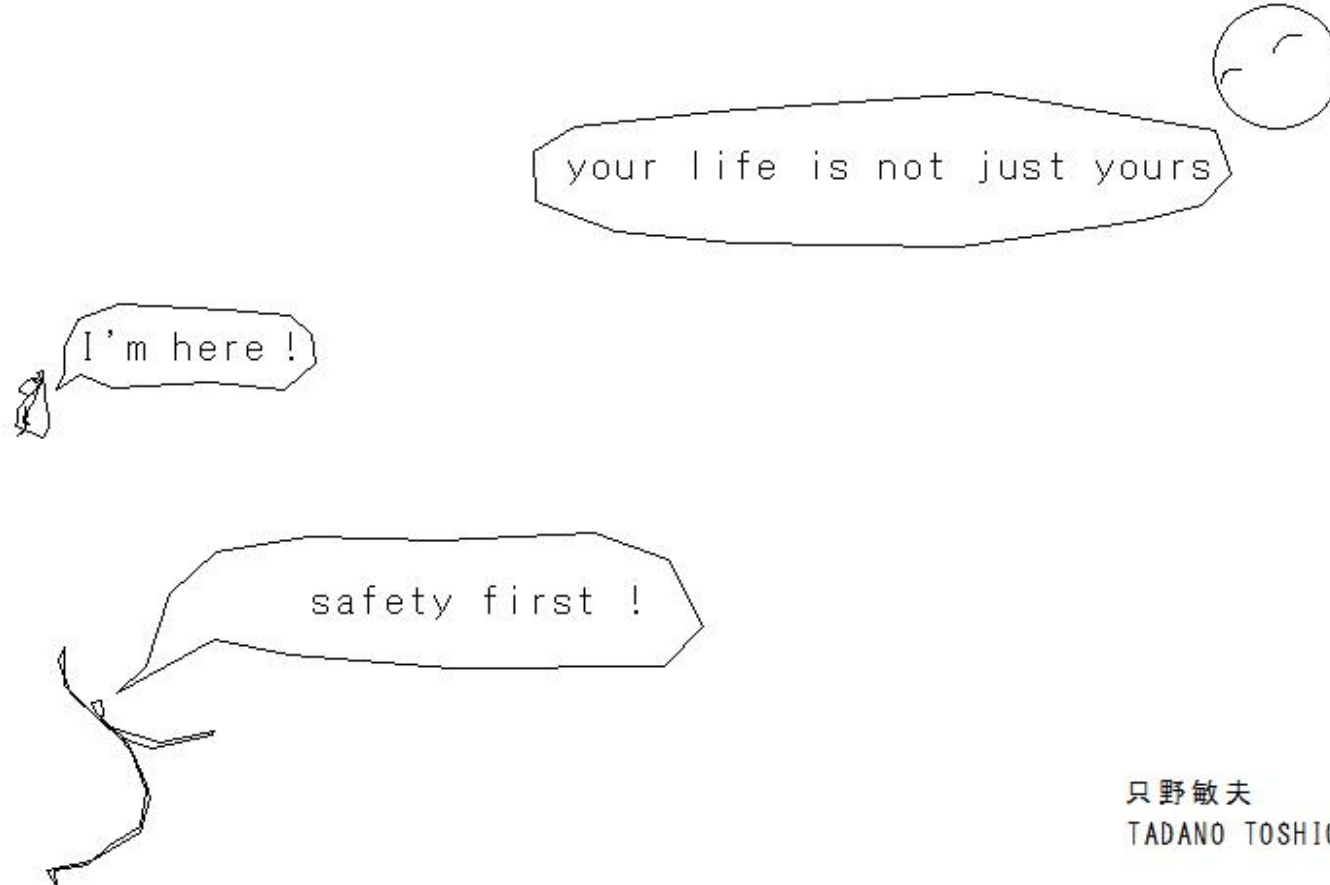


(01)construction machinery works(illustration) in Africa(1-427)

(01)construction machinery works(illustration) in Africa(1-427)



只野敏夫
TADANO TOSHIO

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只野敏夫
Tadano Toshio

1 (M1)construction machinery	construction machinery
2 (M2)construction machinery	construction machinery
3 (M3)construction machinery	construction machinery
4 (M4)construction machinery	construction machinery
5 (M5)construction machinery	construction machinery
6 (M6)construction machinery	construction machinery
7 (M7)construction machinery	construction machinery
8 (M8)construction machinery	construction machinery
9 (M9)construction machinery	construction machinery
10 (M10)construction machinery	construction machinery
11 (M11)construction machinery(traveling device)	traveling device
12 (M12)construction machinery(Hydraulic type/Mechanical)	Hydraulic type/Mechanical
13 (M13)construction machinery(cone penetration)	cone penetration
14 (M14)construction machinery(cone index)	cone index
15 (M15)construction machinery(noise level)	noise level
16 (M16)Earthmoving machinery(Excavating machine)	Excavating machine
17 (M17)Earthmoving machinerye(Excavating machine)	Excavating machine
18 (M18)Earthmoving machinery(Excavating machine)	Excavating machine
19 (M19)Earthmoving machinery(Excavating machine)	Excavating machine
20 (M20)Earthmoving machinery(Excavating machine)	Excavating machine
21 (M21)Earthmoving machinery(Excavating machine)	Excavating machine
22 (M22)Earthmoving machinery(Excavating machine)	Excavating machine
23 (M23)Earthmoving machinery(Excavating machine)	Excavating machine
24 (M24)Earthmoving machinery(loading machine)	loading machine
25 (M25)Earthmoving machinery(loading machine)	loading machine
26 (M26)Earthmoving machinery(loading machine)	loading machine
27 (M27)Earthmoving machinery(loading machine)	loading machine
28 (M28)Earthmoving machinery(loading machine)	loading machine
29 (M29)Earthmoving machinery(loading machine)	loading machine
30 (M30)Earthmoving machinery-transport machinery-Straight dozer	Straight dozer
31 (M31)Earthmoving machinery-transport machinery-Angle dozer	Angle dozer
32 (M32)Earthmoving machinery-transport machinery-Tilt dozer	Tilt dozer
33 (M33)Earthmoving machinery-transport machinery-U dozer	U dozer
34 (M34)Earthmoving machinery-transport machinery-Rake dozer	Rake dozer

35 (M35)Earthmoving machinery-transport machinery-Tridozer	Tridozer
36 (M36)Earthmoving machinery-transport machinery-Bucket dozer	Bucket dozer
37 (M37)Earthmoving machinery-transport machinery-Ripper	Ripper
38 (M38)Earthmoving machinery-transport machinery-Installation pressure	Installation pressure
39 (M39)Earthmoving machinery-transport machinery-Scraper	Scraper
40 (M40)Earthmoving machinery-transport machinery-Scraper-Work procedure	Scraper
41 (M41)Earthmoving machinery-transport machinery-Scraper-Type of scraper	Scraper
42 (M42)Earthmoving machinery-transport machinery-Motor grader	Motor grader
43 (M43)Earthmoving machinery-transport machinery-Dump truck	Dump truck
44 (M44)Earthmoving machinery-transport machinery-crane	crane
45 (M45)Earthmoving machinery-transport machinery-Crawler crane	Crawler crane
46 (M46)Earthmoving machinery-transport machinery-Truck crane	Truck crane
47 (M47)Earthmoving machinery-transport machinery-Cable crane	Cable crane
48 (M48)Earthmoving machinery-transport machinery-Jib crane	Jib crane
49 (M49)Earthmoving machinery-transport machinery-Derrick crane	Derrick crane
50 (M50)Earthmoving machinery-transport machinery-Tower crane	Tower crane
51 (M51)Earthmoving machinery-transport machinery-Motor grader	Motor grader
52 (M52)Earthmoving machinery-Compaction machines	Compaction machines
53 (M53)Earthmoving machinery-Compaction machines(Road roller)	Road roller
54 (M54)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)	two axes and two wheels
55 (M55)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)	three-axis three-wheel
56 (M56)Earthmoving machinery-Compaction machines-Tamping roller	Tamping roller
57 (M57)Earthmoving machinery-Compaction machines-Tire roller	Tire roller
58 (M58)Earthmoving machinery-Compaction machines-Vibration roller	Vibration roller
59 (M59)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
60 (M60)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
61 (M61)Earthmoving machinery-Compaction machines-Wetland bulldozer	Wetland bulldozer
62 (M62)Foundation construction machinery(Ready-made piles)	Ready-made piles
63 (M63)Foundation construction machinery(Cast-in-place piles)	Cast-in-place piles
64 (M64)Foundation construction machinery(Features of steel piles)	Features of steel piles
65 (M65)Foundation construction machinery(concrete piles)	concrete piles
66 (M66)Foundation construction machinery(Diesel pile hammer)	Diesel pile hammer
67 (M67)Foundation construction machinery(Vibrating pile hammer)	Vibrating pile hammer
68 (M68)Foundation construction machinery(Drop hammer)	Drop hammer

69 (M69)Foundation construction machinery(Machine for press-in method)	Machine for press-in method
70 (M70)Foundation construction machinery(Cast-in-place pile machine)	Cast-in-place pile machine
71 (M71)Foundation construction machinery(Cast-in-place pile machine)	Cast-in-place pile machine
72 (M72)Foundation construction machinery(Earth drill method)	Earth drill method
73 (M73)Foundation construction machinery(Reverse circulation method)	Reverse circulation method
74 (M74)Foundation construction machinery(Earth auger method)	Earth auger method
75 (M75)Foundation construction machinery(Pedestal method)	Pedestal method
76 (M76)Earthmoving machinery-Ground improvement machine-Sand drain method	Sand drain method
77 (M77)Earthmoving machinery-Ground improvement machine-Sand compaction method	Sand compaction method
78 (M78)Earthmoving machinery-Ground improvement machine-Vibroflotation method	Vibroflotation method
79 (M79)Earthmoving machinery-Ground improvement machine-Wellpoint construction method	Wellpoint construction method
80 (M80)paving machine-asphalt paving machine(Asphalt plant)	Asphalt plant
81 (M81)paving machine-asphalt paving machine(Asphalt finisher)	Asphalt finisher
82 (M82)paving machine-asphalt paving machine(Asphalt spreader)	Asphalt spreader
83 (M83)paving machine-asphalt paving machine(Asphalt sprayer)	Asphalt sprayer
84 (M84)Internal vibrator	vibrator
85 (M85)concrete compaction	concrete compaction
86 (M86)dredger(Pump dredger)	dredger(Pump dredger)
87 (M87)dredger(Bucket dredger)	dredger(Bucket dredger)
88 (M88)dredger(Dipper dredge boat)	dredger(Dipper dredge boat)
89 (M89)dredger(Grab dredger)	dredger(Grab dredger)
90 (M90)dredger(Non-seaworthy pump ship)	dredger
91 (M91)dredger(self-propelled pump ship)	dredger(self-propelled pump ship)
92 (M92)dredger(grab dredger)	dredger(grab dredger)
93 (M93)dredger(grab dredger)	dredger(grab dredger)
94 (M94)dredger(bucket dredger)	dredger(bucket dredger)
95 (M95)construction machinery(bulldozer/rake dozer)	bulldozer/rake dozer
96 (M96)construction machinery(power shovel/backhoe/drag line/clamshell)	power shovel/backhoe
97 (M97)construction machinery>Loading)	Loading
98 (M98)construction machinery(Excavation/loading)	Excavation/loading
99 (M99)construction machinery(Excavation/Transportation)	Excavation/Transportation
100 (M100)construction machinery(transportation)	transportation
101 (M101)construction machinery(spreading)	spreading
102 (M102)construction machinery(compaction)	compaction

103 (M103)construction machinery(Leveling the ground)	Leveling the ground
104 (M104)construction machinery(Leveling the ground)	Leveling the ground
105 (M105)construction machinery(Transportation distance)	Transportation
106 (M106)construction machinery(Compaction machinery)	Compaction
107 (M107)Front attachment and aptitude work	Front attachment
108 (M108)construction machinery(Display method)	Display method
109 (M109)construction machinery(Display method)	Display method
110 (M110)construction machinery(Display method)	Display method
111 (M111)construction machinery(Display method)	Display method
112 (M112)construction machinery(Display method)	Display method
113 (M113)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
114 (M114)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
115 (M115)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
116 (M116)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
117 (M117)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
118 (M118)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
119 (M119)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
120 (M120)Earthworks-Excavation and transportation method	Earthworks
121 (M121)Embankment construction-Compaction machine	Compaction machine
122 (M122)Tire roller/vibration roller	Tire roller/vibration roller
123 (M123)Construction plan-Appropriate machines for each task	Construction plan
124 (M124)Construction plan-Appropriate machines for each task	Construction plan
125 (M125)Construction plan-Appropriate machines for each task	Construction plan
126 (M126)Construction plan-Appropriate machines for each task	Construction plan
127 (M127)Construction plan-Appropriate machines for each task	Construction plan
128 (M128)Construction plan-Appropriate machines for each task	Construction plan
129 (M129)Construction plan-Appropriate machines for each task	Construction plan
130 (M130)Construction plan-Appropriate machines for each task	Construction plan
131 (M131)Construction plan-Appropriate machines for each task	Construction plan
132 (M132)Construction plan-Appropriate machines for each task	Construction plan
133 (M133)Transport distance and applicable machine type	Transport distance
134 (M134)Transport distance and applicable machine type	Transport distance
135 (M135)Transport distance and applicable machine type	Transport distance
136 (M136)Compaction machinery and soil quality	Compaction machinery

137 (M137)Front attachment and aptitude work	Front attachment
138 (M138)Earthmoving machinery-Excavating machine	Earthmoving machinery
139 (M139)Earthmoving machinery-Excavating machine	Earthmoving machinery
140 (M140)Earthmoving machinery-loading machine-Crawler type tractor excavator	Crawler type tractor excavator
141 (M141)Earthmoving machinery-loading machine-Wheeled tractor excavator	Wheeled tractor excavator
142 (M142)Earthmoving machinery-loading machine-Loading method	loading machine
143 (M143)Earthmoving machinery-loading machine-Loading method	loading machine
144 (M144)Earthmoving machinery-loading machine-Loading method	loading machine
145 (M145)Earthmoving machinery-loading machine-Loading method	loading machine
146 (M146)Earthmoving machinery-transport machinery-Straight dozer	Straight dozer
147 (M147)Earthmoving machinery-transport machinery-Angle dozer	Angle dozer
148 (M148)Earthmoving machinery-transport machinery-Tilt dozer	Tilt dozer
149 (M149)Earthmoving machinery-transport machinery-U dozer	U dozer
150 (M150)Earthmoving machinery-transport machinery-Rake dozer	Rake dozer
151 (M151)Earthmoving machinery-transport machinery-Tridozer	Tridozer
152 (M152)Earthmoving machinery-transport machinery-Bucket dozer	Bucket dozer
153 (M153)Earthmoving machinery-transport machinery-Ripper	Ripper
154 (M154)Earthmoving machinery-transport machinery-Installation pressure	Installation pressure
155 (M155)Earthmoving machinery-transport machinery-Scraper	Scraper
156 (M156)Earthmoving machinery-transport machinery-Scraper-Work procedure	Scraper
157 (M157)Earthmoving machinery-transport machinery-Scraper-Type of scraper	Scraper
158 (M158)Earthmoving machinery-transport machinery-Motor grader	Motor grader
159 (M159)Earthmoving machinery-Compaction machines-Road roller	Road roller
160 (M160)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)	Tandem roller (two axes and two wheels)
161 (M161)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)	Three-axis tandem roller (three-axis three-wheel)
162 (M162)Earthmoving machinery-Compaction machines-Tamping roller	Tamping roller
163 (M163)Earthmoving machinery-Compaction machines-Tire roller	Tire roller
164 (M164)Earthmoving machinery-Compaction machines-Vibration roller	Vibration roller
165 (M165)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
166 (M166)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
167 (M167)Earthmoving machinery-Compaction machines-Wetland bulldozer	Wetland bulldozer
168 (M168)Earthmoving machinery-Transport machinery-Bucket wheel excavator	Bucket wheel excavator
169 (M169)Earthworks-Change in soil volume	Earthworks
170 (M170)Earthworks-Change in soil volume-Calculation of loosened soil volume	Calculation of loosened soil volume

171 (M171)Earthworks-Change in soil volume-Calculation of compacted soil volume	Calculation of compacted soil volume
172 (M172)Earthworks-Change in soil volume-Soil volume conversion factor f	Soil volume conversion factor f
173 (M173)Earthworks-Earthmoving machinery-Work type - Appropriate machine	Earthmoving machinery
174 (M174)Earthmoving machinery-Combination of earthmoving machines	Combination of earthmoving machines
175 (M175)Earthmoving machinery-Machine selection based on transportation distance	transportation distance
176 (M176)Earthmoving machinery-Types of bulldozers-Straight dozer	bulldozers-Straight dozer
177 (M177)Earthmoving machinery-Types of bulldozers-U dozer	bulldozers-U dozer
178 (M178)Earthmoving machinery-Types of bulldozers-Angle dozer	Angle dozer
179 (M179)Earthmoving machinery-Types of bulldozers-Tridozer	Tridozer
180 (M180)Earthmoving machinery-Types of bulldozers-Tilt dozer	Tilt dozer
181 (M181)Earthmoving machinery-Types of bulldozers-Rake dozer	Rake dozer
182 (M182)Earthmoving machinery-Scraper-Self-propelled motor scraper	Scraper
183 (M183)Earthmoving machinery-Scraper-Scraper + bulldozer combination	Scrape
184 (M184)Earthmoving machinery-Shovel type excavation machinery	Shovel type excavation machinery
185 (M185)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method+Downhill construction method	Bench cut method+Downhill construction method
186 (M186)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method	Bench cut method
187 (M187)Earthmoving machinery-How to excavate the ground (by machine)-Combination method	Combination method
188 (M188)Earthmoving machinery-Spreading Leveling/compaction-Motor grader	Motor grader
189 (M189)Earthmoving machinery-Compaction machine-Static pressure	Compaction machine-Static pressure
190 (M190)Earthmoving machinery-Compaction machine-Vibration	Compaction machine-Vibration
191 (M191)Earthmoving machinery-Compaction machine-Impact	Compaction machine-Impact
192 (M192)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
193 (M193)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
194 (M194)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
195 (M195)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
196 (M196)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
197 (M197)Dredging work-Pump dredger	Pump dredger
198 (M198)Dredging work-Grab dredger	Grab dredger
199 (M199)Dredging work-Bucket dredger	Bucket dredger
200 (M200)Dredging work-Dipper dredger	Dipper dredger
201 (M201)Dredging work-Pump ship · Grab ship · Dipper dredge · Bucket dredger	Dredging work
202 (M202)Earthwork planning/design-Working capacity of excavator type excavator	excavator type excavator
203 (M203)Earthwork planning/design-Cycle time Cm of excavator type excavator	Cycle time Cm of excavator type excavator
204 (M204)Earthwork planning/design-Working capacity of excavator type excavator-Work load of power shovel	excavator type excavator

