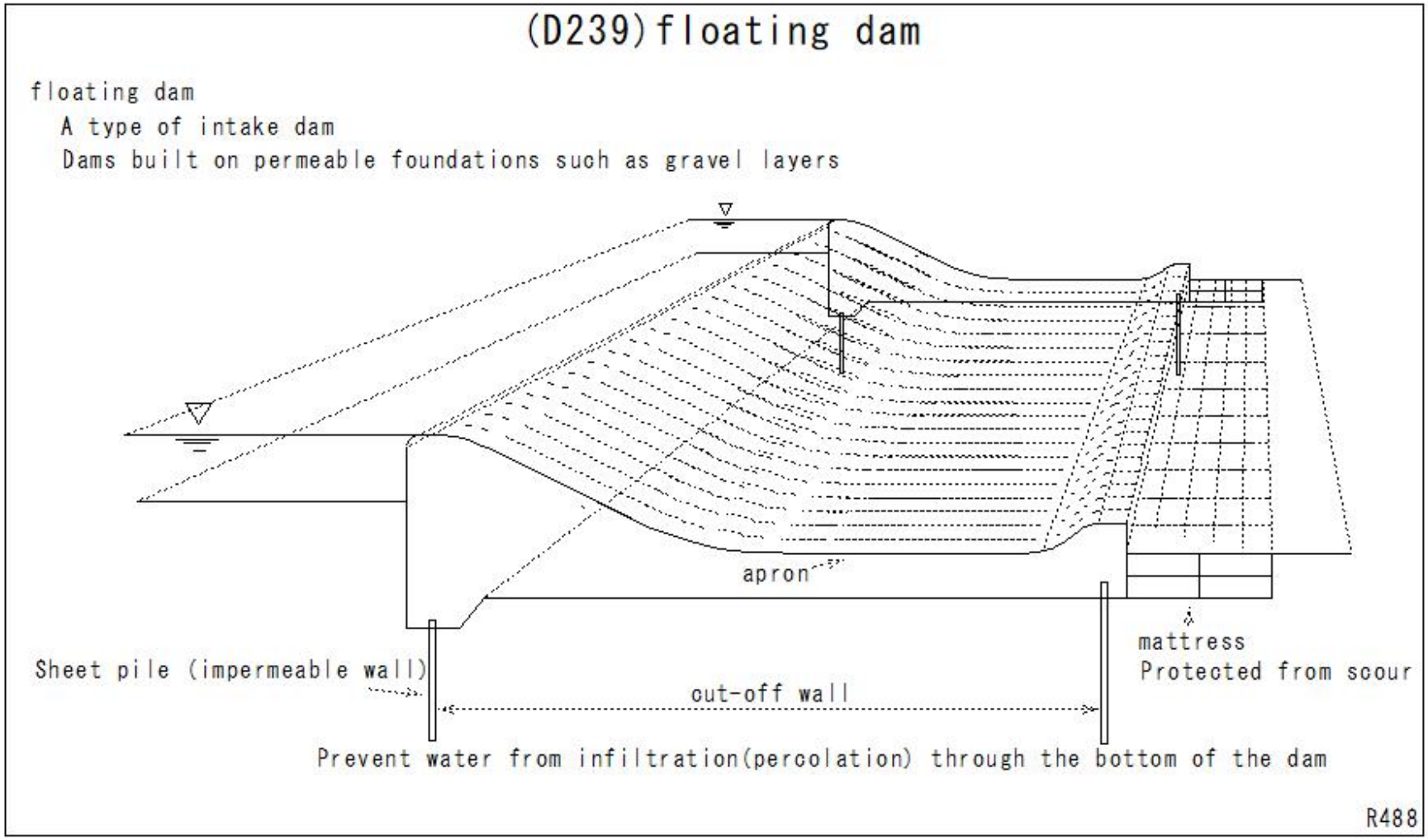
(D237)unsteady flow



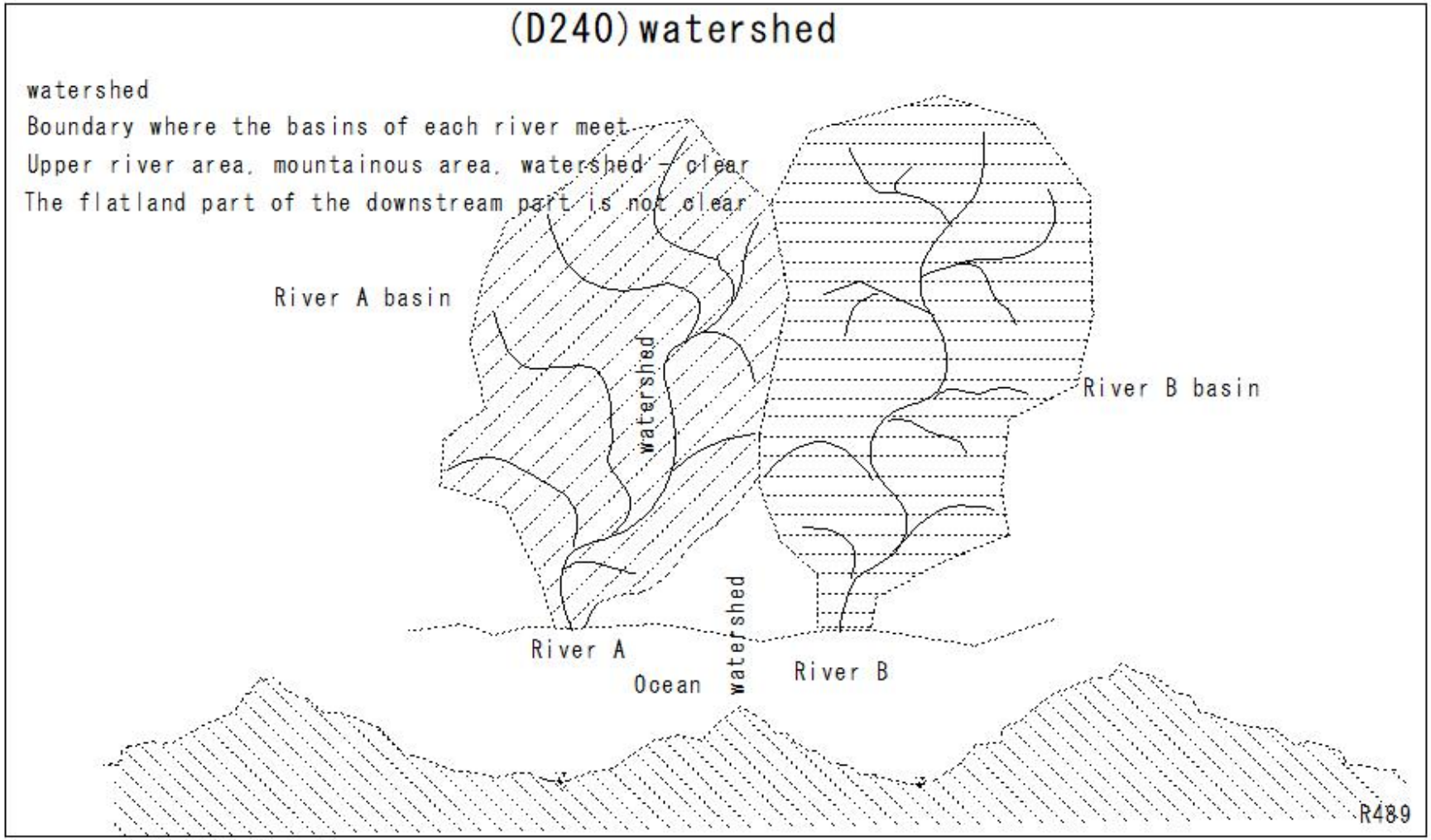
(D238)impermeability layer



(D239)floating dam



(D240)watershed



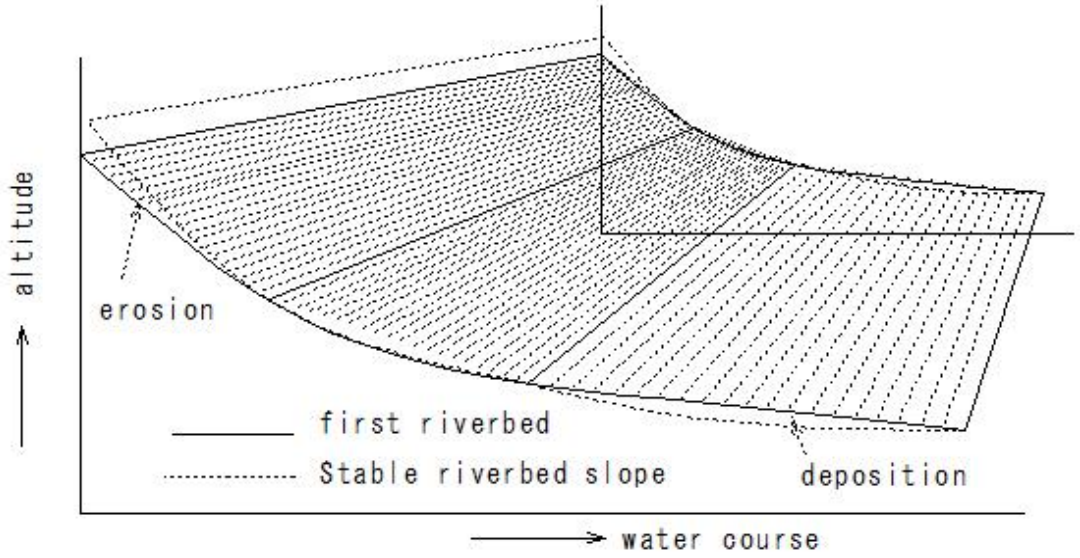
(D241)equilibrium slope

(D241)equilibrium slope

equilibrium slope

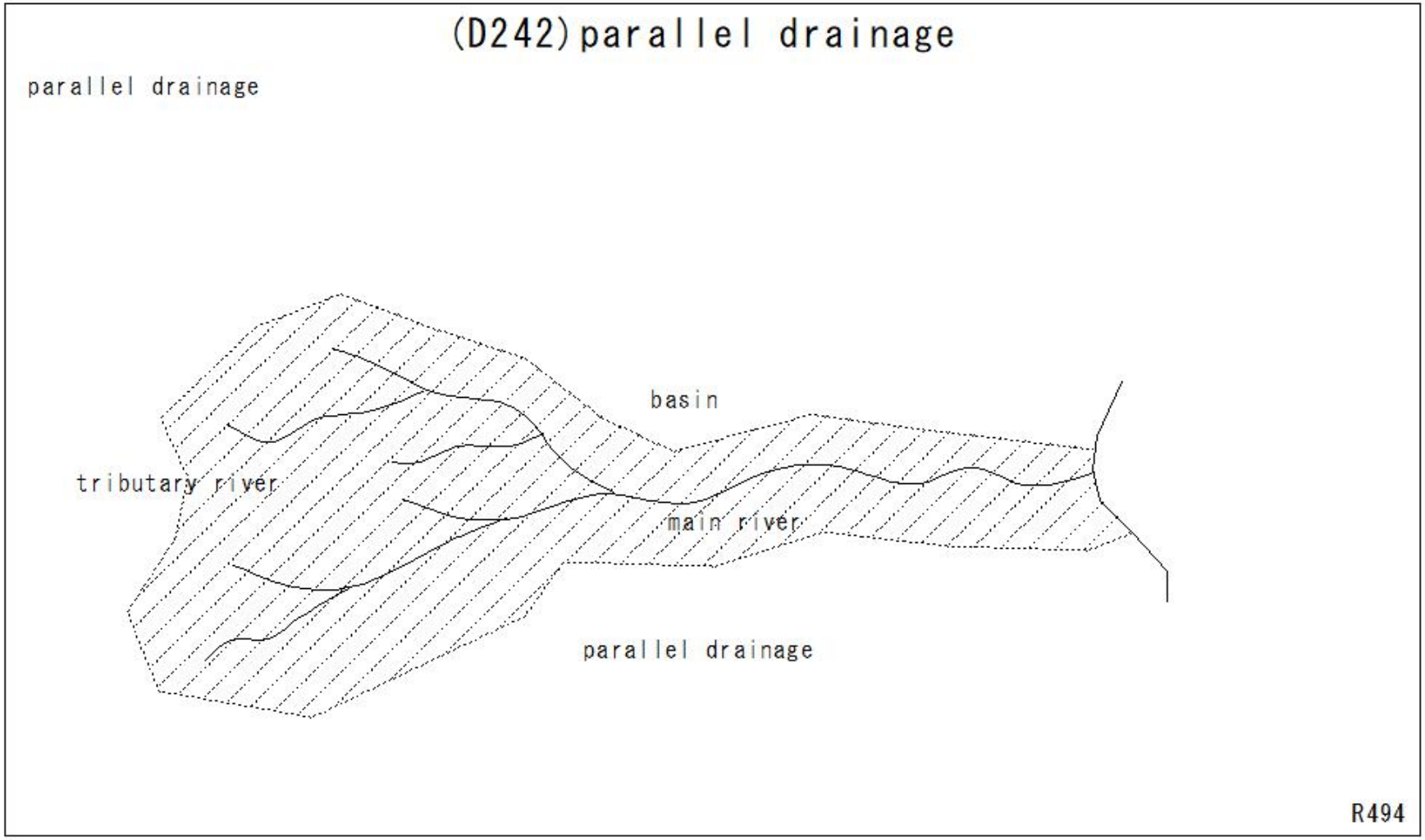
In a river with an equilibrium gradient, neither sedimentation nor scouring occurs.

River water flow, erosion, transportation, deposition

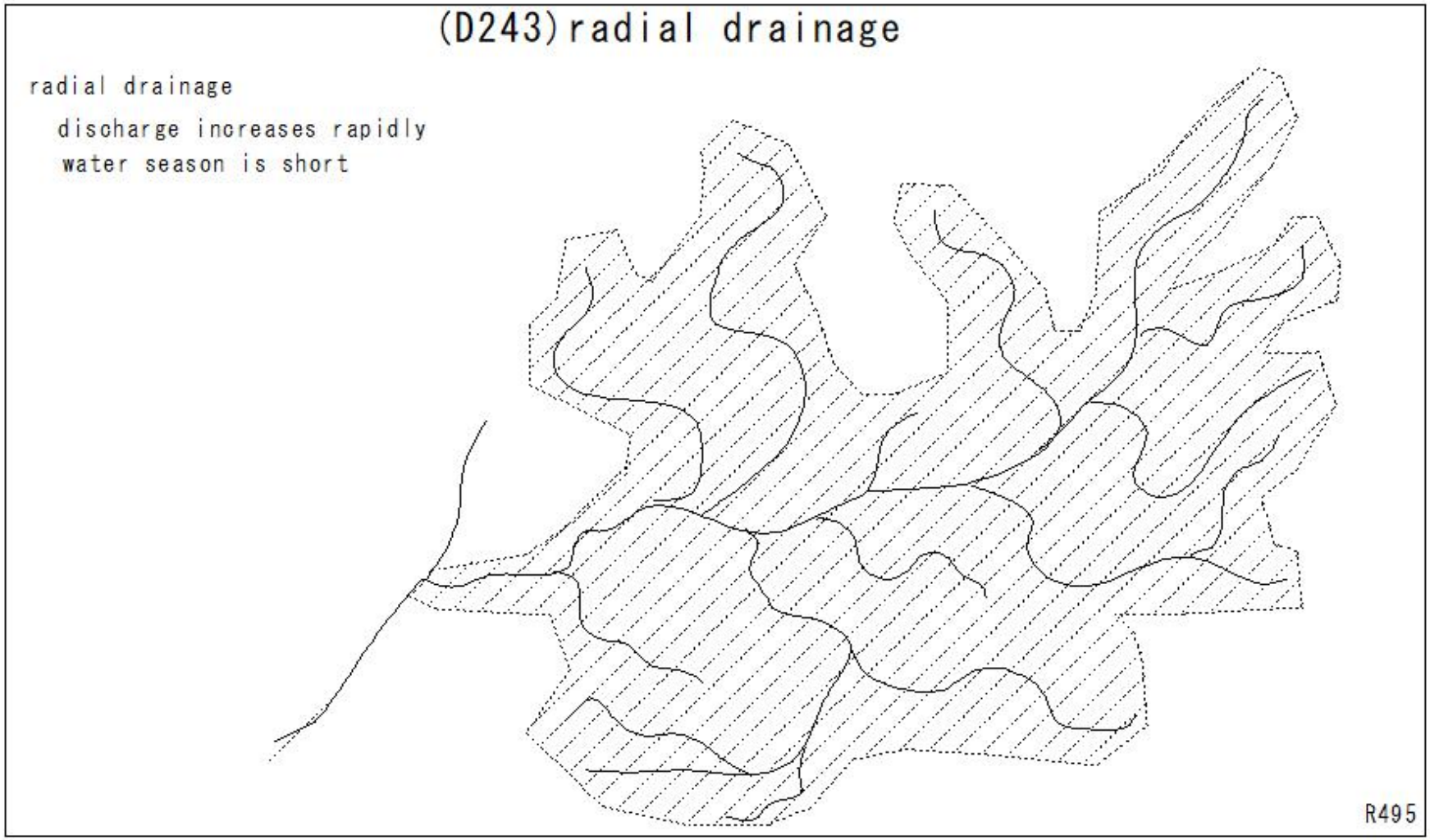


R493

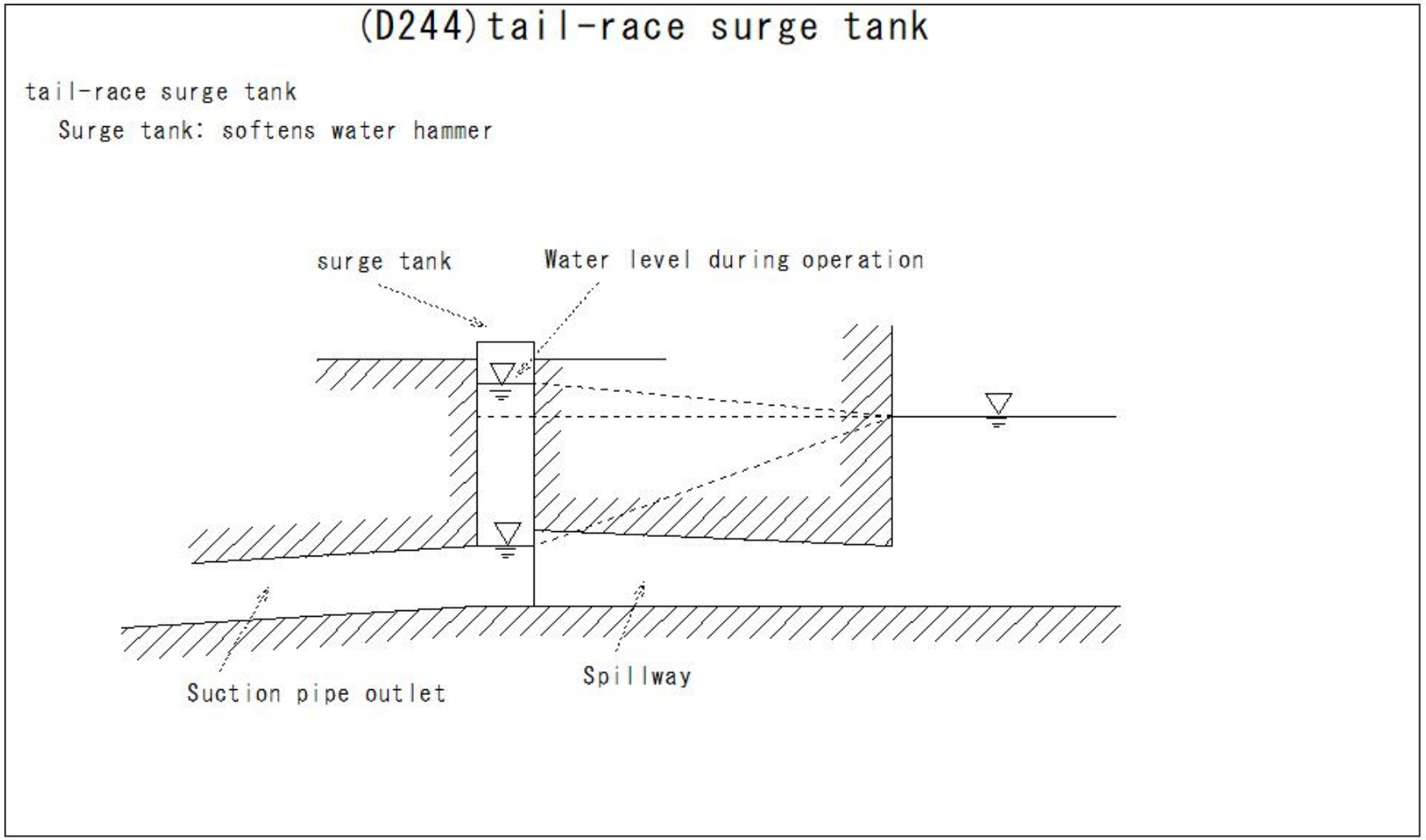
(D242)parallel drainage



(D243)radial drainage



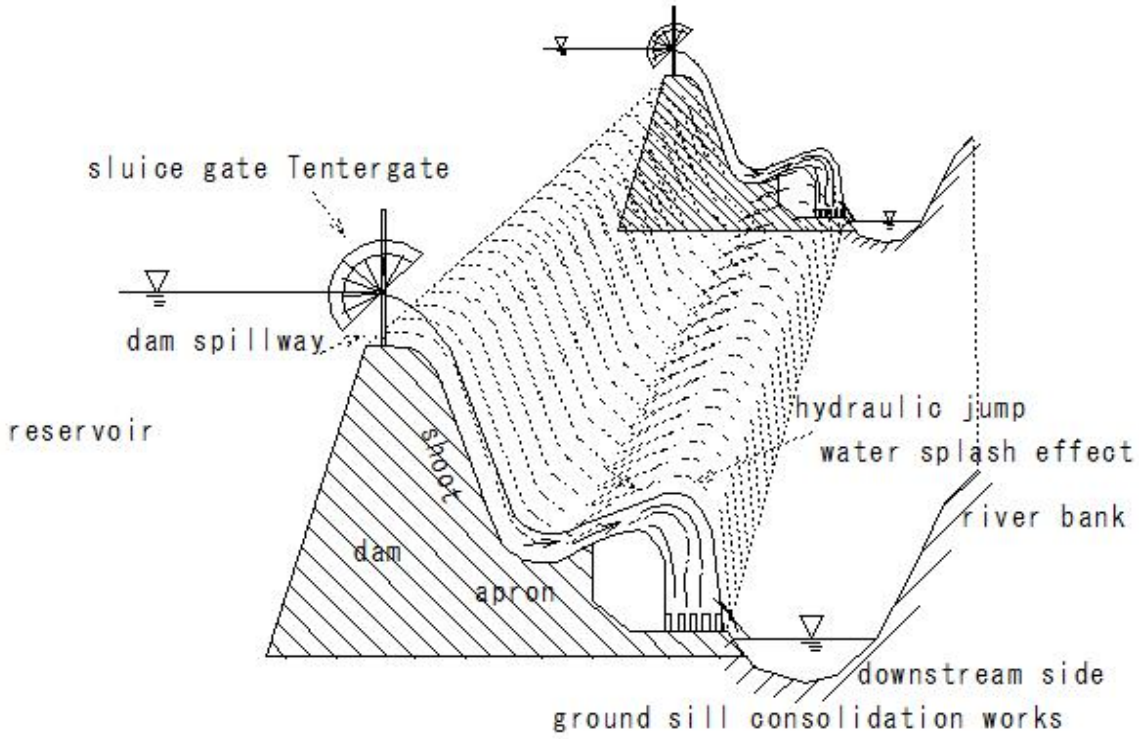
(D244)radial drainage



(D245)spatter's effect

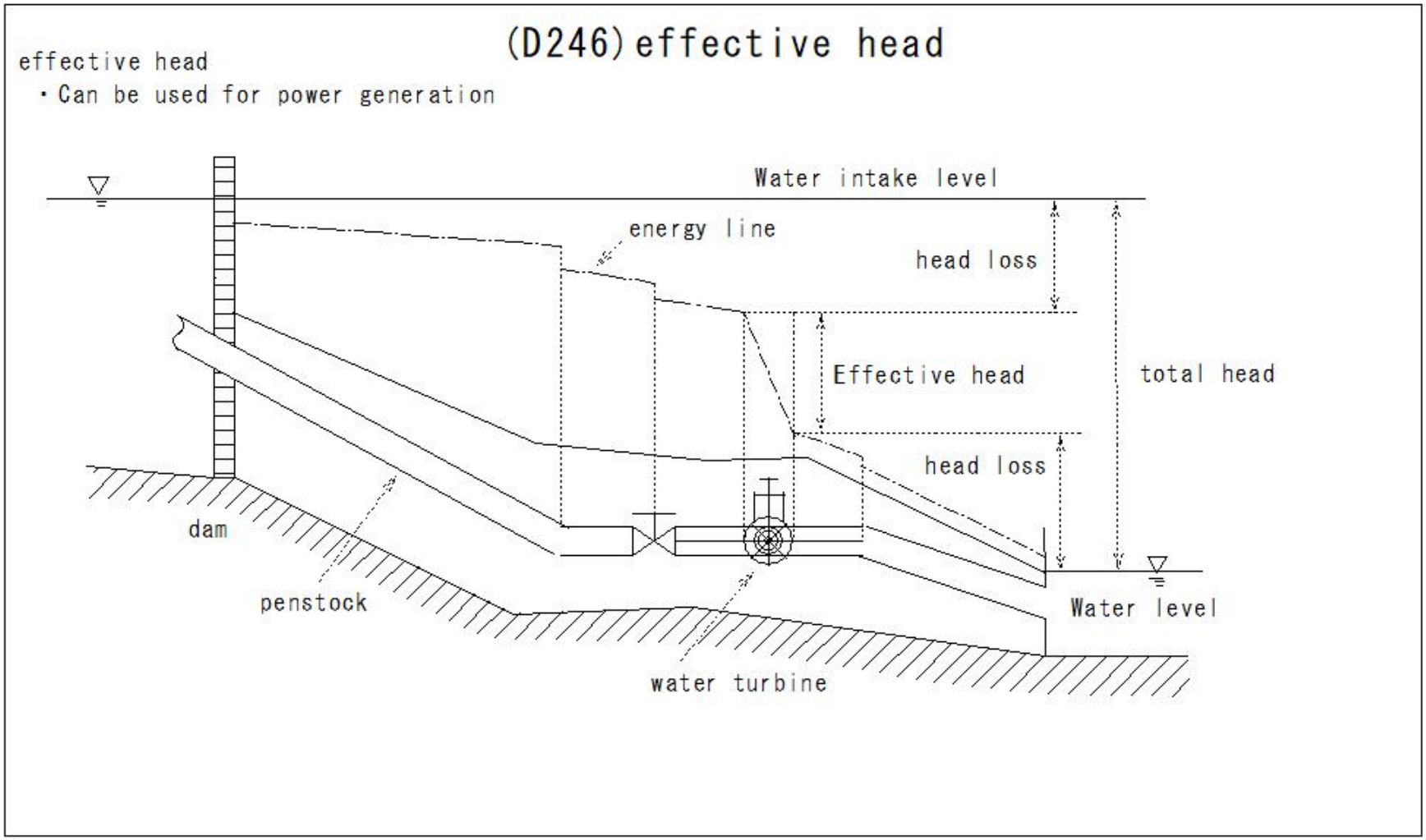
spatter's effect(water splash effect)