205 (M205)Earthwork planning/design-Dump truck working capacity	Dump truck
206 (M206)Earthwork planning/design-Required number of dump trucks	dump trucks
207 (M207)Earthwork planning/design-Required number of dump trucks	dump trucks
208 (M208)Structure excavation-Structures - Excavation machine selection-Points to note during excavating	Excavation machine
209 (M209)Structure excavation-Structures - Excavation machine selection-Points to note during excavating	Excavation machine
210 (M210)Structure excavation-Structures - Excavation machine selection-Points to note during excavating	Excavation machine
211 (M211)Structure excavation-bearing ground	bearing ground
212 (M212)Structure excavation-wastewater treatment	wastewater treatment
213 (M213)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
214 (M214)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
215 (M215)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
216 (M216)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
217 (M217)Structure excavation-Points to note during excavating-compaction appropriate	compaction appropriate
218 (M218)dredging	dredging
219 (M219)earthwork	earthwork
220 (M220)blade bowl	blade bowl
221 (M221)Trafficability	Trafficability
222 (M222)macadam	macadam
223 (M223)spreading	spreading
224 (M224)spreading depth	spreading depth
225 (M225)water bound macadam	water bound macadam
226 (M226)trench dozing	trench dozing
227 (M227)land reclamation in natural slope	land reclamation
228 (M228)Foundation work-Pile foundation	Pile foundation
229 (M229)Foundation work-Caisson foundation	Caisson foundation
230 (M230)Foundation work-Classification of piles	Classification of piles
231 (M231)Foundation work-Steel pile	Steel pile
232 (M232)Foundation work-RC pile (concrete pile) PC pile	RC pile (concrete pile) PC pile
233 (M233)Foundation work-Ready-made pile construction method	made pile construction method
234 (M234)Foundation work-Cast-in-place pile method	Cast-in-place pile method
235 (M235)pile foundation-Standard application of piles	pile foundation
236 (M236)pile foundation-Driving ready-made piles-Diesel hammer	Diesel hammer
237 (M237)pile foundation-Driving ready-made piles-Steam hammer/air hammer	Steam hammer/air hammer
238 (M238)pile foundation-Driving ready-made piles-Vibro hammer	Vibro hammer

239 (M239)pile foundation-Driving ready-made piles-(Pre-boring method)	Pre-boring method
240 (M240)pile foundation-(Hollow excavation pile method/Prefabricated pile)	Hollow excavation pile method
241 (M241)pile foundation-(Jet method)	pile foundation
242 (M242)pile foundation-(Hydraulic hammer press-in method)	Hydraulic hammer press-in method
243 (M243)pile foundation-(Soundproof cover)	pile foundation-(Soundproof cover)
244 (M244)pile foundation-(Welding)	pile foundation-(Welding)
245 (M245)pile foundation-(piling)	piling
246 (M246)pile foundation-(Stopping piling)	Stopping piling
247 (M247)pile foundation-(cast-in-place pile)	cast-in-place pile
248 (M248)pile foundation-(Deep foundation)	Deep foundation
249 (M249)pile foundation-(Benoto method)	Benoto method
250 (M250)pile foundation-(Earth drill method)	Earth drill method
251 (M251)pile foundation-(Reverse circulation method)	Reverse circulation method
252 (M252)pile foundation-(Construction management of cast-in-place piles)	cast-in-place piles
253 (M253)pile foundation-Construction management of Benoto Earth Drill Reverse Method	Benoto Earth Drill Reverse Method
254 (M254)pile foundation-(Construction management of Benoto piles)	Benoto piles
255 (M255)pile foundation-(Benoto piles Slime processing)	Benoto piles
256 (M256)pile foundation-(Earth drill method Treatment of hole walls)	Earth drill method
257 (M257)pile foundation-(cast-in-place piles Prevention of construction pollution)	cast-in-place piles
258 (M258)pile foundation-(caisson foundation)	caisson foundation
259 (M259)pile foundation-(caisson foundation)	caisson foundation
260 (M260)pile foundation-(caisson foundation)	caisson foundation
261 (M261)truck mixer	truck mixer
262 (M262)pile foundation-(pneumatic caisson)	pneumatic caisson
263 (M263)pile foundation-(sheet pile foundation)	sheet pile foundation
264 (M264)Foundation work-(Drainage method)	Drainage method
265 (M265)Foundation work-(Drainage method-Shallow sump)	Shallow sump
266 (M266)Foundation work-Drainage method(Well point construction method)	Well point construction method\
267 (M267)Foundation work-Drainage method(Deep well method)	Deep well method
268 (M268)Foundation work-Drainage method(Deep well vacuum construction method)	Deep well vacuum construction method
269 (M269)Foundation work-(Drainage method)	Drainage method
270 (M270)Construction plan for piles and caissons(Drop hammer)	Drop hammer
271 (M271)Construction plan for piles and caissons(Diesel hammer)	Diesel hammer
272 (M272)Construction plan for piles and caissons(Vibrohammer)	caissoVibrohammer

273 (M273)Construction plan for piles and caissons(Test piles)	piles and caissons(Test piles)
274 (M274)Construction plan for piles and caissons-cast-in-place pile(Deep foundation method)	Deep foundation metho
275 (M275)cast-in-place pile(Benoto method)	Benoto method
276 (M276)cast-in-place pile(Earth drill method)	Earth drill method
277 (M277)cast-in-place pile(Reverse method)	Reverse method
278 (M278)cast-in-place pile(Open caisson foundation)	Open caisson foundation
279 (M279)cast-in-place pile(Pneumatic caisson construction method)	Pneumatic caisson
280 (M280)Foundation construction machinery(Ready-made piles)	Ready-made piles
281 (M281)Foundation construction machinery(Cast-in-place piles)	Cast-in-place piles
282 (M282)Foundation construction machinery(Benoto method)	Benoto method
283 (M283)Foundation construction machinery(Earth drill method)	Earth drill method
284 (M284)Foundation construction machinery(Reverse circulation method)	Reverse circulation method
285 (M285)Underground structure(Shield method)	Shield method
286 (M286)Open cut method(Well point construction method)	Well point
287 (M287)Open cut method(Deep well: sandy soil)	Deep well
288 (M288)Types of foundation work	foundation work
289 (M289)Types of foundation work	foundation work
290 (M290)Types of foundation work(Ready-made pile foundation)	Ready-made pile foundatio
291 (M291)Types of foundation work(cast-in-place pile foundation)	cast-in-place pile foundation
292 (M292)Types of foundation work(caisson foundation)	caisson foundation
293 (M293)foundation work(ready-made piles)	ready-made piles
294 (M294)foundation work(ready-made piles)	ready-made piles
295 (M295)foundation work(built-in construction method)	foundation work
296 (M296)foundation work(Impact construction method for ready-made piles)	ready-made piles
297 (M297)foundation work(diesel hammer)	diesel hammer
298 (M298)foundation work(steam hammer)	steam hammer
299 (M299)foundation work(drop hammer)	drop hammer
300 (M300)foundation work(vibration method)	vibration method
301 (M301)foundation work(Press-in method)	Press-in method
302 (M302)foundation work(Jet method: injection)	Jet method: injection
303 (M303)cast-in-place pile(Benoto method: All casing method)	Benoto method: All casing method
304 (M304)cast-in-place pile(Earth drill method)	cast-in-place pile(Earth drill method)
305 (M305)cast-in-place pile(Reverse construction method)	Reverse construction method
306 (M306)cast-in-place pile(Deep foundation method)	Deep foundation method

307 (M307)cast-in-place pile(Benoto method)	Benoto method
308 (M308)cast-in-place pile(Earth drill method)	Earth drill method
309 (M309)cast-in-place pile(Reverse construction method)	Reverse construction method
310 (M310)cast-in-place pile(Deep foundation method)	Deep foundation method
311 (M311)cast-in-place pile	cast-in-place pile
312 (M312)cast-in-place pile(open caisson foundation)	open caisson foundation
313 (M313)cast-in-place pile(Pneumatic caisson)	Pneumatic caisson
314 (M314)cast-in-place pile	cast-in-place pile
315 (M315)earth drill method	earth drill method
316 (M316)caisson foundation	caisson foundation
317 (M317)air lock	air lock
318 (M318)H-section steel pile	H-section steel pile
319 (M319)main rope	main rope
320 (M320)all casing method	all casing method
321 (M321)pile-driver	pile-driver
322 (M322)Caisson foundation	Caisson foundation
323 (M323)dowel works:Deep foundation method	dowel works:Deep foundation method
324 (M324)lime pile	lime pile
325 (M325)drop hammer	drop hammer
326 (M326)Hollow excavation pile method	Hollow excavation pile method
327 (M327)pile driving frame	(M327)pile driving frame
328 (M328)benoto method:open:all casing method	benoto method:open:all casing method
329 (M329)all casing excavator	all casing excavator
330 (M330)Reverse circulation method	Reverse circulation method
331 (M331)earth drill	earth drill
332 (M332)cast in place concrete	cast in place concrete
333 (M333)cast in place concrete-Benoto pile	Benoto pile
334 (M334)Earth drill method	Earth drill method
335 (M335)Reverse circulation methodd	Reverse circulation methodd
336 (M336)caisson excavation workng foundation-open caisson	open caisson
337 (M337)pneumatic caisson-air lock	pneumatic caisson-air lock
338 (M338)Piling	Piling
339 (M339)crawler crane	crawler crane
340 (M340)casing tube	casing tube

341 (M341)piling
342 (M342)deep foundation method
343 (M343)piling
344 (M344)cast-in-place concrete- bentonite solution
345 (M345)cast-in-place concrete- tremie pipe
346 (M346)Vibrohammer method
347 (M347)pile driver
348 (M348)Benoto method:All casing construction method
349 (M349)pile driving
350 (M350)Foundation work-(Ready-made pile foundation)-Cast-in-place pile foundation
351 (M351)Foundation work-open caisson-pneumatic caisson
352 (M352)Foundation work-Deep foundation
353 (M353)Foundation work-pile foundation-ready-made piles
354 (M354)Foundation work-pile foundation-caisson foundation
355 (M355)cast-in-place pile Earth drill method
356 (M356)agitator truck
357 (M357)attachment
358 (M358)winch
359 (M359)guy derrick crane
360 (M360)tilting mixer
361 (M361)wooden winch
362 (M362)kazusa dig well
363 (M363)crawler drill
364 (M364)Cable crane
365 (M365)Cable crane
366 (M366)Concrete bucket
367 (M367)Concrete spraying
368 (M368)Conveyor
369 (M369)Crusher
370 (M370)axial flow pump
371 (M371)jib crane
372 (M372)dredging(Pump dredger)
373 (M373)dredging(Bucket dredger)
374 (M374)dredging(Grab dredger)

piling
deep foundation method
piling
cast-in-place concrete- bentonite solution
cast-in-place concrete- tremie pipe
Vibrohammer method
pile driver
Benoto method
pile driving
Ready-made pile foundation
open caisson-pneumatic caisson
Deep foundation
ready-made piles
pile foundation-caisson foundation
cast-in-place pile Earth drill method
agitator truck
attachment
winch
guy derrick crane
tilting mixer
wooden winch
kazusa dig well
crawler drill
Cable crane
Cable crane
Concrete bucket
Concrete spraying
Conveyor
Crusher
axial flow pump
jib crane
dredging(Pump dredger)
dredging(Bucket dredger)
dredging(Grab dredger)

375 (M375)dredging(Dipper dredger)
376 (M376)jaw crusher
377 (M377)excavator
378 (M378)shovel-type excavator
379 (M379)vibrating roller
380 (M380)scraper
381 (M381)Cement gun
382 (M382)soil stabilizer
383 (M383)sounding machine
384 (M384)Tire dozer
385 (M385)Tire roller
386 (M386)Tandem roller
387 (M387)dumper
388 (M388)tamping roller
389 (M389)dipper dredger
390 (M390)derrick crane
391 (M391)tower crane
392 (M392)tractor
393 (M393)truck-crane
394 (M394)trailer
395 (M395)bucket elevator
396 (M396)edge cutting pipe jacking
397 (M397)Batcher plant
398 (M398)trailer
399 (M399)hammer drill
400 (M400)Shot crete
401 (M401)Bulldozer
402 (M402)frog rammer
403 (M403)hopper
404 (M404)suction dredger(pump dredger)
405 (M405)Tractor excavator(attachment)
406 (M406)Tractor excavator(attachment)
407 (M407)russel snow plough
408 (M408)rammer

dredging(Dipper dredger)
jaw crusher
excavator
shovel-type excavator
vibrating roller
scraper
Cement gun
soil stabilizer
sounding machine
Tire dozer
Tire roller
Tandem roller
dumper
tamping roller
dipper dredger
derrick crane
tower crane
tractor
truck-crane
trailer
bucket elevator
edge cutting pipe jacking
Batcher plant
trailer
hammer drill
Shot crete
Bulldozer
frog rammer
hopper
suction dredger(pump dredger)
attachment
attachment
russel snow plough
rammer

409 (M409)crawler
410 (M410)ripper
411 (M411)ripper(rippability)
412 (M412)mixing work on the way
413 (M413)Tractor excavator(attachment)
414 (M414)clean plant
415 (M415)Cable crane
416 (M416)Concrete batching and mixing plant
417 (M417)Concrete pump
418 (M418)Wet-type shot crete
419 (M419)fixed jib crane
420 (M420)Shield tunnel
421 (M421)Vibrating roller
422 (M422)truck mixer
423 (M423)Internal vibrator
424 (M424)concrete compaction
425 (M425)breaker
426 (M426)Tractor excavator(attachment)
427 (M427)Tractor excavator(attachment)

crawler
ripper
ripper(rippability)
mixing work on the way
attachment
clean plant
Cable crane
Concrete batching and mixing plant
Concrete pump
Wet-type shot crete
fixed jib crane
Shield tunnel
Vibrating roller
truck mixer
Internal vibrator
concrete compaction
breaker
attachment
attachment

185 (M185)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method+Downhill construction method	Bench cut method+Downhill construction method
356 (M356)agitator truck	agitator truck
317 (M317)air lock	air lock
329 (M329)all casing excavator	all casing excavator
320 (M320)all casing method	all casing method
31 (M31)Earthmoving machinery-transport machinery-Angle dozer	Angle dozer
147 (M147)Earthmoving machinery-transport machinery-Angle dozer	Angle dozer
178 (M178)Earthmoving machinery-Types of bulldozers-Angle dozer	Angle dozer
81 (M81)paving machine-asphalt paving machine(Asphalt finisher)	Asphalt finisher
80 (M80)paving machine-asphalt paving machine(Asphalt plant)	Asphalt plant
83 (M83)paving machine-asphalt paving machine(Asphalt sprayer)	Asphalt sprayer
82 (M82)paving machine-asphalt paving machine(Asphalt spreader)	Asphalt spreader
357 (M357)attachment	attachment
405 (M405)Tractor excavator(attachment)	attachment
406 (M406)Tractor excavator(attachment)	attachment
413 (M413)Tractor excavator(attachment)	attachment
426 (M426)Tractor excavator(attachment)	attachment
427 (M427)Tractor excavator(attachment)	attachment
370 (M370)axial flow pump	axial flow pump
213 (M213)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
214 (M214)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
215 (M215)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
216 (M216)Structure excavation-Points to note regarding backfilling and backfilling soil	backfilling and backfilling soil
397 (M397)Batcher plant	Batcher plant
211 (M211)Structure excavation-bearing ground	bearing ground
186 (M186)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method	Bench cut method
253 (M253)pile foundation-Construction management of Benoto Earth Drill Reverse Method	Benoto Earth Drill Reverse Method
249 (M249)pile foundation-(Benoto method)	Benoto method
275 (M275)cast-in-place pile(Benoto method)	Benoto method
282 (M282)Foundation construction machinery(Benoto method)	Benoto method
307 (M307)cast-in-place pile(Benoto method)	Benoto method
348 (M348)Benoto method:All casing construction method	Benoto method
303 (M303)cast-in-place pile(Benoto method: All casing method)	Benoto method: All casing method
328 (M328)benoto method:open:all casing method	benoto method:open:all casing method

333 (M333)cast in place concrete-Benoto pile	Benoto pile
254 (M254)pile foundation-(Construction management of Benoto piles)	Benoto piles
255 (M255)pile foundation-(Benoto piles Slime processing)	Benoto piles
220 (M220)blade bowl	blade bowl
425 (M425)breaker	breaker
36 (M36)Earthmoving machinery-transport machinery-Bucket dozer	Bucket dozer
152 (M152)Earthmoving machinery-transport machinery-Bucket dozer	Bucket dozer
199 (M199)Dredging work-Bucket dredger	Bucket dredger
395 (M395)bucket elevator	bucket elevator
168 (M168)Earthmoving machinery-Transport machinery-Bucket wheel excavator	Bucket wheel excavator
401 (M401)Bulldozer	Bulldozer
95 (M95)construction machinery(bulldozer/rake dozer)	bulldozer/rake dozer
176 (M176)Earthmoving machinery-Types of bulldozers-Straight dozer	bulldozers-Straight dozer
177 (M177)Earthmoving machinery-Types of bulldozers-U dozer	bulldozers-U dozer
47 (M47)Earthmoving machinery-transport machinery-Cable crane	Cable crane
364 (M364)Cable crane	Cable crane
365 (M365)Cable crane	Cable crane
415 (M415)Cable crane	Cable crane
322 (M322)Caisson foundation	Caisson foundation
229 (M229)Foundation work-Caisson foundation	Caisson foundation
258 (M258)pile foundation-(caisson foundation)	caisson foundation
259 (M259)pile foundation-(caisson foundation)	caisson foundation
260 (M260)pile foundation-(caisson foundation)	caisson foundation
292 (M292)Types of foundation work(caisson foundation)	caisson foundation
316 (M316)caisson foundation	caisson foundation
272 (M272)Construction plan for piles and caissons(Vibrohammer)	caissoVibrohammer
171 (M171)Earthworks-Change in soil volume-Calculation of compacted soil volume	Calculation of compacted soil volume
170 (M170)Earthworks-Change in soil volume-Calculation of loosened soil volume	Calculation of loosened soil volume
340 (M340)casing tube	casing tube
332 (M332)cast in place concrete	cast in place concrete
344 (M344)cast-in-place concrete- bentonite solution	cast-in-place concrete- bentonite solution
345 (M345)cast-in-place concrete- tremie pipe	cast-in-place concrete- tremie pipe
247 (M247)pile foundation-(cast-in-place pile)	cast-in-place pile
311 (M311)cast-in-place pile	cast-in-place pile

314 (M314)cast-in-place pile	cast-in-place pile
355 (M355)cast-in-place pile Earth drill method	cast-in-place pile Earth drill method
291 (M291)Types of foundation work(cast-in-place pile foundation)	cast-in-place pile foundation
70 (M70)Foundation construction machinery(Cast-in-place pile machine)	Cast-in-place pile machine
71 (M71)Foundation construction machinery(Cast-in-place pile machine)	Cast-in-place pile machine
234 (M234)Foundation work-Cast-in-place pile method	Cast-in-place pile method
304 (M304)cast-in-place pile(Earth drill method)	cast-in-place pile(Earth drill method)
63 (M63)Foundation construction machinery(Cast-in-place piles)	Cast-in-place piles
252 (M252)pile foundation-(Construction management of cast-in-place piles)	cast-in-place piles
257 (M257)pile foundation-(cast-in-place piles Prevention of construction pollution)	cast-in-place piles
281 (M281)Foundation construction machinery(Cast-in-place piles)	Cast-in-place piles
381 (M381)Cement gun	Cement gun
230 (M230)Foundation work-Classification of piles	Classification of piles
414 (M414)clean plant	clean plant
187 (M187)Earthmoving machinery-How to excavate the ground (by machine)-Combination method	Combination method
192 (M192)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
193 (M193)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
194 (M194)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
195 (M195)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
196 (M196)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type	Combination of compaction machine and soil type
174 (M174)Earthmoving machinery-Combination of earthmoving machines	Combination of earthmoving machines
102 (M102)construction machinery(compaction)	compaction
106 (M106)construction machinery(Compaction machinery)	Compaction
217 (M217)Structure excavation-Points to note during excavating-compaction appropriate	compaction appropriate
121 (M121)Embankment construction-Compaction machine	Compaction machine
191 (M191)Earthmoving machinery-Compaction machine-Impact	Compaction machine-Impact
136 (M136)Compaction machinery and soil quality	Compaction machinery
52 (M52)Earthmoving machinery-Compaction machines	Compaction machines
189 (M189)Earthmoving machinery-Compaction machine-Static pressure	Compaction machine-Static pressure
190 (M190)Earthmoving machinery-Compaction machine-Vibration	Compaction machine-Vibration
416 (M416)Concrete batching and mixing plant	Concrete batching and mixing plant
366 (M366)Concrete bucket	Concrete bucket
85 (M85)concrete compaction	concrete compaction
424 (M424)concrete compaction	concrete compaction

65 (M65)Foundation construction machinery(concrete piles)	concrete piles
417 (M417)Concrete pump	Concrete pump
367 (M367)Concrete spraying	Concrete spraying
14 (M14)construction machinery(cone index)	cone index
13 (M13)construction machinery(cone penetration)	cone penetration
1 (M1)construction machinery	construction machinery
2 (M2)construction machinery	construction machinery
3 (M3)construction machinery	construction machinery
4 (M4)construction machinery	construction machinery
5 (M5)construction machinery	construction machinery
6 (M6)construction machinery	construction machinery
7 (M7)construction machinery	construction machinery
8 (M8)construction machinery	construction machinery
9 (M9)construction machinery	construction machinery
10 (M10)construction machinery	construction machinery
123 (M123)Construction plan-Appropriate machines for each task	Construction plan
124 (M124)Construction plan-Appropriate machines for each task	Construction plan
125 (M125)Construction plan-Appropriate machines for each task	Construction plan
126 (M126)Construction plan-Appropriate machines for each task	Construction plan
127 (M127)Construction plan-Appropriate machines for each task	Construction plan
128 (M128)Construction plan-Appropriate machines for each task	Construction plan
129 (M129)Construction plan-Appropriate machines for each task	Construction plan
130 (M130)Construction plan-Appropriate machines for each task	Construction plan
131 (M131)Construction plan-Appropriate machines for each task	Construction plan
132 (M132)Construction plan-Appropriate machines for each task	Construction plan
368 (M368)Conveyor	Conveyor
44 (M44)Earthmoving machinery-transport machinery-crane	crane
409 (M409)crawler	crawler
45 (M45)Earthmoving machinery-transport machinery-Crawler crane	Crawler crane
339 (M339)crawler crane	crawler crane
363 (M363)crawler drill	crawler drill
140 (M140)Earthmoving machinery-loading machine-Crawler type tractor excavator	Crawler type tractor excavator
369 (M369)Crusher	Crusher
203 (M203)Earthwork planning/design-Cycle time Cm of excavator type excavator	Cycle time Cm of excavator type excavator

248 (M248)pile foundation-(Deep foundation)	Deep foundation
352 (M352)Foundation work-Deep foundation	Deep foundation
274 (M274)Construction plan for piles and caissons-cast-in-place pile(Deep foundation method)	Deep foundation metho
306 (M306)cast-in-place pile(Deep foundation method)	Deep foundation method
310 (M310)cast-in-place pile(Deep foundation method)	Deep foundation method
342 (M342)deep foundation method	deep foundation method
287 (M287)Open cut method(Deep well: sandy soil)	Deep well
267 (M267)Foundation work-Drainage method(Deep well method)	Deep well method
268 (M268)Foundation work-Drainage method(Deep well vacuum construction method)	Deep well vacuum construction method
49 (M49)Earthmoving machinery-transport machinery-Derrick crane	Derrick crane
390 (M390)derrick crane	derrick crane
236 (M236)pile foundation-Driving ready-made piles-Diesel hammer	Diesel hammer
271 (M271)Construction plan for piles and caissons(Diesel hammer)	Diesel hammer
297 (M297)foundation work(diesel hammer)	diesel hammer
66 (M66)Foundation construction machinery(Diesel pile hammer)	Diesel pile hammer
200 (M200)Dredging work-Dipper dredger	Dipper dredger
389 (M389)dipper dredger	dipper dredger
108 (M108)construction machinery(Display method)	Display method
109 (M109)construction machinery(Display method)	Display method
110 (M110)construction machinery(Display method)	Display method
111 (M111)construction machinery(Display method)	Display method
112 (M112)construction machinery(Display method)	Display method
323 (M323)dowel works:Deep foundation method	dowel works:Deep foundation method
264 (M264)Foundation work-(Drainage method)	Drainage method
269 (M269)Foundation work-(Drainage method)	Drainage method
90 (M90)dredger(Non-seaworthy pump ship)	dredger
87 (M87)dredger(Bucket dredger)	dredger(Bucket dredger)
94 (M94)dredger(bucket dredger)	dredger(bucket dredger)
88 (M88)dredger(Dipper dredge boat)	dredger(Dipper dredge boat)
89 (M89)dredger(Grab dredger)	dredger(Grab dredger)
92 (M92)dredger(grab dredger)	dredger(grab dredger)
93 (M93)dredger(grab dredger)	dredger(grab dredger)
86 (M86)dredger(Pump dredger)	dredger(Pump dredger)
91 (M91)dredger(self-propelled pump ship)	dredger(self-propelled pump ship)

218 (M218)dredging
201 (M201)Dredging work-Pump ship · Grab ship · Dipper dredge · Bucket dredger
373 (M373)dredging(Bucket dredger)
375 (M375)dredging(Dipper dredger)
374 (M374)dredging(Grab dredger)
372 (M372)dredging(Pump dredger)
68 (M68)Foundation construction machinery(Drop hammer)
270 (M270)Construction plan for piles and caissons(Drop hammer)
299 (M299)foundation work(drop hammer)
325 (M325)drop hammer
43 (M43)Earthmoving machinery-transport machinery-Dump truck
205 (M205)Earthwork planning/design-Dump truck working capacity
206 (M206)Earthwork planning/design-Required number of dump trucks
207 (M207)Earthwork planning/design-Required number of dump trucks
387 (M387)dumper
74 (M74)Foundation construction machinery(Earth auger method)
331 (M331)earth drill
72 (M72)Foundation construction machinery(Earth drill method)
250 (M250)pile foundation-(Earth drill method)
256 (M256)pile foundation-(Earth drill method Treatment of hole walls)
276 (M276)cast-in-place pile(Earth drill method)
283 (M283)Foundation construction machinery(Earth drill method)
308 (M308)cast-in-place pile(Earth drill method)
315 (M315)earth drill method
334 (M334)Earth drill method
138 (M138)Earthmoving machinery-Excavating machine
139 (M139)Earthmoving machinery-Excavating machine
173 (M173)Earthworks-Earthmoving machinery-Work type - Appropriate machine
219 (M219)earthwork
113 (M113)Earthworks-Characteristics of Earthmoving Machinery
114 (M114)Earthworks-Characteristics of Earthmoving Machinery
115 (M115)Earthworks-Characteristics of Earthmoving Machinery
116 (M116)Earthworks-Characteristics of Earthmoving Machinery
117 (M117)Earthworks-Characteristics of Earthmoving Machinery

dredging
Dredging work
dredging(Bucket dredger)
dredging(Dipper dredger)
dredging(Grab dredger)
dredging(Pump dredger)
Drop hammer
Drop hammer
drop hammer
drop hammer
Dump truck
Dump truck
dump trucks
dump trucks
dumper
Earth auger method
earth drill
Earth drill method
Earth drill method
Earth drill method
Earth drill method
Earth drill method
Earth drill method
Earth drill method
earth drill method
Earth drill method
Earthmoving machinery
Earthmoving machinery
Earthmoving machinery
earthwork
Earthworks
Earthworks
Earthworks
Earthworks
Earthworks

118 (M118)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
119 (M119)Earthworks-Characteristics of Earthmoving Machinery	Earthworks
120 (M120)Earthworks-Excavation and transportation method	Earthworks
169 (M169)Earthworks-Change in soil volume	Earthworks
396 (M396)edge cutting pipe jacking	edge cutting pipe jacking
16 (M16)Earthmoving machinery(Excavating machine)	Excavating machine
17 (M17)Earthmoving machinery(Excavating machine)	Excavating machine
18 (M18)Earthmoving machinery(Excavating machine)	Excavating machine
19 (M19)Earthmoving machinery(Excavating machine)	Excavating machine
20 (M20)Earthmoving machinery(Excavating machine)	Excavating machine
21 (M21)Earthmoving machinery(Excavating machine)	Excavating machine
22 (M22)Earthmoving machinery(Excavating machine)	Excavating machine
23 (M23)Earthmoving machinery(Excavating machine)	Excavating machine
208 (M208)Structure excavation-Structures - Excavation machine selection-Points to note during excavating	Excavation machine
209 (M209)Structure excavation-Structures - Excavation machine selection-Points to note during excavating	Excavation machine
210 (M210)Structure excavation-Structures - Excavation machine selection-Points to note during excavating	Excavation machine
98 (M98)construction machinery(Excavation/loading)	Excavation/loading
99 (M99)construction machinery(Excavation/Transportation)	Excavation/Transportation
377 (M377)excavator	excavator
202 (M202)Earthwork planning/design-Working capacity of excavator type excavator	excavator type excavator
204 (M204)Earthwork planning/design-Working capacity of excavator type excavator-Work load of power shovel	excavator type excavator
64 (M64)Foundation construction machinery(Features of steel piles)	Features of steel piles
419 (M419)fixed jib crane	fixed jib crane
288 (M288)Types of foundation work	foundation work
289 (M289)Types of foundation work	foundation work
295 (M295)foundation work(built-in construction method)	foundation work
402 (M402)frog rammer	frog rammer
107 (M107)Front attachment and aptitude work	Front attachment
137 (M137)Front attachment and aptitude work	Front attachment
198 (M198)Dredging work-Grab dredger	Grab dredger
359 (M359)guy derrick crane	guy derrick crane
399 (M399)hammer drill	hammer drill
240 (M240)pile foundation-(Hollow excavation pile method/Prefabricated pile)	Hollow excavation pile method
326 (M326)Hollow excavation pile method	Hollow excavation pile method

403 (M403)hopper	hopper
318 (M318)H-section steel pile	H-section steel pile
242 (M242)pile foundation-(Hydraulic hammer press-in method)	Hydraulic hammer press-in method
12 (M12)construction machinery(Hydraulic type/Mechanical)	Hydraulic type/Mechanical
38 (M38)Earthmoving machinery-transport machinery-Installation pressure	Installation pressure
154 (M154)Earthmoving machinery-transport machinery-Installation pressure	Installation pressure
423 (M423)Internal vibrator	Internal vibrator
376 (M376)jaw crusher	jaw crusher
302 (M302)foundation work(Jet method: injection)	Jet method: injection
48 (M48)Earthmoving machinery-transport machinery-Jib crane	Jib crane
371 (M371)jib crane	jib crane
362 (M362)kazusa dig well	kazusa dig well
227 (M227)land reclamation in natural slope	land reclamation
103 (M103)construction machinery(Leveling the ground)	Leveling the ground
104 (M104)construction machinery(Leveling the ground)	Leveling the ground
324 (M324)lime pile	lime pile
97 (M97)construction machinery>Loading)	Loading
24 (M24)Earthmoving machinery(loading machine)	loading machine
25 (M25)Earthmoving machinery(loading machine)	loading machine
26 (M26)Earthmoving machinery(loading machine)	loading machine
27 (M27)Earthmoving machinery(loading machine)	loading machine
28 (M28)Earthmoving machinery(loading machine)	loading machine
29 (M29)Earthmoving machinery(loading machine)	loading machine
142 (M142)Earthmoving machinery-loading machine-Loading method	loading machine
143 (M143)Earthmoving machinery-loading machine-Loading method	loading machine
144 (M144)Earthmoving machinery-loading machine-Loading method	loading machine
145 (M145)Earthmoving machinery-loading machine-Loading method	loading machine
222 (M222)macadam	macadam
69 (M69)Foundation construction machinery(Machine for press-in method)	Machine for press-in method
233 (M233)Foundation work-Ready-made pile construction method	made pile construction method
319 (M319)main rope	main rope
412 (M412)mixing work on the way	mixing work on the way
42 (M42)Earthmoving machinery-transport machinery-Motor grader	Motor grader
51 (M51)Earthmoving machinery-transport machinery-Motor grader	Motor grader

158 (M158)Earthmoving machinery-transport machinery-Motor grader	Motor grader
188 (M188)Earthmoving machinery-Spreading Leveling/compaction-Motor grader	Motor grader
15 (M15)construction machinery(noise level)	noise level
336 (M336)caisson excavation workng foundation-open caisson	open caisson
278 (M278)cast-in-place pile(Open caisson foundation)	Open caisson foundation
312 (M312)cast-in-place pile(open caisson foundation)	open caisson foundation
351 (M351)Foundation work-open caisson-pneumatic caisson	open caisson-pneumatic caisson
75 (M75)Foundation construction machinery(Pedestal method)	Pedestal method
327 (M327)pile driving frame	pile driving frame
347 (M347)pile driver	pile driver
349 (M349)pile driving	pile driving
228 (M228)Foundation work-Pile foundation	Pile foundation
235 (M235)pile foundation-Standard application of piles	pile foundation
241 (M241)pile foundation-(Jet method)	pile foundation
243 (M243)pile foundation-(Soundproof cover)	pile foundation-(Soundproof cover)
244 (M244)pile foundation-(Welding)	pile foundation-(Welding)
354 (M354)Foundation work-pile foundation-caisson foundation	pile foundation-caisson foundation
321 (M321)pile-driver	pile-driver
273 (M273)Construction plan for piles and caissons(Test piles)	piles and caissons(Test piles)
245 (M245)pile foundation-(piling)	piling
338 (M338)Piling	Piling
341 (M341)piling	piling
343 (M343)piling	piling
262 (M262)pile foundation-(pneumatic caisson)	pneumatic caisson
279 (M279)cast-in-place pile(Pneumatic caisson construction method)	Pneumatic caisson
313 (M313)cast-in-place pile(Pneumatic caisson)	Pneumatic caisson
337 (M337)pneumatic caisson-air lock	pneumatic caisson-air lock
96 (M96)construction machinery(power shovel/backhoe/drag line/clamshell)	power shovel/backhoe
239 (M239)pile foundation-Driving ready-made piles-(Pre-boring method)	Pre-boring method
301 (M301)foundation work(Press-in method)	Press-in method
197 (M197)Dredging work-Pump dredger	Pump dredger
34 (M34)Earthmoving machinery-transport machinery-Rake dozer	Rake dozer
150 (M150)Earthmoving machinery-transport machinery-Rake dozer	Rake dozer
181 (M181)Earthmoving machinery-Types of bulldozers-Rake dozer	Rake dozer