Diminishing effect



R498

(D246)effective head



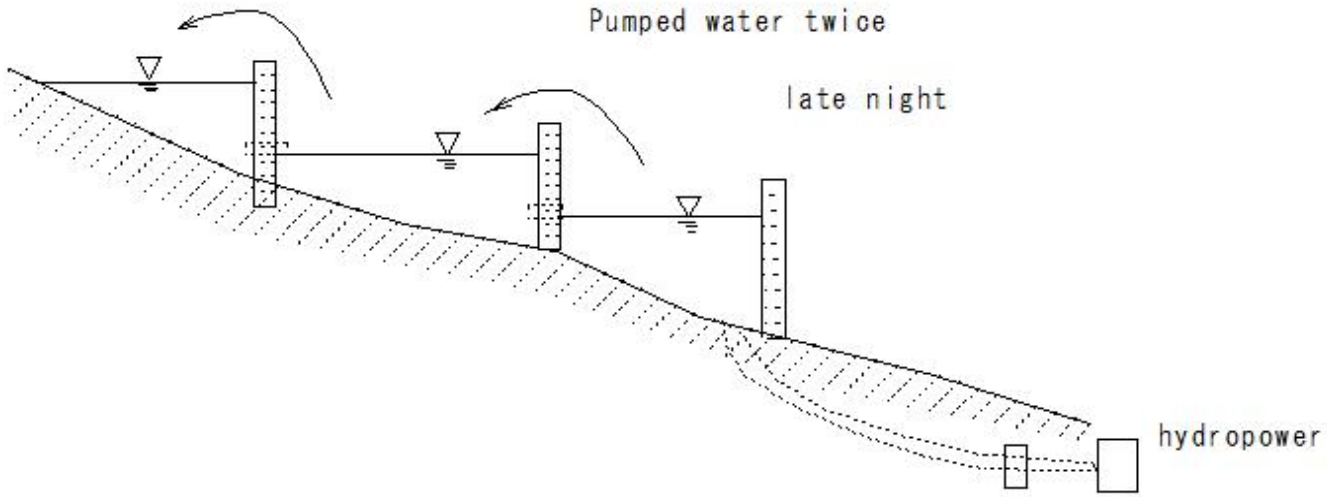
(D247)pumped storage power

(D247)pumped storage power

pumped storage power

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

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

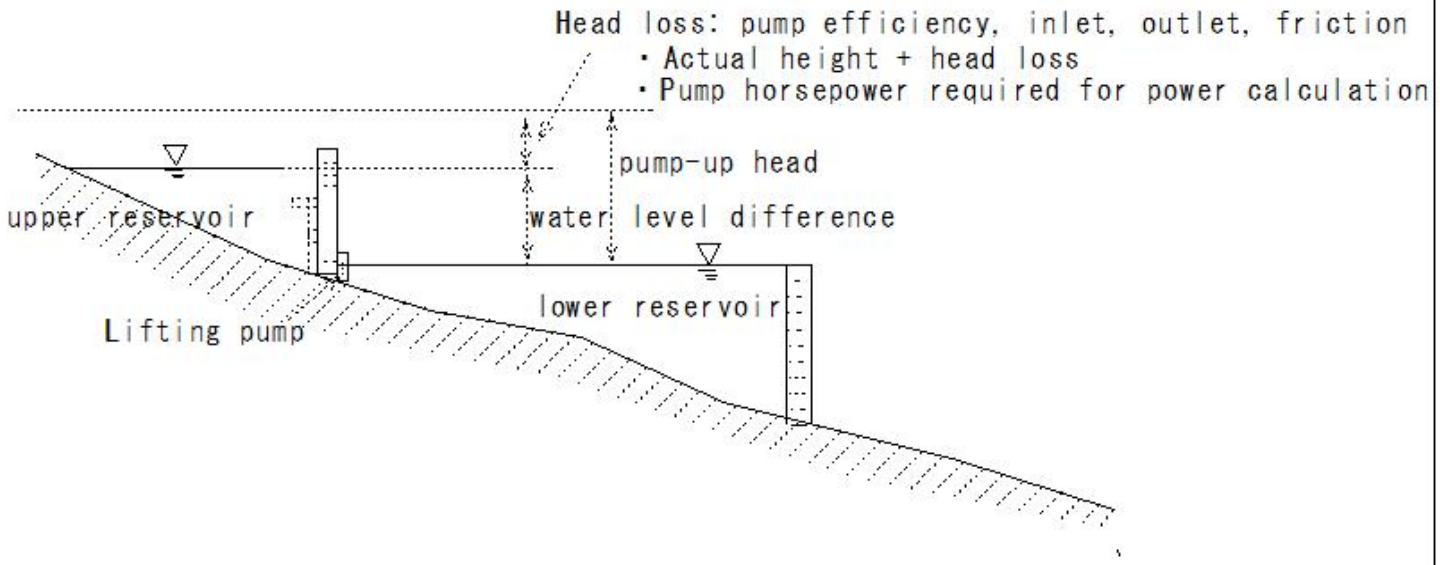


(D248)pump-up head

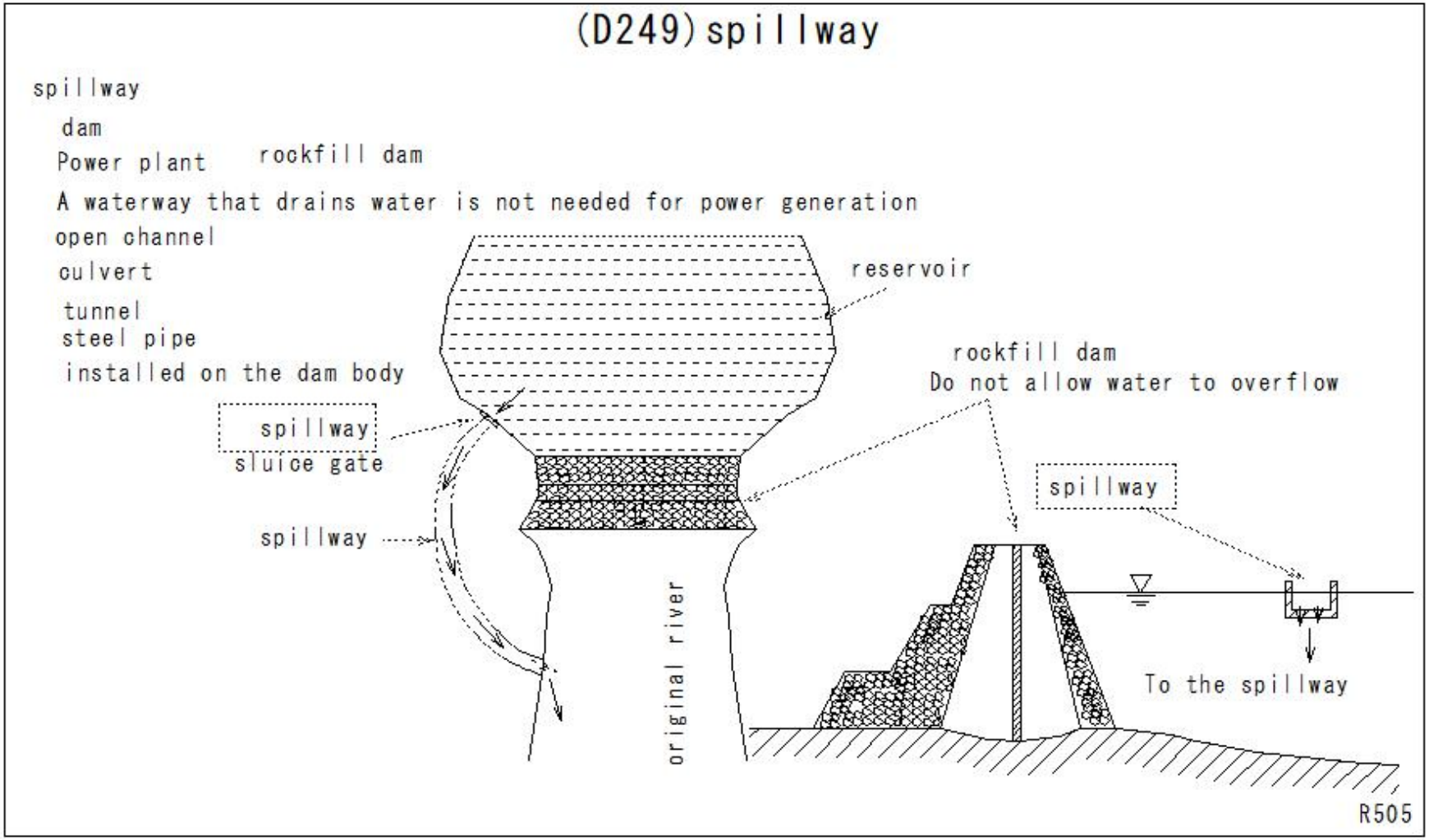
(D248)pump-up head

pump-up head

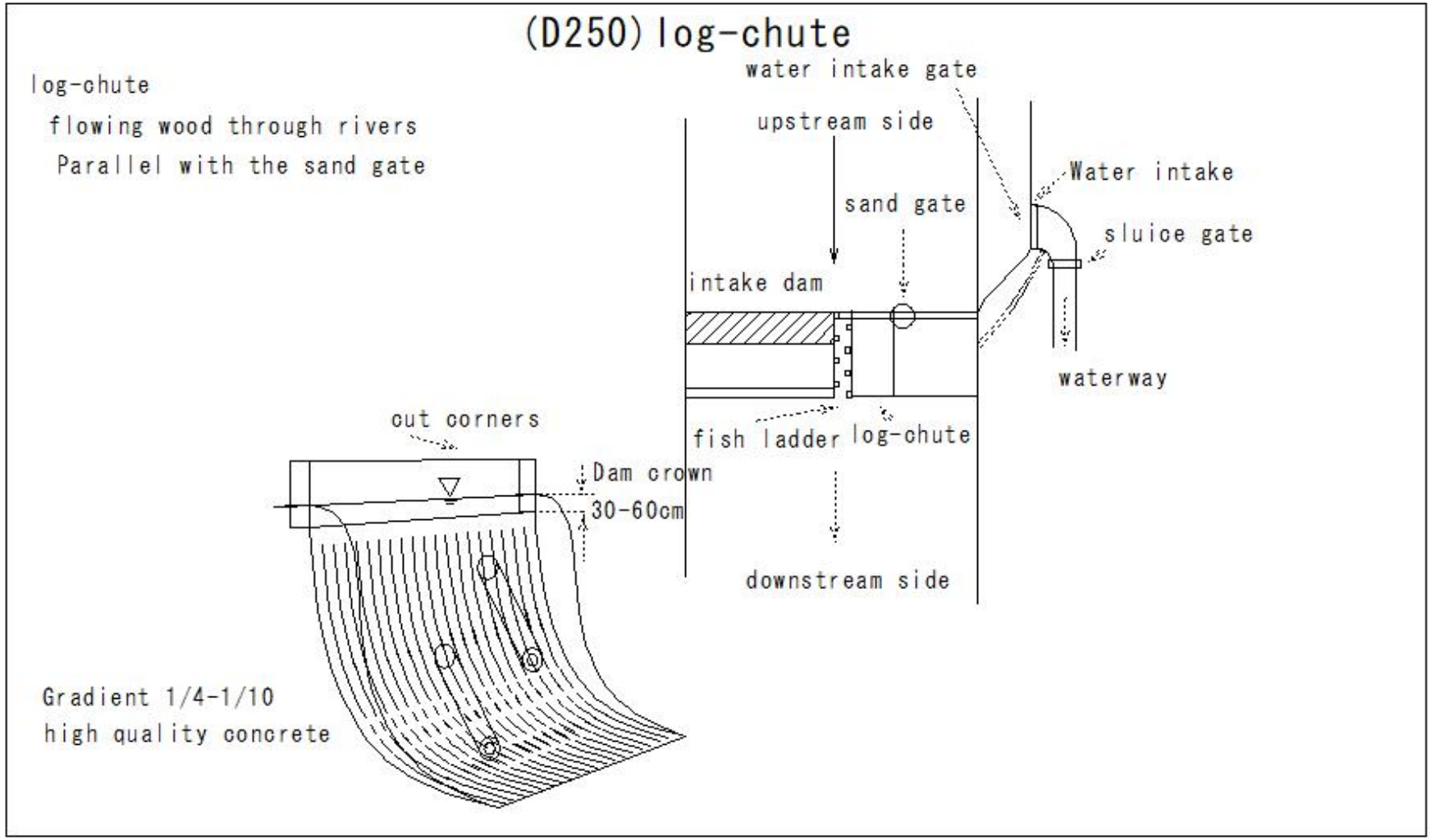
- Pump water
- height considering loss



(D249)spillway



(D250)log-chute



(D251)basin coefficient

(D251)basin coefficient

basin coefficient

Used to understand the shape and properties of rivers

F＝A/L＾2

F: basin coefficient

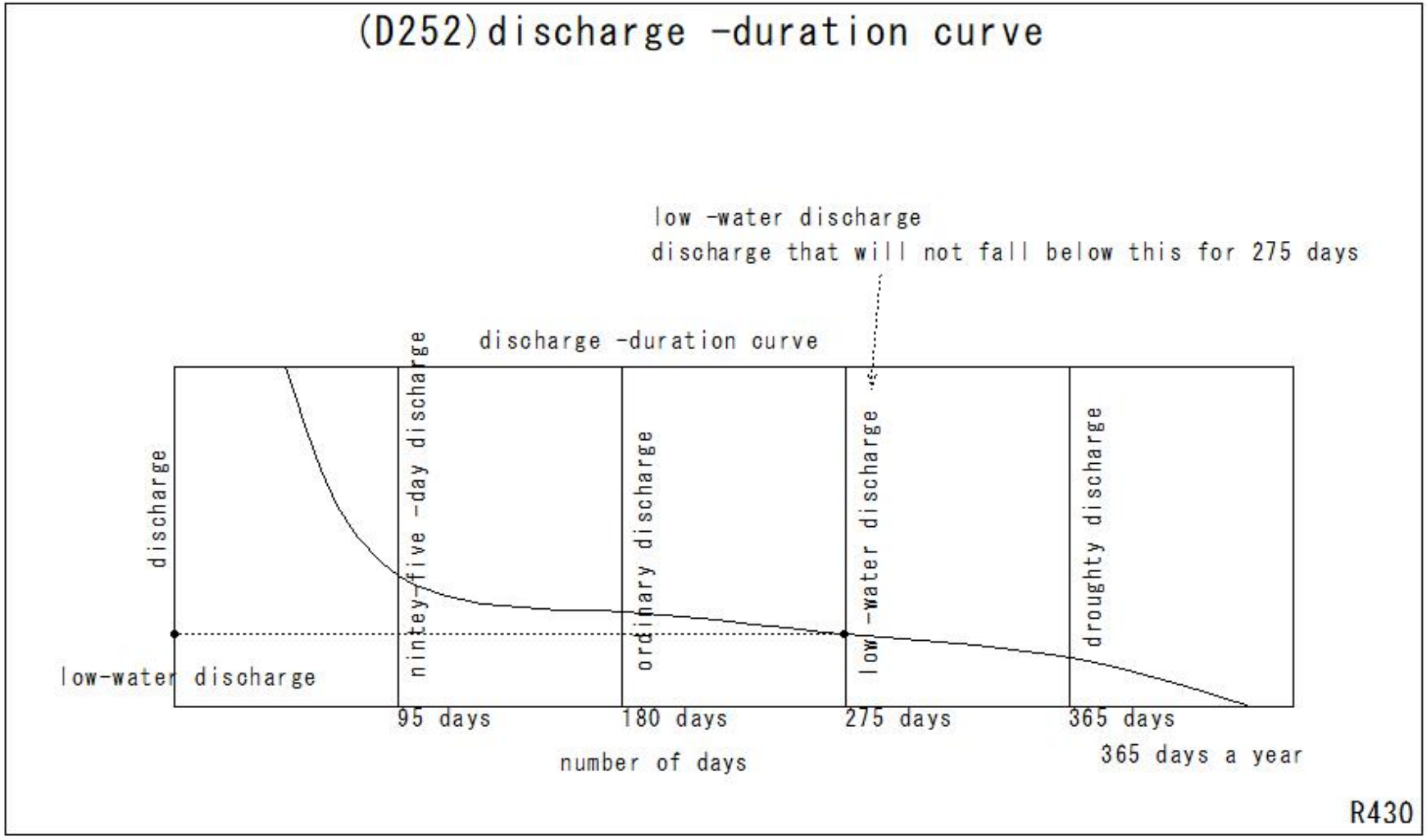
A: Basin area

L: Extension of main water course

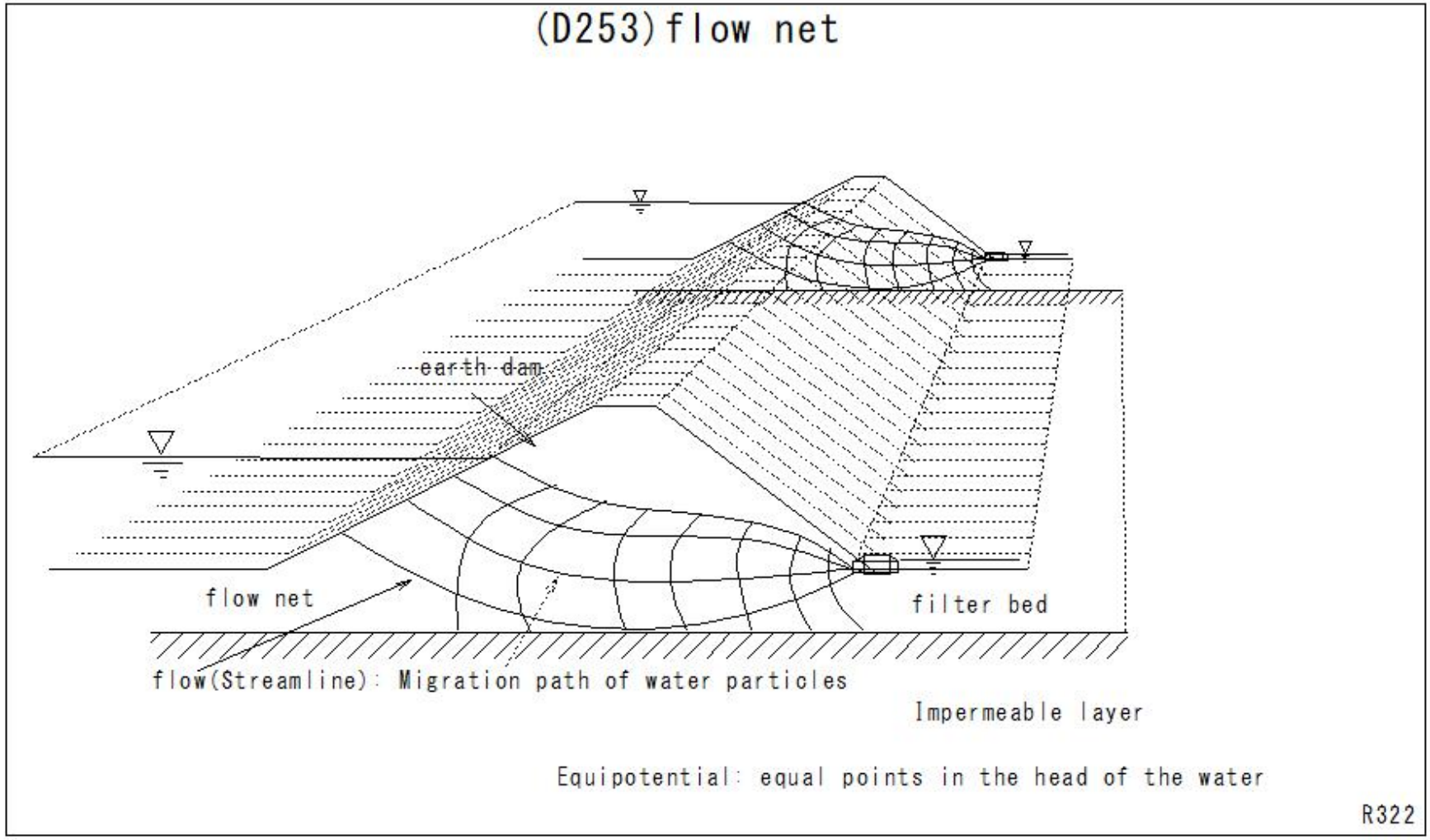
value of (F)	basin	Water flow time	Maximum discharge	Shape example
Big	wide range	short	Big	
small	long	long	small	

R511

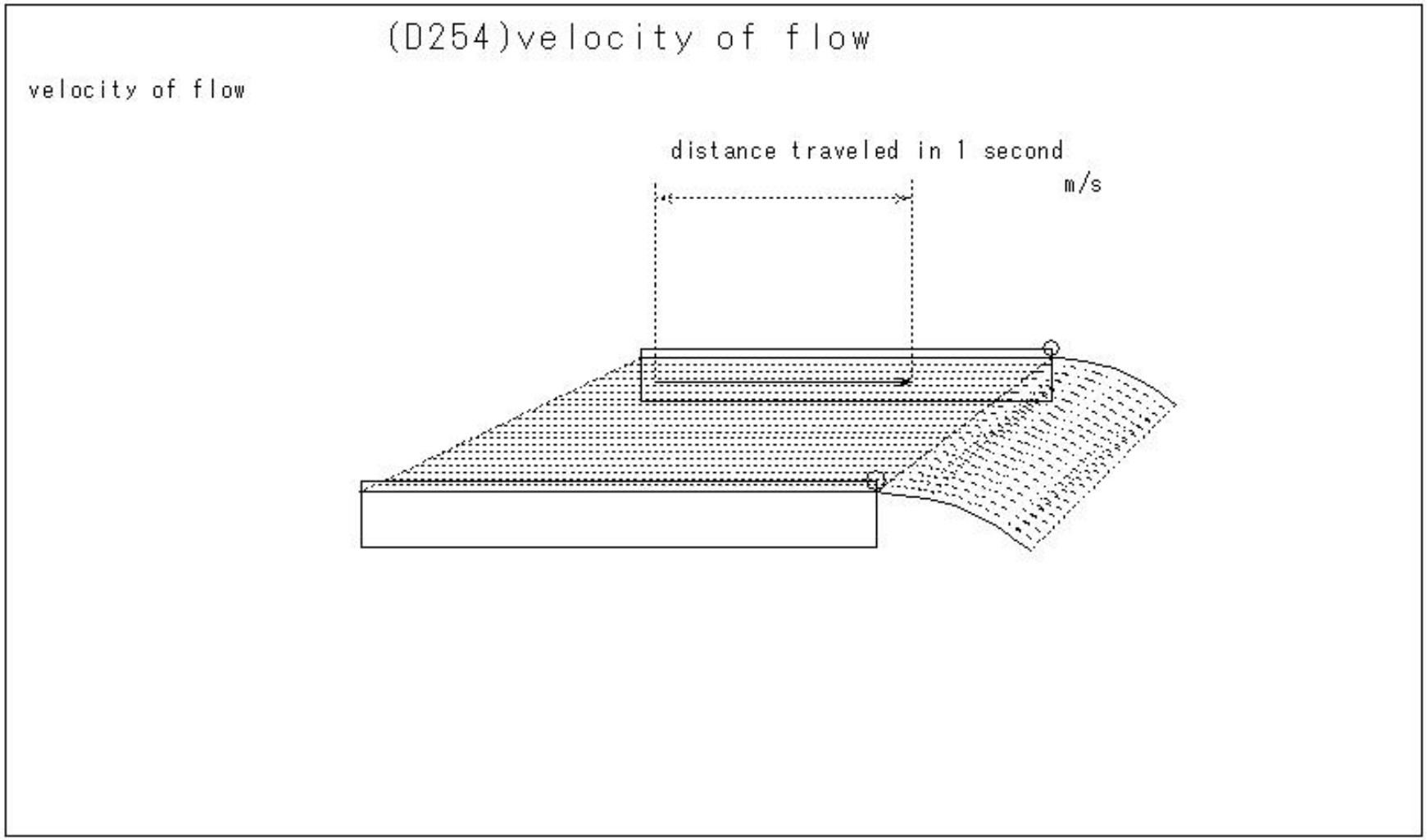
(D252)discharge -duration curve



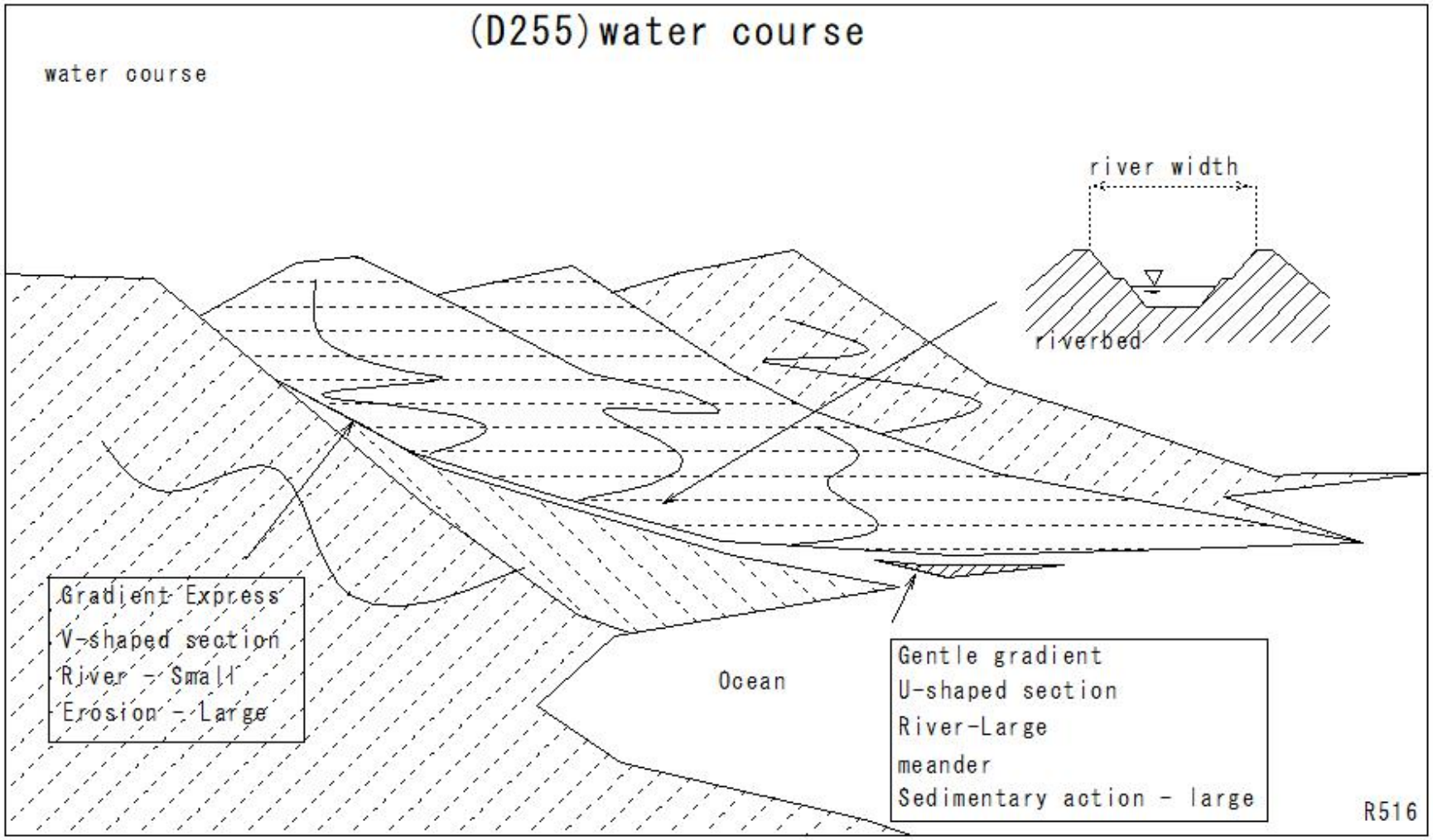
(D253)flow net



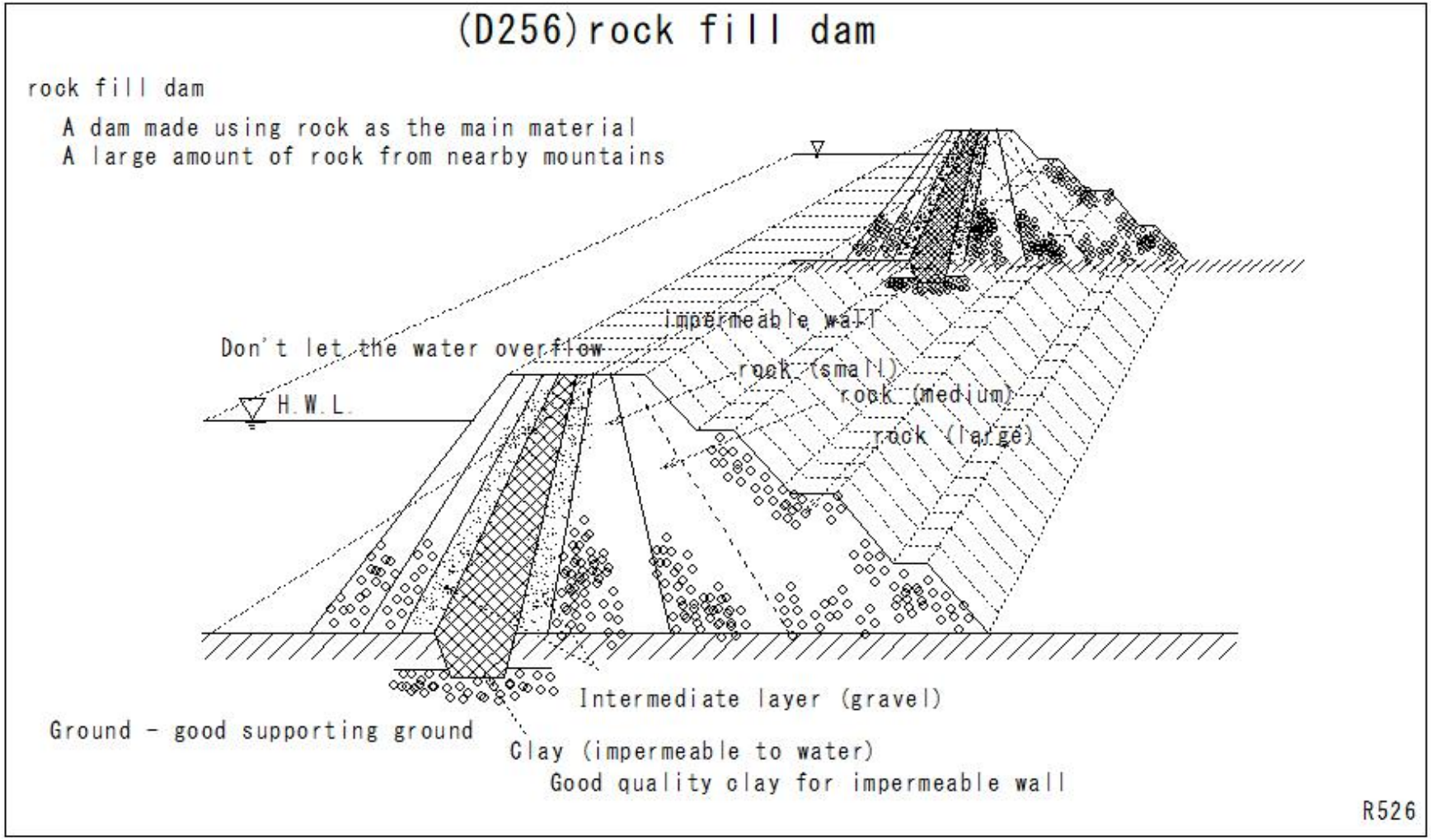
(D254)velocity of flow



(D255)water course



(D256)rock fill dam

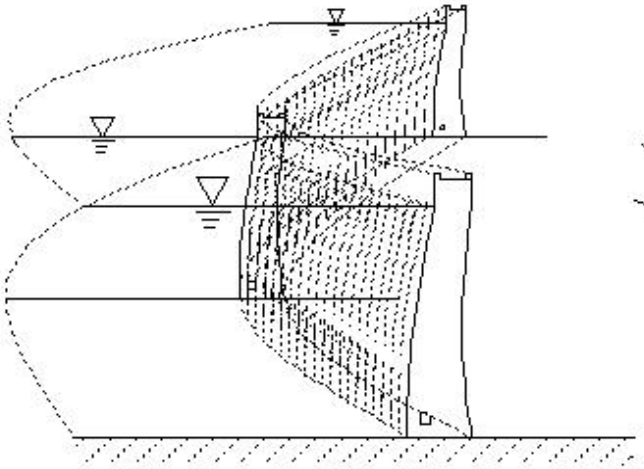


(D257)concrete arch dam

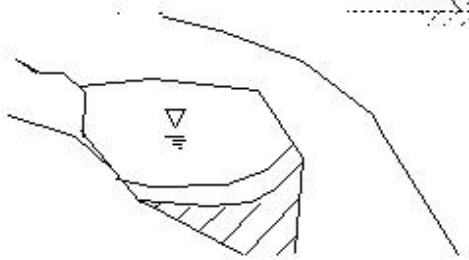
(D257)concrete arch dam

concrete arch dam

- Arch action
- Hydraulic load of reservoir
- Supported by foundation rock on both banks
- Hard foundation rock
- Narrow valley width

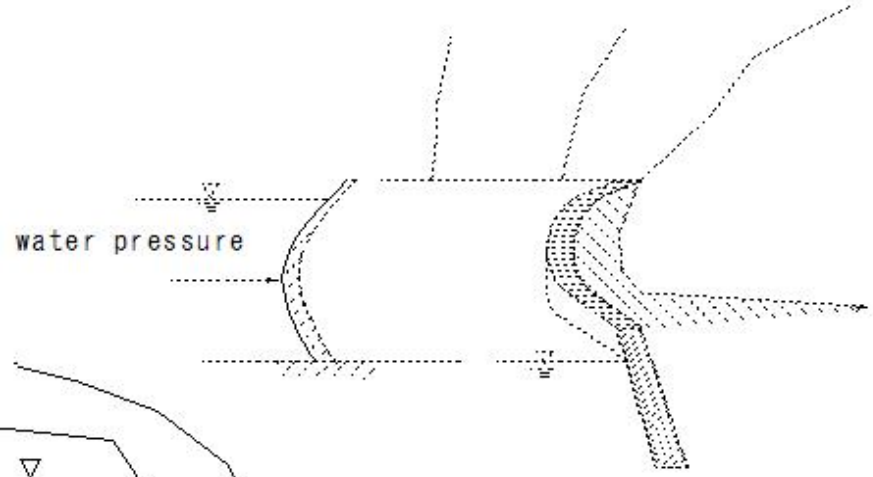


D3



Arch dam

C904



Arch dam

C1233

D155

(D258)roller compacted concrete dams(RCD)

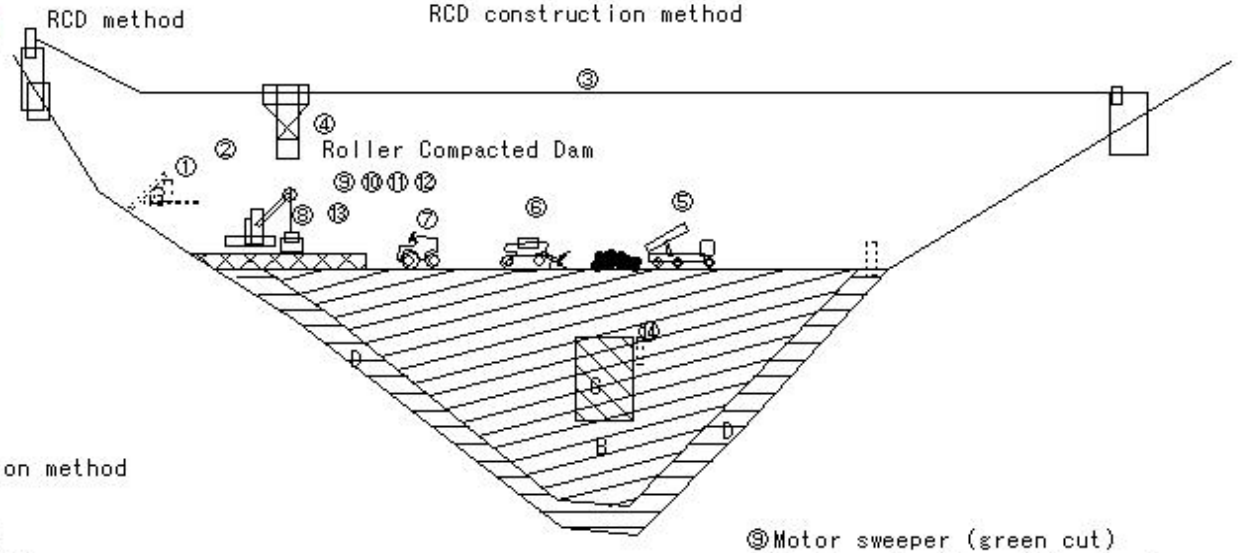
(D258)roller compacted concrete dams(RCD)

Construction of concrete dam using RCD method

Characteristics of RCD method

④Placing method

Full layer method



RCD construction method

①Batcher plant
②Bunker (bucket)
③Fixed cable crane
④Mobile hopper
⑤Dump truck transportation
⑥Bulldozer laying
⑦Vibrating roller (compaction)
⑧Joint cutter
(vibration press fit type)

⑨Motor sweeper (green cut)
⑩Washing (washing with water)
⑪Watering curing
⑫Laying the next layer of mortar
⑬Vibrating joint cutting machine
⑭Human-powered compaction

D77
C981

(D259) compacted concrete dams(RCD)

(D259)roller compacted concrete dams(RCD)

Construction of concrete dam using RCD method

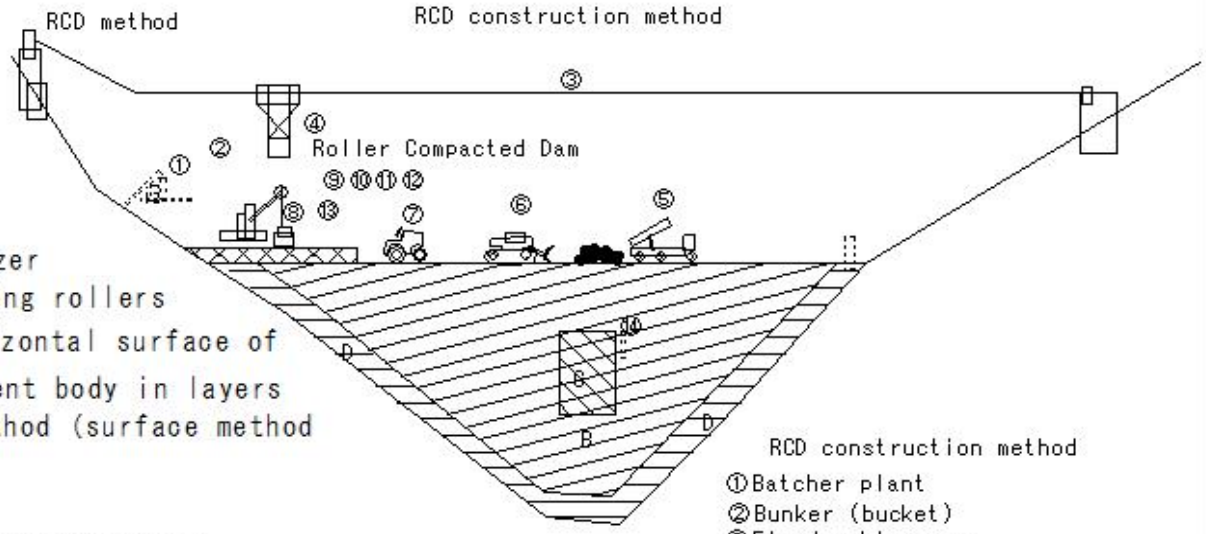
RCD method

- Streamlining dam construction
- Poor mix ultra-hard concrete
- Concrete for RCD
- Dump truck
- Fixed cable crane
- Incline
- belt conveyor

transportation

spreading with a bulldozer

- Compaction using vibrating rollers
- Concrete the entire horizontal surface of the embankment body in layers
- Full surface layer method (surface method



A Mix Proportion: Upstream and downstream concrete
B Mix Proportion: Internal concrete
C Mix Proportion: Concrete around the structure
D Mix Proportion: Impregnated concrete

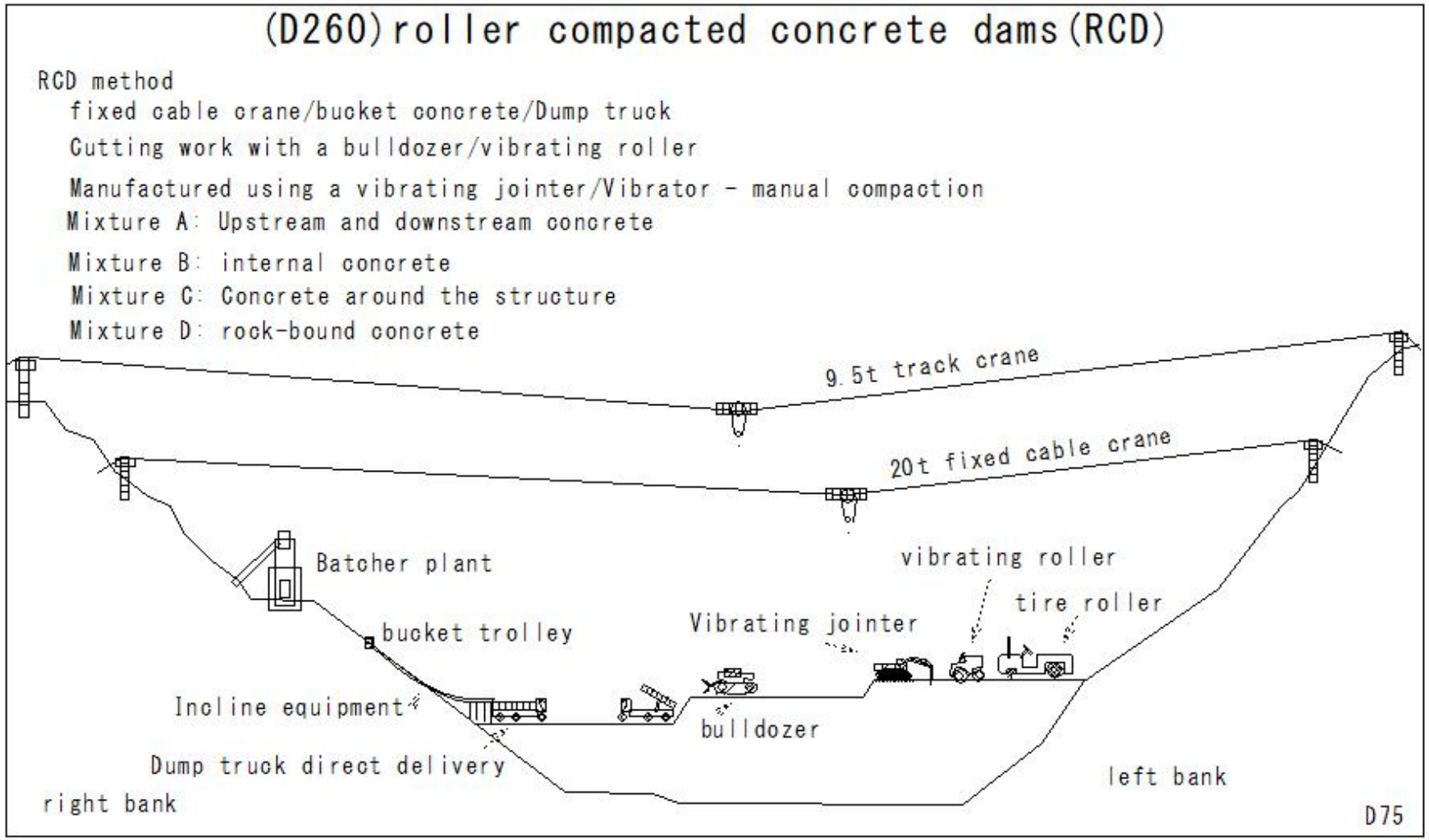
⑨Motor sweeper (green cut)
⑩Washing (washing with water)
⑪Watering curing
⑫Laying the next layer of mortar
⑬Vibrating joint cutting machine
⑭Human-powered compaction

RCD construction method

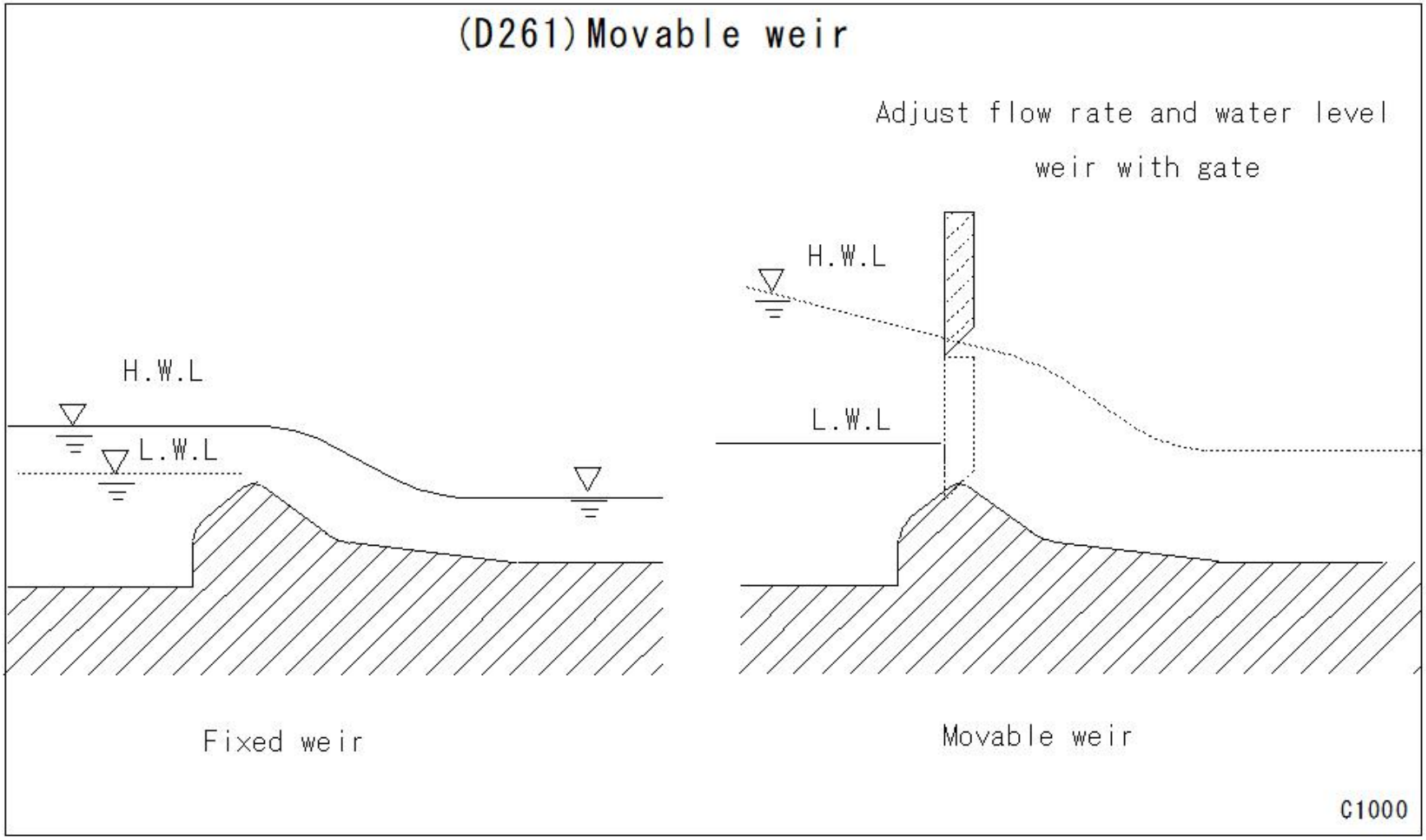
①Batcher plant
②Bunker (bucket)
③Fixed cable crane
④Mobile hopper
⑤Dump truck transportation
⑥Bulldozer laying
⑦Vibrating roller (compaction)
⑧Joint cutter (vibration press fit type)