408 (M408)rammer	rammer
232 (M232)Foundation work-RC pile (concrete pile) PC pile	RC pile (concrete pile) PC pile
290 (M290)Types of foundation work(Ready-made pile foundation)	Ready-made pile foundatio
350 (M350)Foundation work-(Ready-made pile foundation)-Cast-in-place pile foundation	Ready-made pile foundation
62 (M62)Foundation construction machinery(Ready-made piles)	Ready-made piles
280 (M280)Foundation construction machinery(Ready-made piles)	Ready-made piles
293 (M293)foundation work(ready-made piles)	ready-made piles
294 (M294)foundation work(ready-made piles)	ready-made piles
296 (M296)foundation work(Impact construction method for ready-made piles)	ready-made piles
353 (M353)Foundation work-pile foundation-ready-made piles	ready-made piles
73 (M73)Foundation construction machinery(Reverse circulation method)	Reverse circulation method
251 (M251)pile foundation-(Reverse circulation method)	Reverse circulation method
284 (M284)Foundation construction machinery(Reverse circulation method)	Reverse circulation method
330 (M330)Reverse circulation method	Reverse circulation method
335 (M335)Reverse circulation methodd	Reverse circulation methodd
305 (M305)cast-in-place pile(Reverse construction method)	Reverse construction method
309 (M309)cast-in-place pile(Reverse construction method)	Reverse construction method
277 (M277)cast-in-place pile(Reverse method)	Reverse method
37 (M37)Earthmoving machinery-transport machinery-Ripper	Ripper
153 (M153)Earthmoving machinery-transport machinery-Ripper	Ripper
410 (M410)ripper	ripper
411 (M411)ripper(rippability)	ripper(rippability)
53 (M53)Earthmoving machinery-Compaction machines(Road roller)	Road roller
159 (M159)Earthmoving machinery-Compaction machines-Road roller	Road roller
407 (M407)russel snow plough	russel snow plough
77 (M77)Earthmoving machinery-Ground improvement machine-Sand compaction method	Sand compaction method
76 (M76)Earthmoving machinery-Ground improvement machine-Sand drain method	Sand drain method
183 (M183)Earthmoving machinery-Scraper-Scraper + bulldozer combination	Scrape
39 (M39)Earthmoving machinery-transport machinery-Scraper	Scraper
40 (M40)Earthmoving machinery-transport machinery-Scraper-Work procedure	Scraper
41 (M41)Earthmoving machinery-transport machinery-Scraper-Type of scraper	Scraper
155 (M155)Earthmoving machinery-transport machinery-Scraper	Scraper
156 (M156)Earthmoving machinery-transport machinery-Scraper-Work procedure	Scraper
157 (M157)Earthmoving machinery-transport machinery-Scraper-Type of scraper	Scraper

182 (M182)Earthmoving machinery-Scraper-Self-propelled motor scraper	Scraper
380 (M380)scraper	scraper
265 (M265)Foundation work-(Drainage method-Shallow sump)	Shallow sump
263 (M263)pile foundation-(sheet pile foundation)	sheet pile foundation
285 (M285)Underground structure(Shield method)	Shield method
420 (M420)Shield tunnel	Shield tunnel
400 (M400)Shot crete	Shot crete
184 (M184)Earthmoving machinery-Shovel type excavation machinery	Shovel type excavation machinery
378 (M378)shovel-type excavator	shovel-type excavator
382 (M382)soil stabilizer	soil stabilizer
172 (M172)Earthworks-Change in soil volume-Soil volume conversion factor f	Soil volume conversion factor f
383 (M383)sounding machine	sounding machine
101 (M101)construction machinery(spreading)	spreading
223 (M223)spreading	spreading
224 (M224)spreading depth	spreading depth
298 (M298)foundation work(steam hammer)	steam hammer
237 (M237)pile foundation-Driving ready-made piles-Steam hammer/air hammer	Steam hammer/air hammer
231 (M231)Foundation work-Steel pile	Steel pile
246 (M246)pile foundation-(Stopping piling)	Stopping piling
30 (M30)Earthmoving machinery-transport machinery-Straight dozer	Straight dozer
146 (M146)Earthmoving machinery-transport machinery-Straight dozer	Straight dozer
404 (M404)suction dredger(pump dredger)	suction dredger(pump dredger)
56 (M56)Earthmoving machinery-Compaction machines-Tamping roller	Tamping roller
162 (M162)Earthmoving machinery-Compaction machines-Tamping roller	Tamping roller
388 (M388)tamping roller	tamping roller
386 (M386)Tandem roller	Tandem roller
160 (M160)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)	Tandem roller (two axes and two wheels)
161 (M161)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)	Three-axis tandem roller (three-axis three-wheel)
55 (M55)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)	three-axis three-wheel
32 (M32)Earthmoving machinery-transport machinery-Tilt dozer	Tilt dozer
148 (M148)Earthmoving machinery-transport machinery-Tilt dozer	Tilt dozer
180 (M180)Earthmoving machinery-Types of bulldozers-Tilt dozer	Tilt dozer
360 (M360)tilting mixer	tilting mixer
384 (M384)Tire dozer	Tire dozer

57 (M57)Earthmoving machinery-Compaction machines-Tire roller	Tire roller
163 (M163)Earthmoving machinery-Compaction machines-Tire roller	Tire roller
385 (M385)Tire roller	Tire roller
122 (M122)Tire roller/vibration roller	Tire roller/vibration roller
50 (M50)Earthmoving machinery-transport machinery-Tower crane	Tower crane
391 (M391)tower crane	tower crane
392 (M392)tractor	tractor
221 (M221)Trafficability	Trafficability
394 (M394)trailer	trailer
398 (M398)trailer	trailer
133 (M133)Transport distance and applicable machine type	Transport distance
134 (M134)Transport distance and applicable machine type	Transport distance
135 (M135)Transport distance and applicable machine type	Transport distance
100 (M100)construction machinery(transportation)	transportation
105 (M105)construction machinery(Transportation distance)	Transportation
175 (M175)Earthmoving machinery-Machine selection based on transportation distance	transportation distance
11 (M11)construction machinery(traveling device)	traveling device
226 (M226)trench dozing	trench dozing
35 (M35)Earthmoving machinery-transport machinery-Tridozer	Tridozer
151 (M151)Earthmoving machinery-transport machinery-Tridozer	Tridozer
179 (M179)Earthmoving machinery-Types of bulldozers-Tridozer	Tridozer
46 (M46)Earthmoving machinery-transport machinery-Truck crane	Truck crane
261 (M261)truck mixer	truck mixer
422 (M422)truck mixer	truck mixer
393 (M393)truck-crane	truck-crane
54 (M54)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)	two axes and two wheels
33 (M33)Earthmoving machinery-transport machinery-U dozer	U dozer
149 (M149)Earthmoving machinery-transport machinery-U dozer	U dozer
67 (M67)Foundation construction machinery(Vibrating pile hammer)	Vibrating pile hammer
379 (M379)vibrating roller	vibrating roller
421 (M421)Vibrating roller	Vibrating roller
59 (M59)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
60 (M60)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
165 (M165)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor

166 (M166)Earthmoving machinery-Compaction machines-Vibration compactor	Vibration compactor
300 (M300)foundation work(vibration method)	vibration method
58 (M58)Earthmoving machinery-Compaction machines-Vibration roller	Vibration roller
164 (M164)Earthmoving machinery-Compaction machines-Vibration roller	Vibration roller
84 (M84)Internal vibrator	vibrator
238 (M238)pile foundation-Driving ready-made piles-Vibro hammer	Vibro hammer
78 (M78)Earthmoving machinery-Ground improvement machine-Vibroflotation method	Vibroflotation method
346 (M346)Vibrohammer method	Vibrohammer method
212 (M212)Structure excavation-wastewater treatment	wastewater treatment
225 (M225)water bound macadam	water bound macadam
286 (M286)Open cut method(Well point construction method)	Well point
266 (M266)Foundation work-Drainage method(Well point construction method)	Well point construction method\
79 (M79)Earthmoving machinery-Ground improvement machine-Wellpoint construction method	Wellpoint construction method
61 (M61)Earthmoving machinery-Compaction machines-Wetland bulldozer	Wetland bulldozer
167 (M167)Earthmoving machinery-Compaction machines-Wetland bulldozer	Wetland bulldozer
418 (M418)Wet-type shot crete	Wet-type shot crete
141 (M141)Earthmoving machinery-loading machine-Wheeled tractor excavator	Wheeled tractor excavator
358 (M358)winch	winch
361 (M361)wooden winch	wooden winch

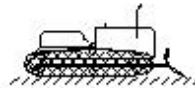
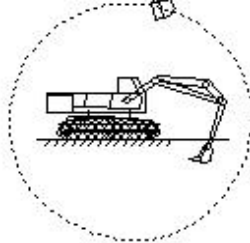
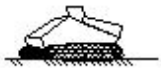
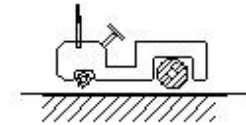
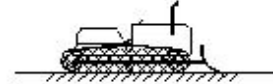
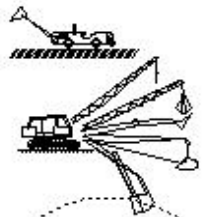
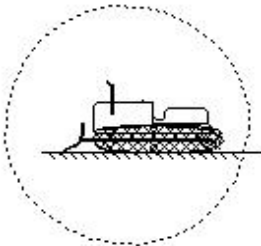
(M1)construction machinery

(M1)construction machinery

construction work

bulldozer

power shovel



(M2)construction machinery

(M2) construction machinery

construction machinery

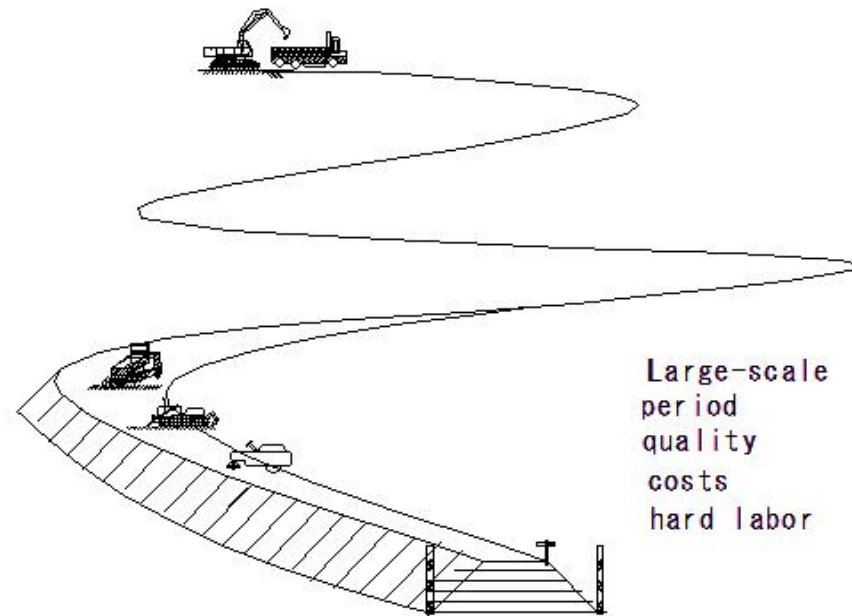
Purpose of construction mechanization

Rationalization

Streamline planning

Rationalization of construction aspects

- ① Advantages of mechanized construction
- ① Large-scale construction possible
- ② Construction period can be shortened
- ③ Improving the quality of structures
- ④ Construction costs are cheaper
- ⑤ Free from hard labor



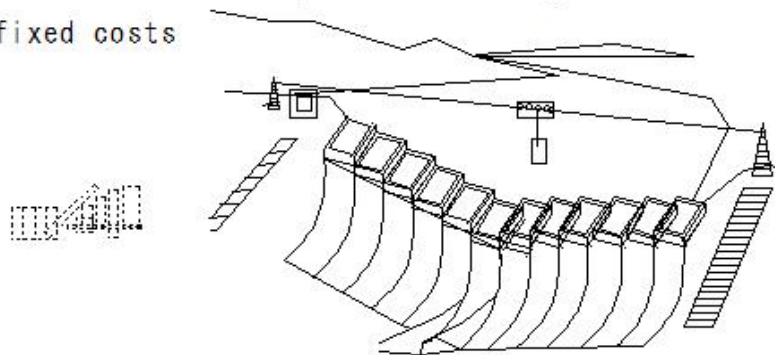
E623

(M3) construction machinery

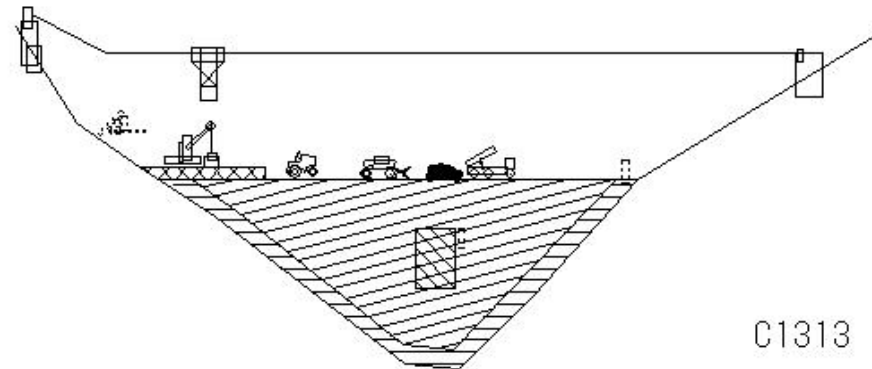
construction machinery

(M3) construction machinery

- ② Disadvantages of construction machinery
- ① A large amount of funds
- ② Secure the amount of work - improve efficiency
- ③ Increase in fixed costs



funds
efficiency
fixed costs



C1313

(M4)construction machinery

(M4) construction machinery

construction machinery

Types of construction machinery

earthworks

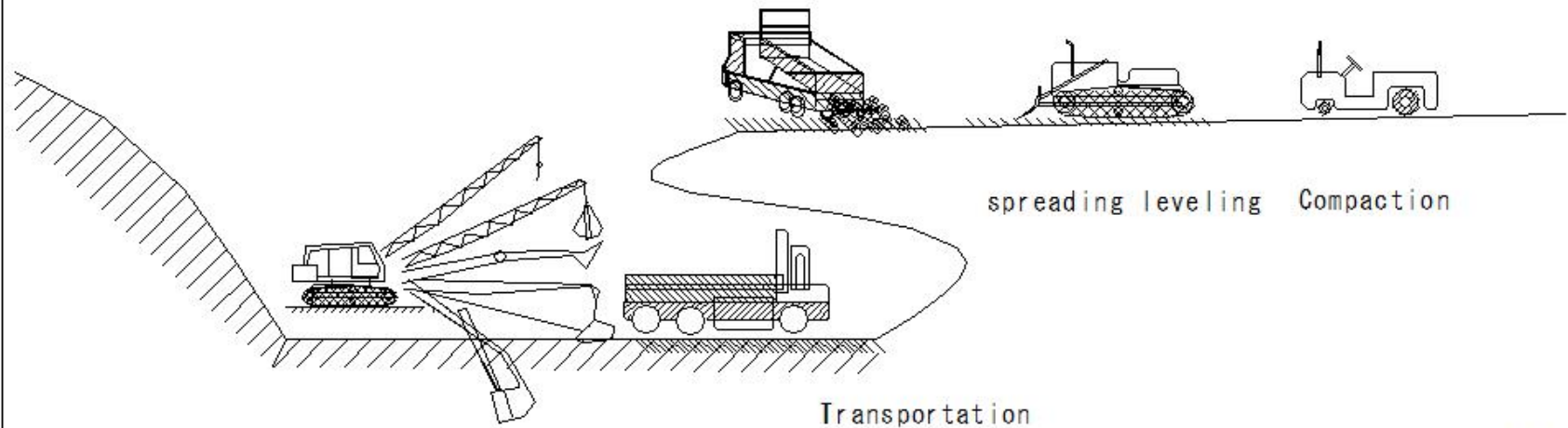
Excavation: Power shovel

Loading: Tractor excavator

Transportation: bulldozer/crane

spreading leveling: grader

Compaction: tire roller



Excavation

Loading:

Transportation

spreading leveling Compaction

E331

(M5)construction machinery

(M5) construction machinery

construction machinery

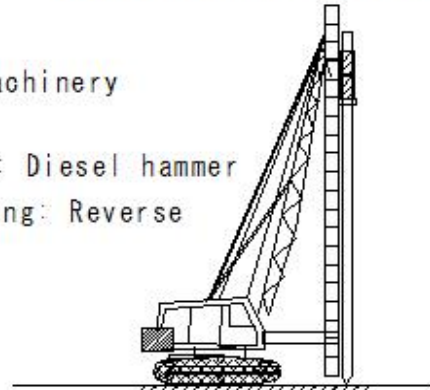
Types of construction machinery

Foundation work

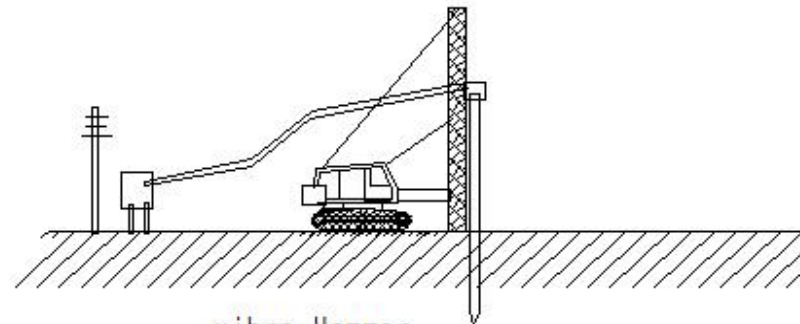
Ready-made pile driving: Diesel hammer

Cast-in-place pile driving: Reverse

Ground improvement

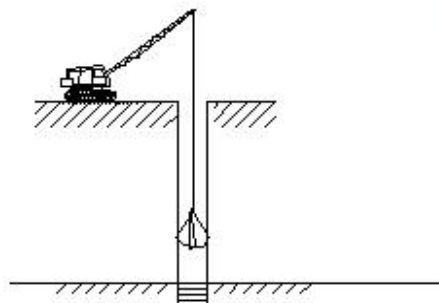


Diesel hammer

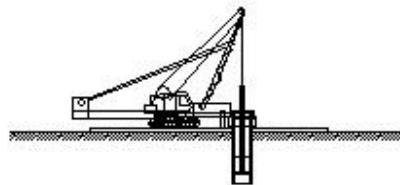


vibro Hammer

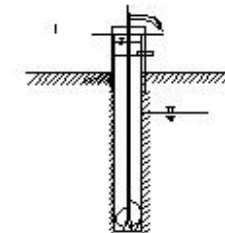
F110



All-casing method(Benoto method)



earth drill method



Reverse circulation method

F111

(M6)construction machinery

(M6) construction machinery

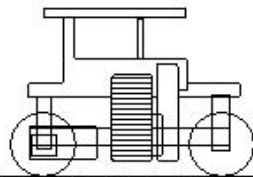
construction machinery

Types of construction machinery

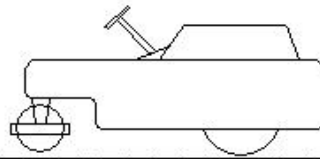
Paving work

Asphalt pavement: Asphalt finisher

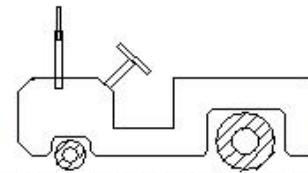
Concrete pavement: concrete finisher



macadam roller



tandem roller



tire roller

(M7)construction machinery

(M7) construction machinery

construction machinery

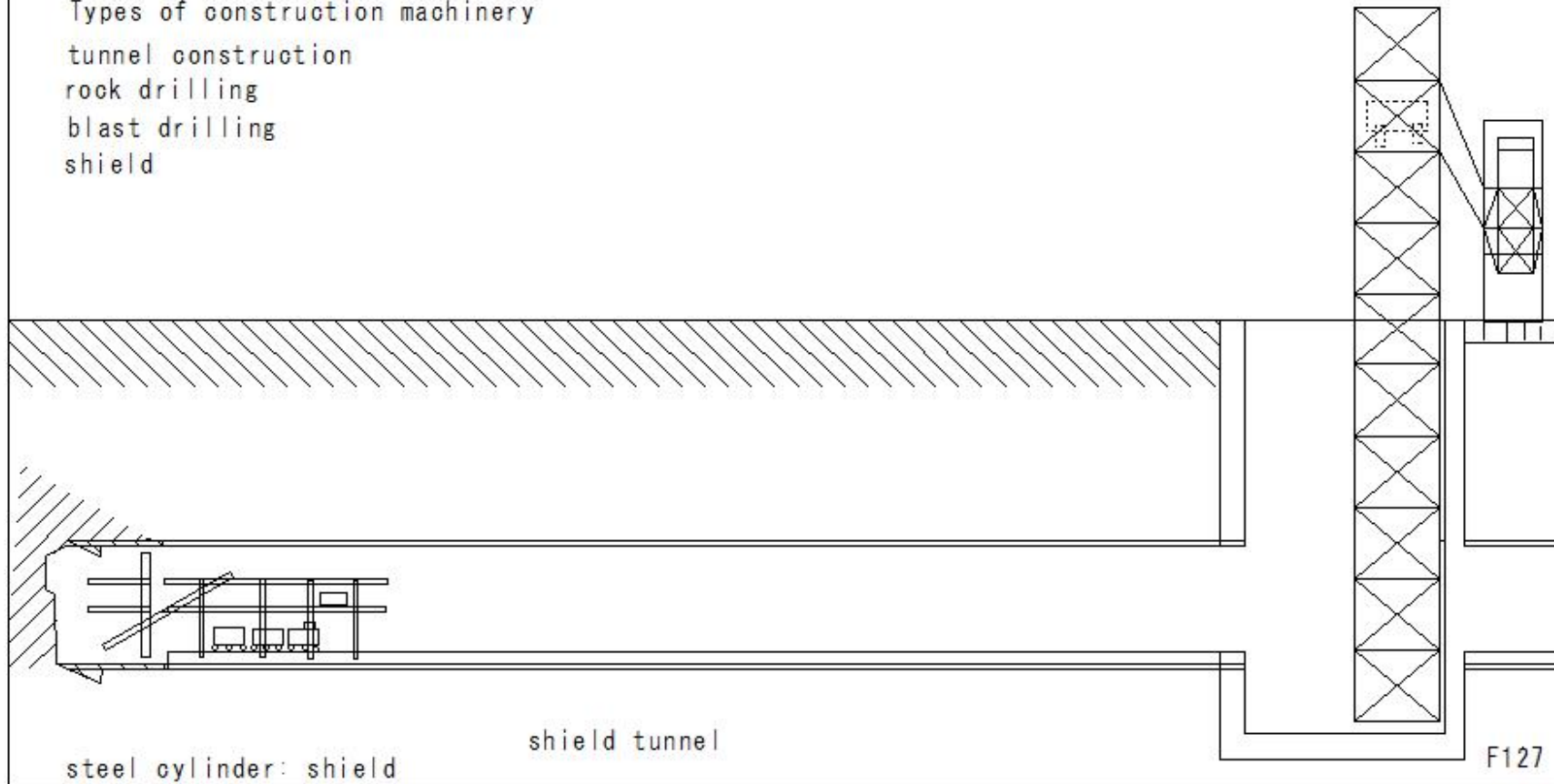
Types of construction machinery

tunnel construction

rock drilling

blast drilling

shield



(M8) construction machinery

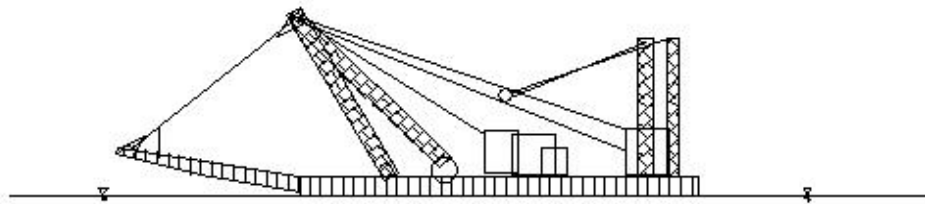
(M8) construction machinery

construction machinery

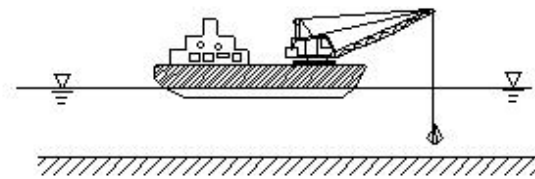
Types of construction machinery

Marine construction

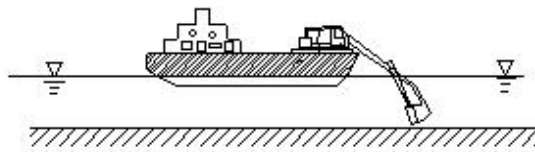
Various work boats



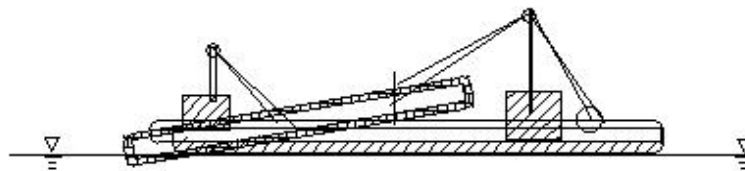
Pump dredger



Grab dredger



Dipper dredger



Bucket dredger

(M9) construction machinery

(M9) construction machinery

construction machinery

Types of construction machinery

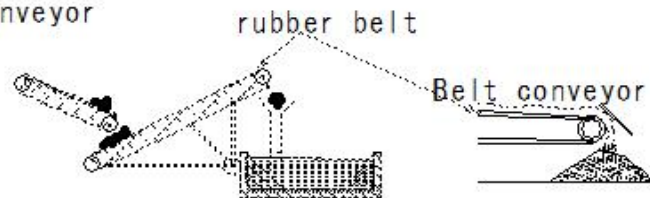
Various construction works

air compressor

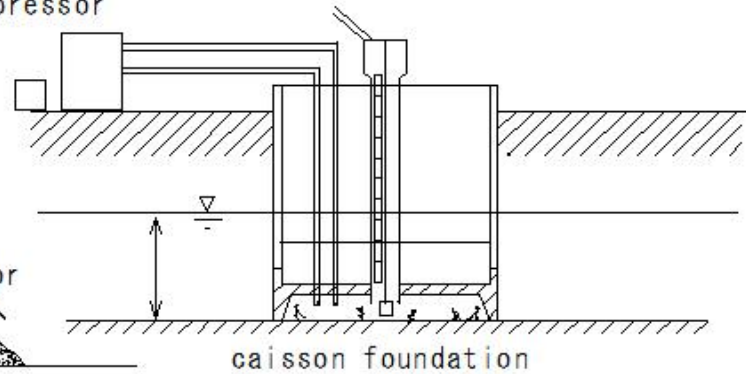
drainage pump

concrete and asphalt machinery

conveyor

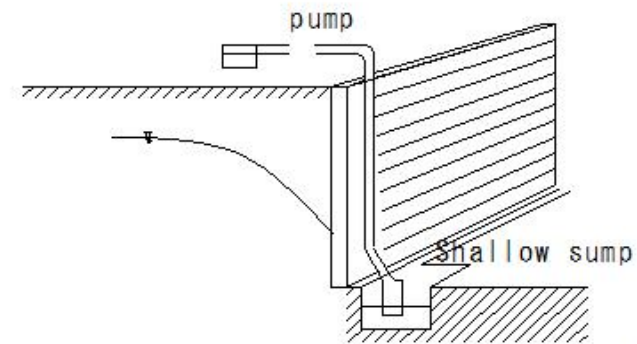
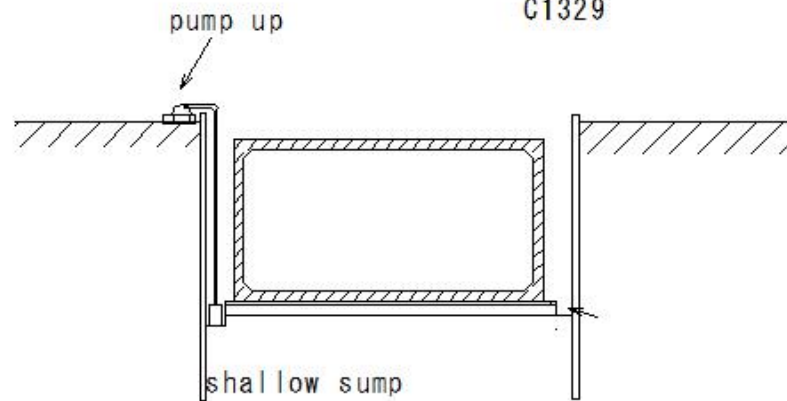


air compressor



F59

C1329



F93

(M10)construction machinery

(M10)construction machinery
 construction machinery
 power source

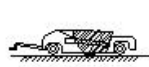
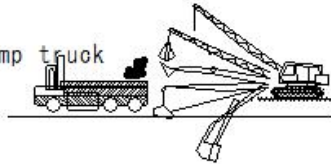
	diesel engine	gasoline engine
①Fuel used	Light oil	gasoline
②Ignition method	Compression-self-ignition	electric spark ignition
③Compression ratio	1:15-20	1;5-10
④Thermal efficiency	30-40%	25-30%
⑤Fuel consumption rate	160-225g/PS · h	200-280g/PS · h
⑥Engine weight per horsepower	big	small
⑦Price per horsepower	expensive	cheap
⑧Operating expenses	cheap	expensive
⑨Risk against fire	few	many
⑩ Malfunction	few	many

(M10) construction machinery

construction machinery

power source

+ dump truck



Towed scraper



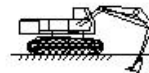
scrape dozer



motor scraper



Excavator



backhoe



drag line



clamshell



Tractor excavator
+ dump truck

E238

(M11) construction machinery(traveling device)

(M11) construction machinery(traveling device)

construction machinery

traveling device

①Crawler type

caterpillar type

Installation pressure - small

Soft ground - possible to drive on

②Wheel type

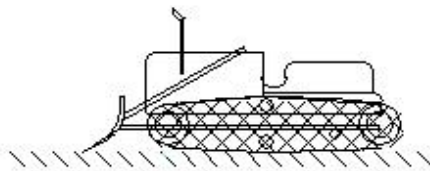
wheeled

Installation pressure - large

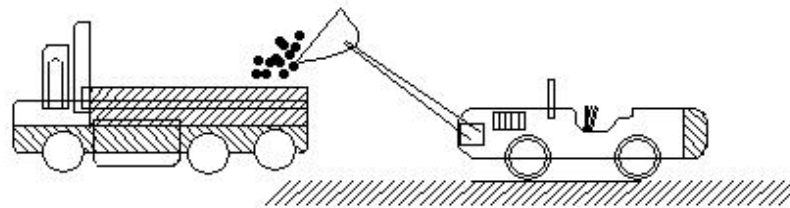
Comparison of crawler type and wheel type

	①Crawler type	②Wheel type
① Influence of soil quality	few	many
② Working on soft ground	Suitable	unsuitable
③ Work on uneven ground	easy	difficulty
④ Traction power	big	small
⑤ Climbing power	big	small
⑥ Suspension maintenance	difficulty	easy
⑦ Working distance	short distance	long distance
⑧ Working speed	relatively slow	high speed
⑨ Mobility	small	big
⑩ Continuous heavy load work	easy	difficulty

(M11) construction machinery(traveling device)



① Crawler type



② Wheel type

(M12)construction machinery(Hydraulic type/Mechanical)

(M12)construction machinery(Hydraulic type/Mechanical)

construction machinery

transmission mechanism

①Hydraulic type: Small and medium-sized machines

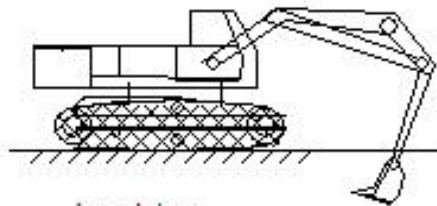
②Mechanical: Large machinery

Compare hydraulic and mechanical types

①Item	①Hydraulic type	②Mechanical
②Mechanism	easy	complicated
③Weight	light	heavy
④Workability	strong digging power	impact force can be used
⑤Transmission efficiency	Somewhat bad	good
⑥Easy to operate	easy	Operation force - large
⑦Maintainability	Inspection points - few	Maintenance is time-consuming
⑧Versatility	Dedicated machine	wide range of uses

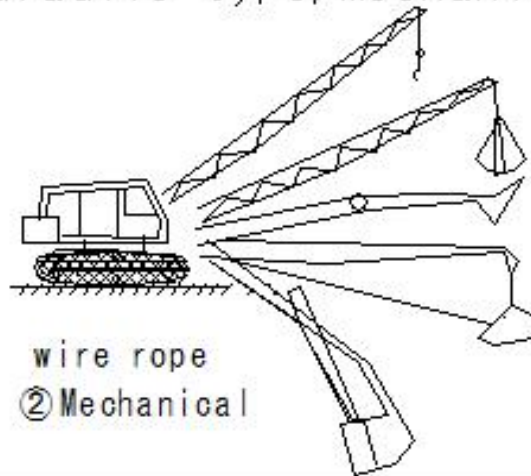
(M12)construction machinery(Hydraulic type/Mechanical)

hydraulic cylinder



backhoe

①Hydraulic type

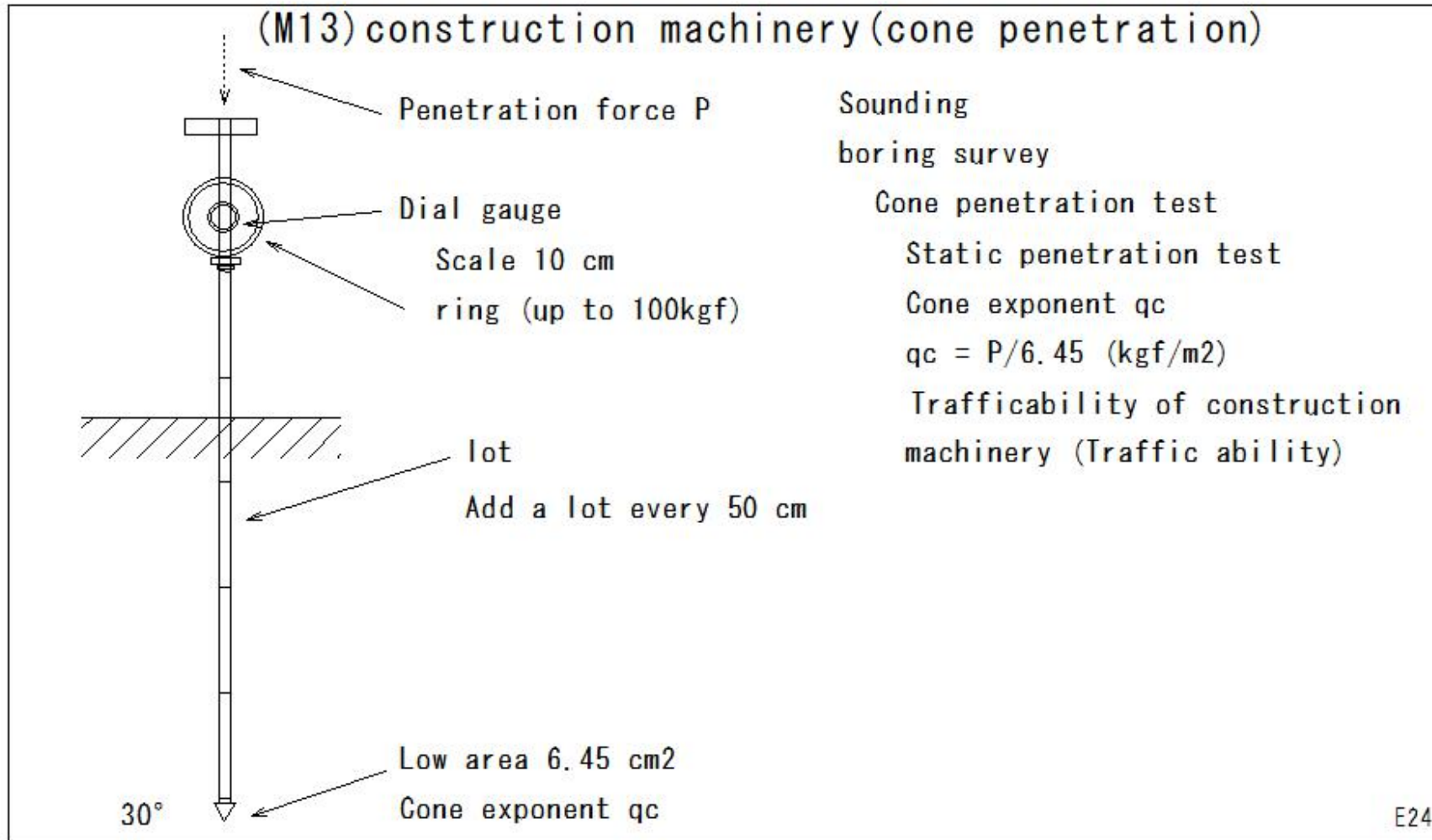


wire rope

②Mechanical

M125

(M13) construction machinery (cone penetration)



(M14)construction machinery(cone index)

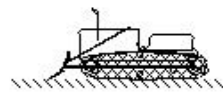
(M14) construction machinery (cone index)

construction machinery

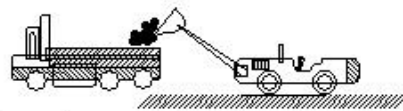
cone index

Cone index required for running construction machinery

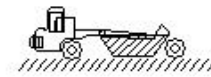
Types of construction machinery	Cone index value qc (kgf/cm ²)
① Bulldozer for super wetlands	2 or more
② Bulldozer for wetlands	3 or more
③ Scrape dozer	6 or more (4 or more for super wetland type)
④ Bulldozer medium size	5-7
⑤ Large bulldozer	7-10
tow-and-pull scraper	7-10
⑥ Motor scraper	10-13
⑦ Dump truck (6-7.5t)	12-15 and above