D74
C981

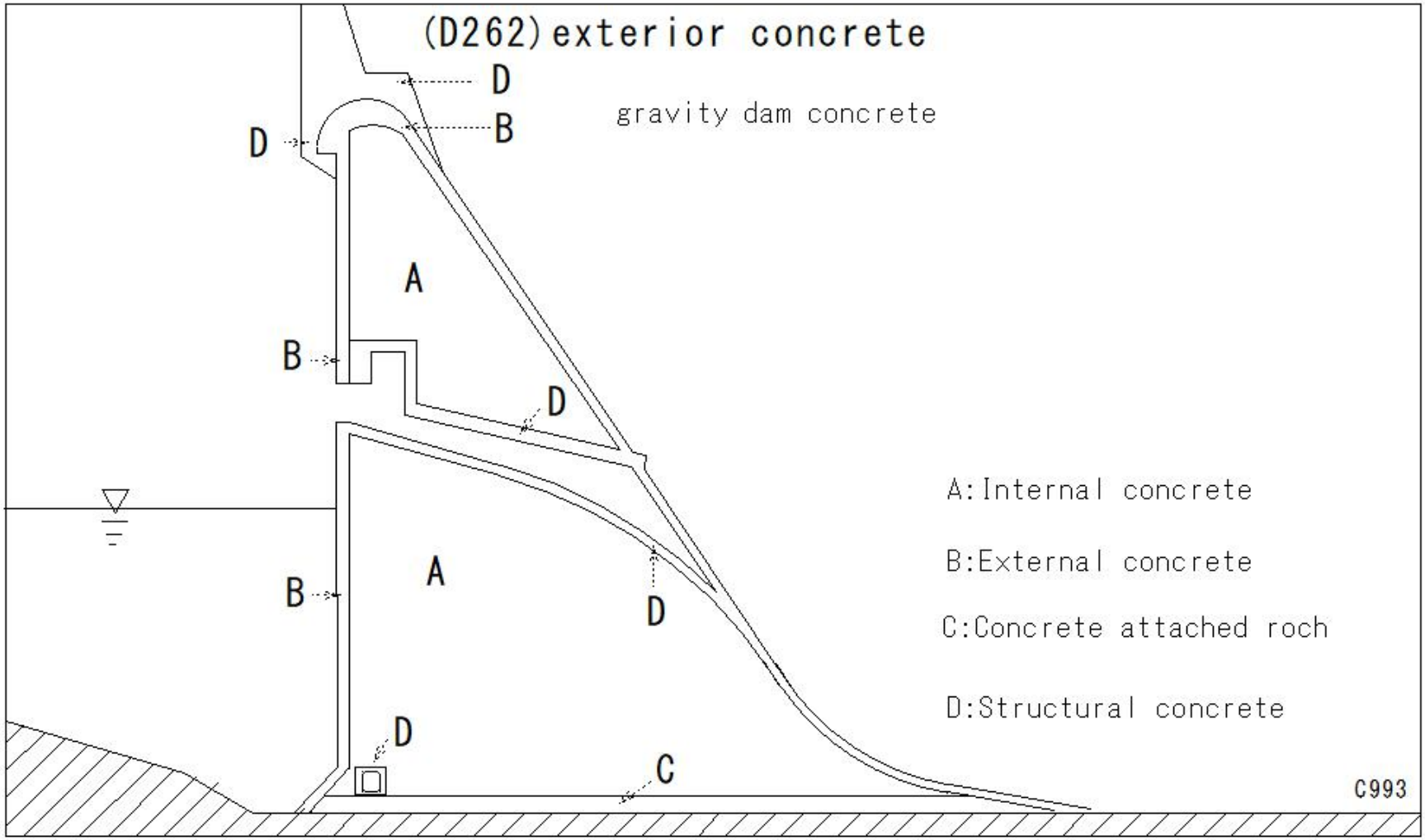
(D260)roller compacted concrete dams(RCD)



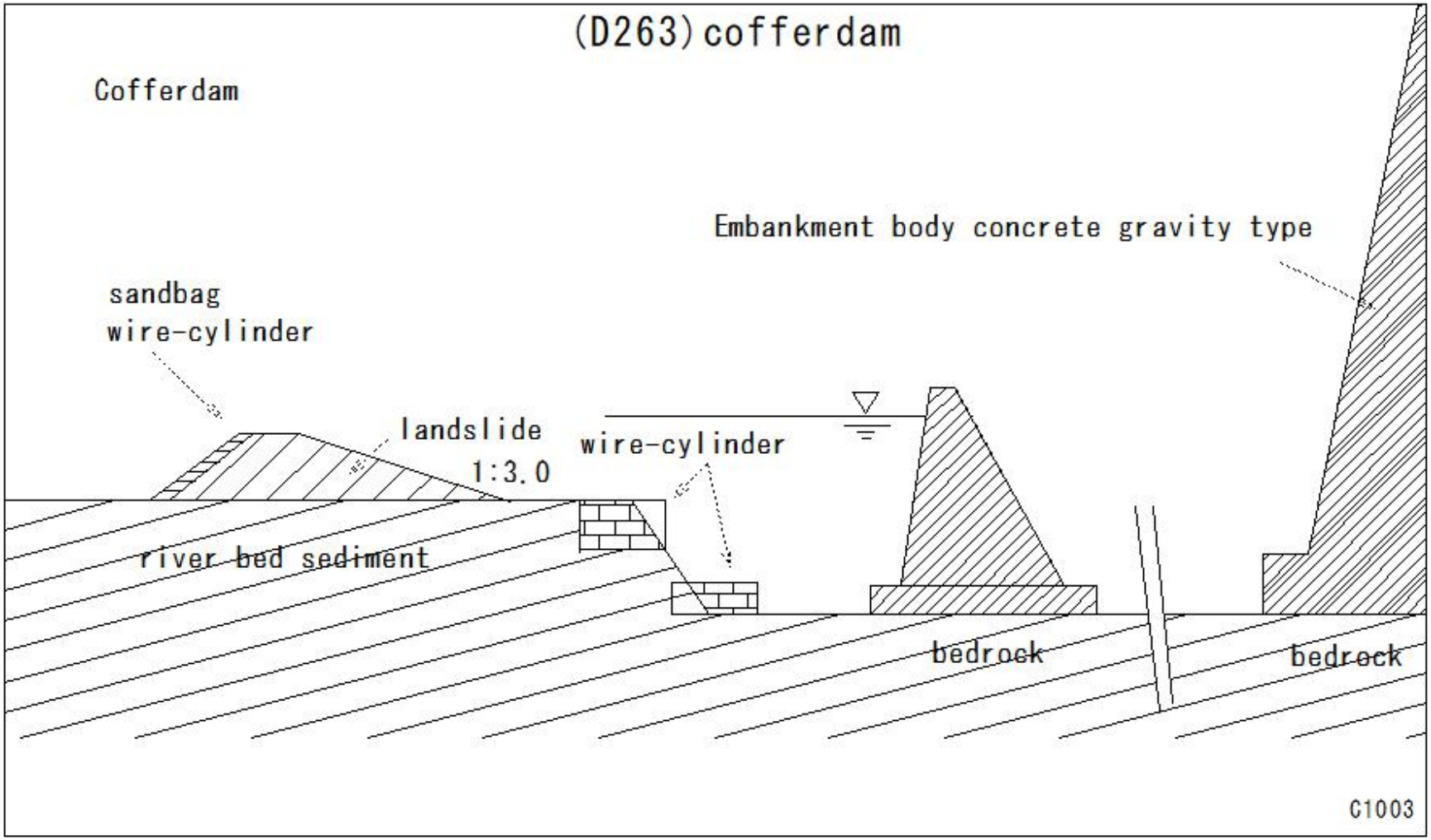
(D261)Movable weir



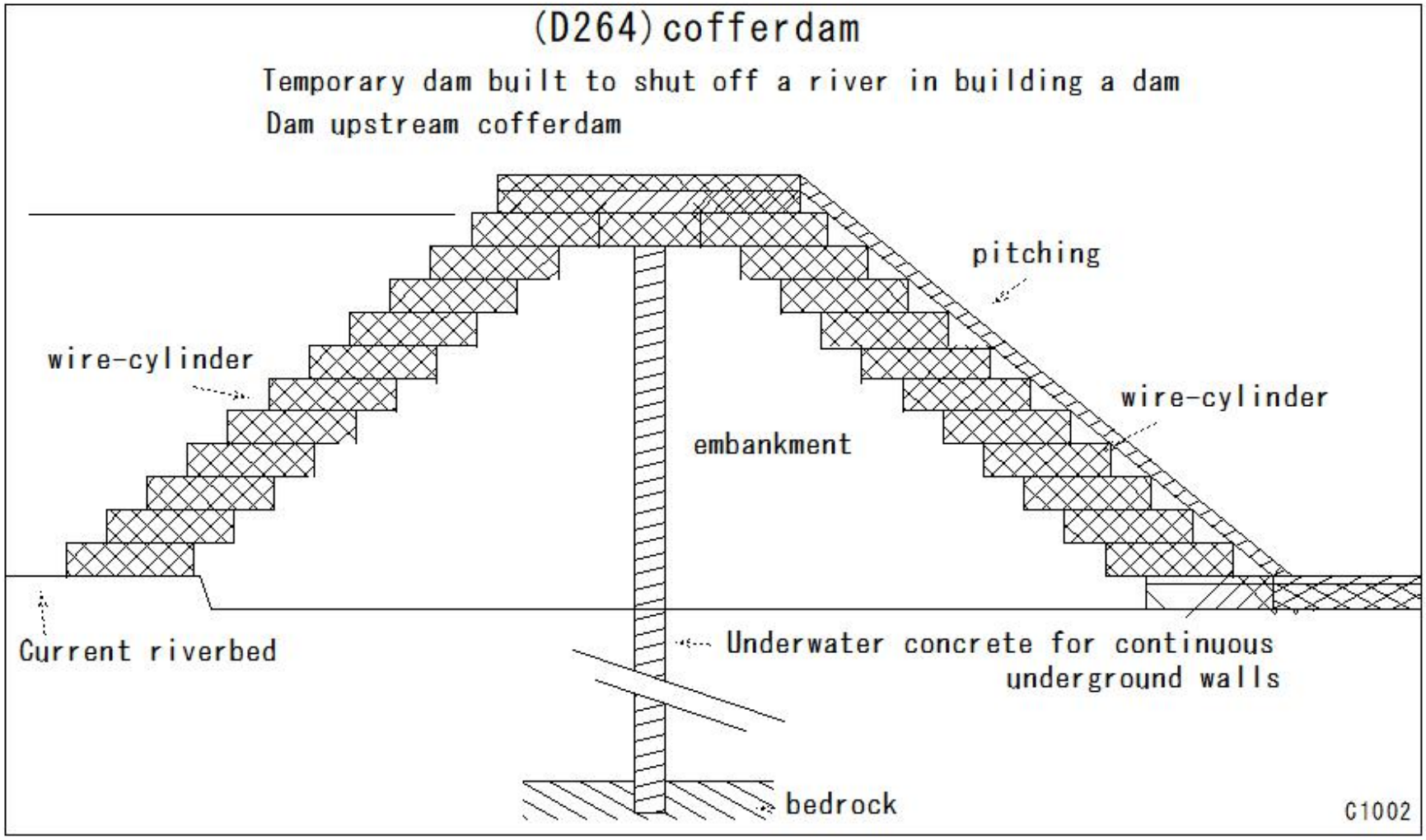
(D262)exterior concrete



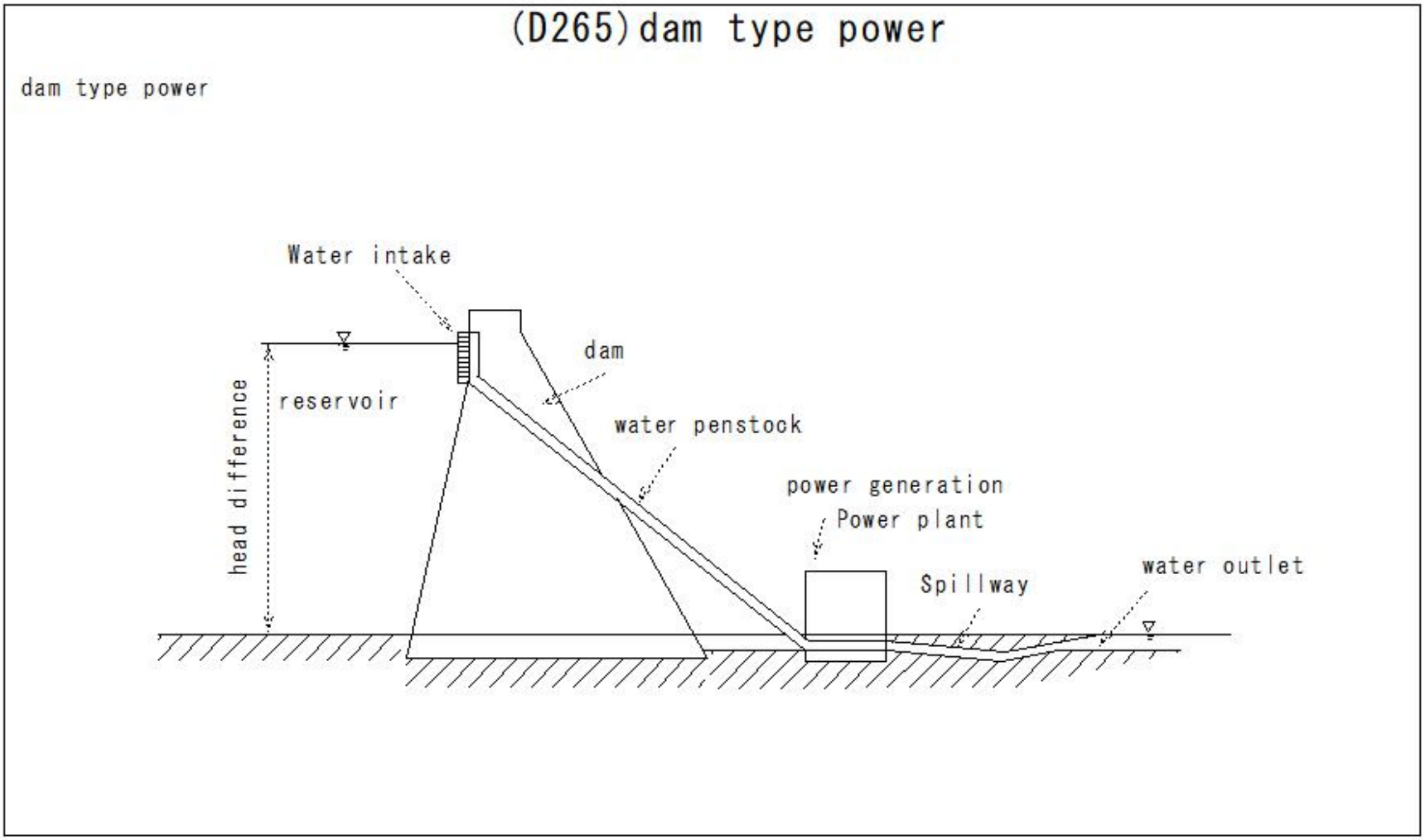
(D263)cofferdam



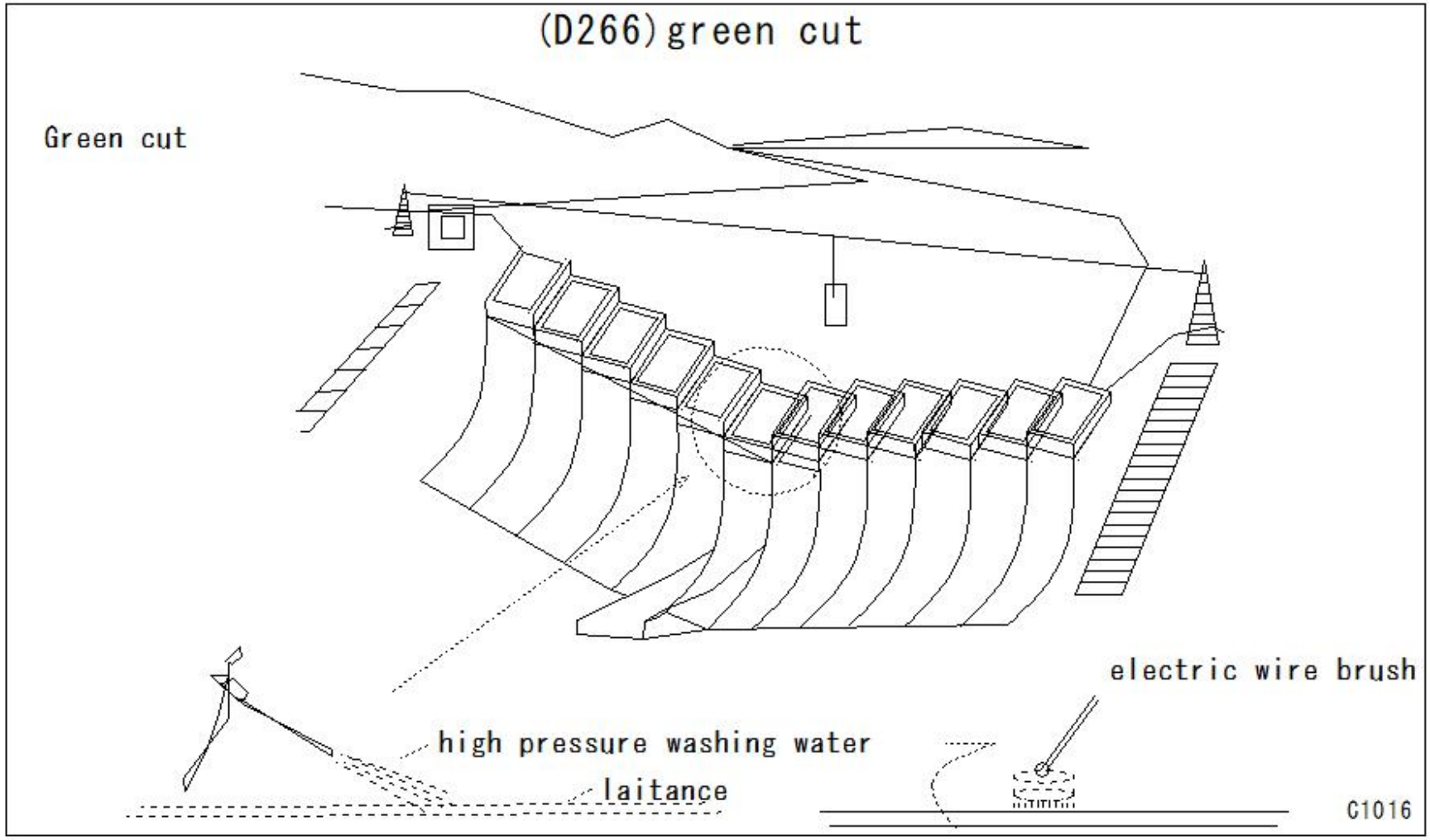
(D264)cofferdam



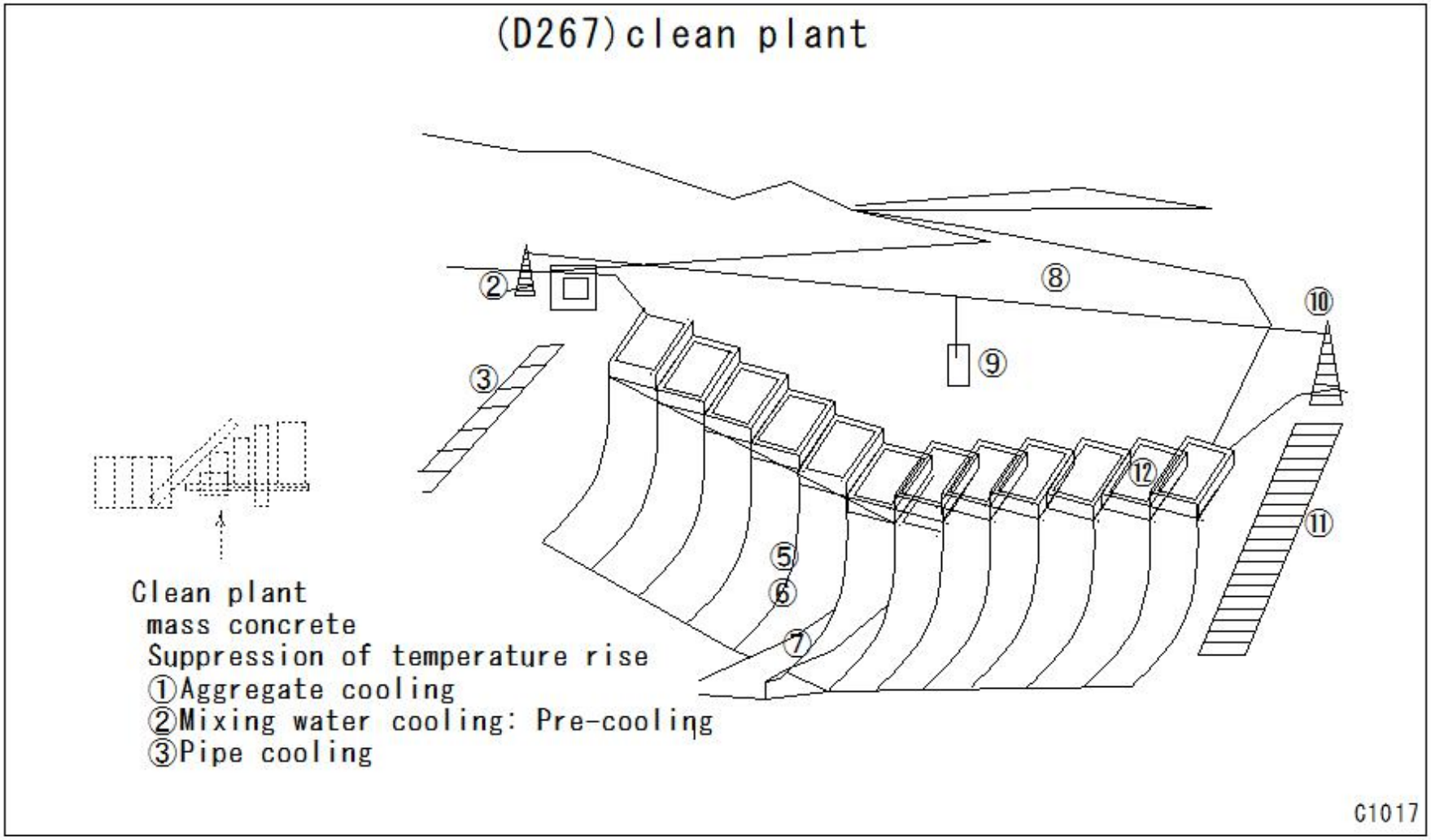
(D265)dam type power



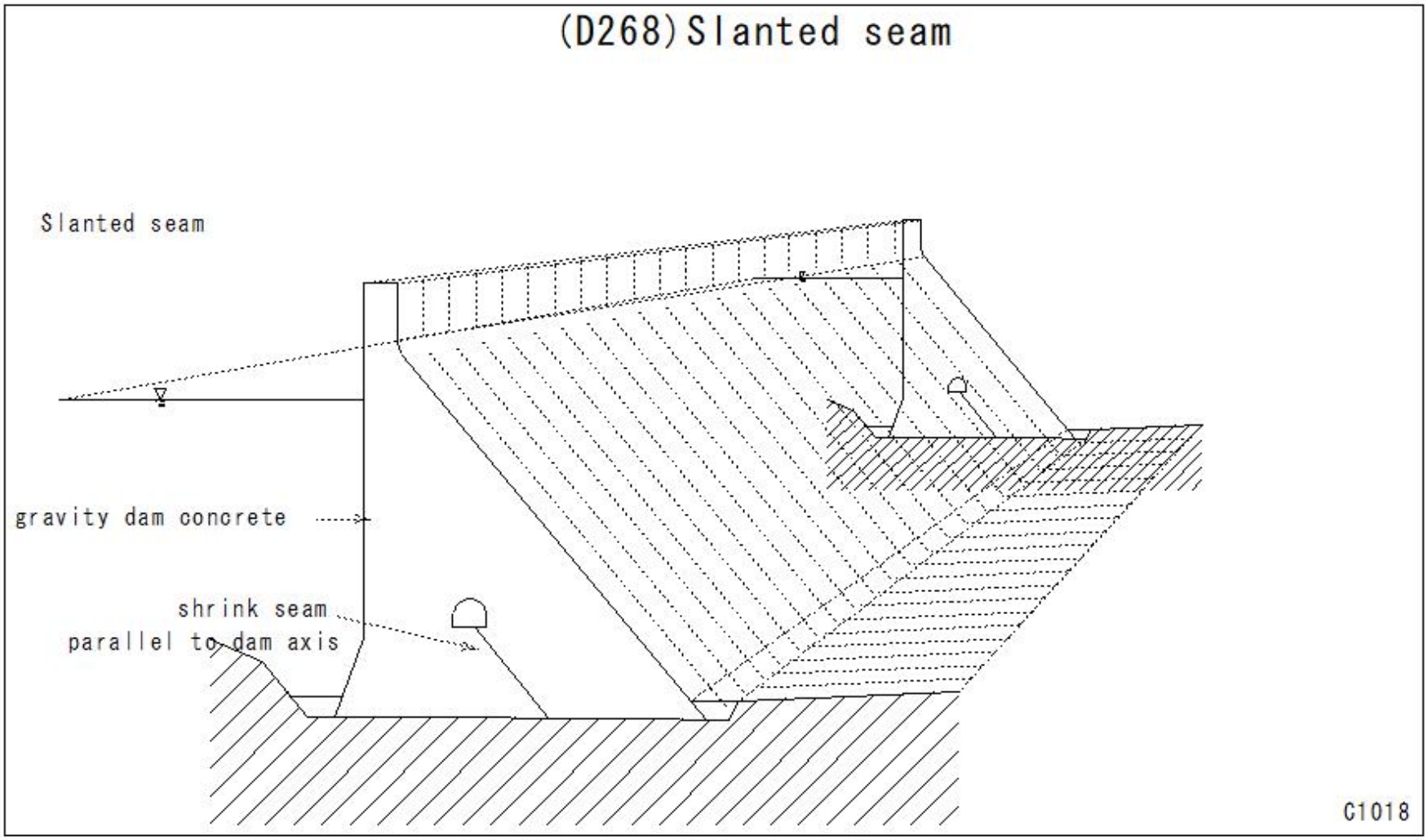
(D266)green cut



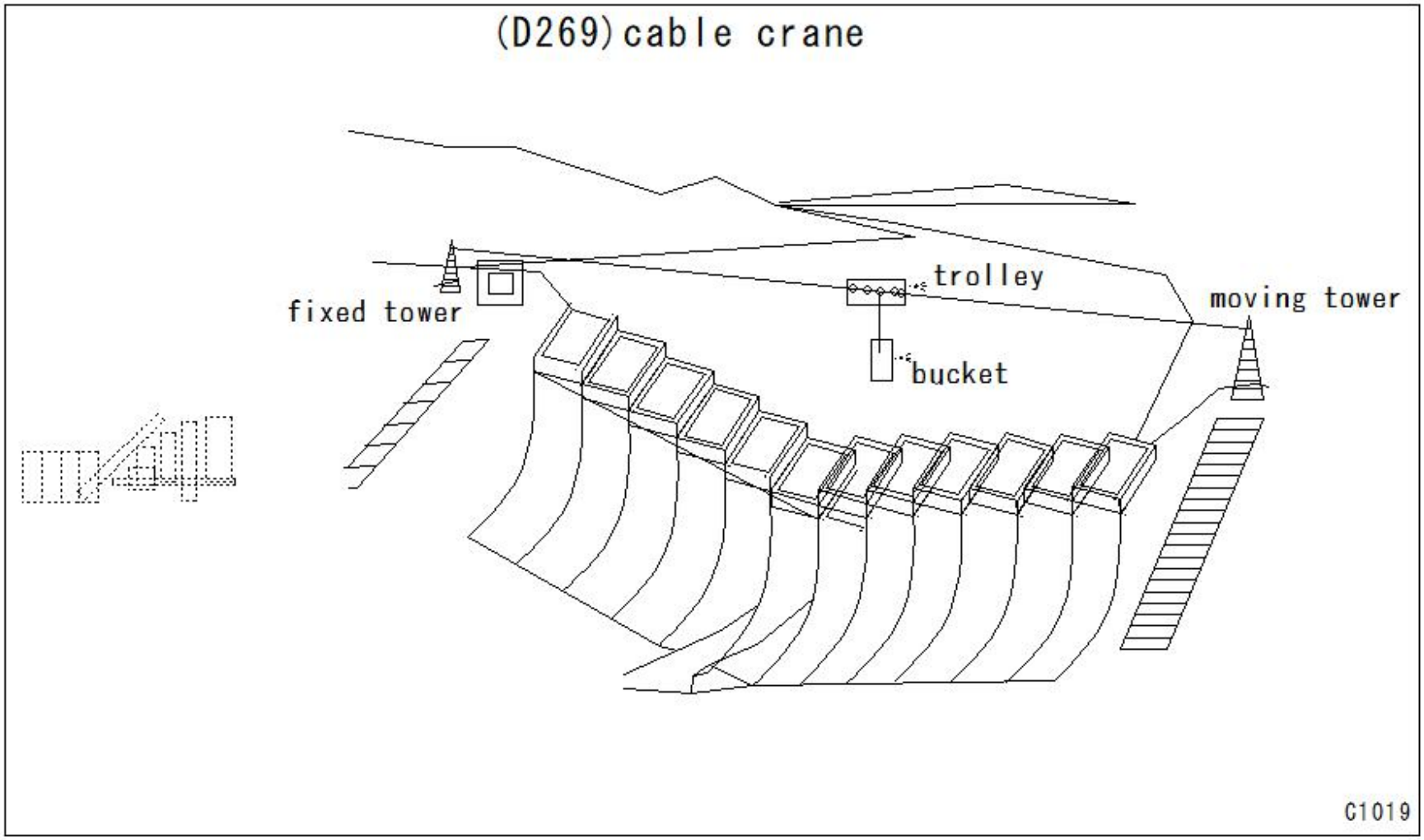
(D267)clean plant



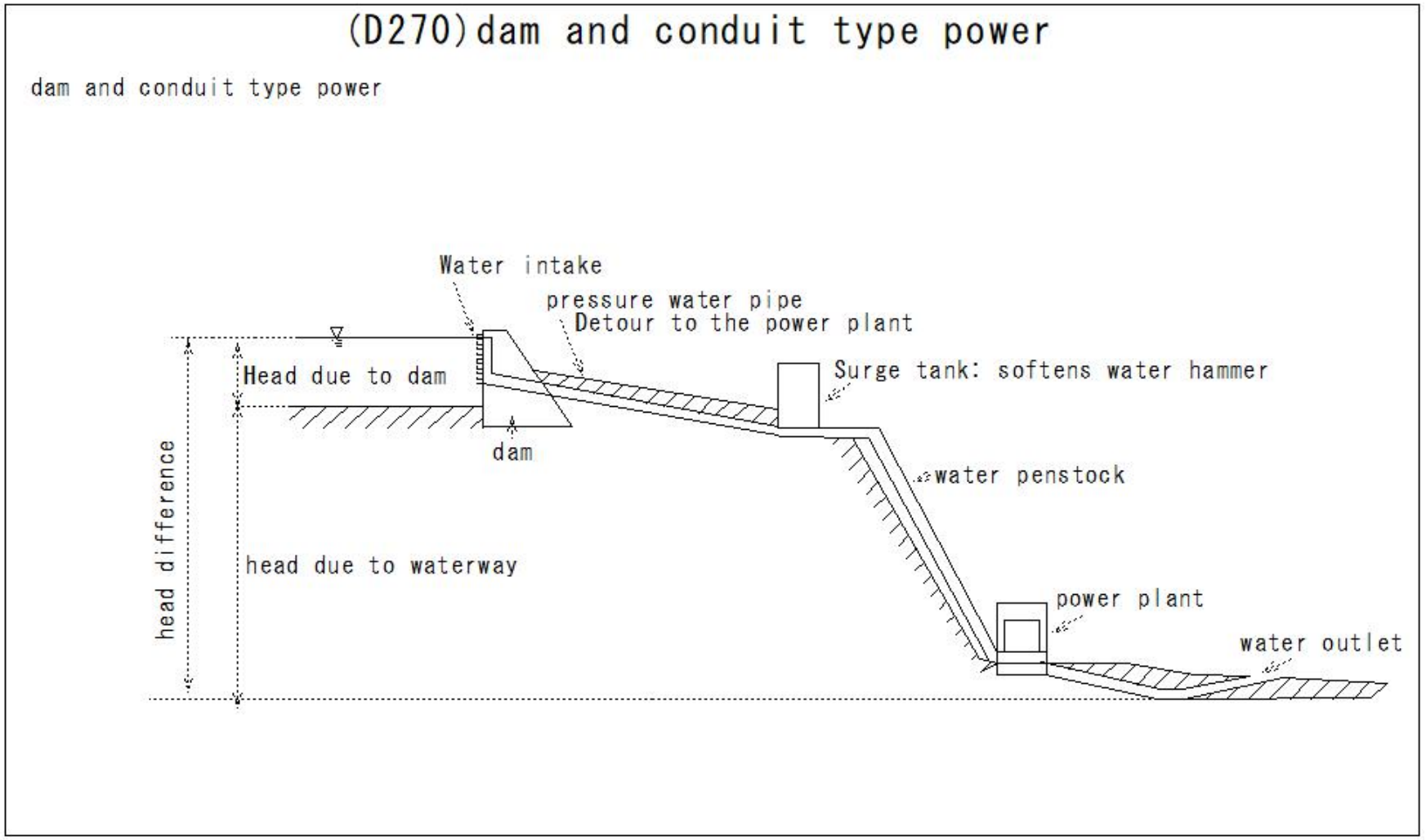
(D268)Slanted seam



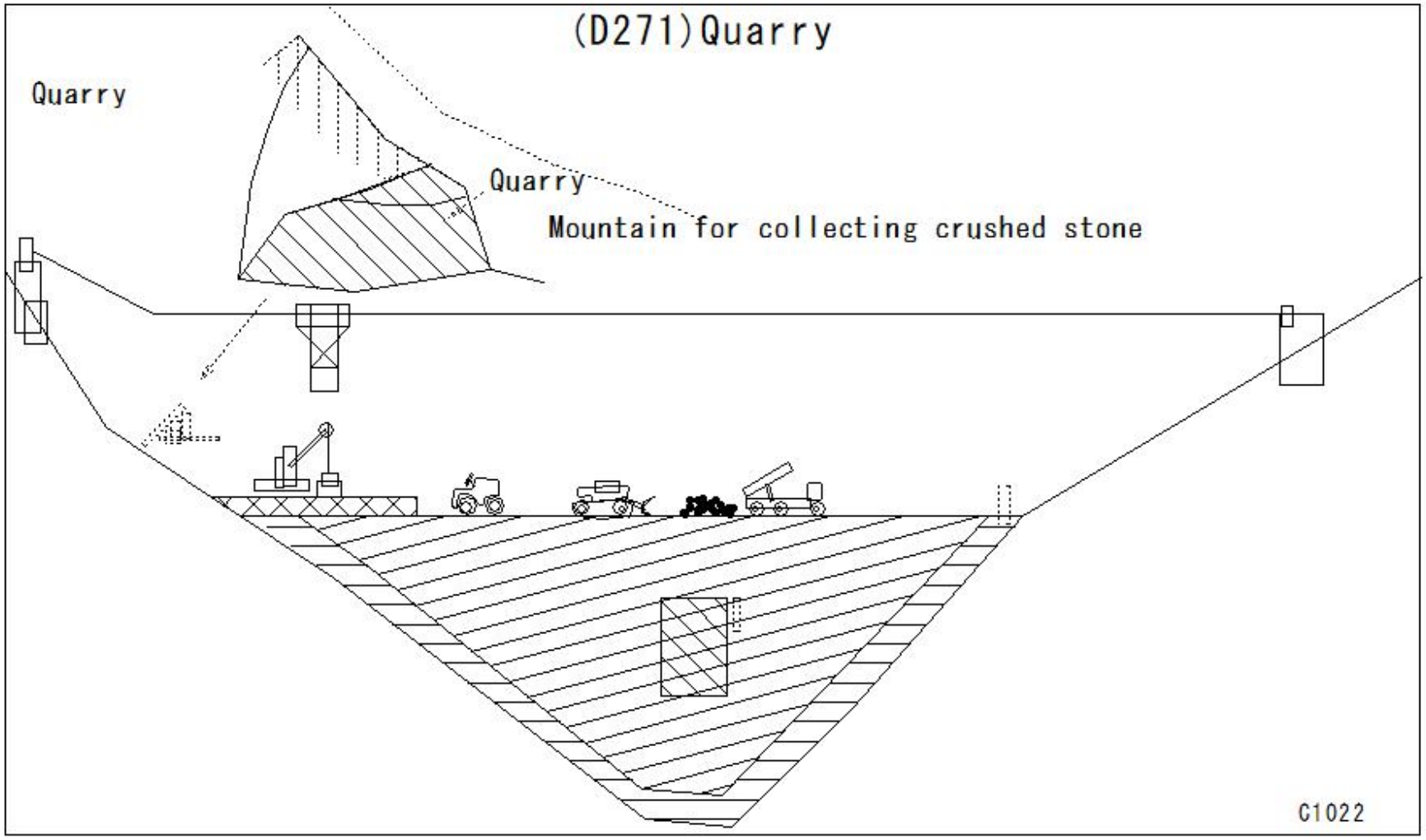
(D269)cable crane



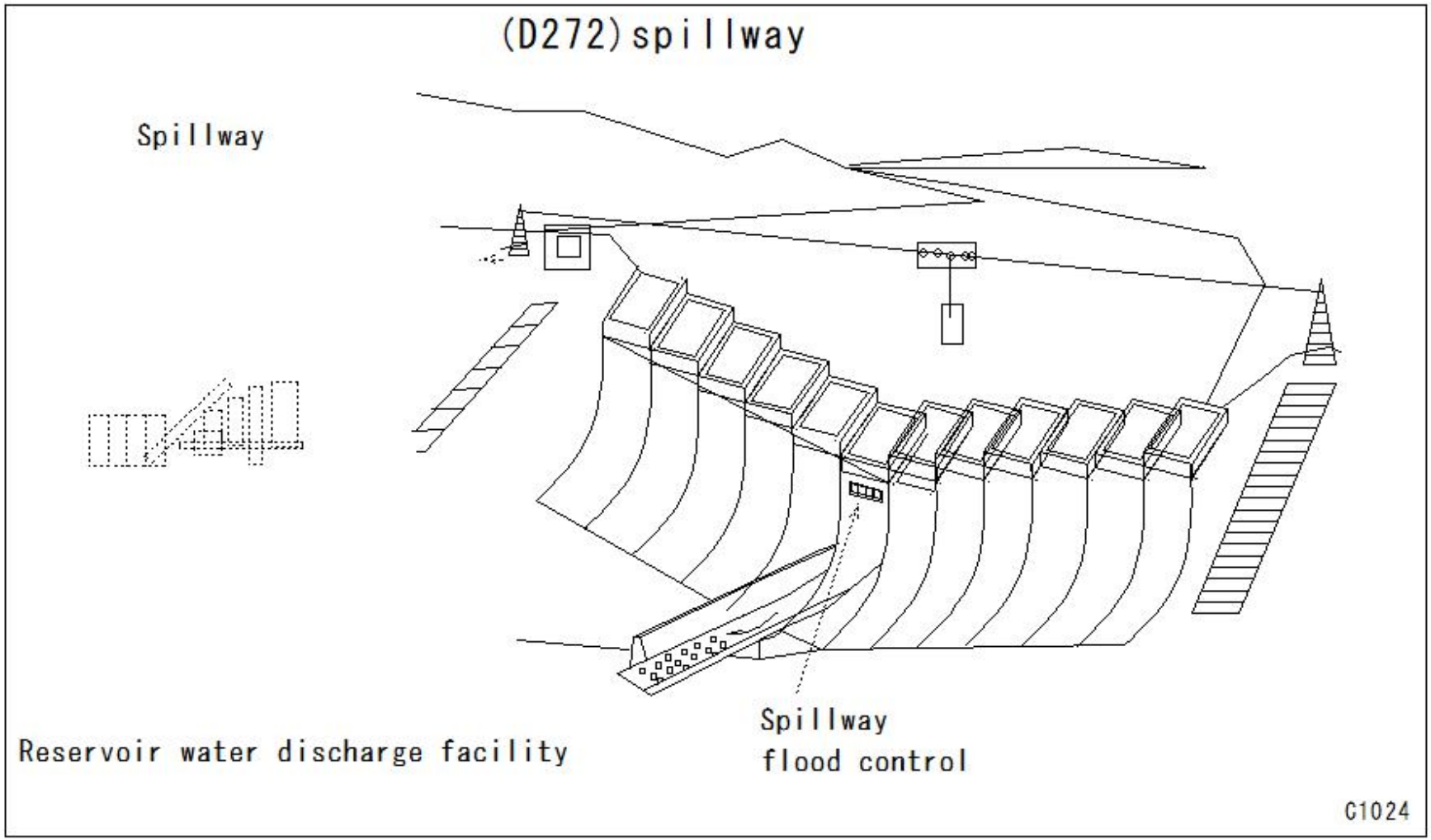
(D270)Energy dissipater



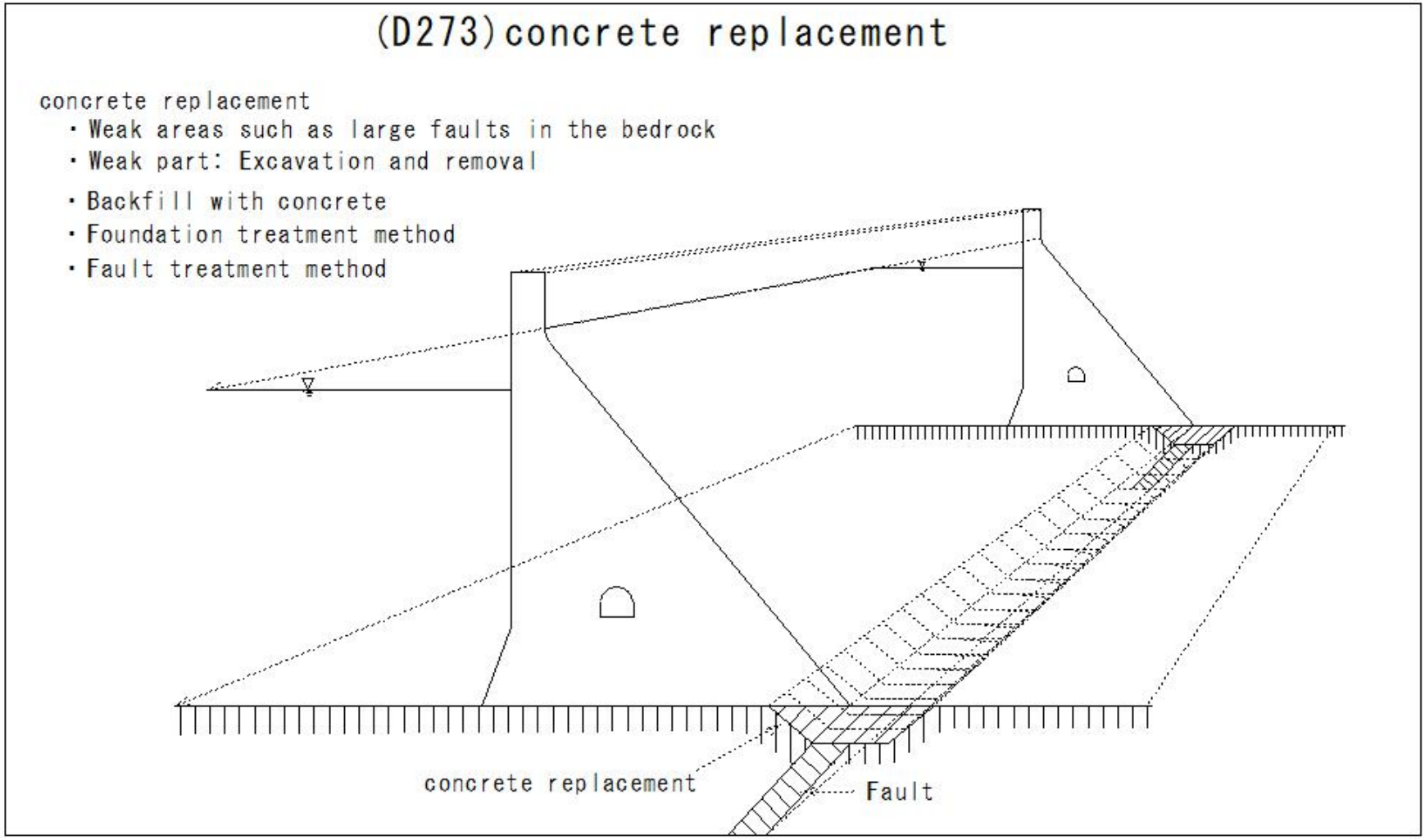
(D271)Quarry


(D271)Quarry
Quarry
Quarry
Mountain for collecting crushed stone
C1022

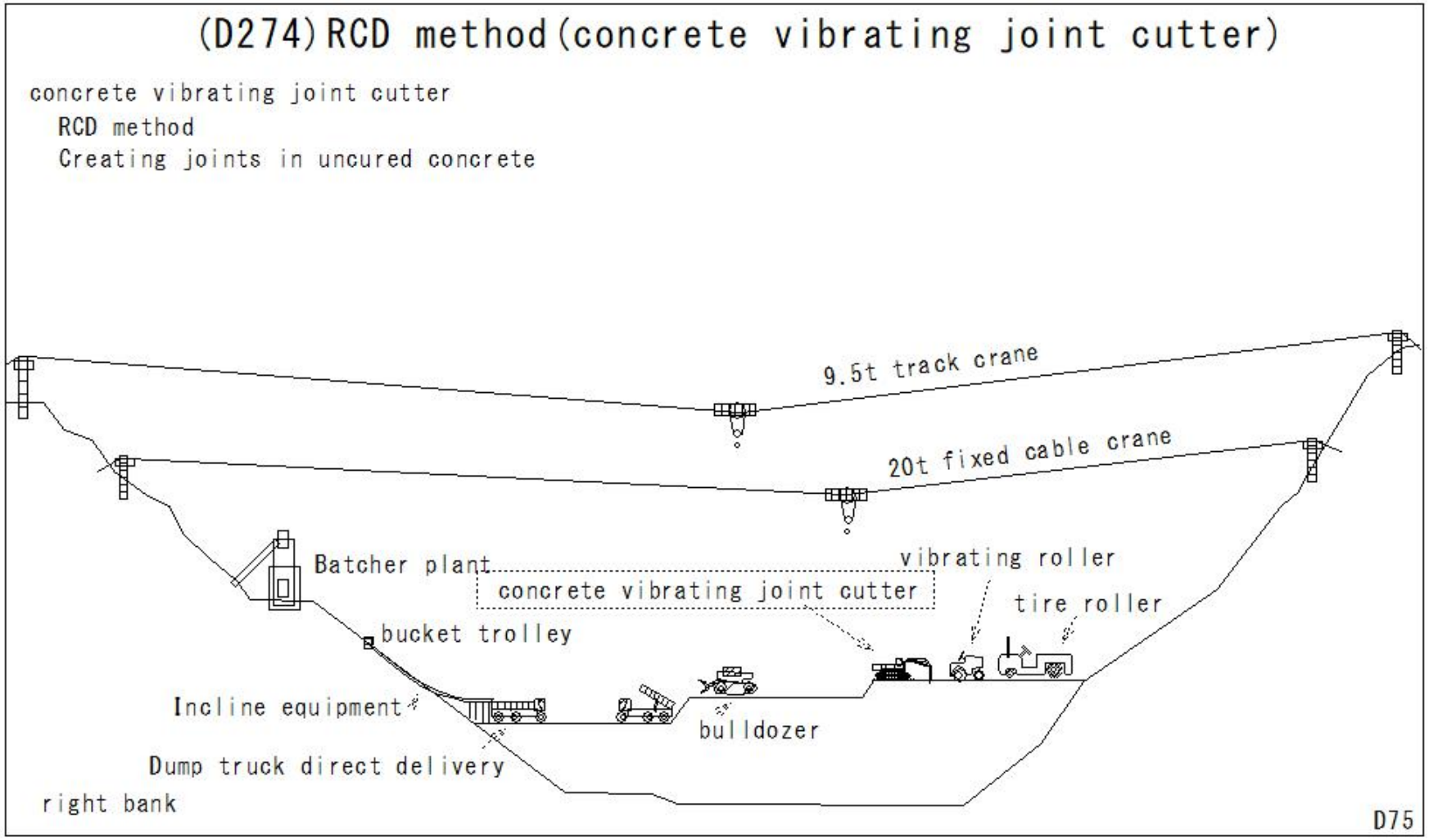
(D272)spillway



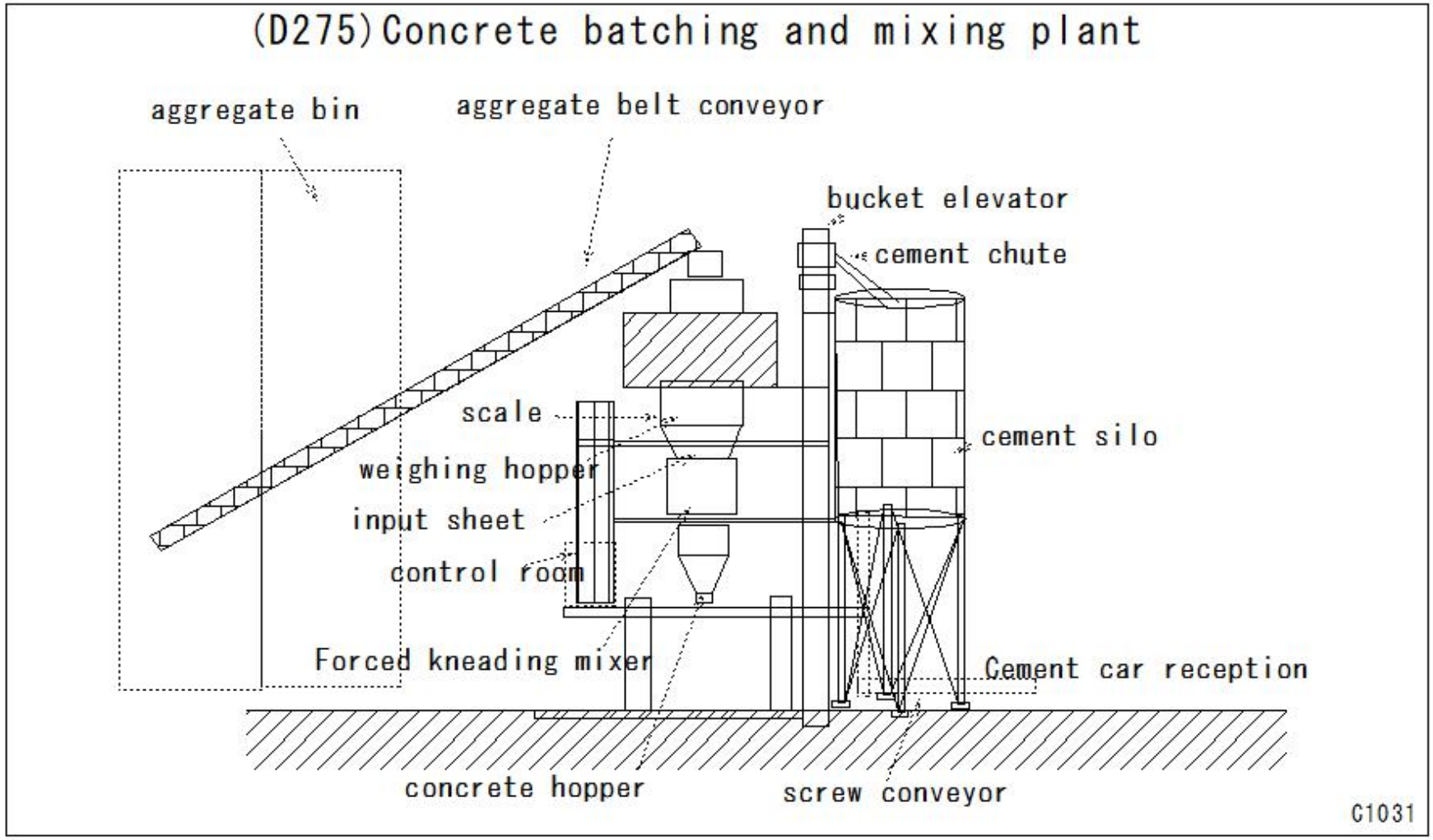
(D273)concrete replacement



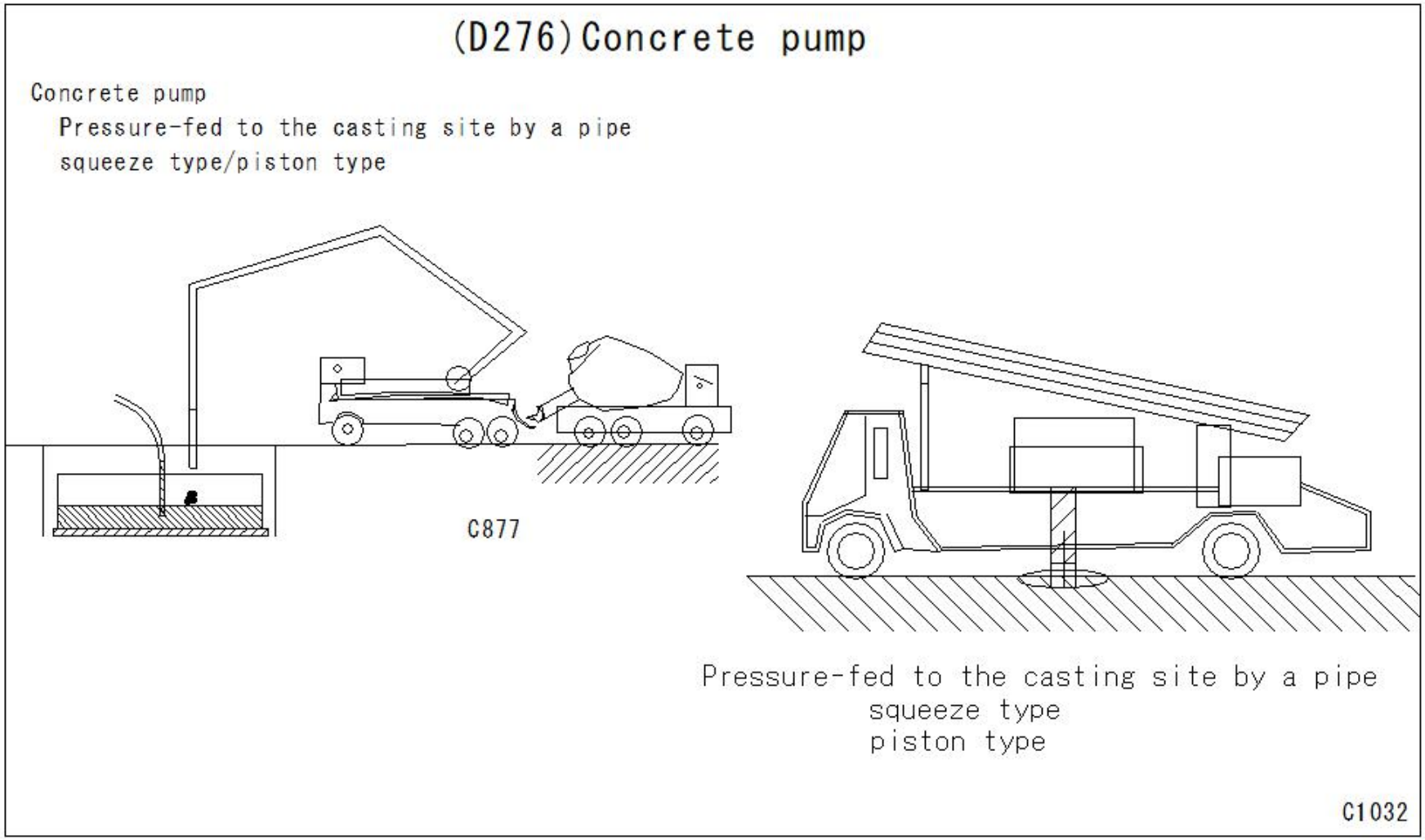
(D274)RCD method(concrete vibrating joint cutter)



(D275)Concrete batching and mixing plant



(D276)Concrete pump

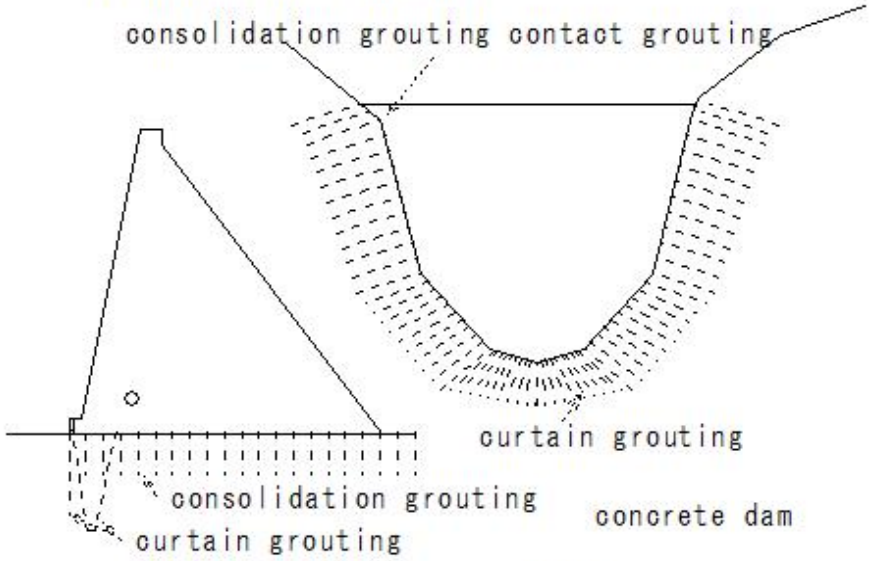


(D277)consolidation grouting

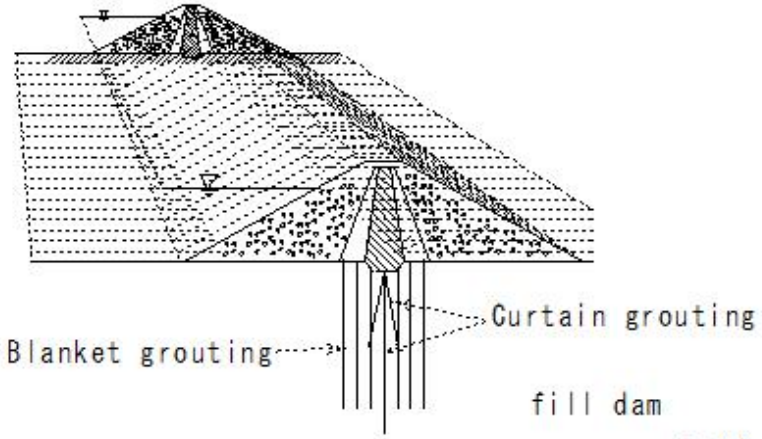
(D277)consolidation grouting

consolidation grouting

- Injection of cement milk into cracks in the foundation rock
- Improvement of rock properties
- Bedrock deformation - Improvement
- Improved water impermeability
- Improvement of loose rock



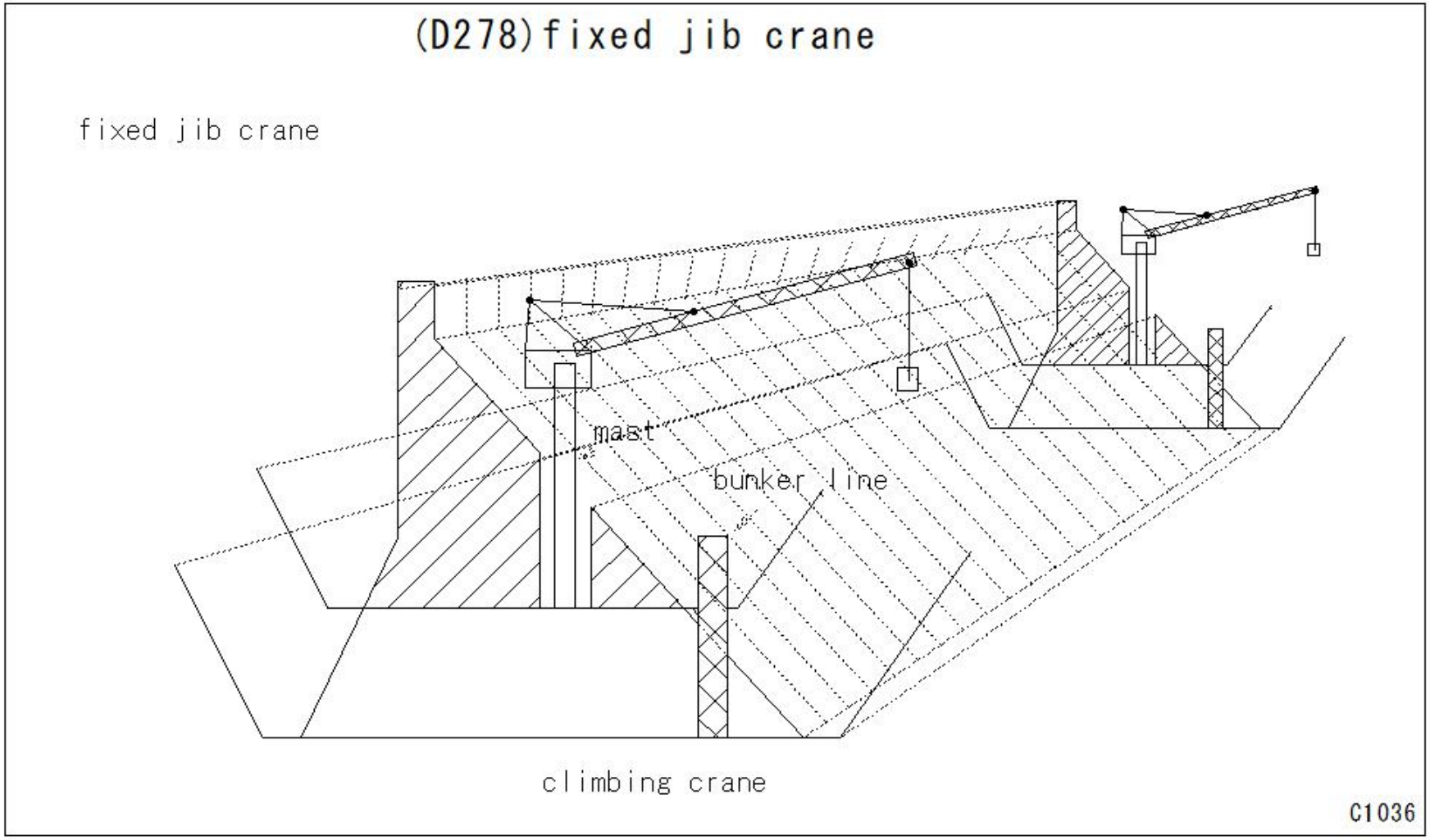
D130



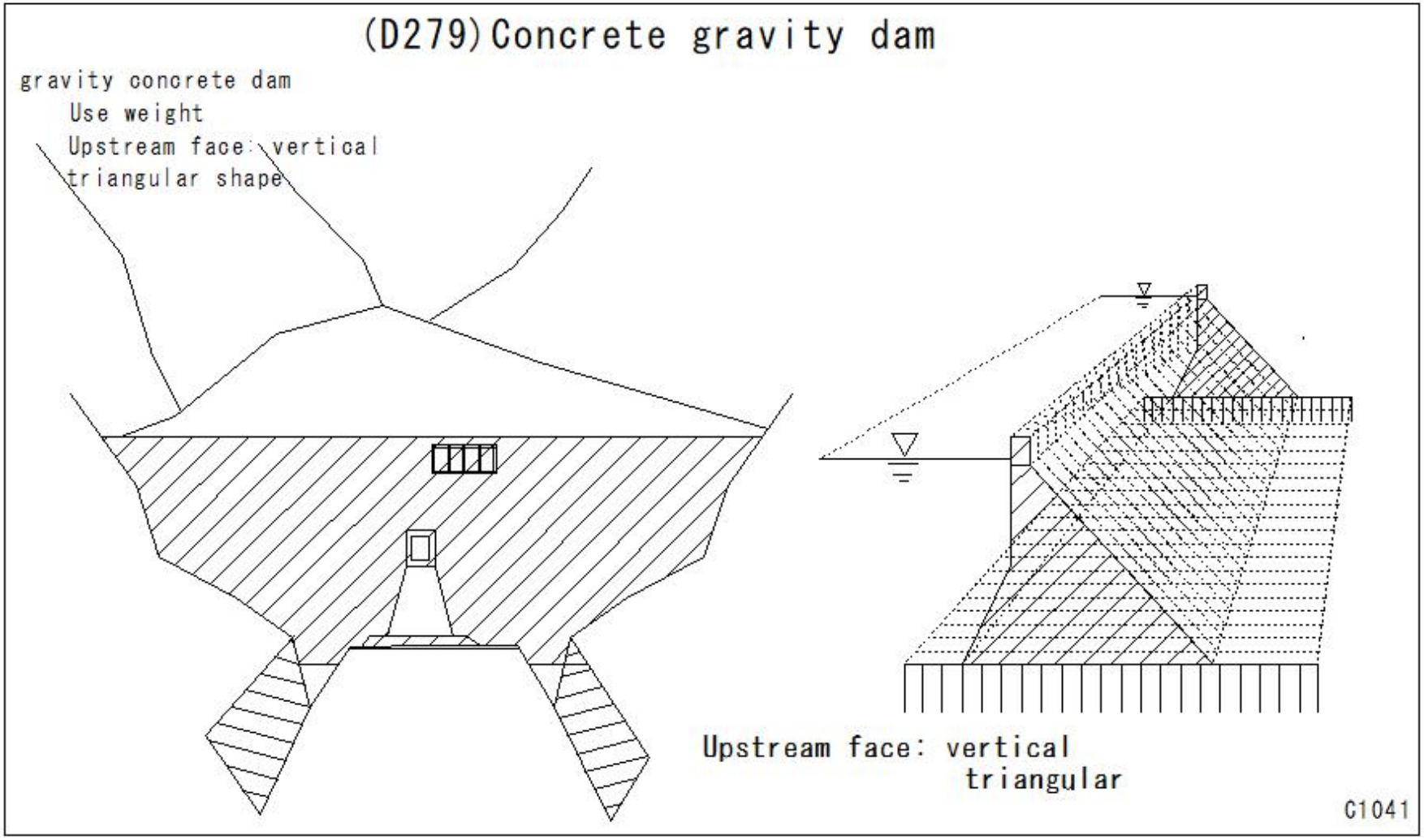
D138

D167

(D278)fixed jib crane



(D279)Concrete gravity dam

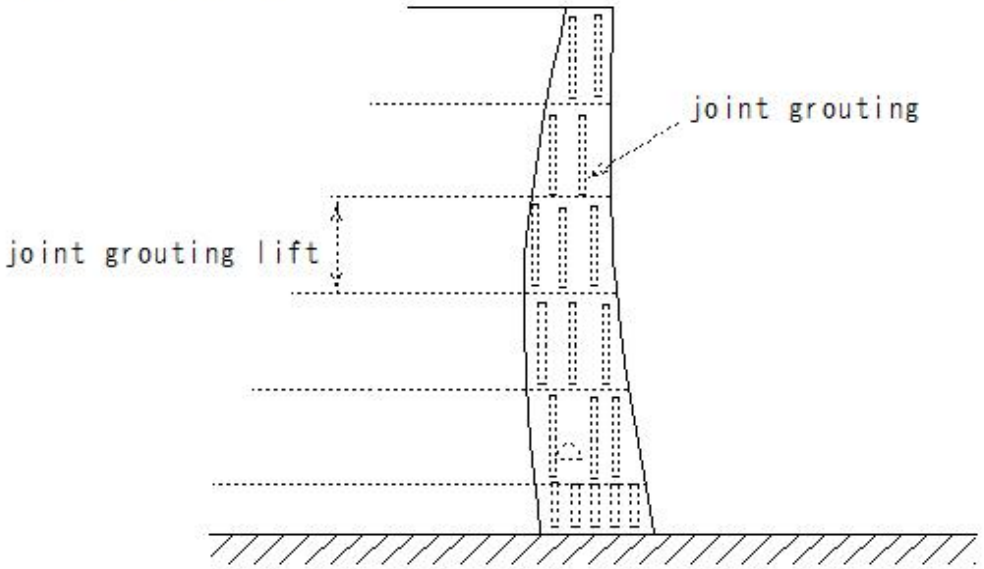


(D280)joint grouting lift

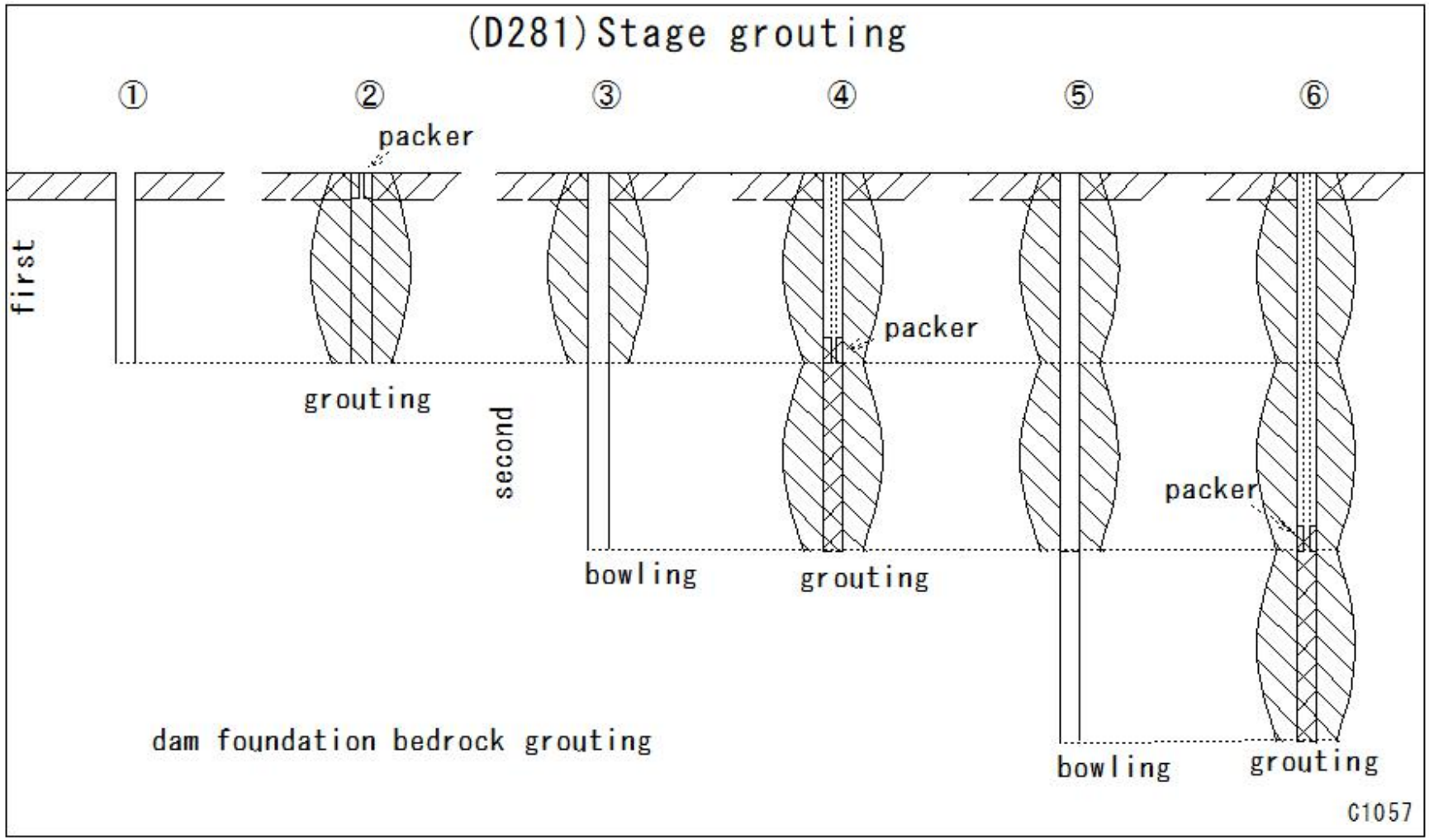
(D280) joint grouting lift

joint grouting lift

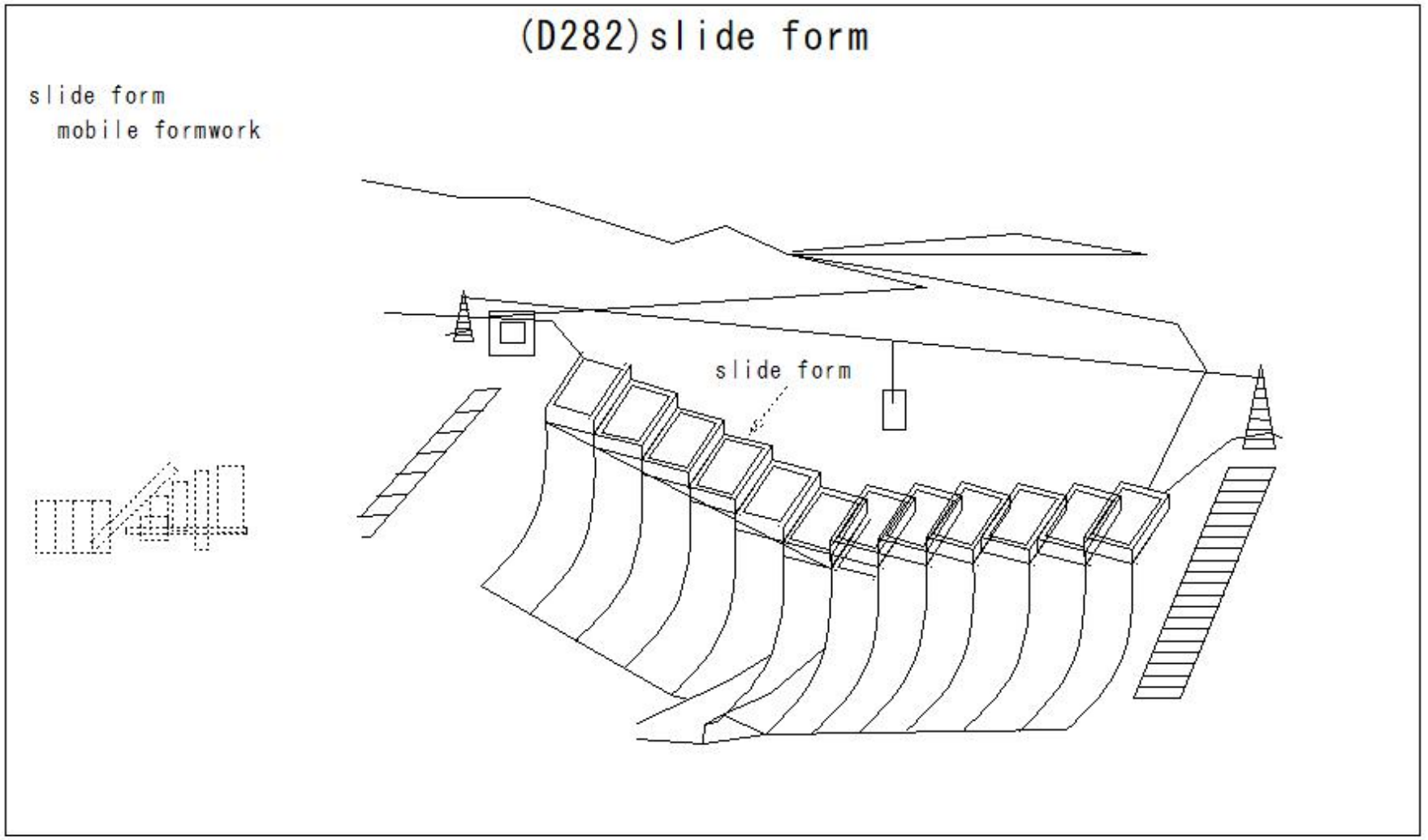
- Concrete shrinkage joints
- Pressure injection of cement milk
- Integration of concrete as a structure
- supply tube
- Usually 12-15m standard