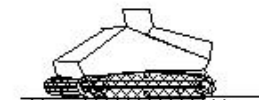
Bulldozer



Excavator and dump truck



Motor Scraper



Scrape dozer

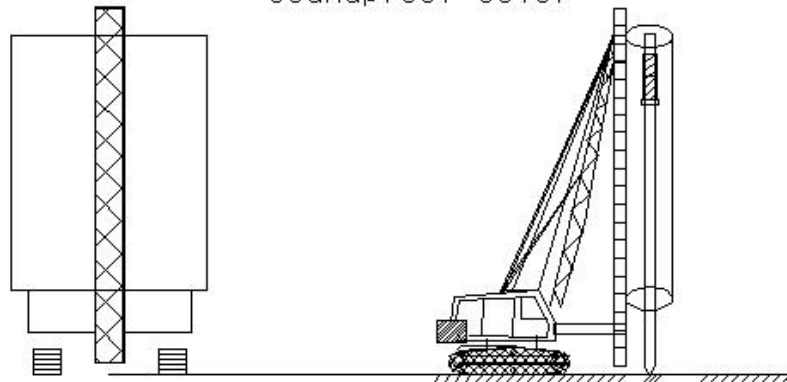
(M15)construction machinery(noise level)

(M15)construction machinery(noise level)
construction machinery
Noise from major construction machinery
noise level

Noise from major construction machinery	phon
①Bulldozer	63
②Power shovel	64
③Clamshell	63
④Road roller	62
⑤ Diesel hammer	95
⑥Benoto Grab Bucket	68
⑦Dump truck	78
⑧Various plants	80

(M15) construction machinery (noise level)

• Soundproof cover



⑥Soundproof cover

(M16)Earthmoving machinery(Excavating machine)

(M16)Earthmoving machinery(Excavating machine)

earthmoving machinery

Excavating machine

① Shovel type excavator

② Bulldozer type excavator Excavation + transportation work

③ Continuous bucket excavator

① Shovel type excavator

1 Upper rotating body

2 Boom

3 Boom point

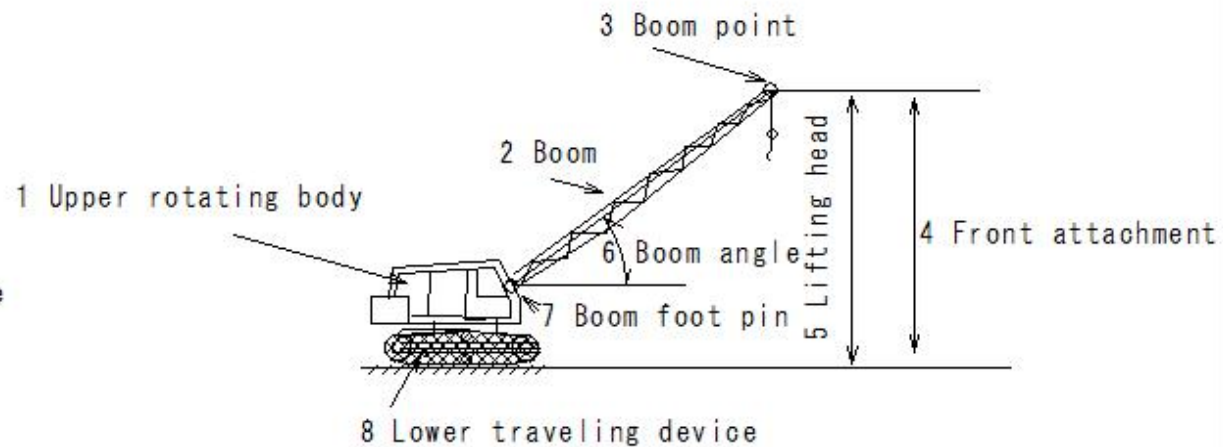
4 Front attachment

5 Lifting head

6 Boom angle

7 Boom foot pin

8 Lower traveling device



Shovel type excavator

(M17)Earthmoving machinery(Excavating machine)

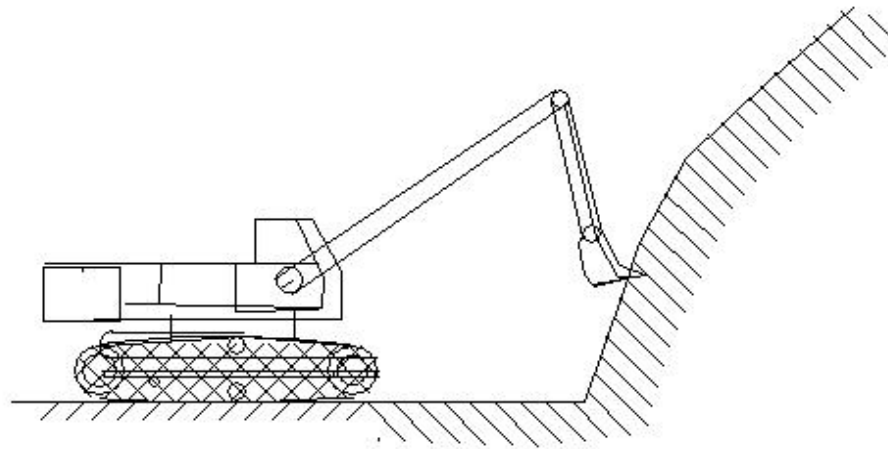
(M17) Earthmoving machinerye(Excavating machine)

Earthmoving machinery

Excavating machine

① Shovel type excavator

Front attachment type
hydraulic breaker



① Shovel type excavator

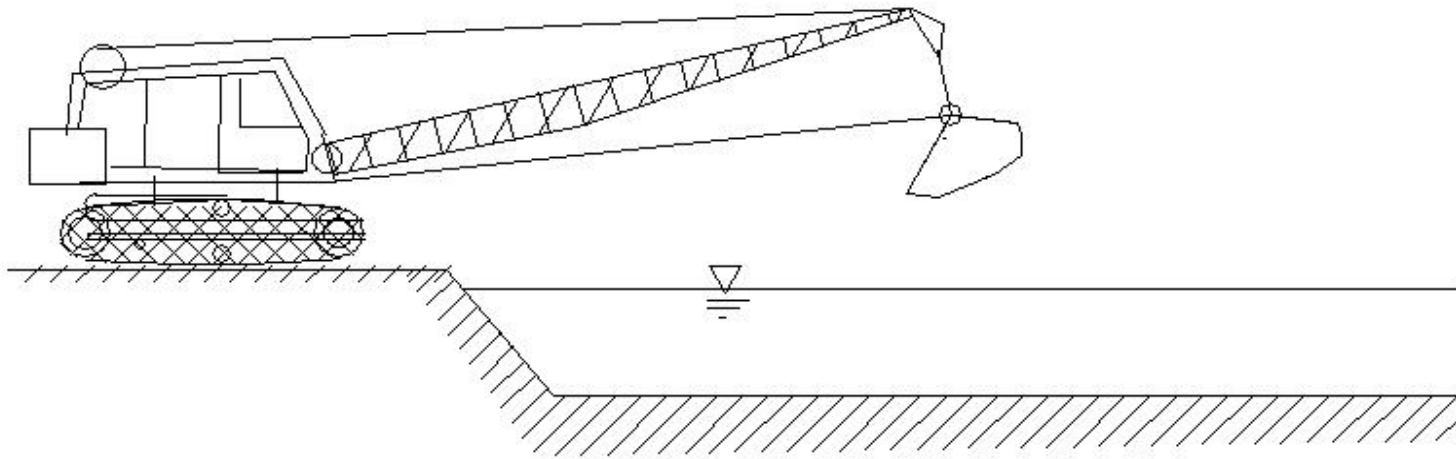
M125

(M18)Earthmoving machinery(Excavating machine)

(M18) Earthmoving machinery (Excavating machine)

Earthmoving machinery
Excavating machine
drag line

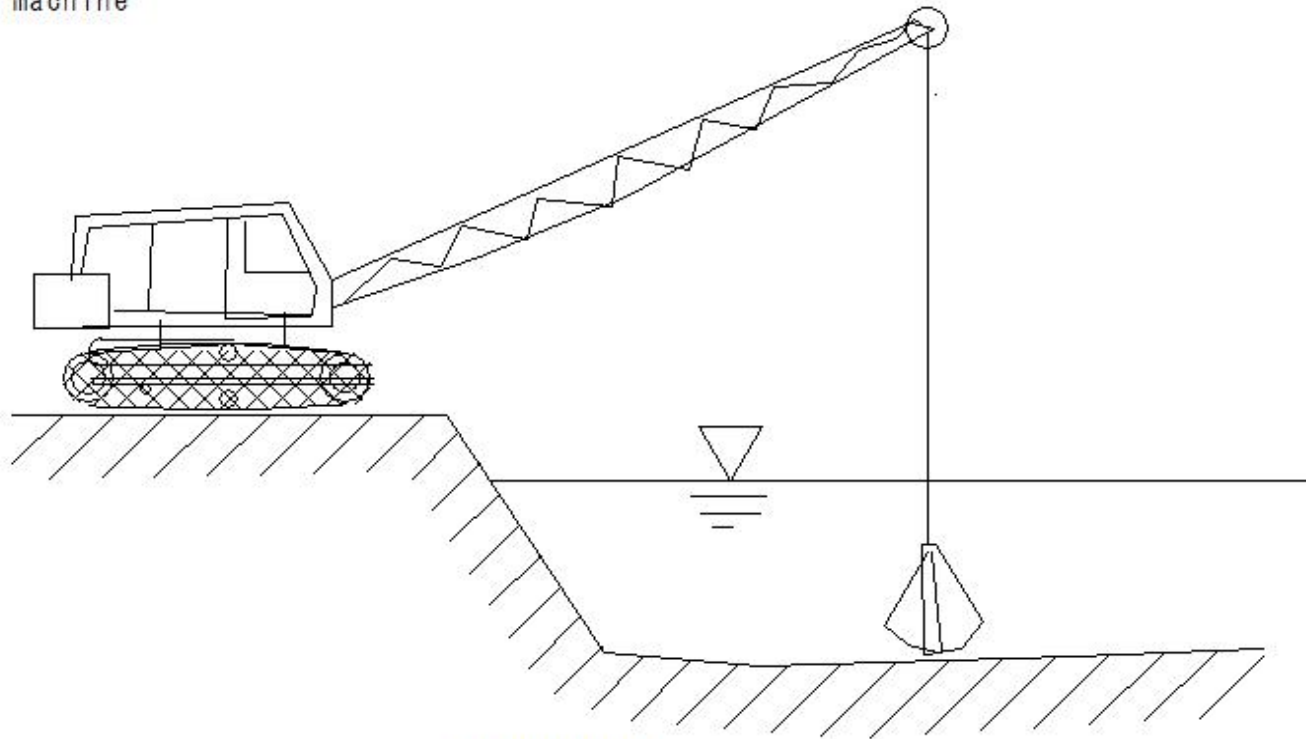
drag line



(M19)Earthmoving machinery(Excavating machine)

(M19)Earthmoving machinery(Excavating machine)

construction machinery
earthmoving machinery
Excavating machine
clamshell



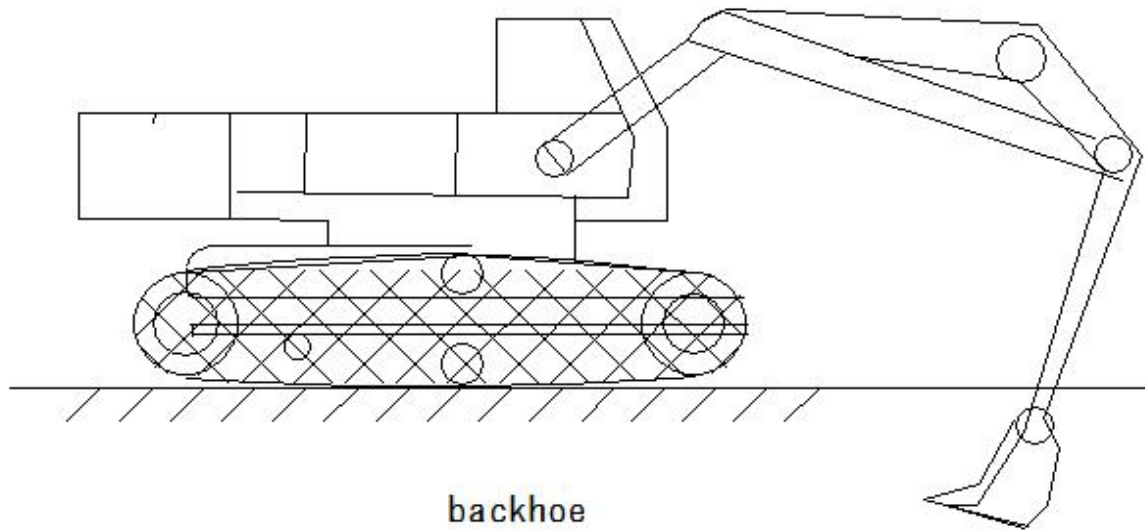
clamshell

E229

(M20)Earthmoving machinery(Excavating machine)

(M20)Earthmoving machinery(Excavating machine)

construction machinery
earthmoving machinery
Excavating machine
backhoe

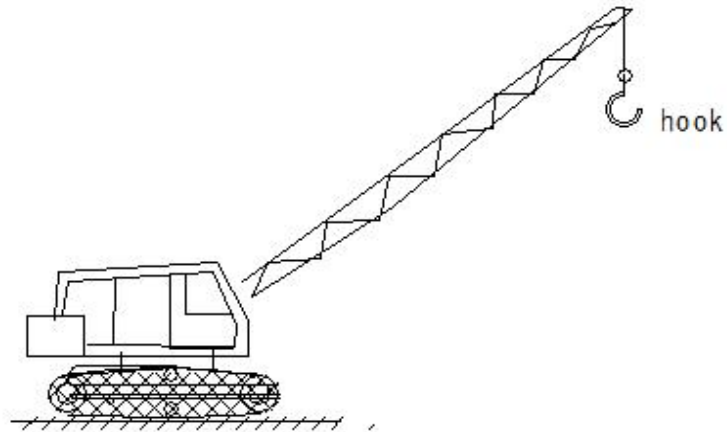


E229

(M21)Earthmoving machinery(Excavating machine)

(M21)Earthmoving machinery(Excavating machine)

construction machinery
earthmoving machinery
Excavating machine
crane

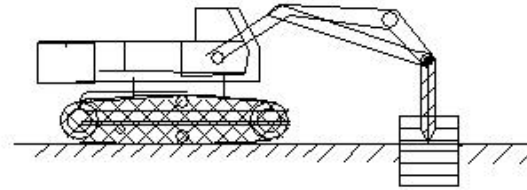


crane

(M22)Earthmoving machinery(Excavating machine)

(M22) Earthmoving machinery (Excavating machine)

construction machinery
earthmoving machinery
Excavating machine
hydraulic breaker

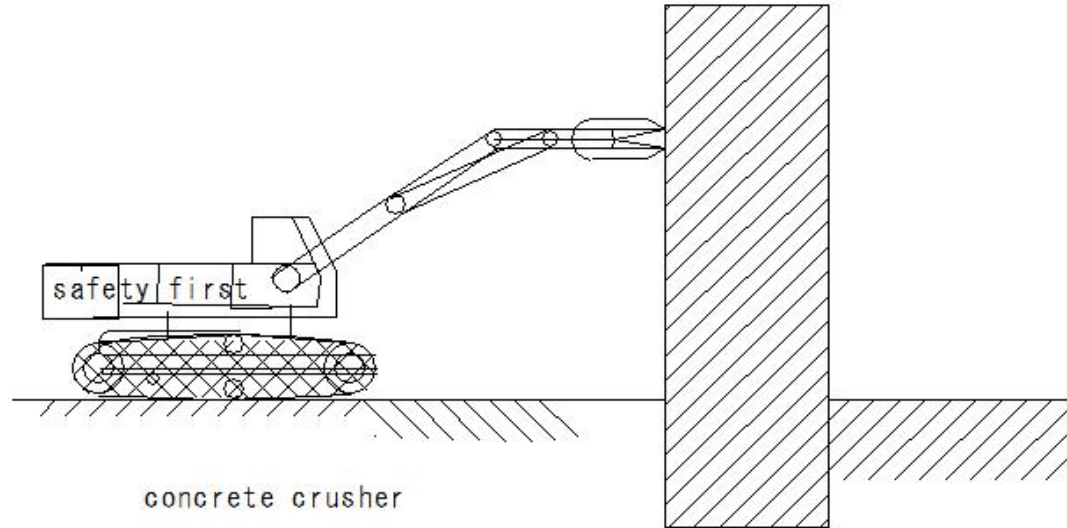


hydraulic breaker

(M23)Earthmoving machinery(Excavating machine)

(M23)Earthmoving machinery(Excavating machine)

construction machinery
earthmoving machinery
Excavating machine
concrete crusher



(M24)Earthmoving machinery(loading machine)

(M24)Earthmoving machinery(loading machine)

Earthmoving machinery

loading machine

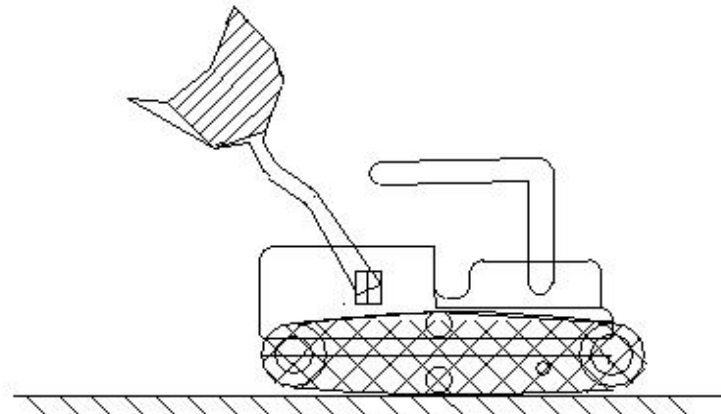
①Crawler type tractor excavator

- Based on bulldozer
- Installing a bucket instead of a blade
- Excavating power - inferior
- Ground pressure - low
- Good running performance on soft ground and uneven ground

safety first



guide



bucket dozer

①Crawler type tractor excavator

E237

(M25)Earthmoving machinery(loading machine)