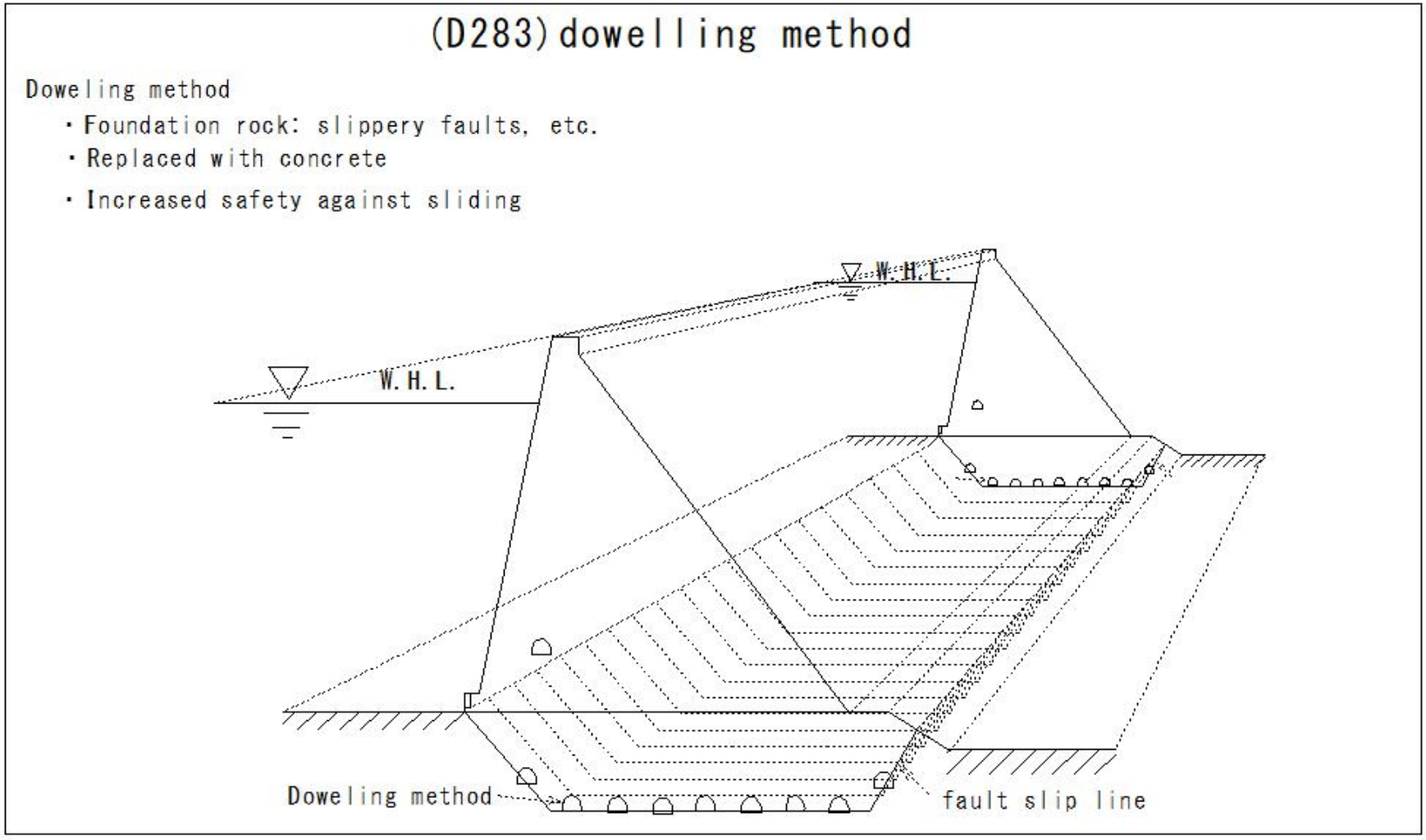
(D281)Stage grouting



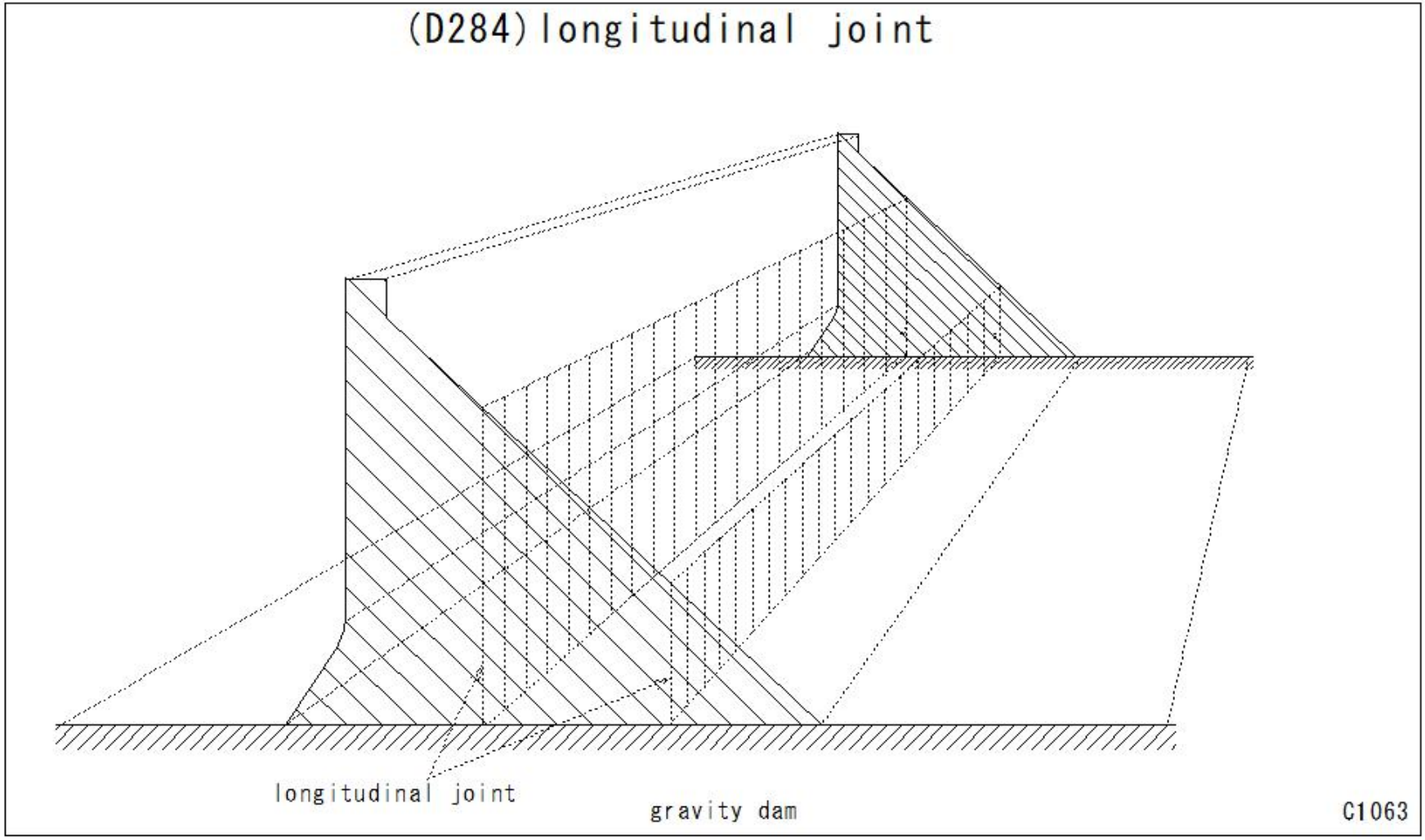
(D282)slide form



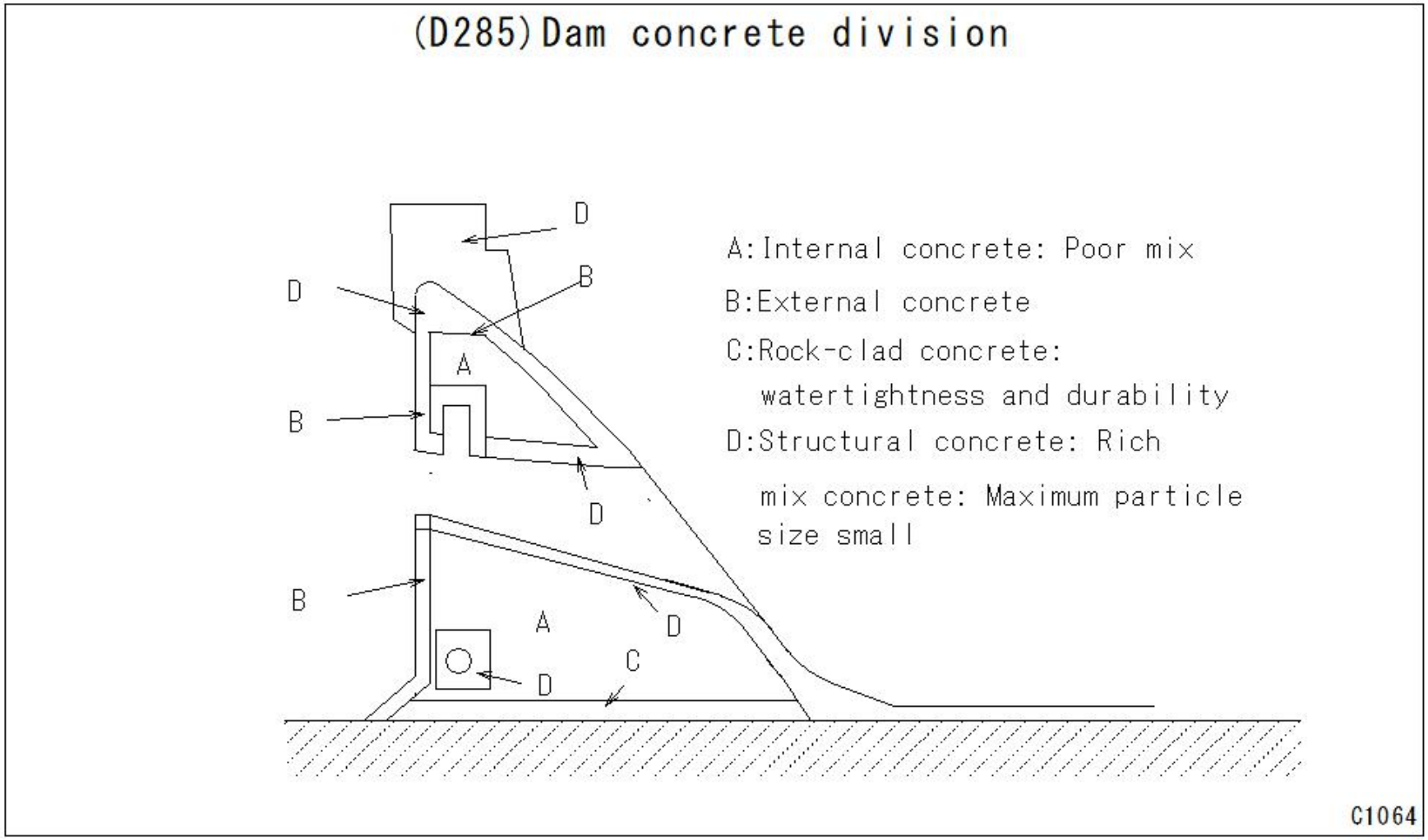
(D283)dowelling method



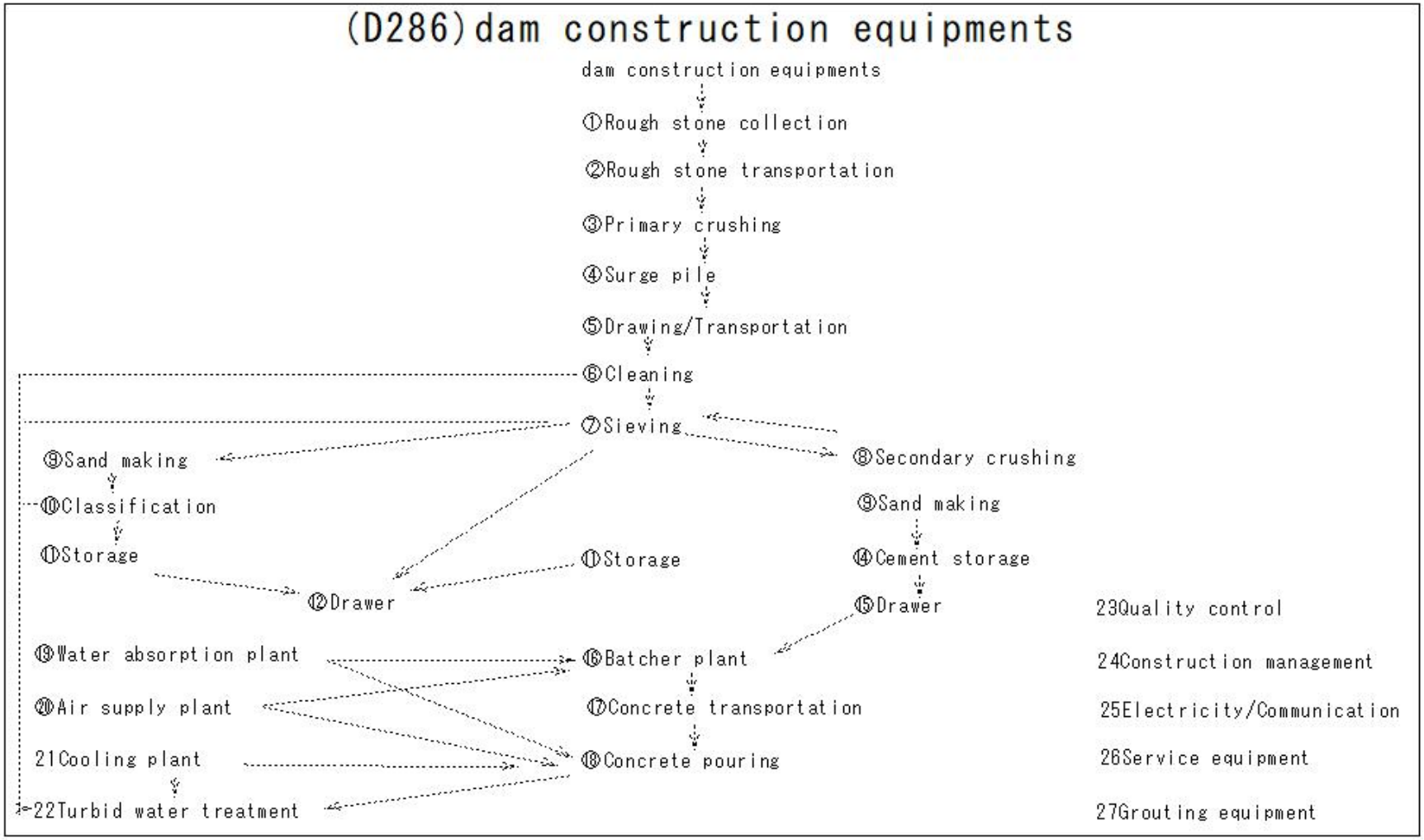
(D284)longitudinal joint



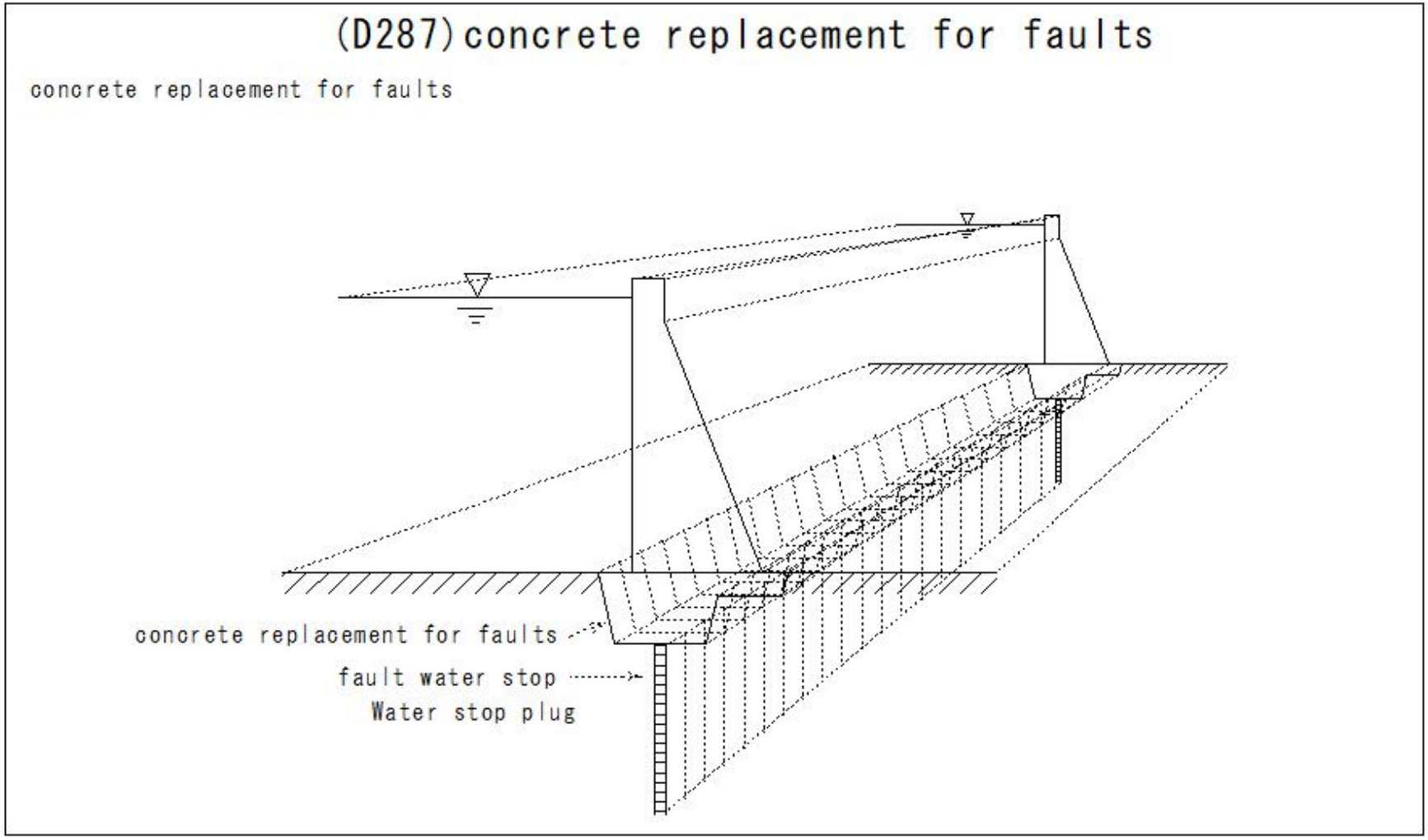
(D285)Dam concrete division



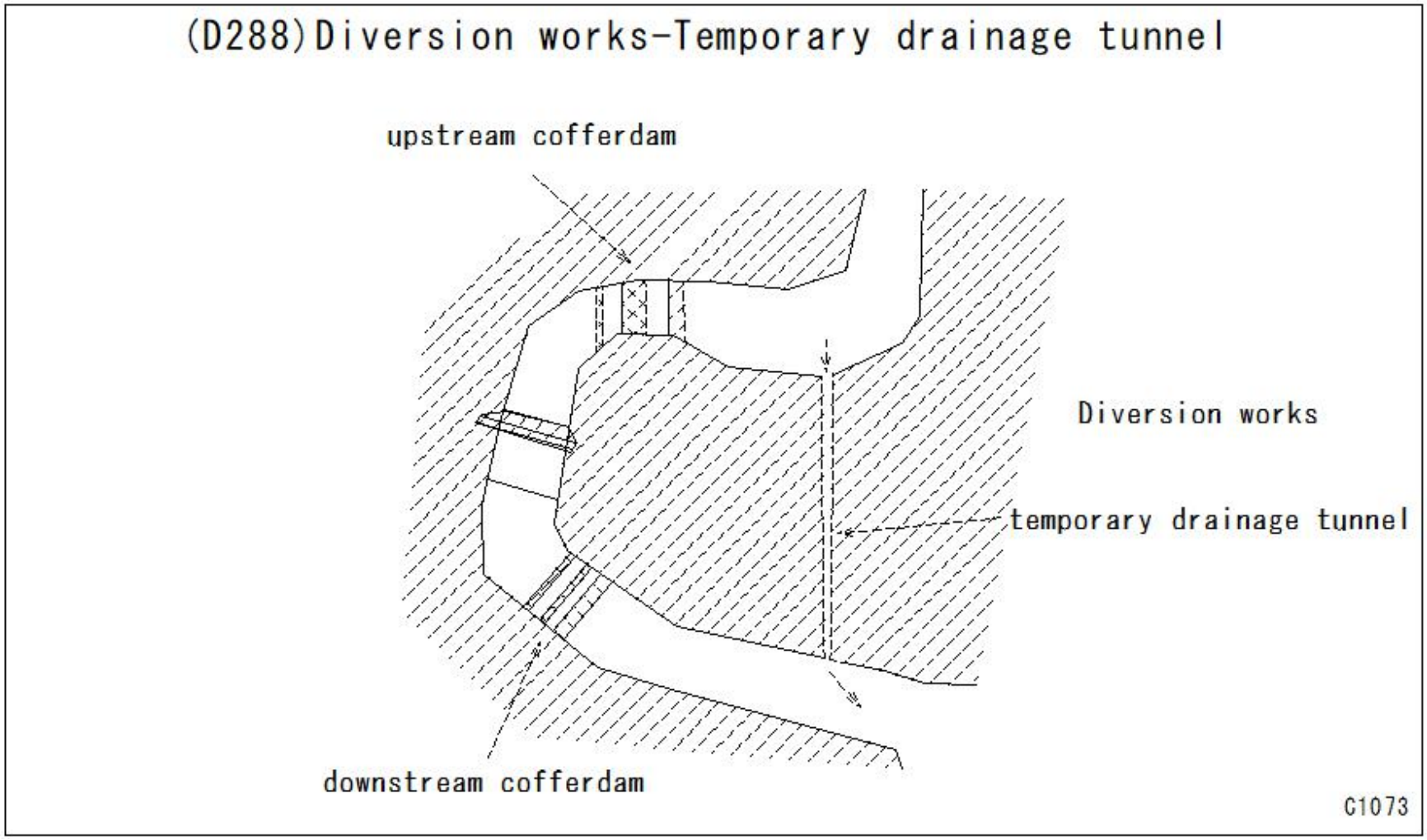
(D286)dam construction equipments



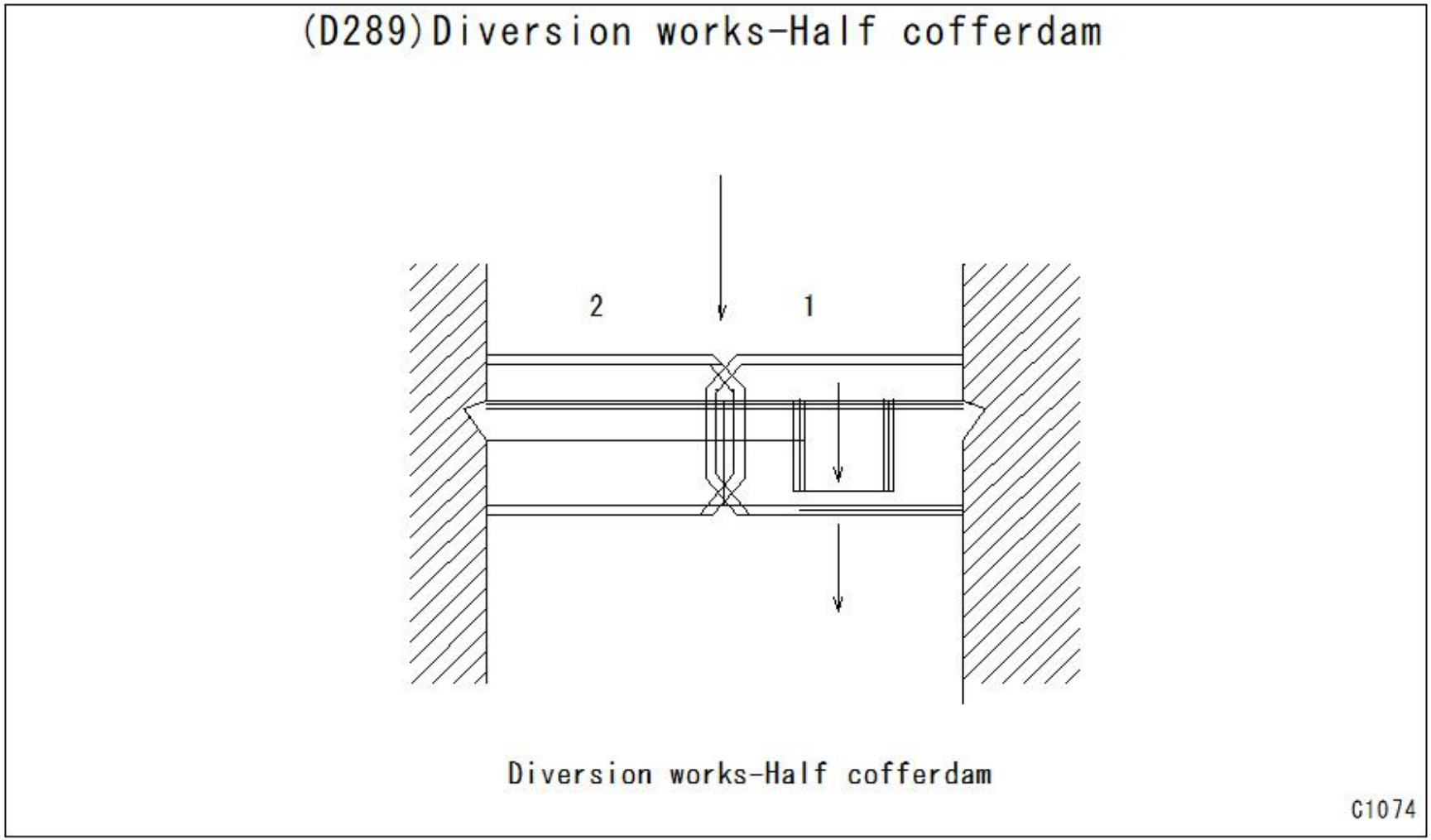
(D287)concrete replacement for faults



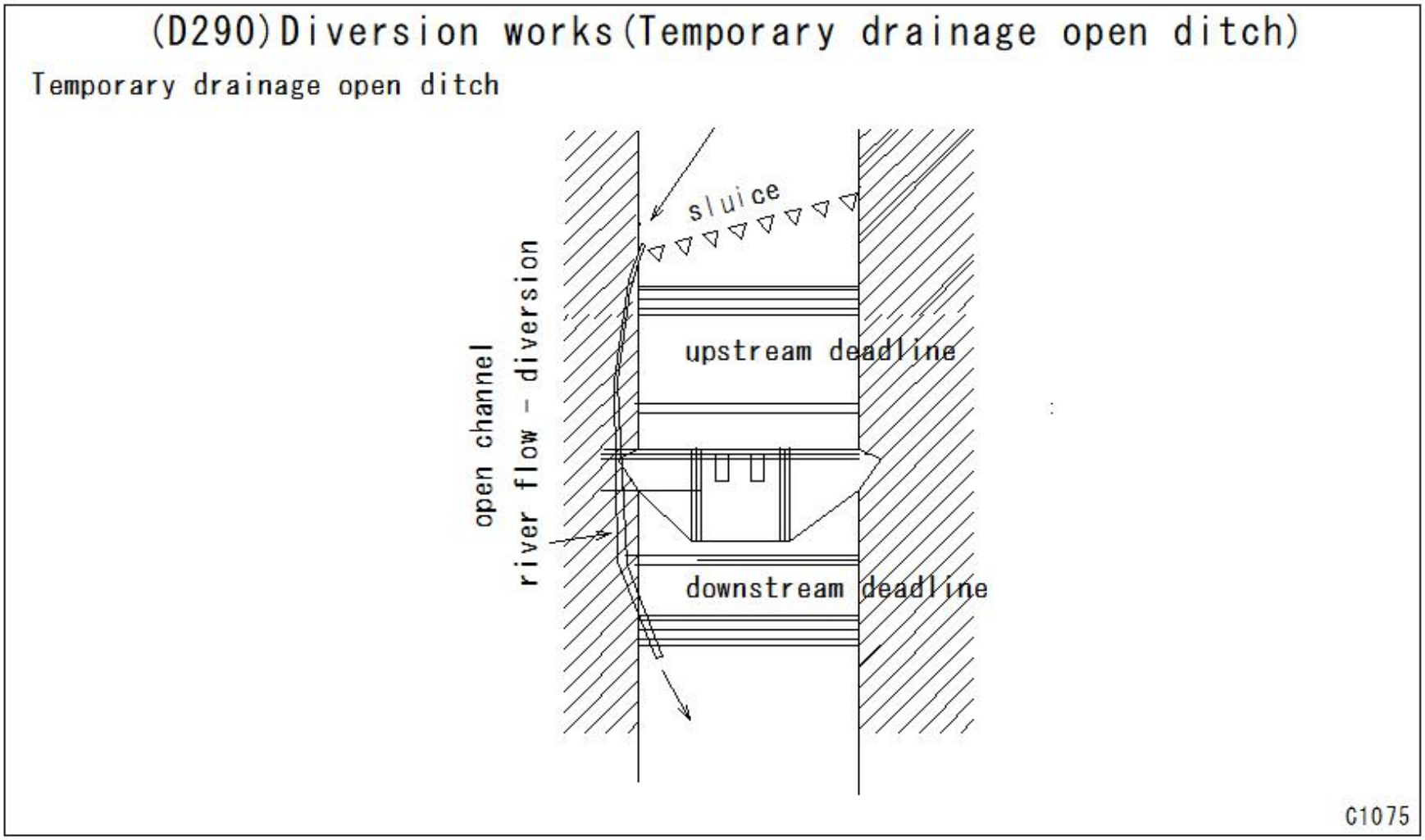
(D288)Diversion works-Temporary drainage tunnel



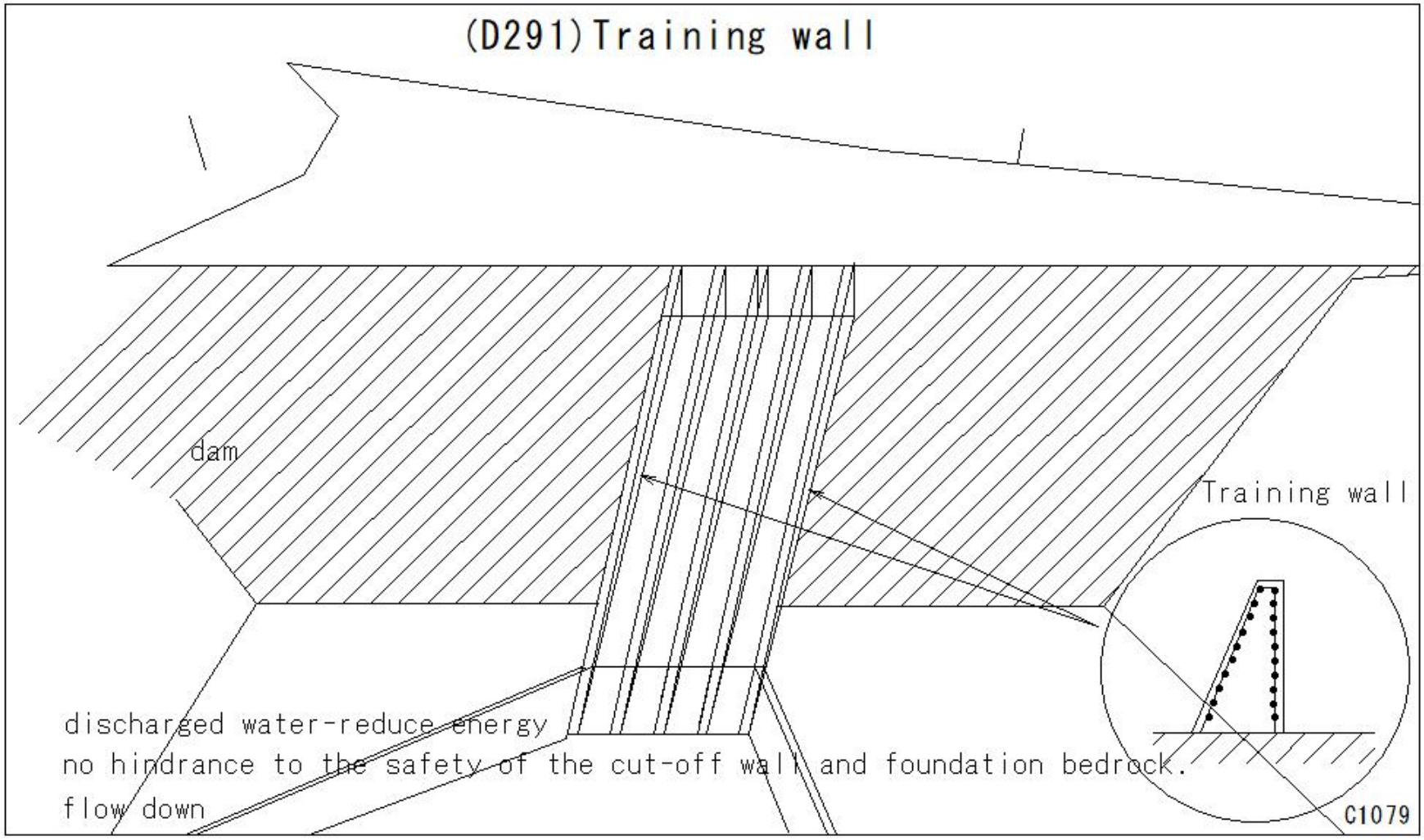
(D289)Diversion works-Half cofferdam



(D290)Diversion works(Temporary drainage open ditch)



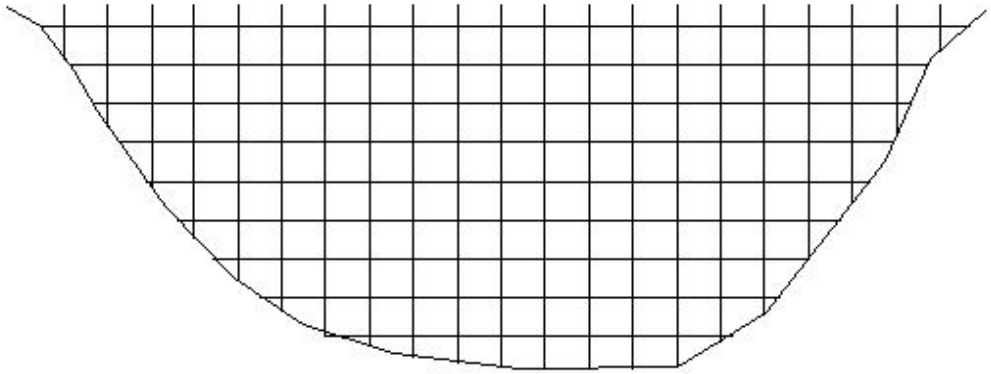
(D291)Training wall

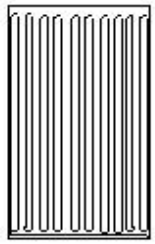


(D292)pipe cooling

(D292)pipe cooling

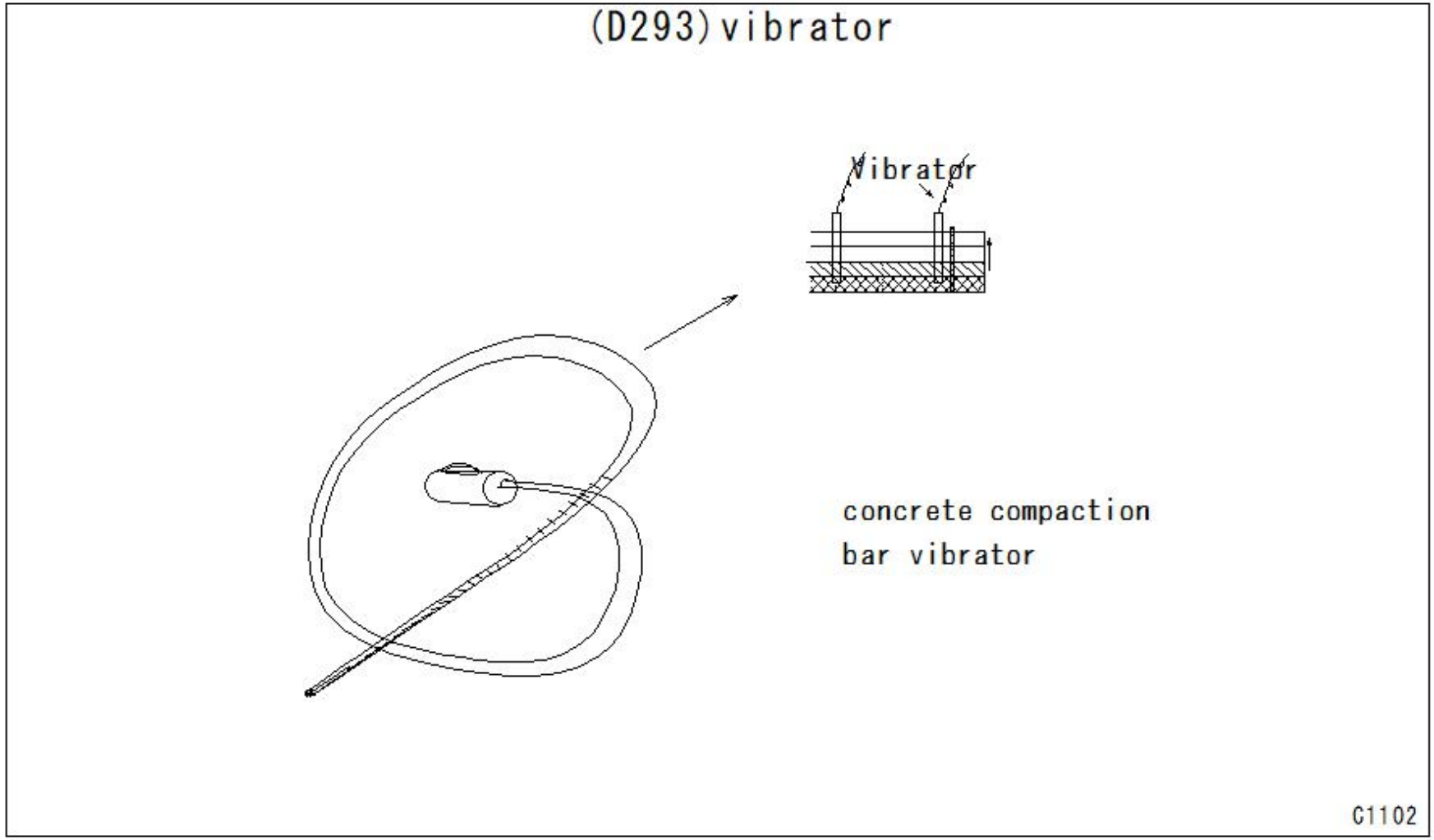
pipe cooling
concrete dam
artificial cooling
Concrete pouring surface
Diameter 3cm
thin wall steel pipe
Cooling water - water flow
lower concrete temperature



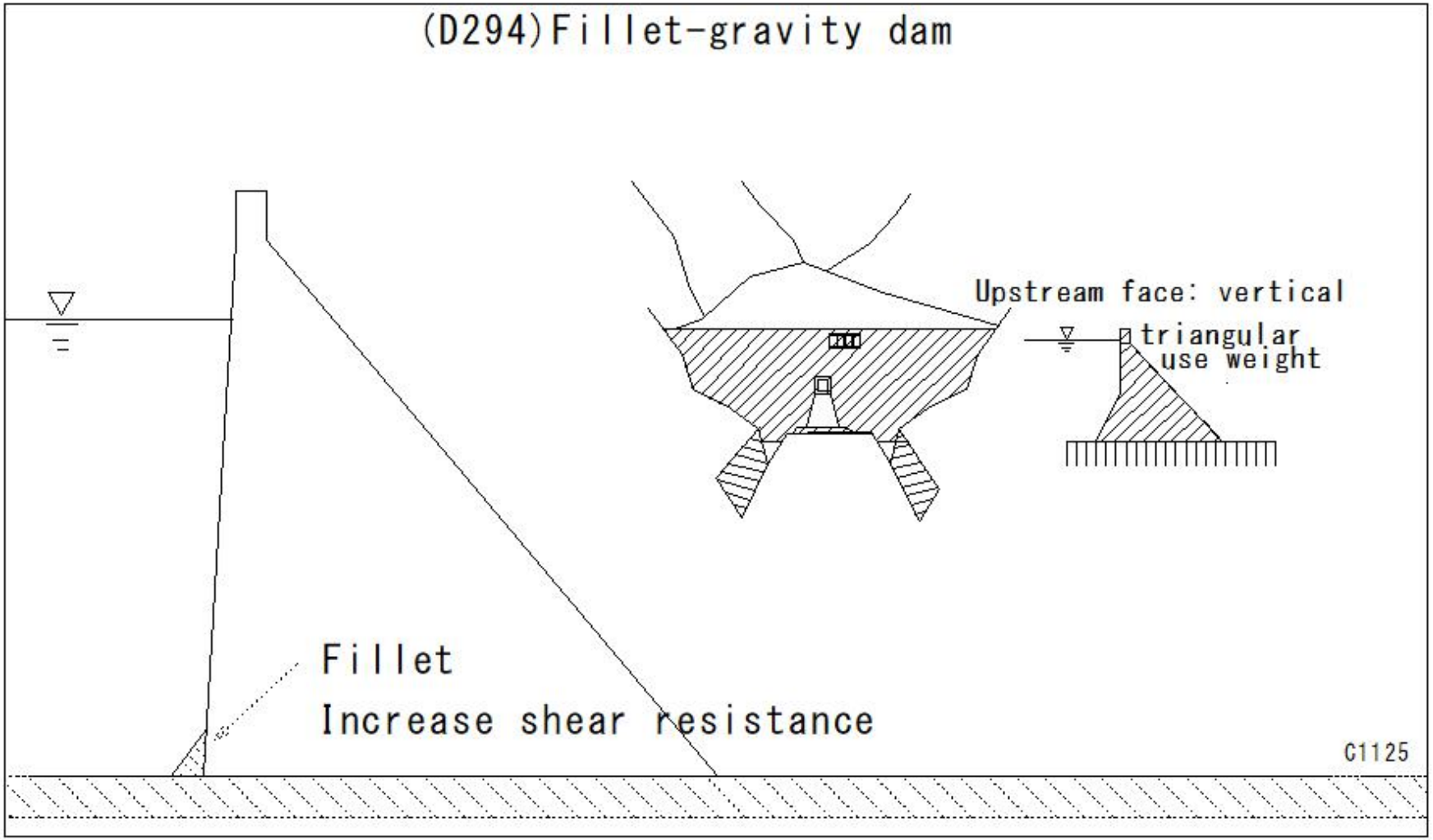


pipe cooling arrangement

(D293)vibrator



(D294)Fillet-gravity dam



(D295)rod vibrator

(D295)rod vibrator

rod vibrator

Applying vibration directly to concrete

Rod-shaped vibrator

①Vibration tube

②Switch case

③Buffer rubber

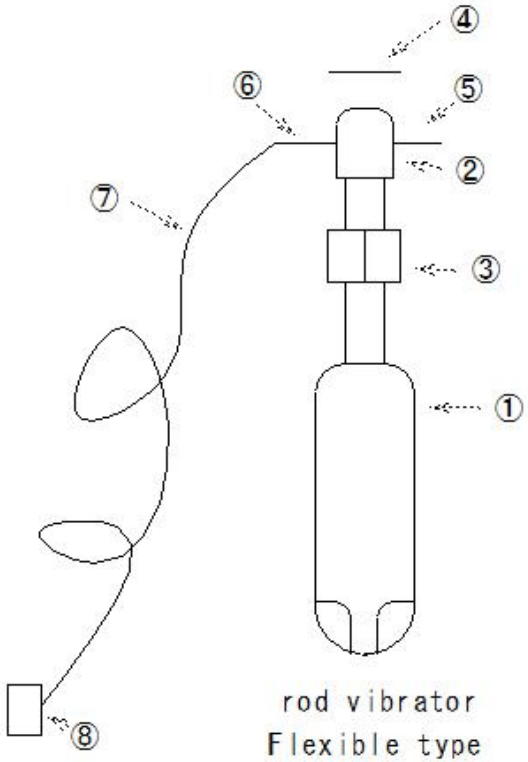
④Switch

⑤Handle

⑥Handle

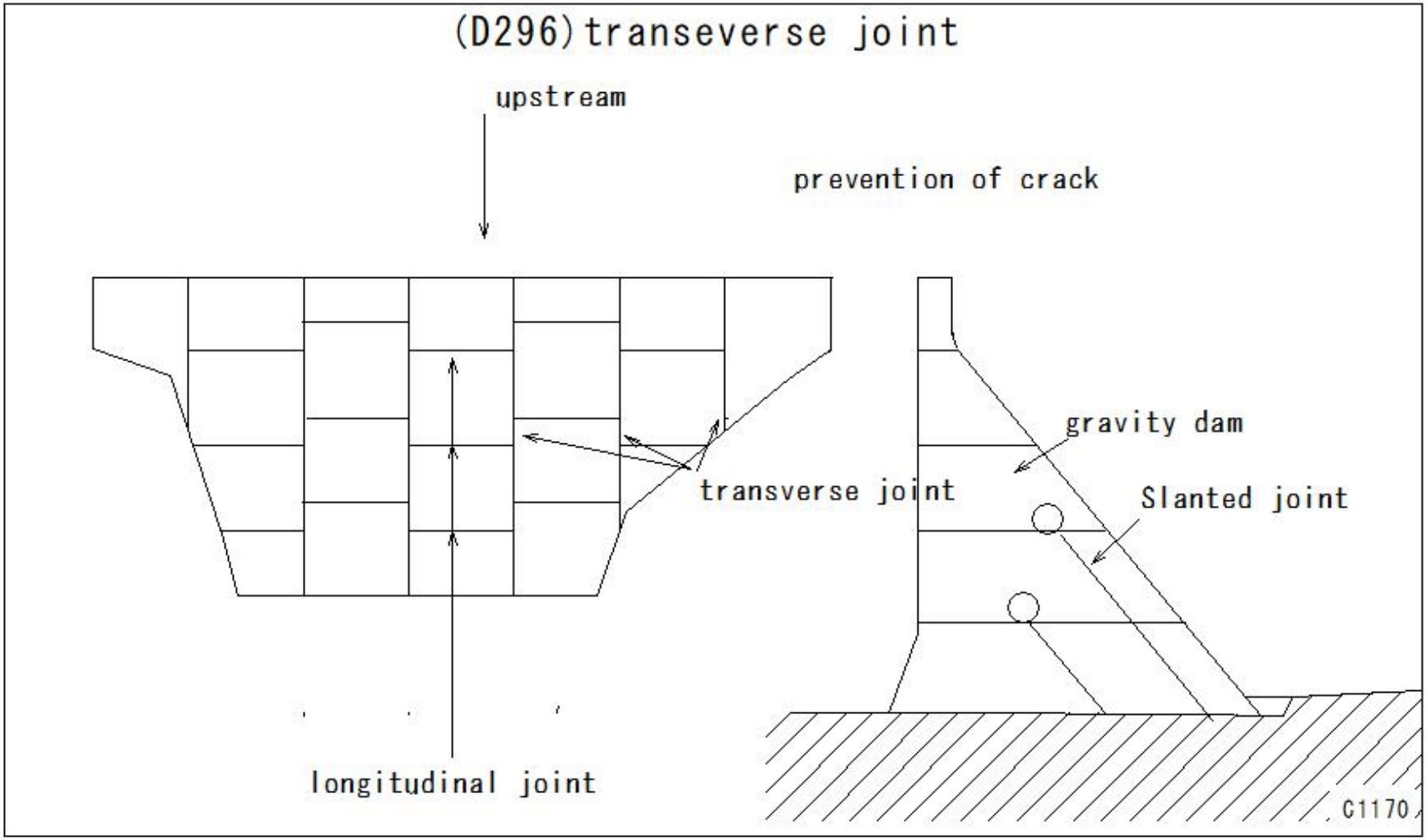
⑦Cable

⑧Connector



rod vibrator
Flexible type

(D296)transeverse joint



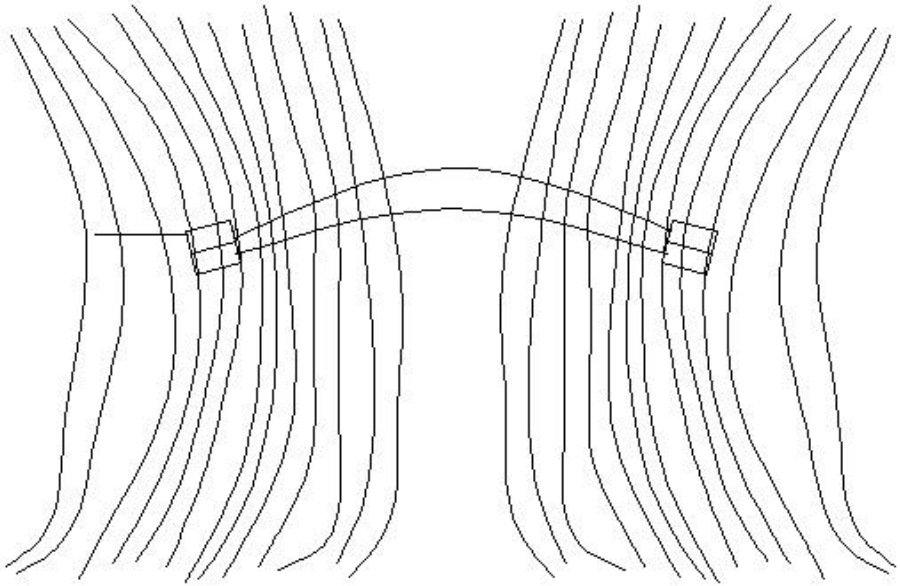
(D297)arch dam

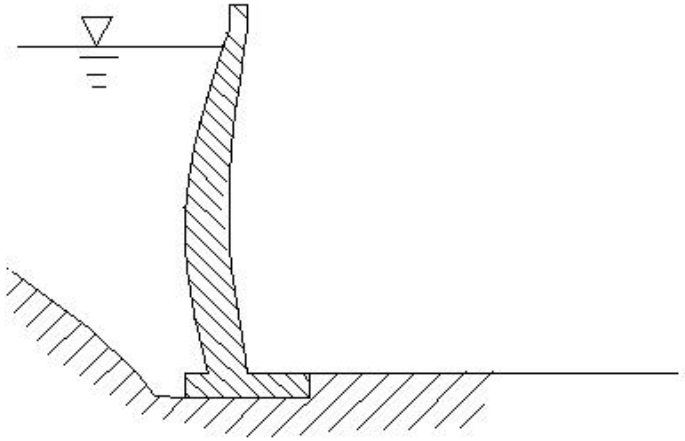
(D297)arch dam

arch dam

Loads such as water pressure
transmitted to both coasts

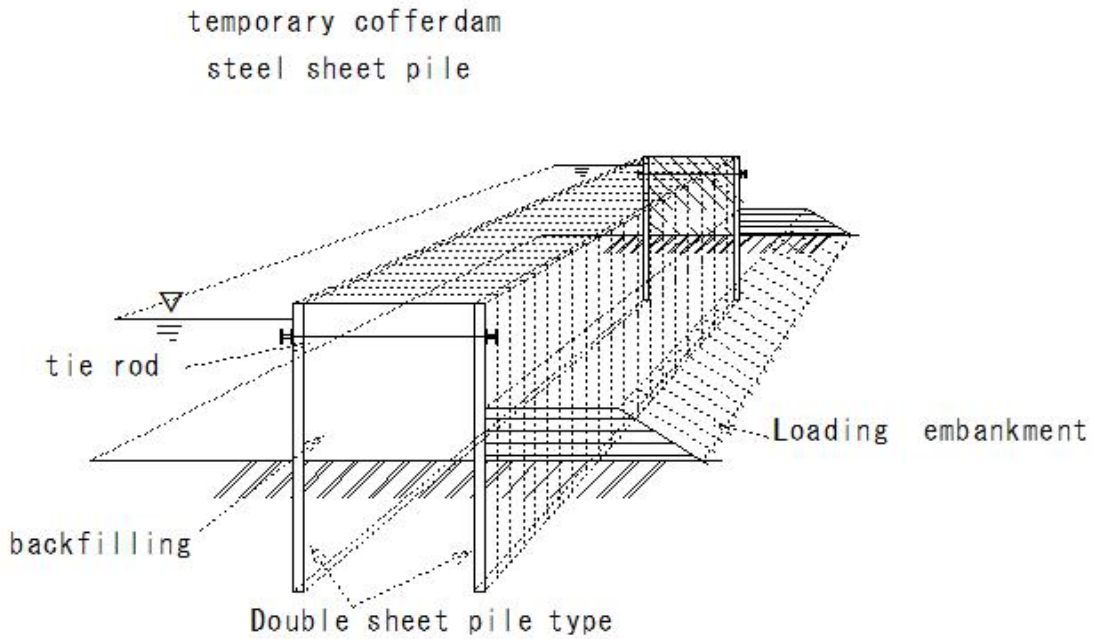
- Dam site bedrock bearing capacity - large
- Valley width - narrow
- Both banks - steep slopes
- V-shaped valley