(M25)Earthmoving machinery(loading machine)

Earthmoving machinery

Loading machine

②Wheeled tractor excavator

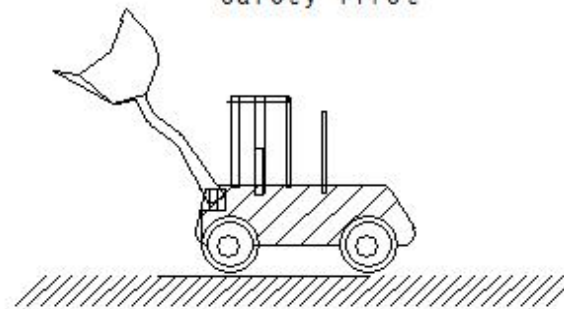
- Running speed - fast
- High mobility
- Paved roads - do not damage the road surface
- work freely

Confirm surroundings



guide

safety first



tractor excavator

②Wheeled tractor excavator

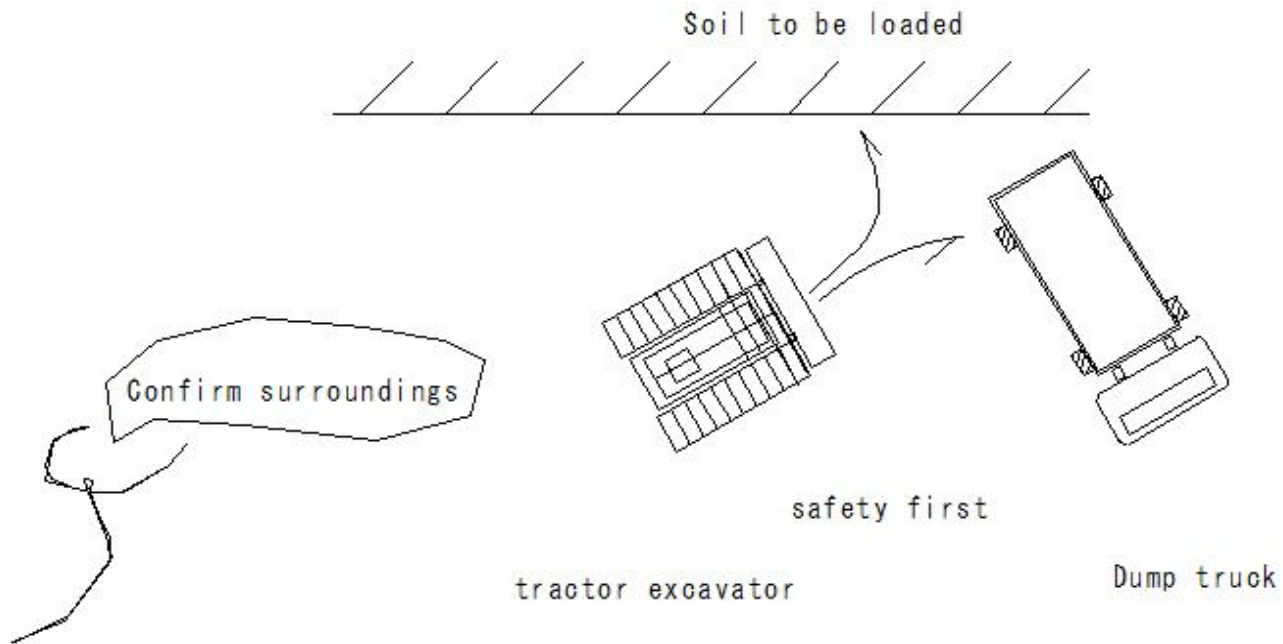
(M26)Earthmoving machinery(loading machine)

(M26)Earthmoving machinery(loading machine)

Earthmoving machinery

Loading method

- V shape



(M27)Earthmoving machinery(loading machine)

(M27)Earthmoving machinery(loading machine)

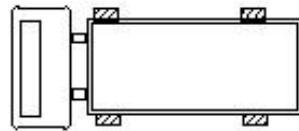
Earthmoving machinery

Loading method

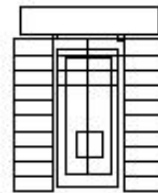
- I shape

Soil to be loaded

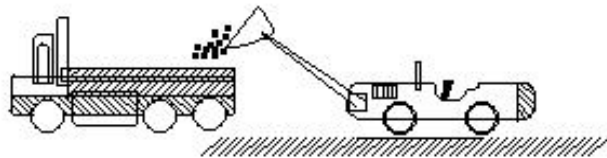
safety first



Dump truck



tractor excavator



E230

E294

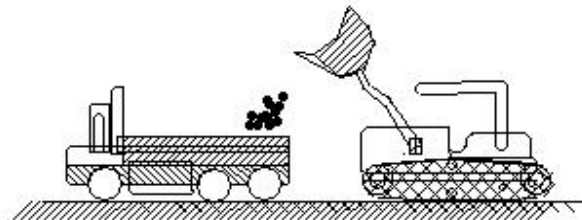
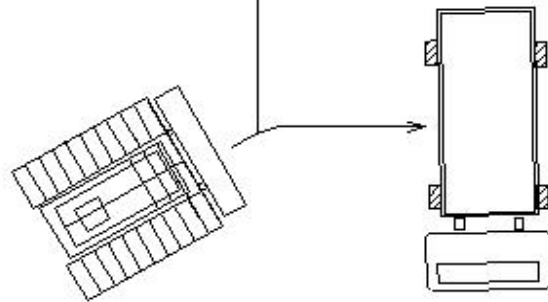
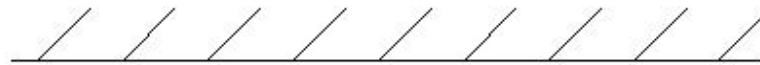
(M28)Earthmoving machinery/loading machine

(M28)Earthmoving machinery (loading machine)

Earthmoving machinery
Loading method
• L shape



Soil to be loaded



Dump truck

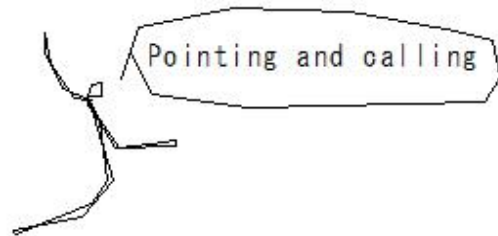
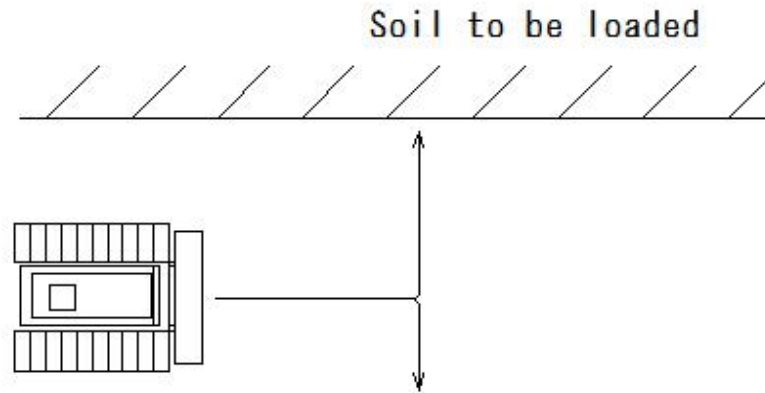
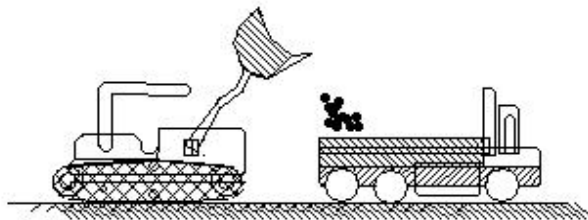
E237

E295

(M29)Earthmoving machinery/loading machine)

(M29) Earthmoving machinery (loading machine)

Earthmoving machinery
Loading method
• T shape



Dump truck

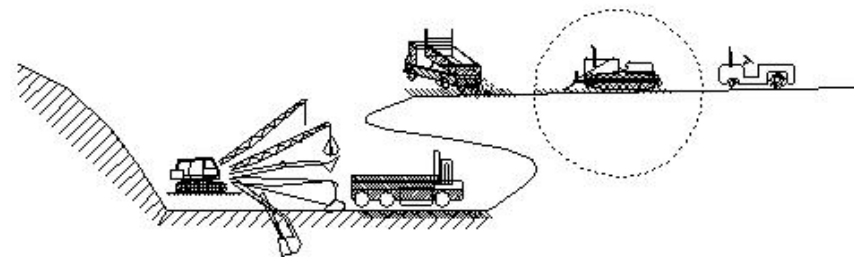
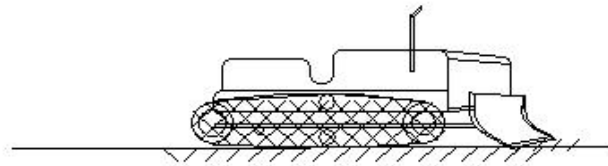
(M30)Earthmoving machinery-transport machinery-Straight dozer

(M30) Earthmoving machinery-transport machinery-Straight dozer

Earthmoving machinery

Transport machinery

- Straight dozer
- Angle is fixed
- Attach the soil removal plate (blade) at right angles
- Suitable for heavy excavation to the direction of travel.



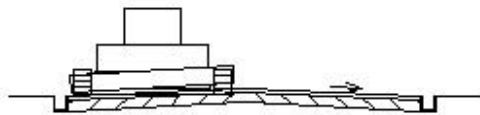
(M31)Earthmoving machinery-transport machinery-Angle dozer

(M31)Earthmoving machinery-transport machinery-Angle dozer

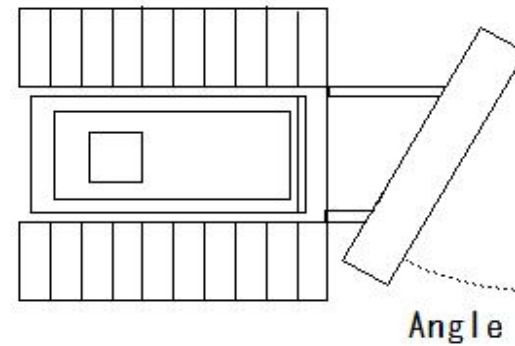
Earthmoving machinery

Transport machinery

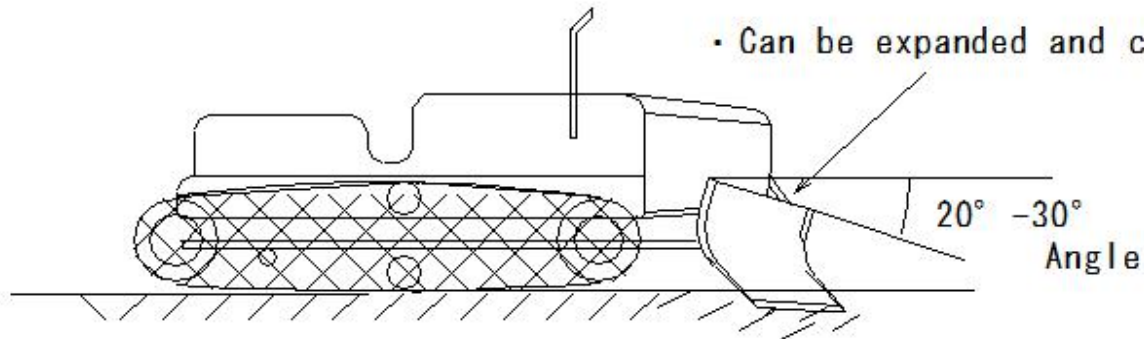
- Angle dozer
- Slope excavation/ground leveling
- Not suitable for heavy excavation



Plan view



• Can be expanded and contracted



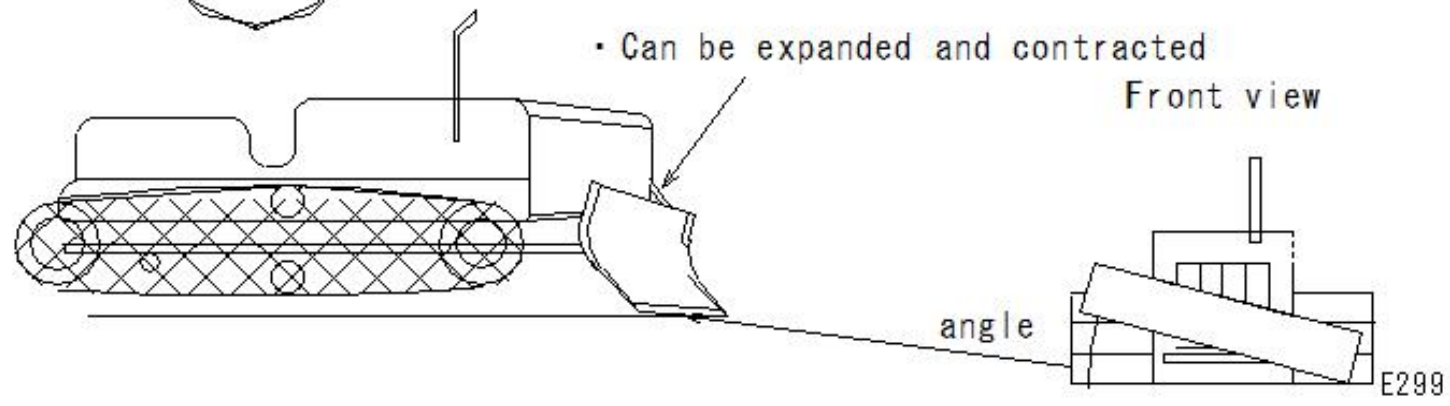
(M32)Earthmoving machinery-transport machinery-Tilt dozer

(M32)Earthmoving machinery-transport machinery-Tilt dozer

Earthmoving machinery

Transport machinery

- Tilt dozer
- Can be expanded and contracted
- Change the height of the left and right blades
- Ditching, cutting, hard soil excavation



(M33)Earthmoving machinery-transport machinery-U dozer

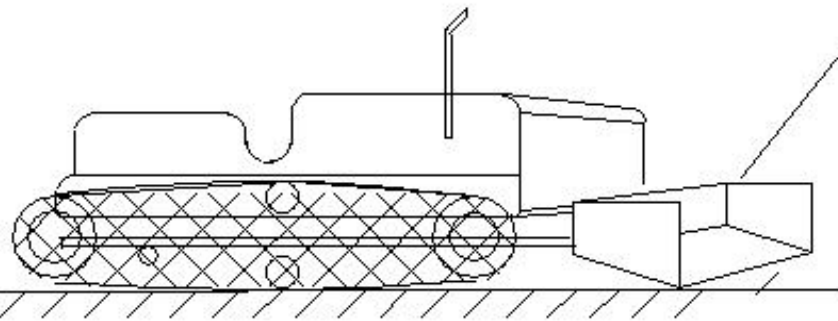
(M33)Earthmoving machinery-transport machinery-U dozer

Earthmoving machinery

Transport machinery

- U dozer
- Improved soil transportation efficiency

Signal/guidance meeting



- U shape
- don't spill soil

(M34)Earthmoving machinery-transport machinery-Rake dozer

(M34) Earthmoving machinery-transport machinery-Rake dozer

Earthmoving machinery

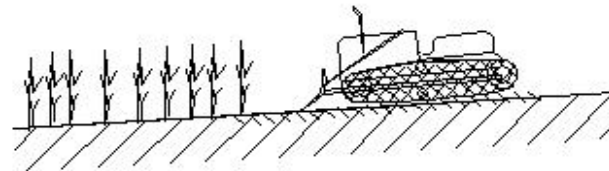
Transport machinery

• Rake dozer

• Clearing and rock digging



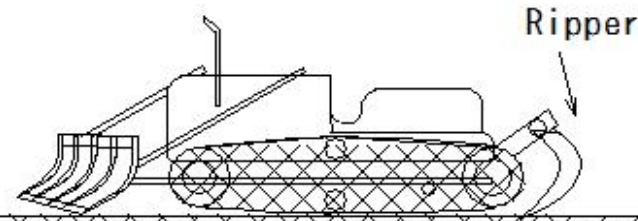
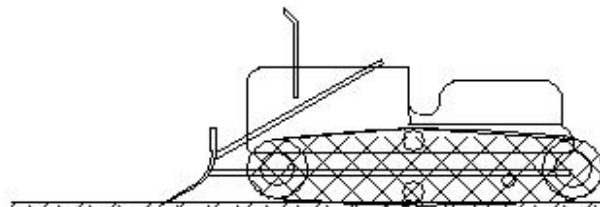
Zero disaster



health care

bulldozer

rake dozer



Ripper

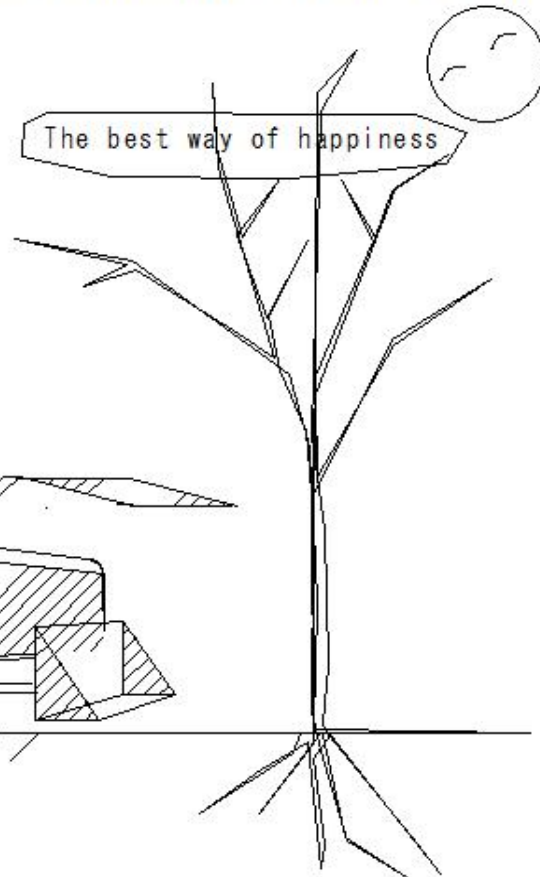
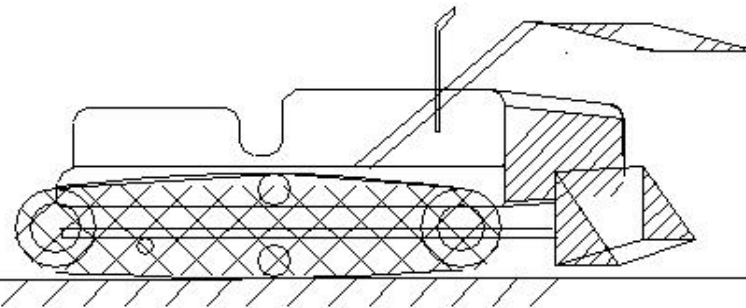
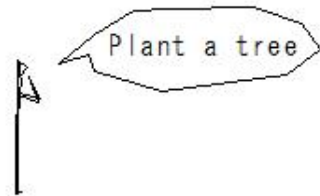
(M35)Earthmoving machinery-transport machinery-Tridozer