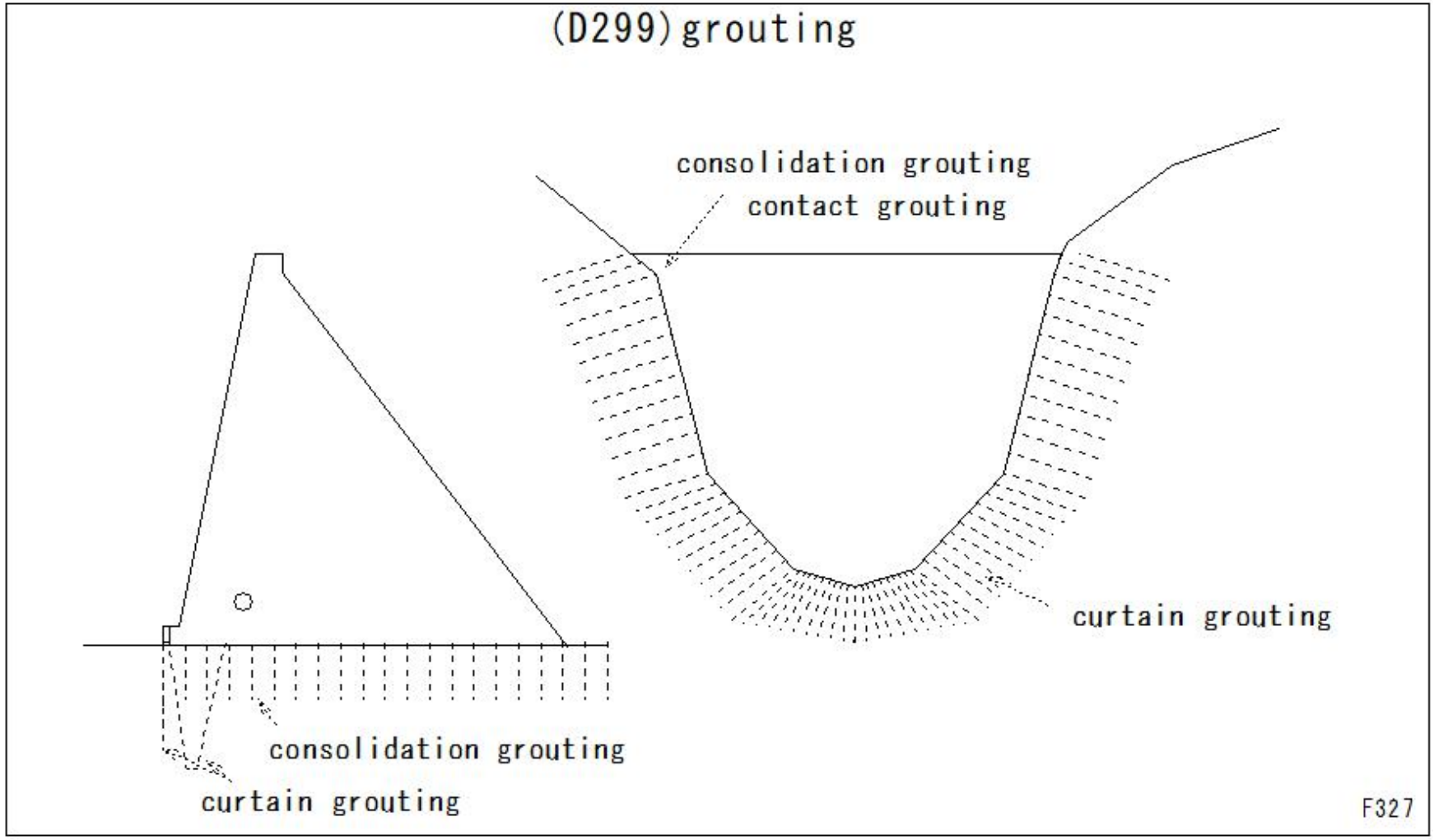
(D298)temporary cofferdam

(D298) temporary cofferdam

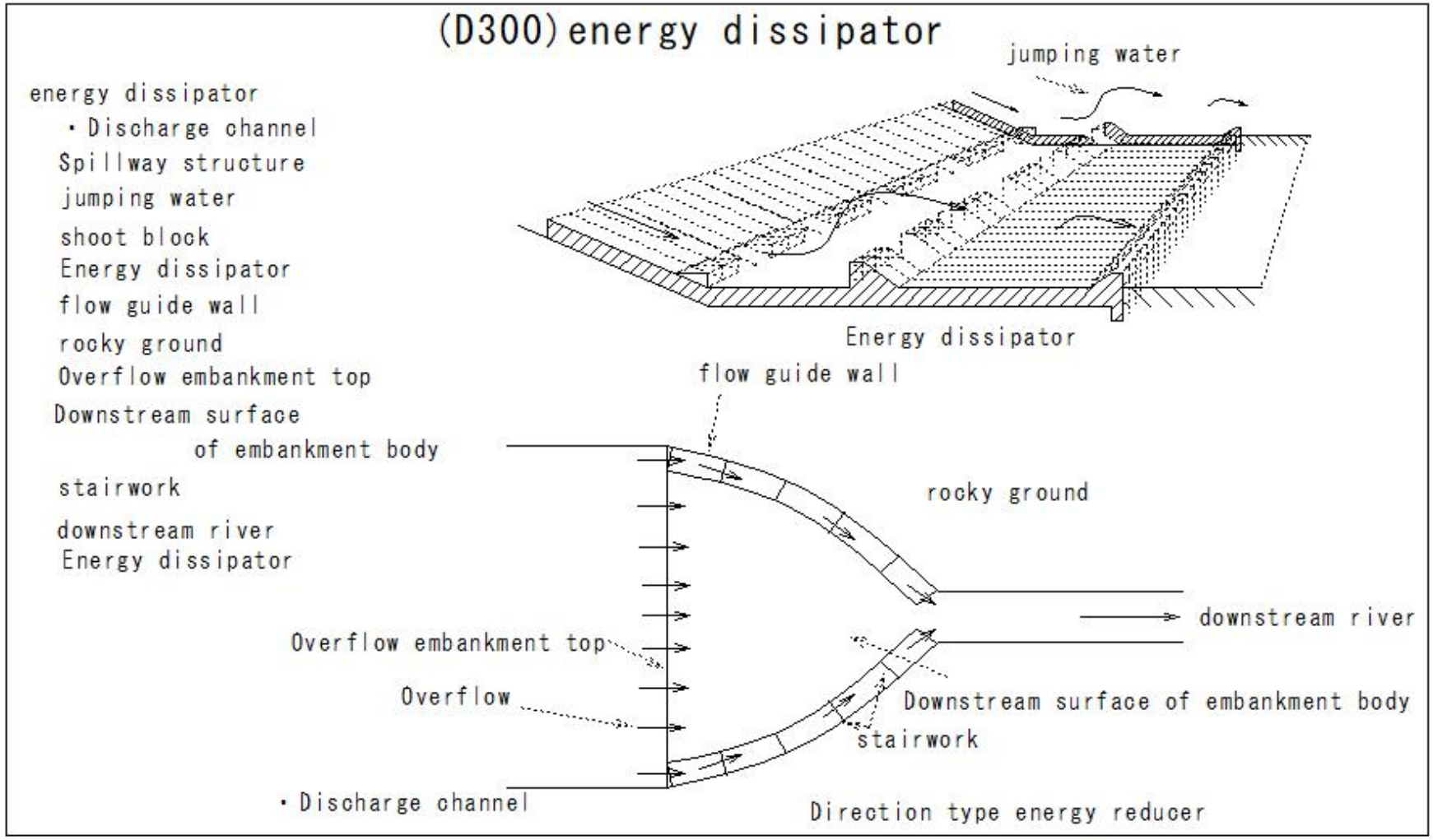


R537

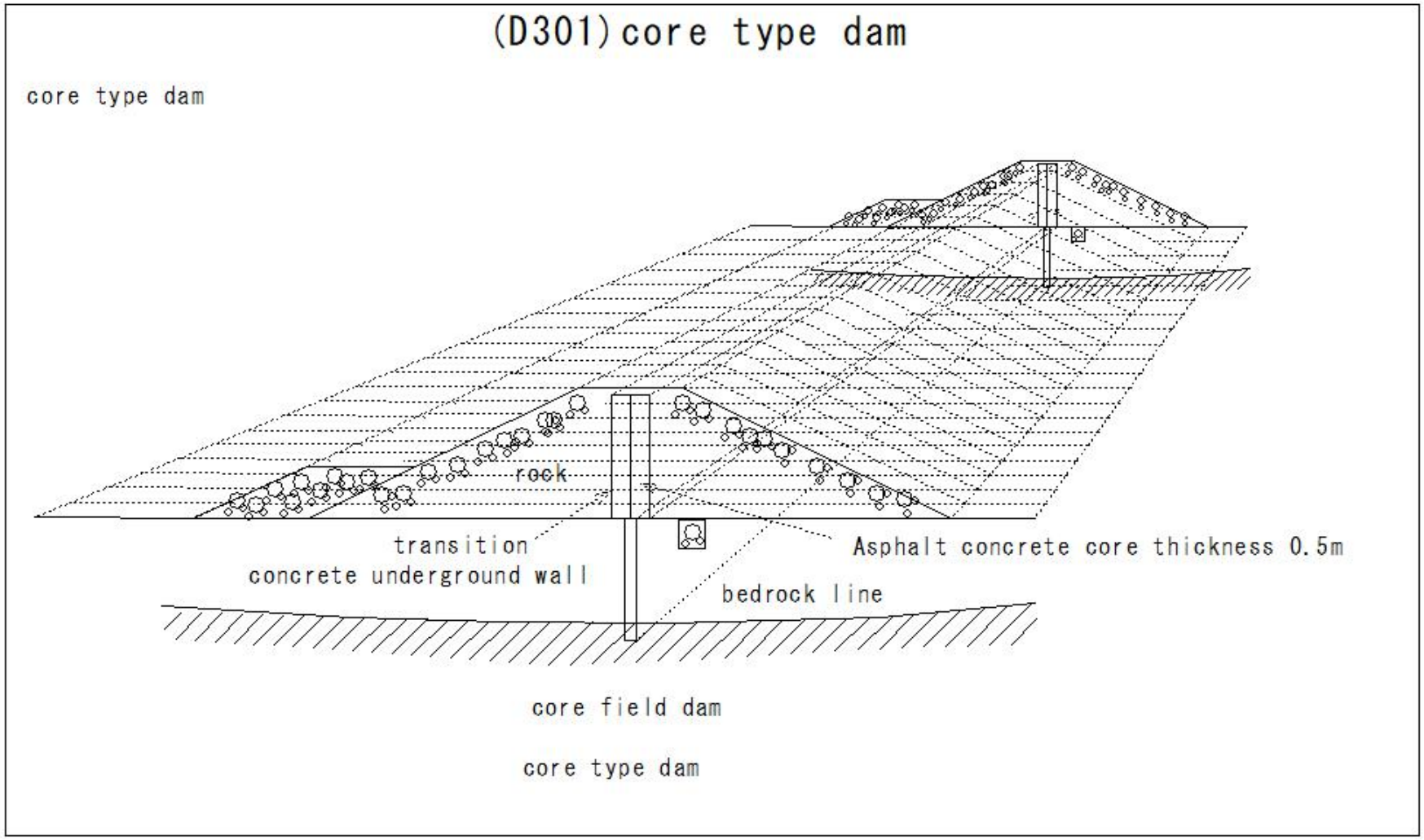
(D299)grouting



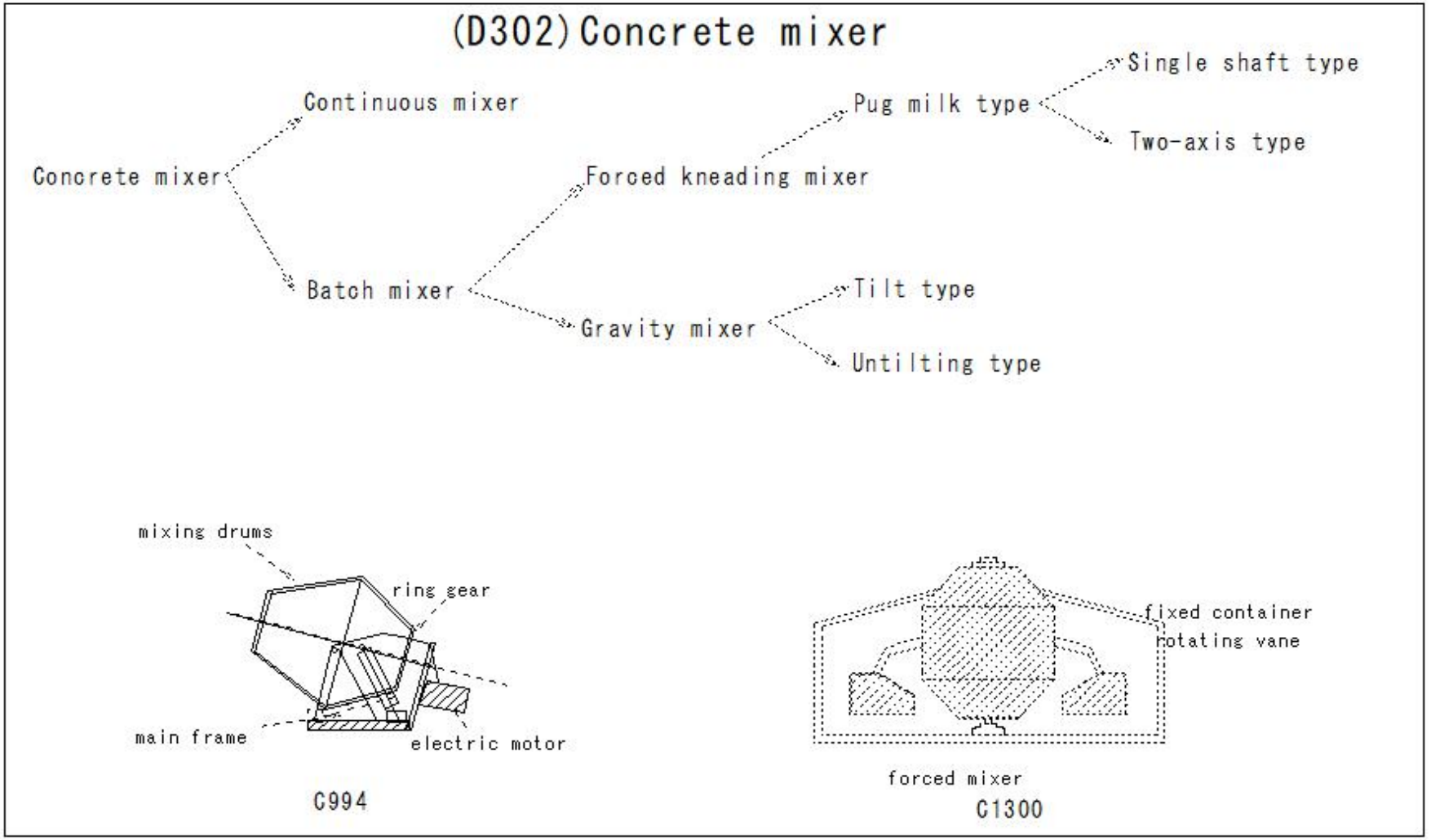
(D300)energy dissipator



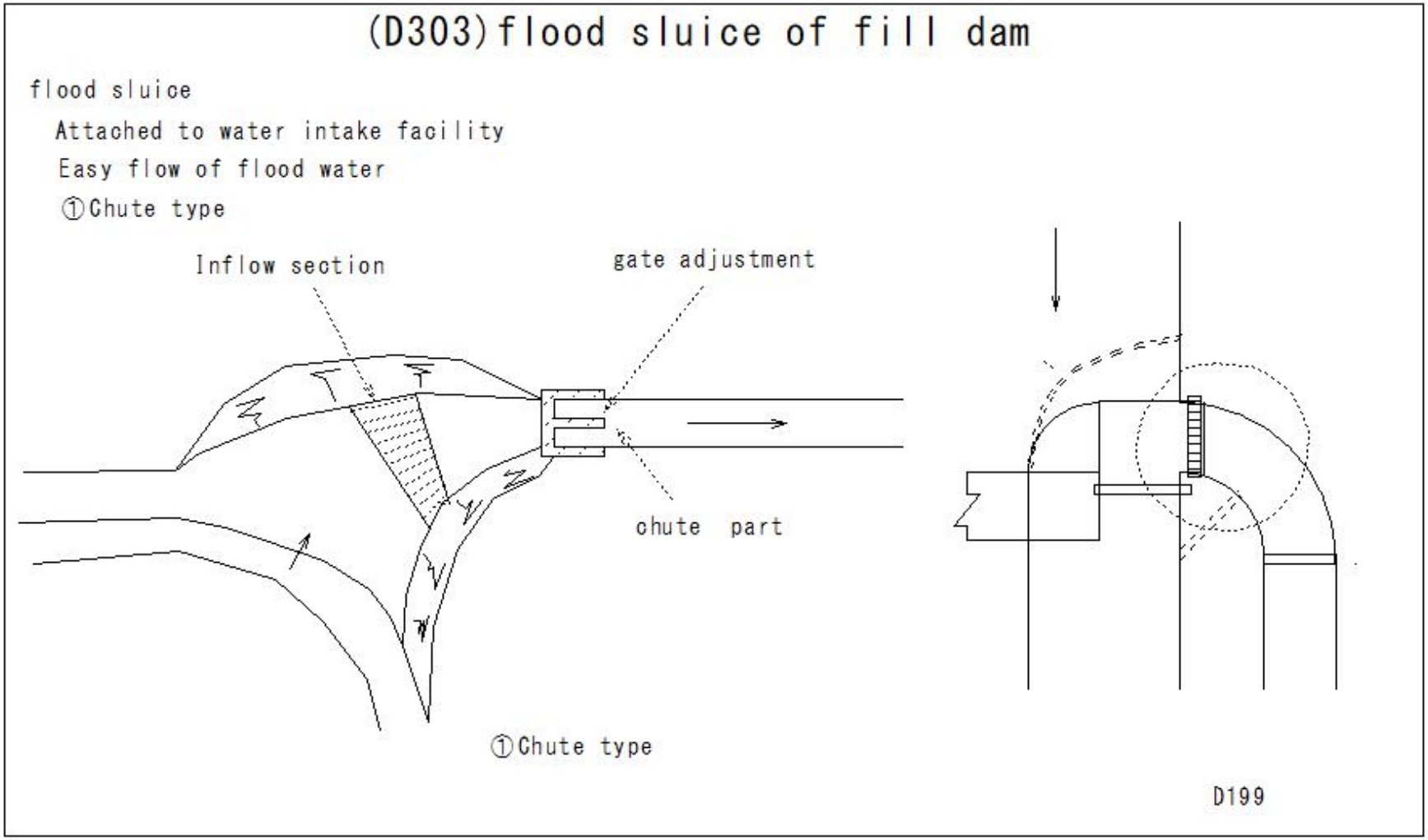
(D301)core type dam



(D302)Concrete mixer



(D303)flood sluice of fill dam



(D304)flood sluice of fill dam

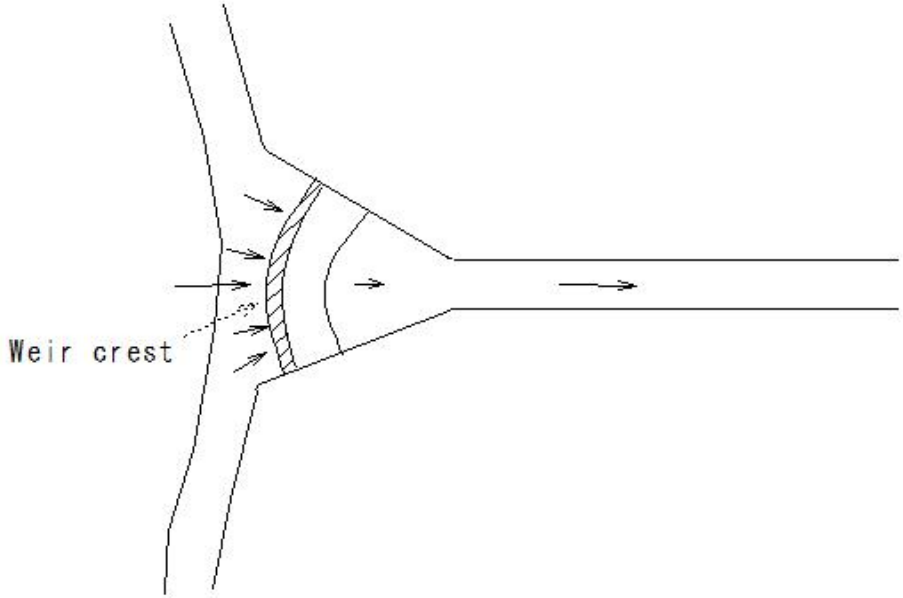
(D304)flood sluice of fill dam

flood sluice of fill dam

Attached to water intake facility

②Standard curve type

Easy flow of flood water

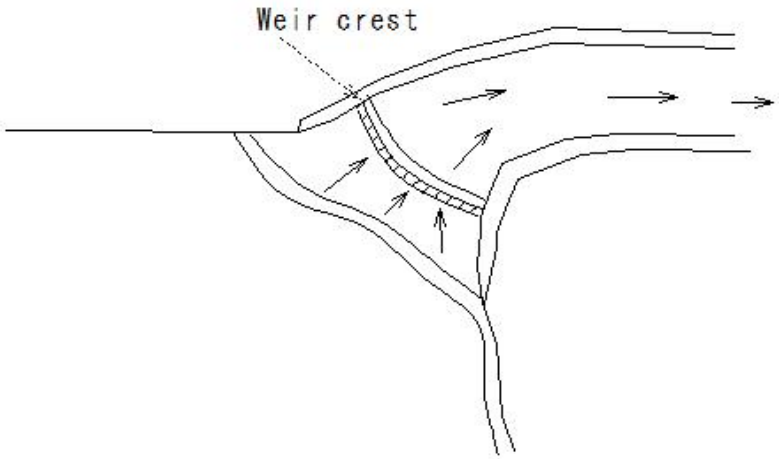


②Standard curve type

(D305)flood sluice of fill dam

(D305)flood sluice of fill dam

flood sluice of fill dam
Attached to water intake facility
③Curve type



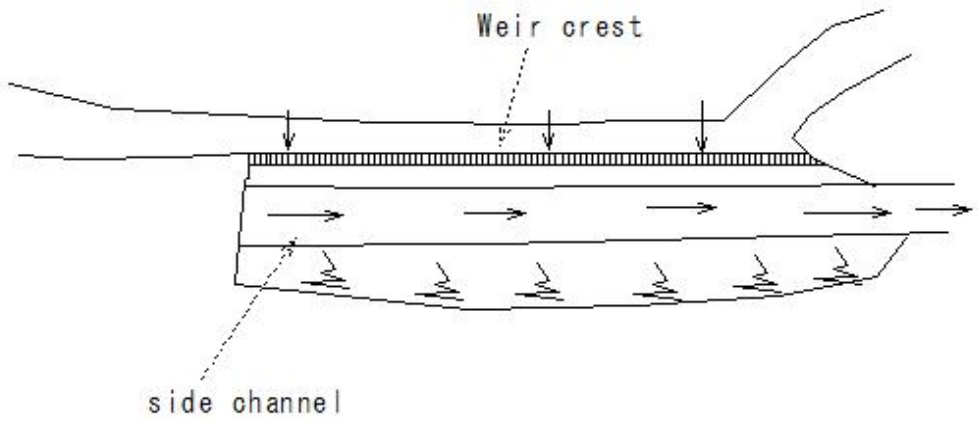
(D306)flood sluice of fill dam

(D306) flood sluice of fill dam

flood sluice of fill dam

Attached to water intake facility

④Standard type side waterway

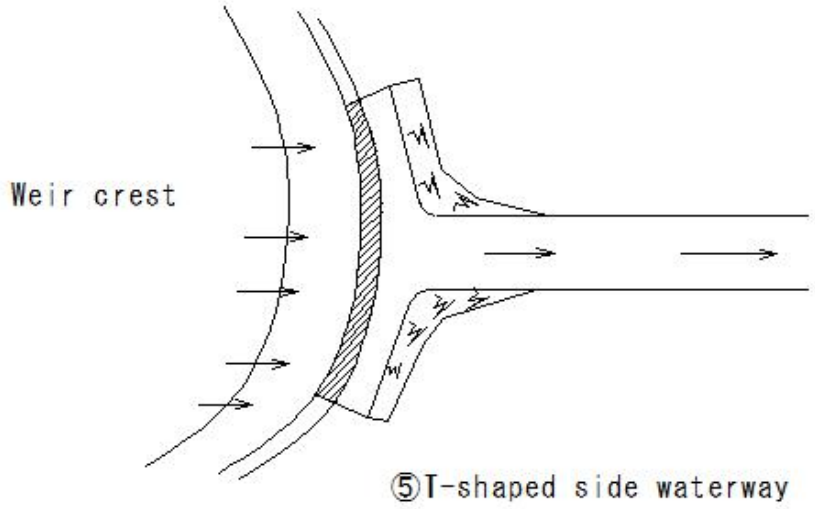


④Standard type side waterway

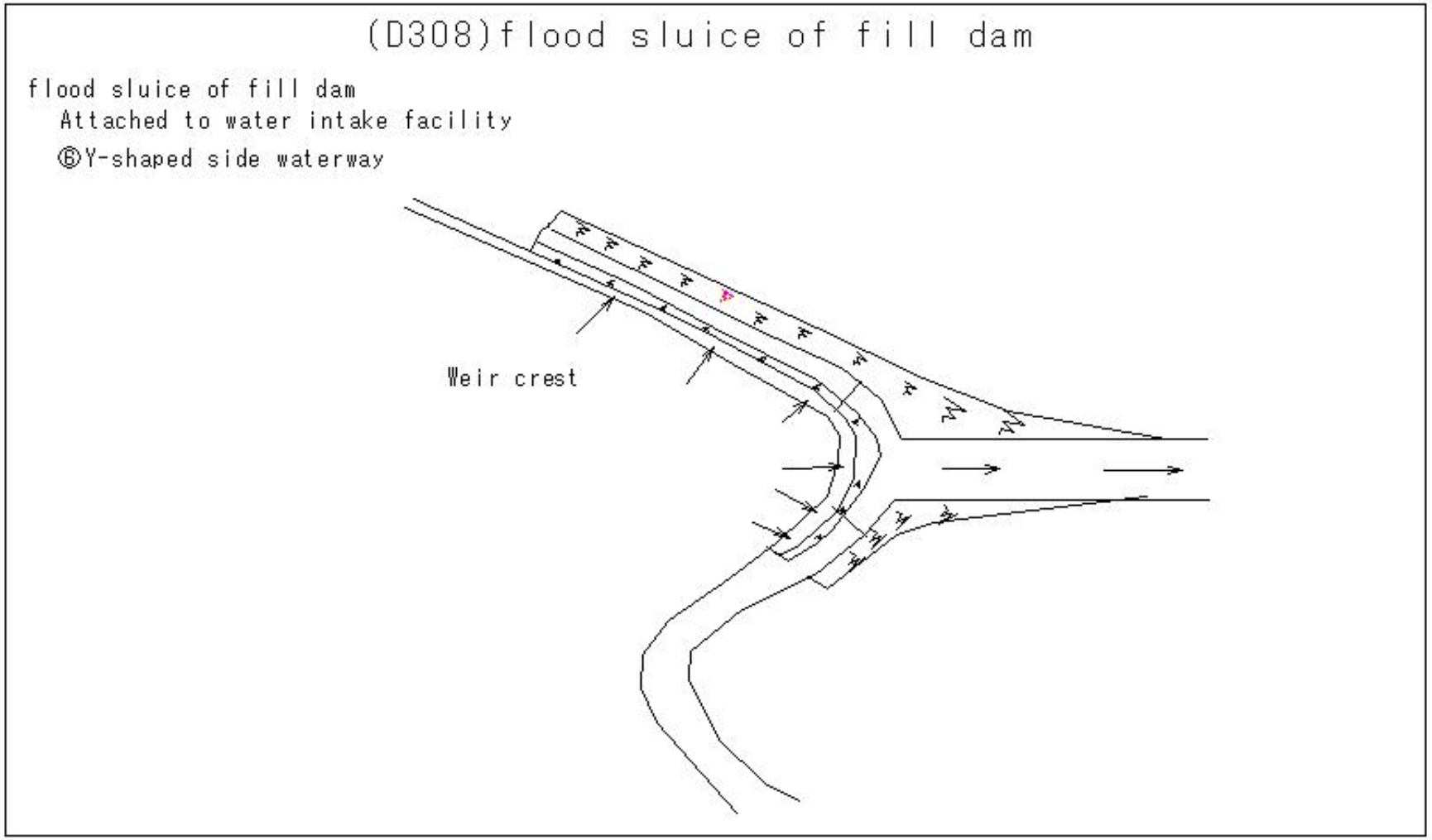
(D307)flood sluice of fill dam

(D307)flood sluice of fill dam

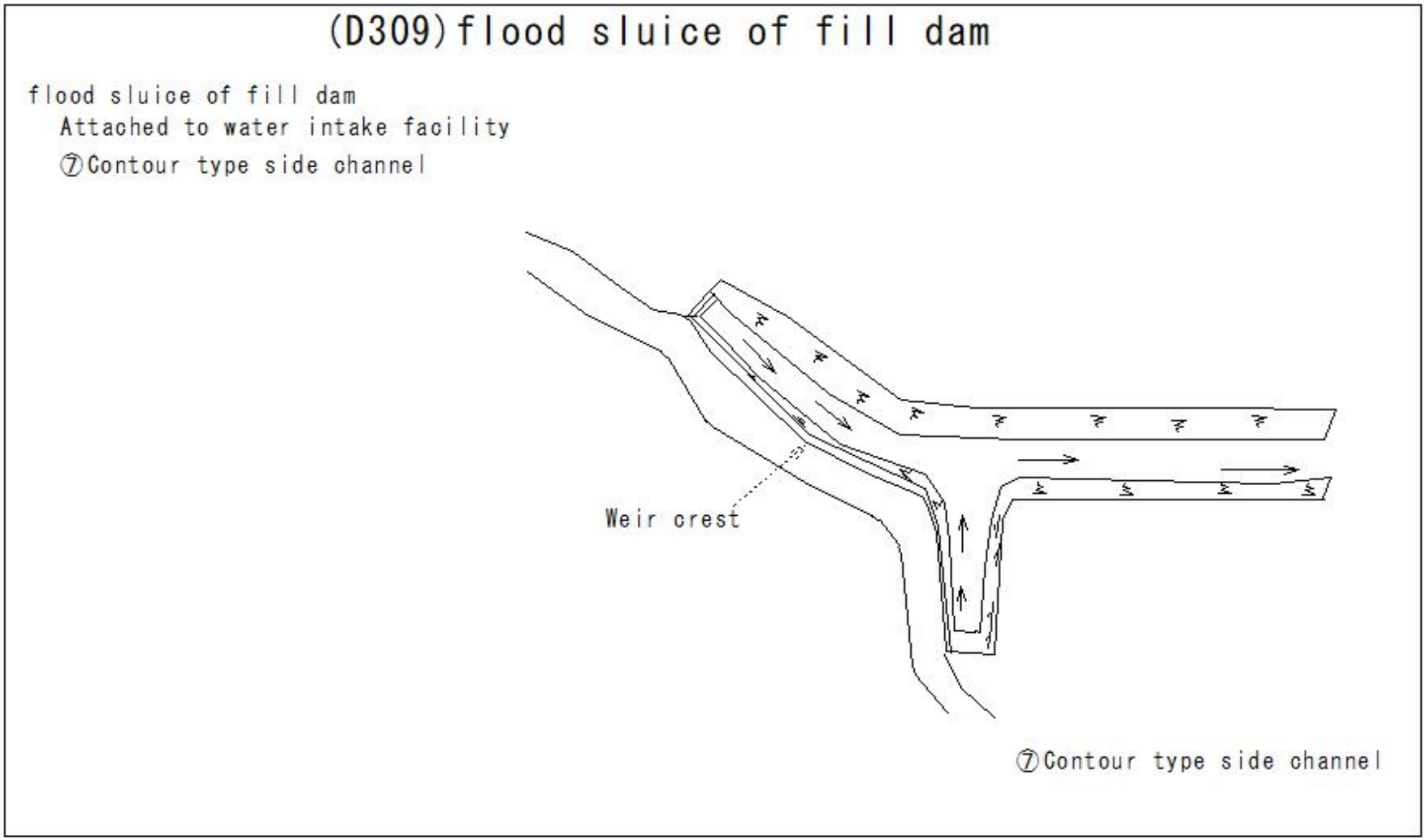
flood sluice of fill dam
Attached to water intake facility
⑤T-shaped side waterway



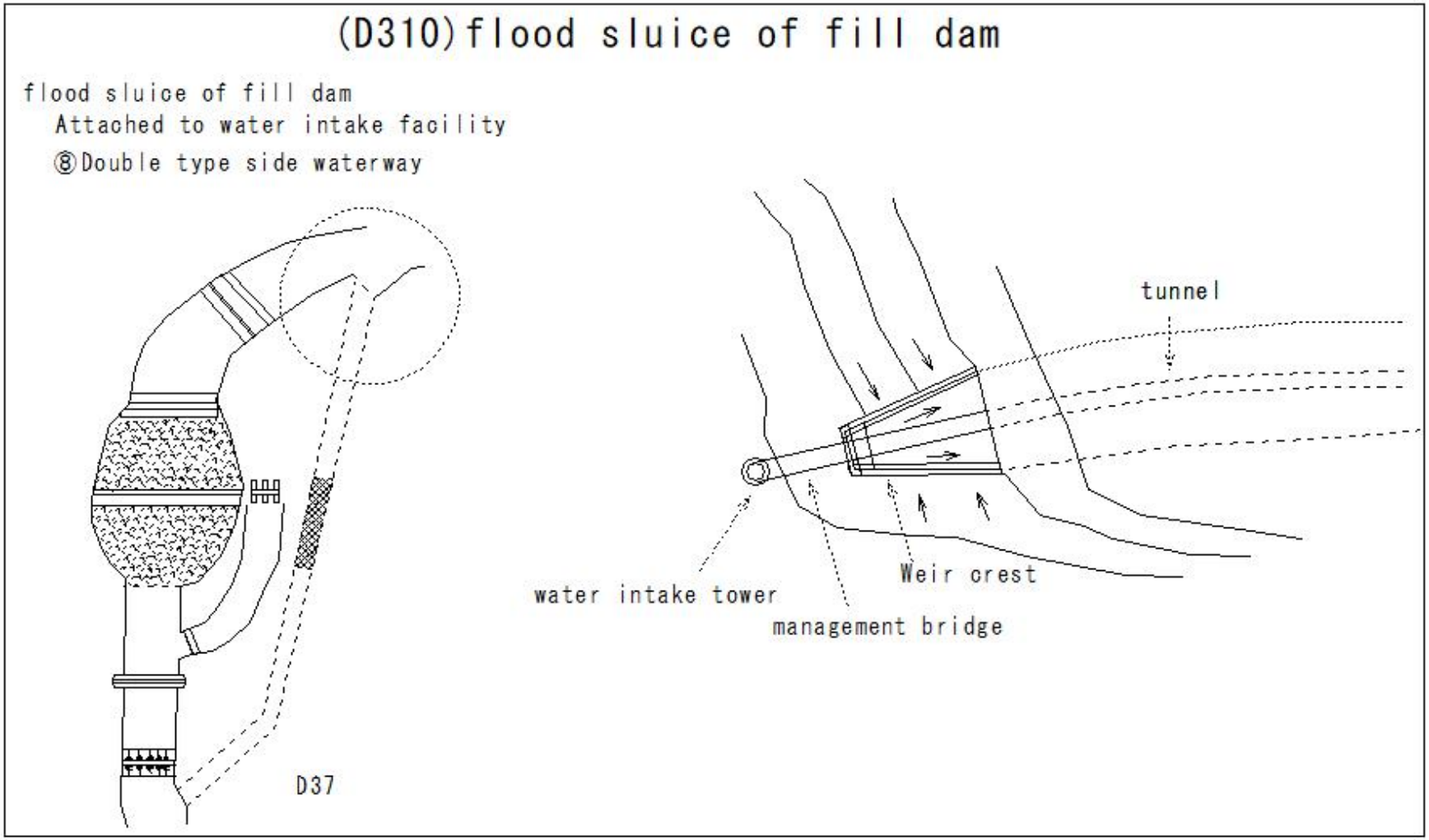
(D308)flood sluice of fill dam



(D309)flood sluice of fill dam



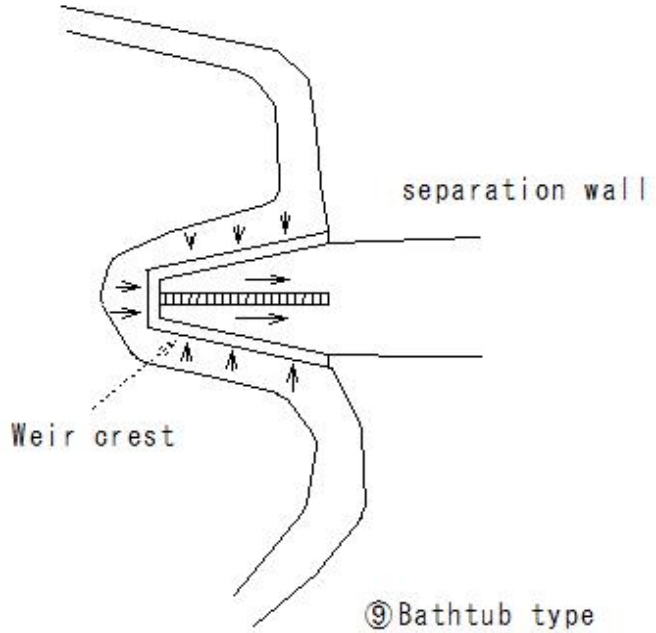
(D310)flood sluice of fill dam



(D311)flood sluice of fill dam

(D311)flood sluice of fill dam

flood sluice of fill dam
Attached to water intake facility
⑨Bathtub type

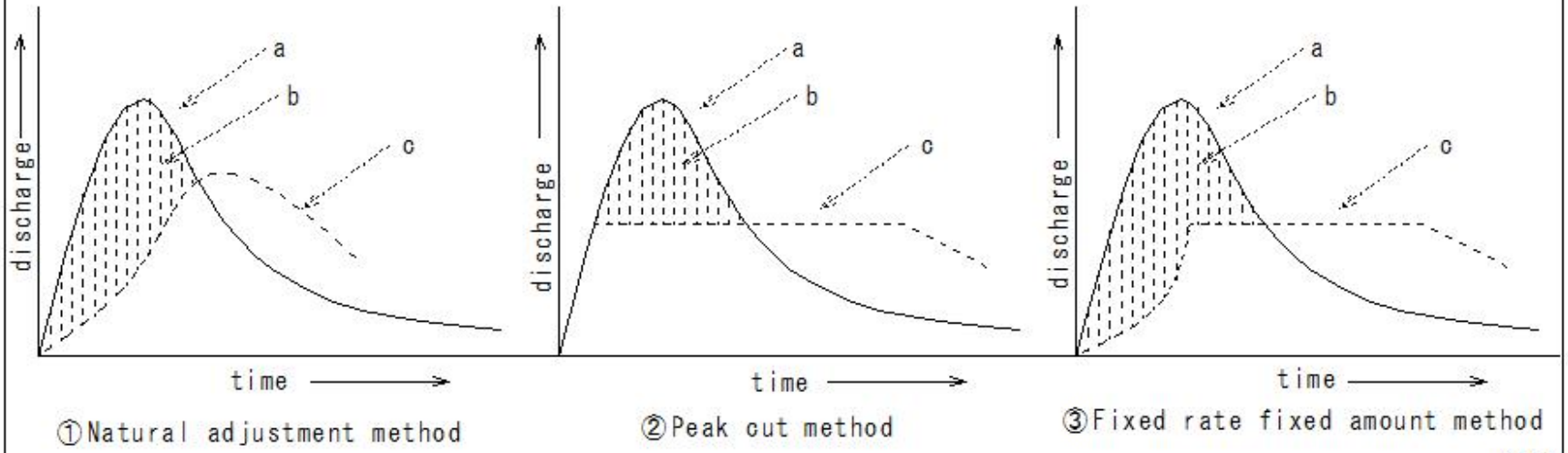


(D312)flood control

(D312)flood control

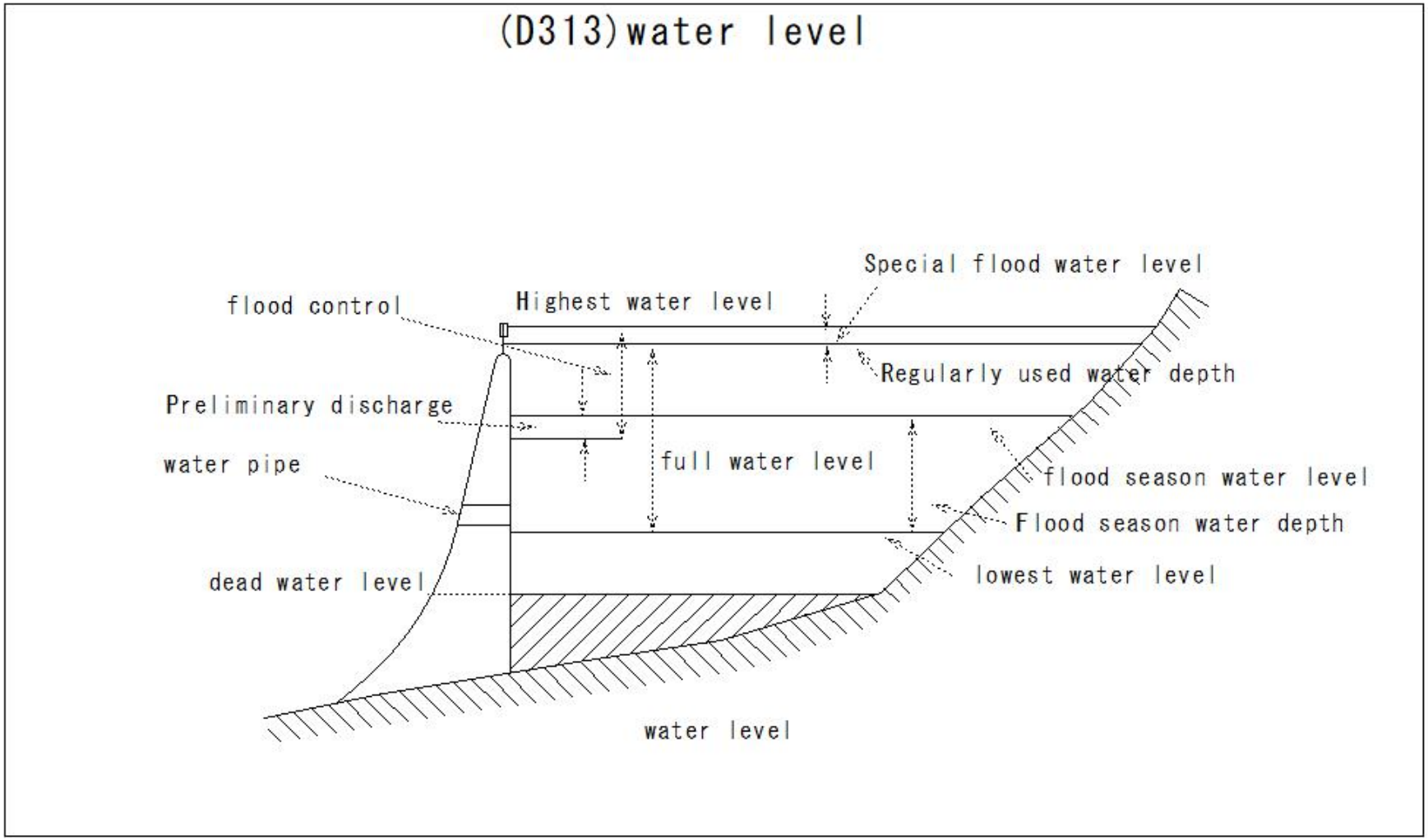
flood control
discharge
discharge changes over time
A portion of flood runoff is stored in reservoirs, etc. for flood control and disaster prevention purposes.
change flow time
Reduce downstream flood peak flows

a:flood discharge
b:discharge after flood control
c:flood control amount

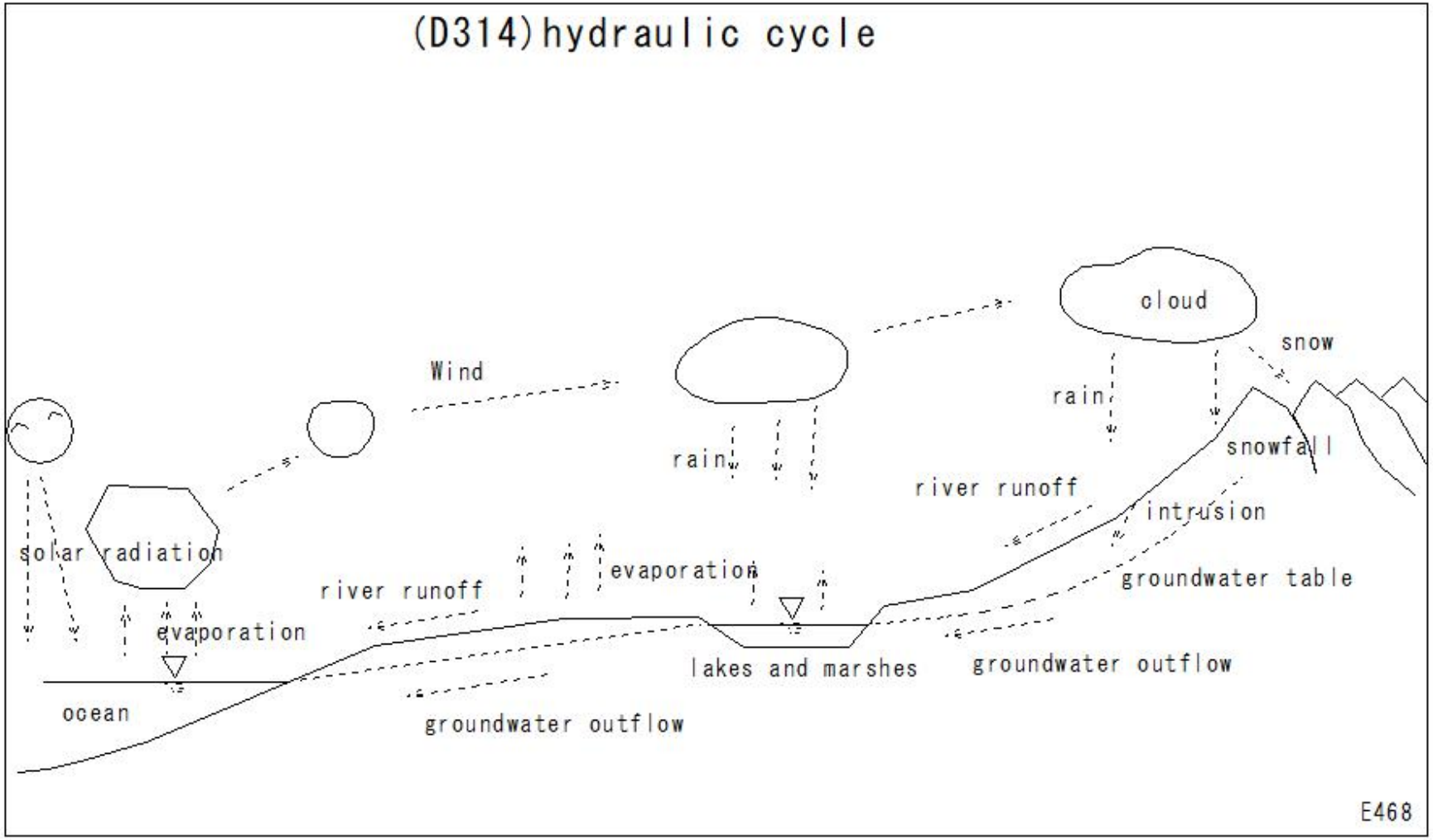


R540

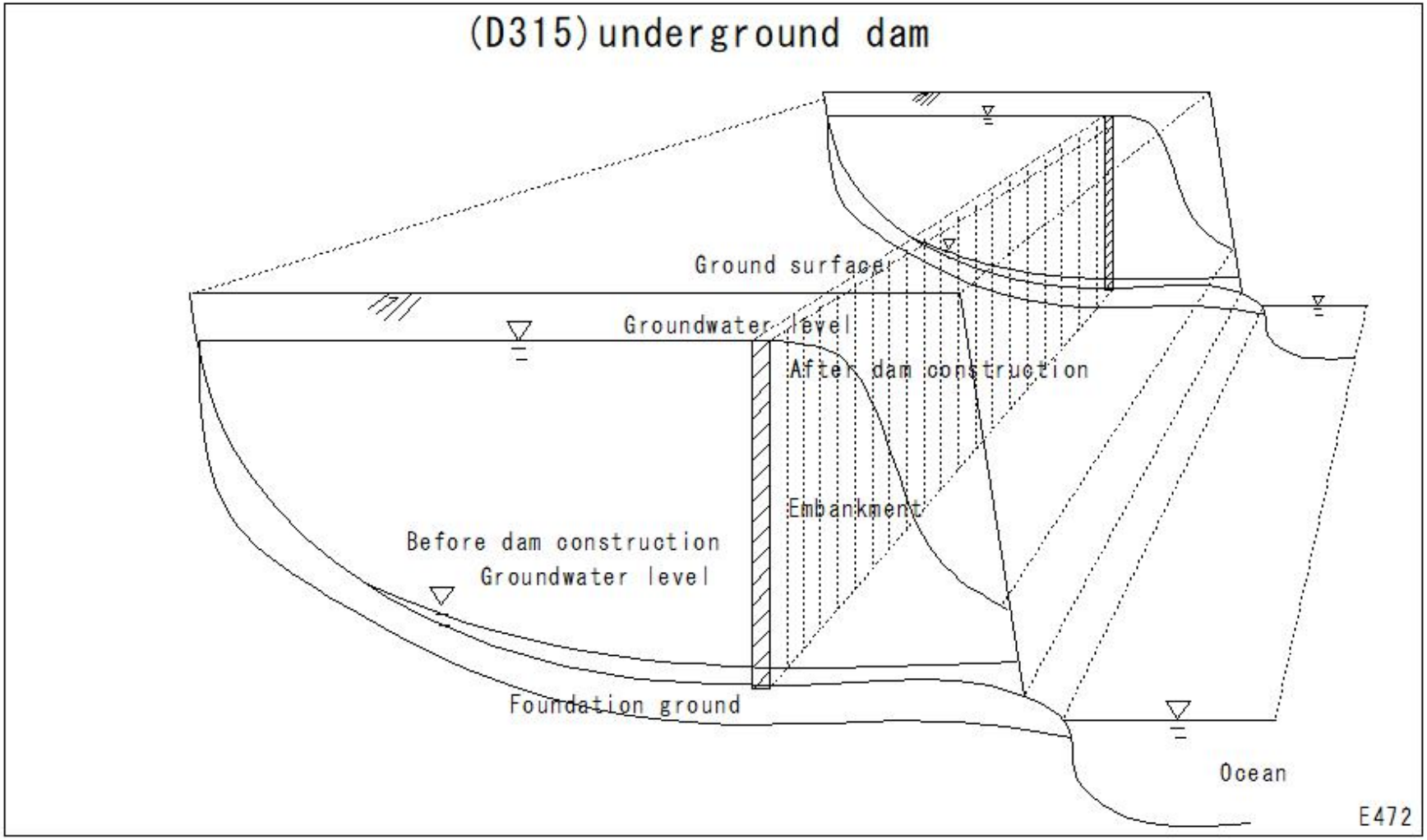
(D313)water level



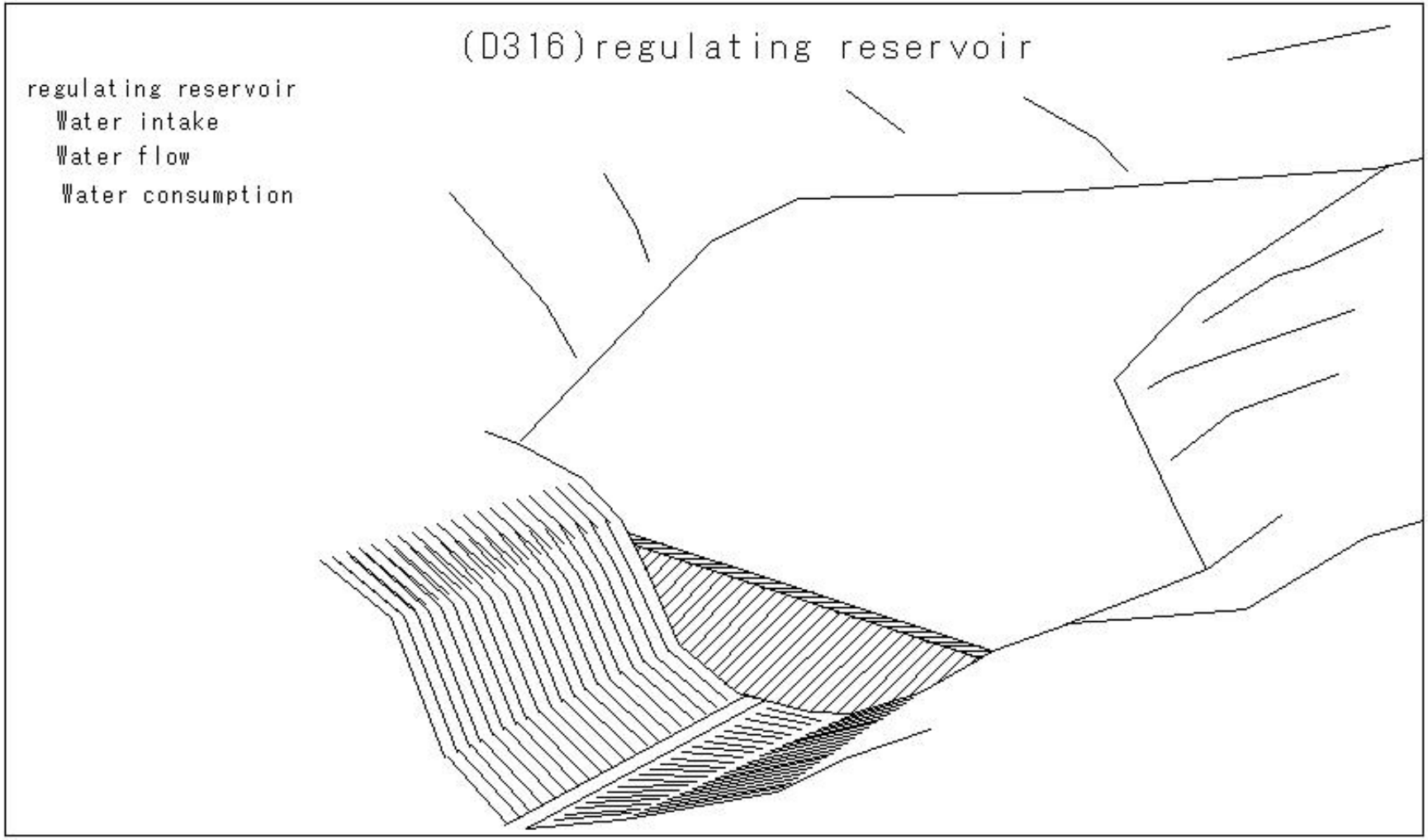
(D314)hydraulic cycle



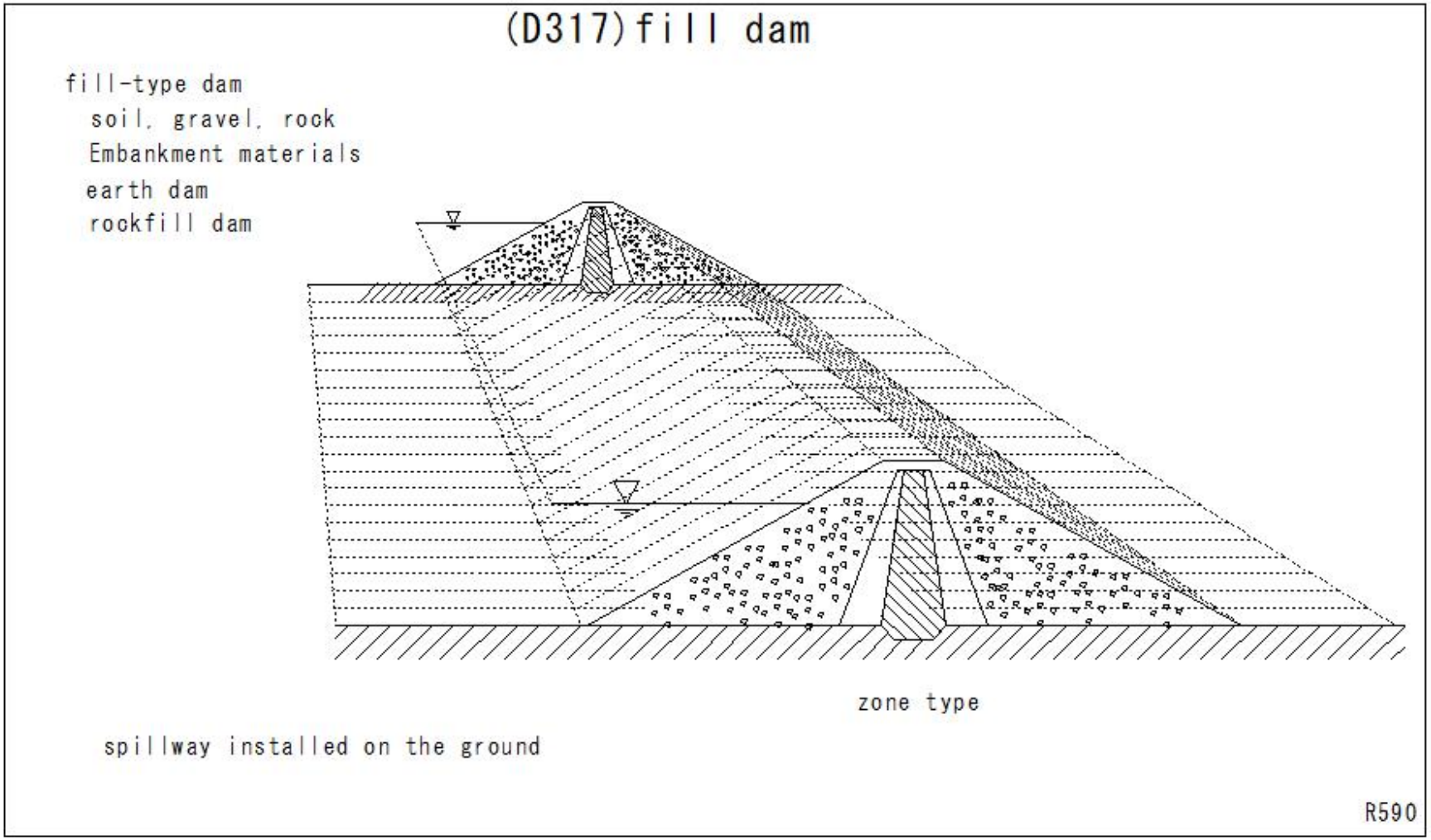
(D315)underground dam



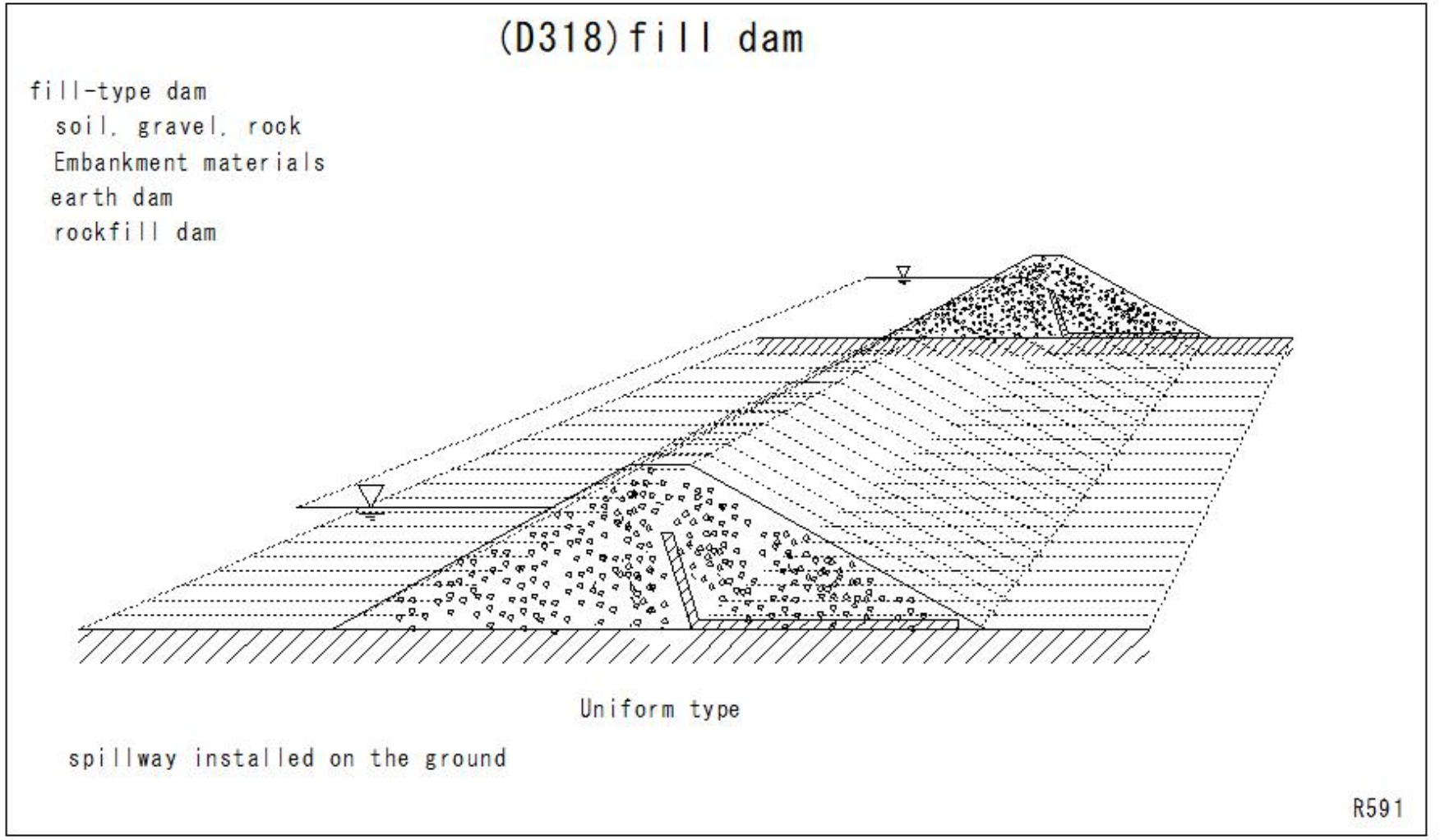
(D316)regulating reservoir



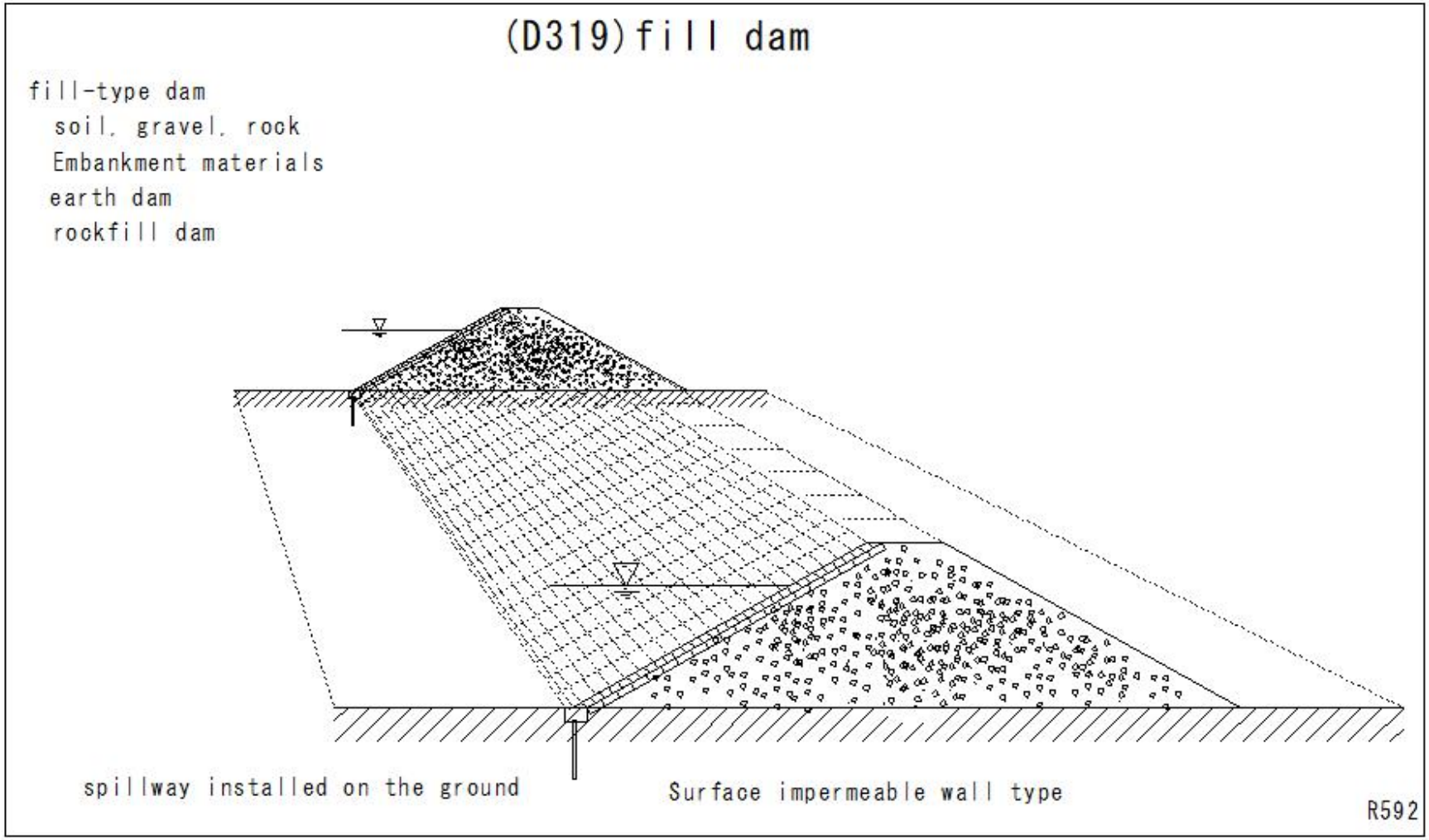
(D317)fill dam



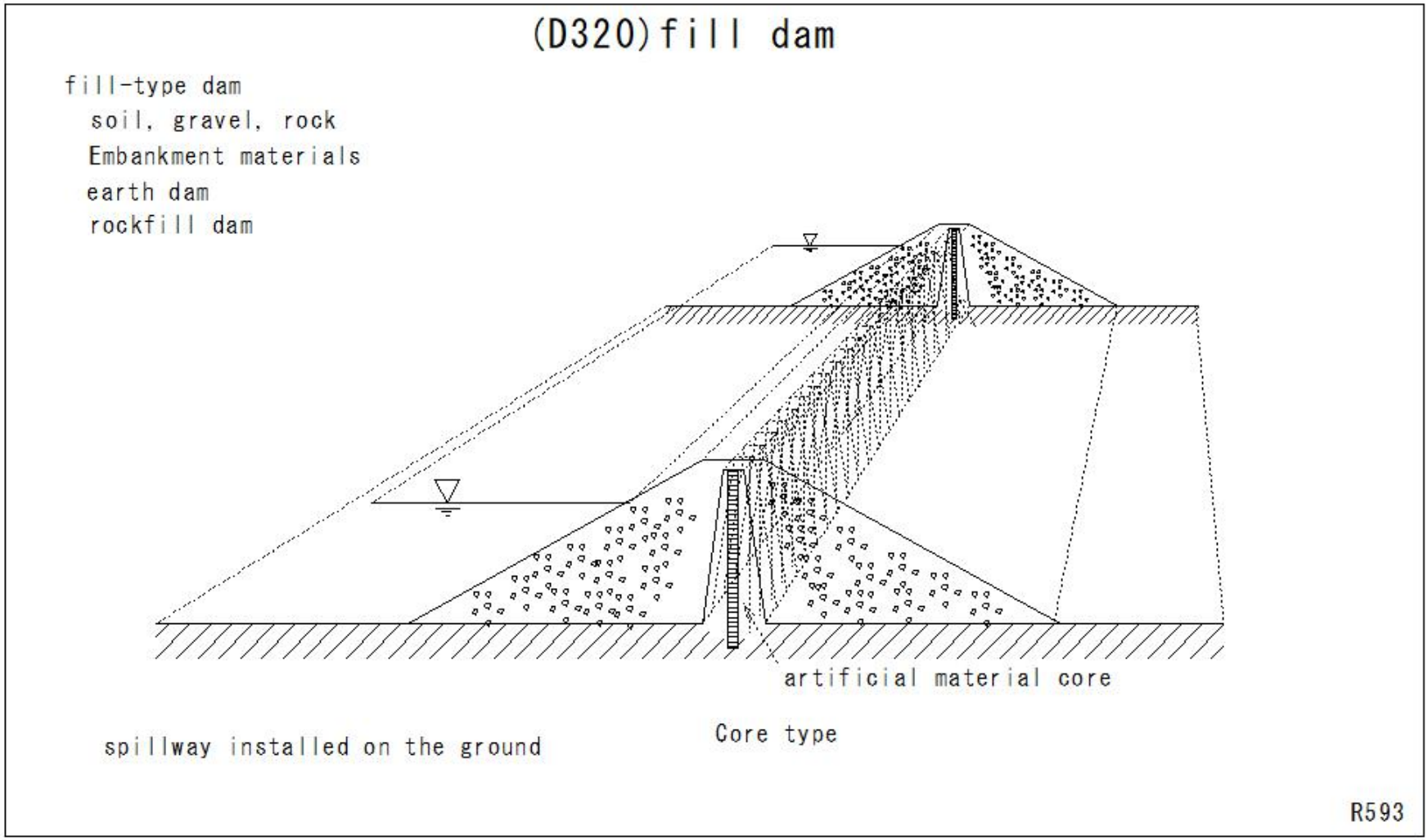
(D318)fill dam



(D319)fill dam



(D320)fill dam



(D321)effective storage capacity

(D321)effective storage capacity

Effective water storage amount

①full water level

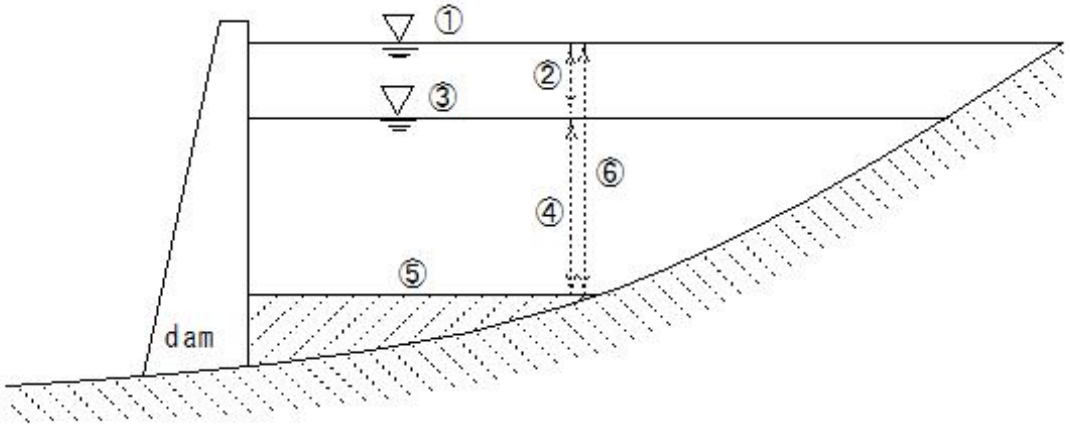
②Flood control capacity (B)

③Flood season limit water level

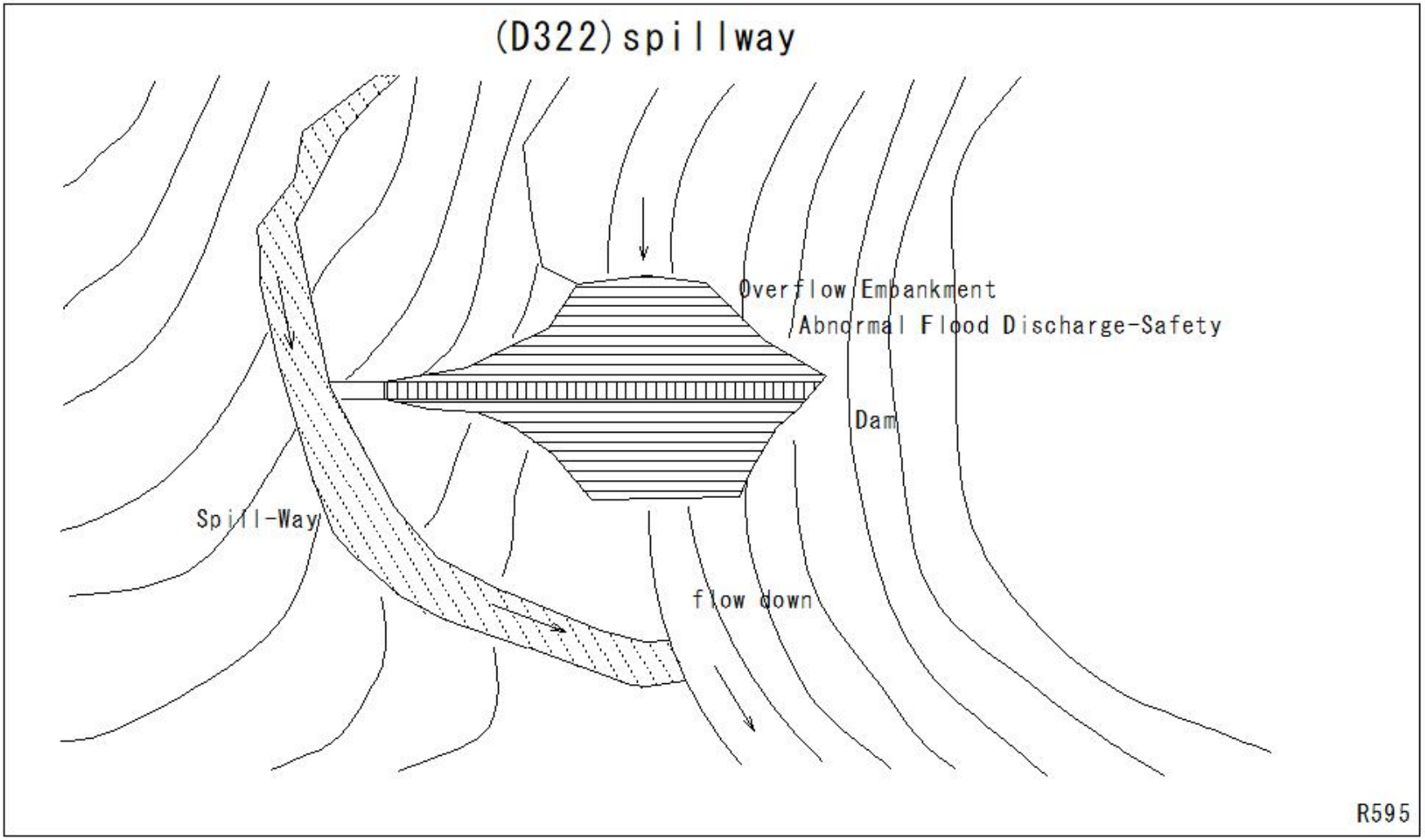
④Flood season water usage capacity (A)

⑤sand surface

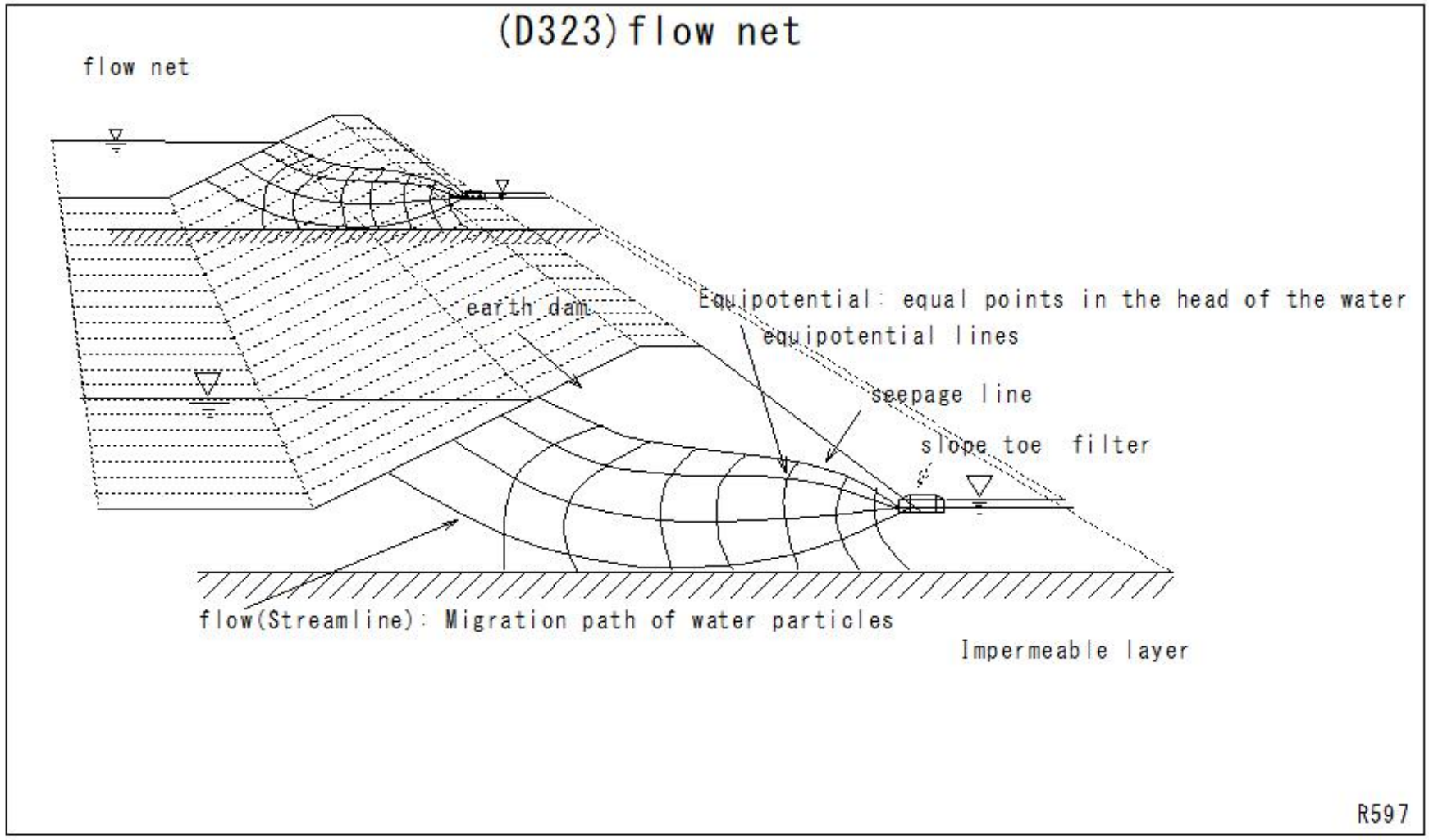
⑥Water usage capacity during non-flood season



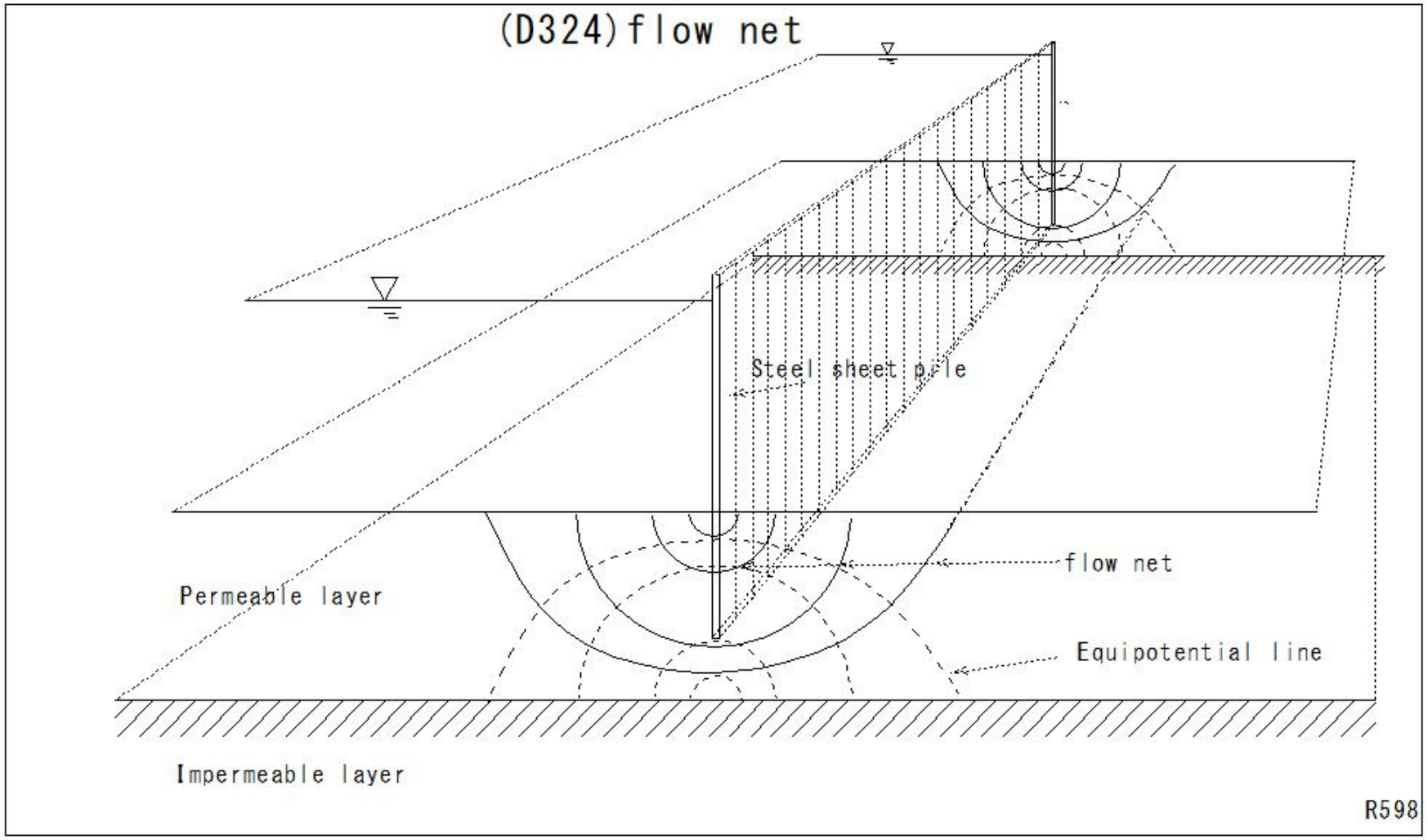
(D322)spillway



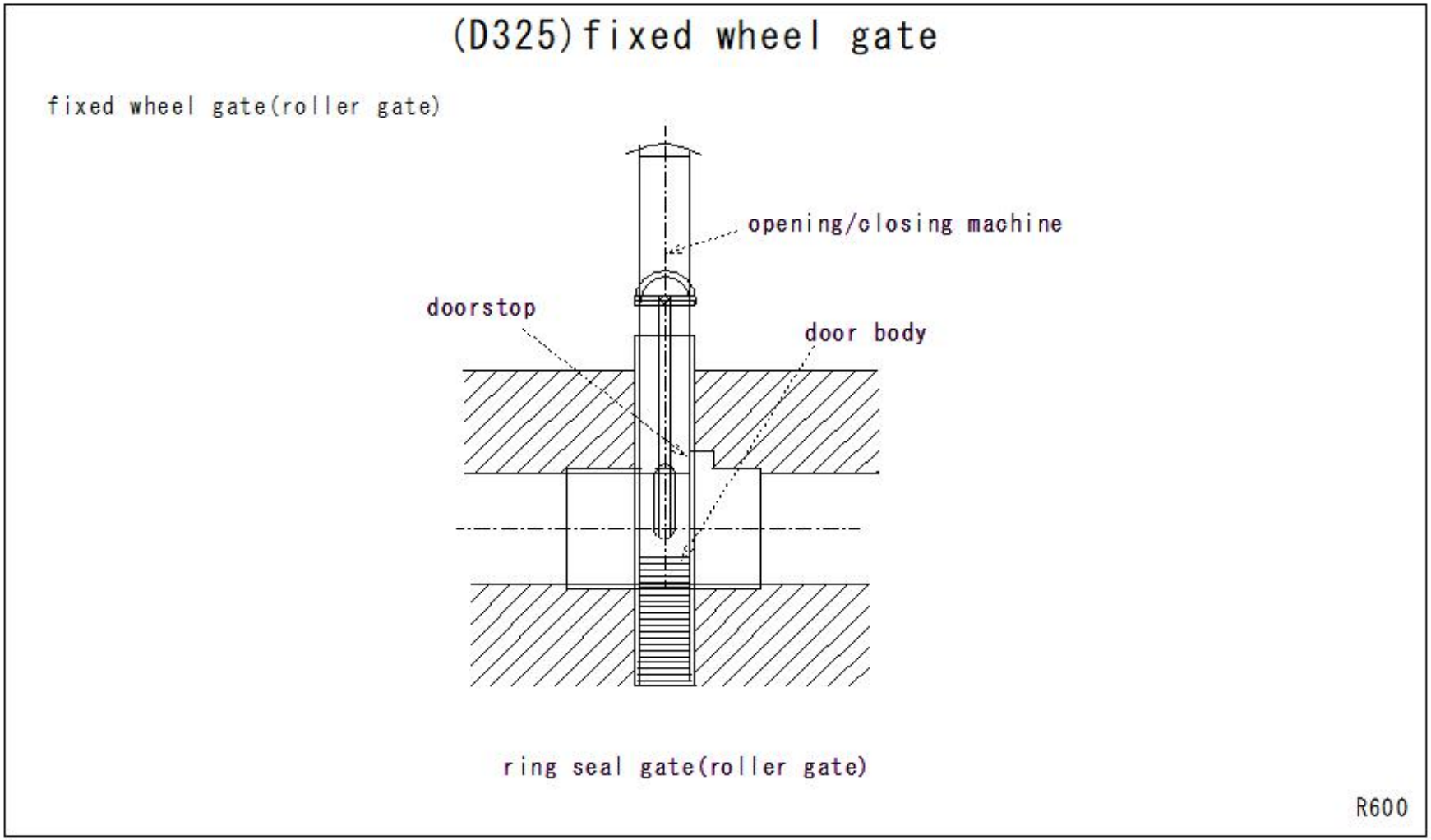
(D323)flow net



(D324)flow net



(D325)fixed wheel gate



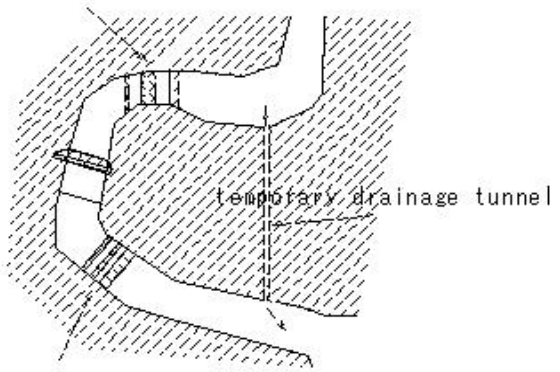
(D326)Diversion works

(D326)Diversion works

temporary drainage tunnel

Diversion works

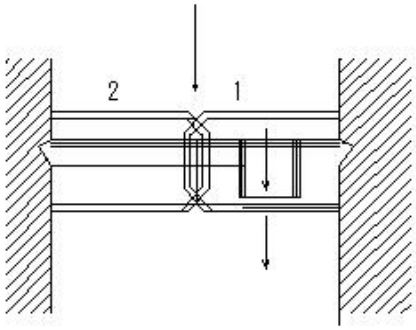
upstream cofferdam



downstream cofferdam

D288

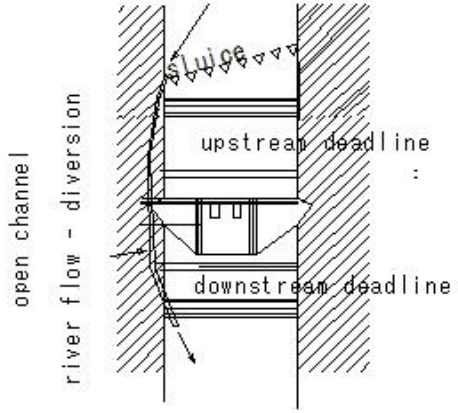
Half cofferdam



Diversion works-Half cofferdam

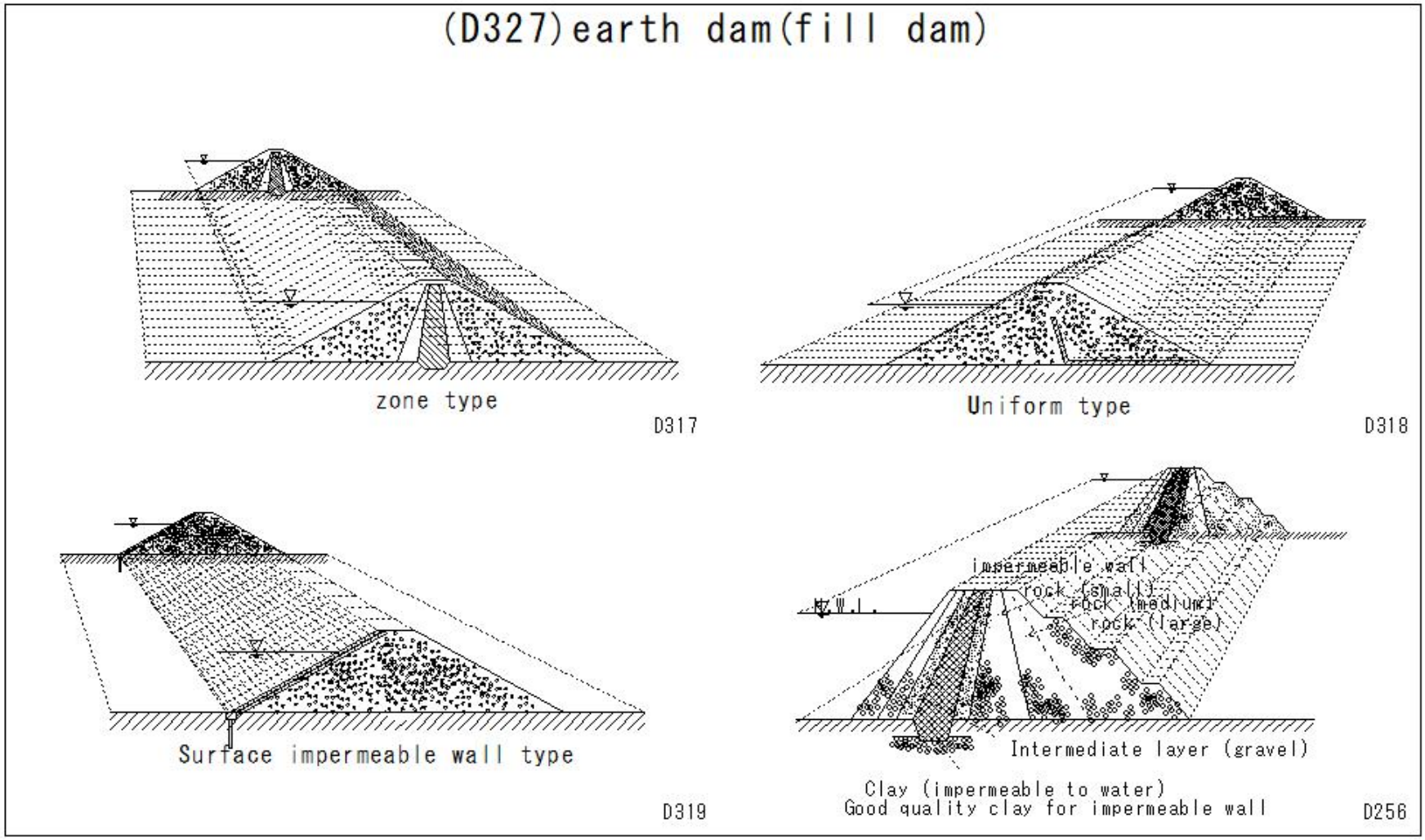
D289

Temporary drainage open ditch



D290

(D327)earth dam(fill dam)



(D328)RCD method(Roller Compacted Dam-Concrete)