(M35)Earthmoving machinery-transport machinery-Tridozer

Earthmoving machinery

Transport machinery

- Tridozer
- Fallen standing tree
- Root cutting



• Tridozer

E302

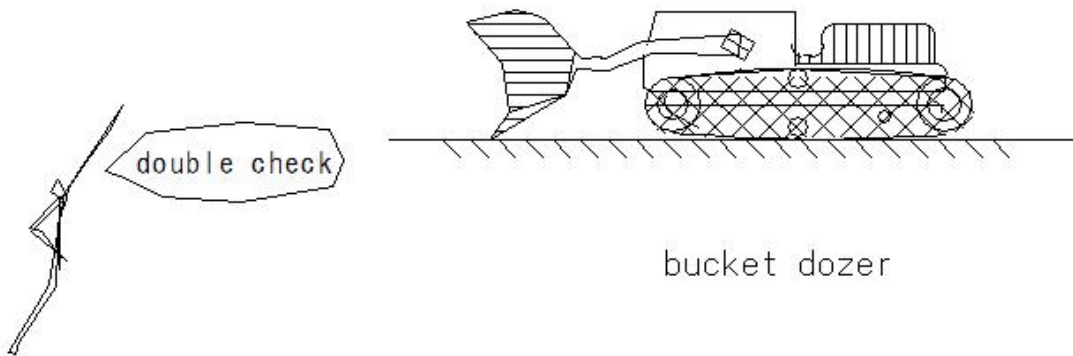
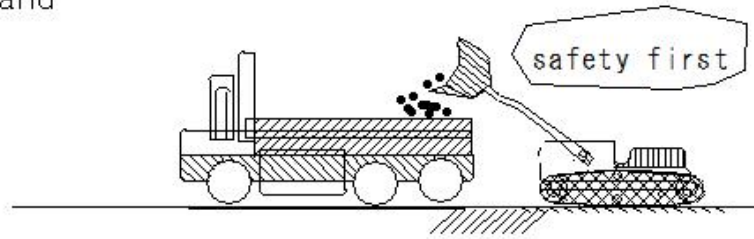
(M36)Earthmoving machinery-transport machinery-Bucket dozer

(M36)Earthmoving machinery-transport machinery-Bucket dozer

Earthmoving machinery

Transport machinery

- Bucket dozer
- Loading of earth and sand
- Transportation



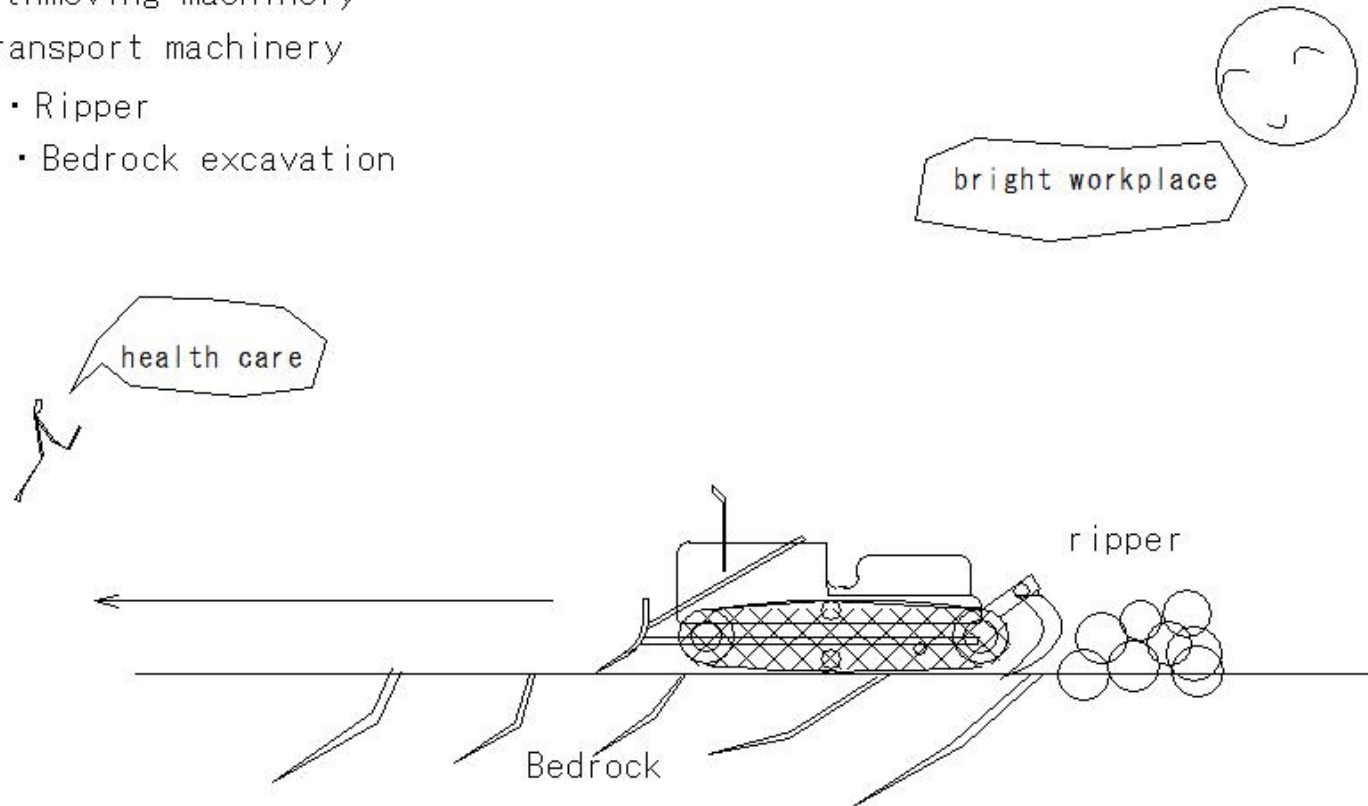
(M37)Earthmoving machinery-transport machinery-Ripper

(M37)Earthmoving machinery-transport machinery-Ripper

Earthmoving machinery

Transport machinery

- Ripper
- Bedrock excavation



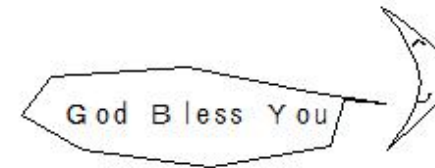
(M38)Earthmoving machinery-transport machinery-Installation pressure

(M38)Earthmoving machinery-transport machinery-Installation pressure

Earthmoving machinery

Transport machinery

- Installation pressure
 - Average installation pressure (kgf/cm²)
 - Operating and maintenance weight/total installation area
- = Total weight (kgf/cm²) / 2 x crawler width x ground contact length (cm)



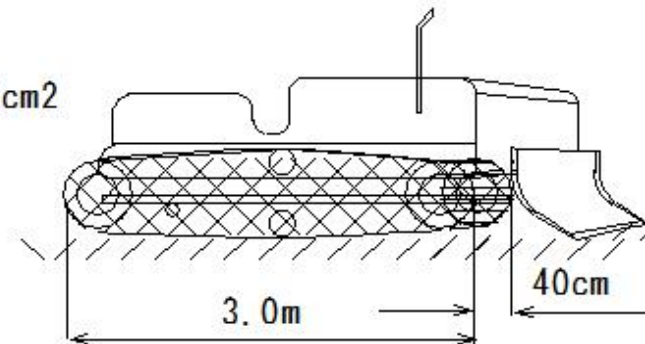
example

- 20t bulldozer
- Width 40cm
- Length 3.0m

- Installation pressure
= 20000kgf / (2 x 40cm x 300cm) = 0.83kgf/cm²



20t bulldozer



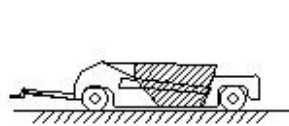
(M39)Earthmoving machinery-transport machinery-Scraper

(M39)Earthmoving machinery-transport machinery-Scraper

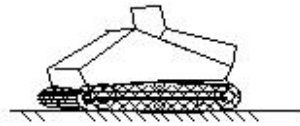
Earthmoving machinery

Transport machinery

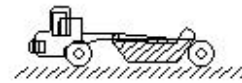
- Scraper
 - 1 cycle: excavation, loading, transportation, unrolling, leveling
 - Transportation at high speed and in large quantities
- ① Towed scraper
 - ② Self-propelled scraper (motor scraper)
 - ③ Scraper dozer: bulldozer + scraper



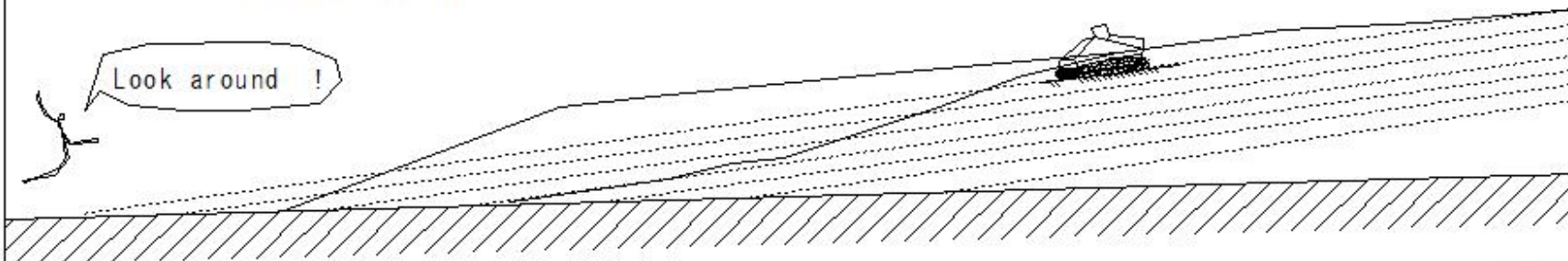
Towed scraper



scrape dozer



motor scraper

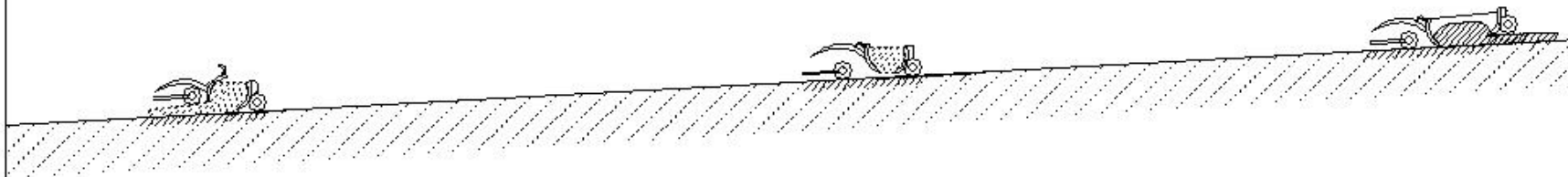
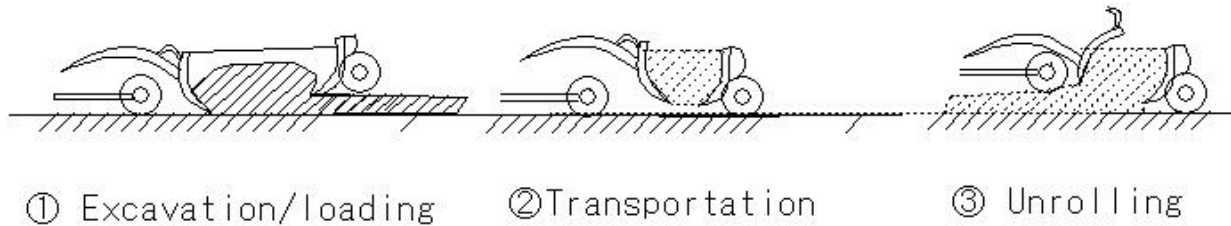


(M40)Earthmoving machinery-transport machinery-Scraper-Work procedure

(M40) Earthmoving machinery-transport machinery-Scraper-Work procedure

Earthmoving machinery
Transport machinery

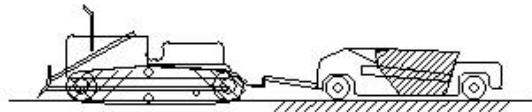
- scraper
- Work procedure
 - ① Excavation/loading
 - ② Transportation
 - ③ Unrolling



(M41)Earthmoving machinery-transport machinery-Scraper-Type of scraper

(M41) Earthmoving machinery-transport machinery-Scraper-Type of scraper

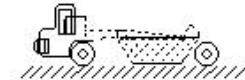
- Earthmoving machinery ① Towed scraper
Transport machinery ② Self-propelled scraper (motor scraper)
• scraper ③ Scraper dozer: bulldozer + scraper
• Type of scraper



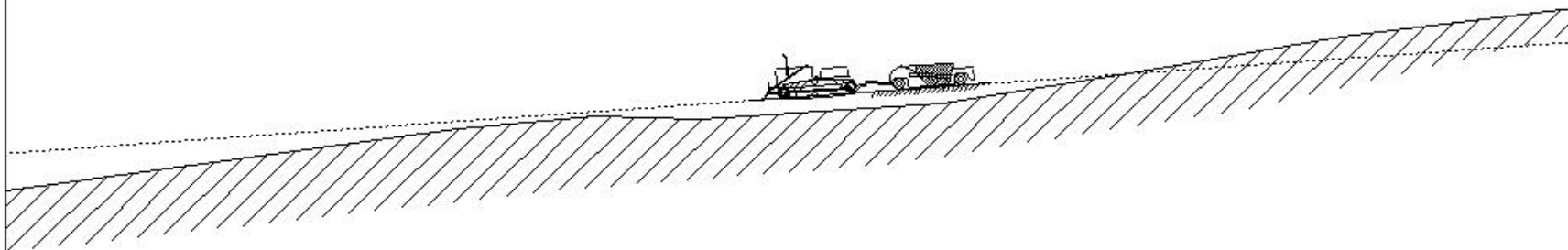
Towed scraper



scrape dozer



motor scraper



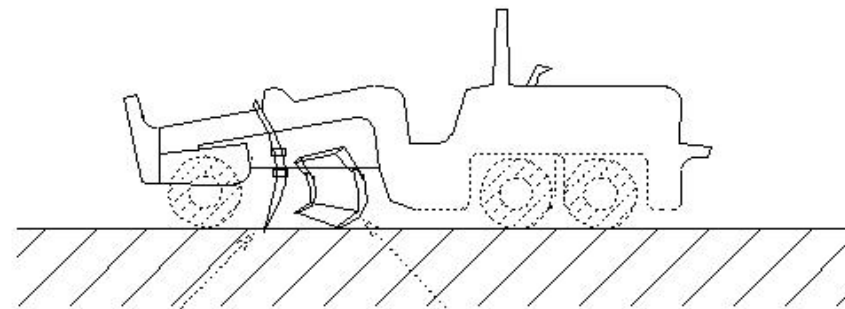
(M42)Earthmoving machinery-transport machinery-Motor grader

(M42) Earthmoving machinery-transport machinery-Motor grader

Earthmoving machinery

Transport machinery

- Spreading
- Motor grader

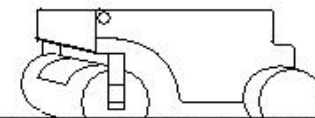
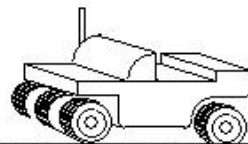


Scarifier

blade

Scraping claws

motor grader



(M43)Earthmoving machinery-transport machinery-Dump truck

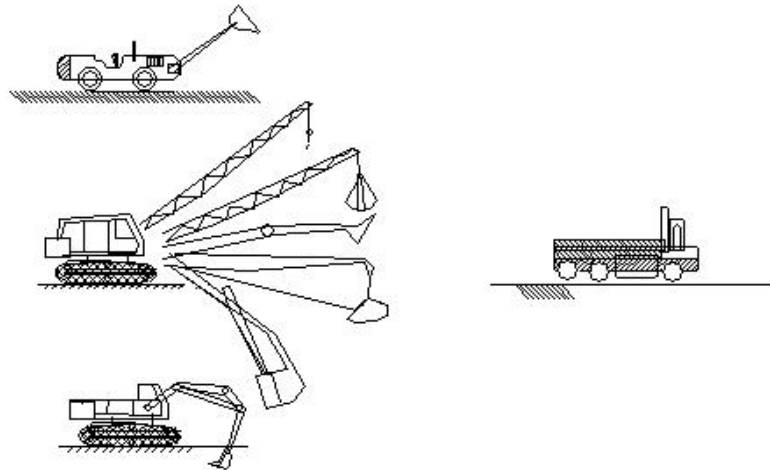
(M43)Earthmoving machinery-transport machinery-Dump truck

earthmoving machinery

transport machinery

Dump truck

- Ordinary dump truck
- Heavy dump truck
- Dump truck size: maximum loading capacity



(M44)Earthmoving machinery-transport machinery-crane

(M44)Earthmoving machinery-transport machinery-crane

construction machinery
earthmoving machinery
transport machinery
crane

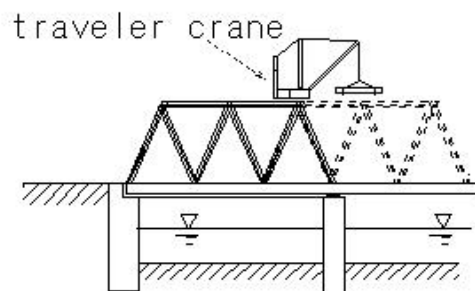
self-moved

track crane type

derick crane type

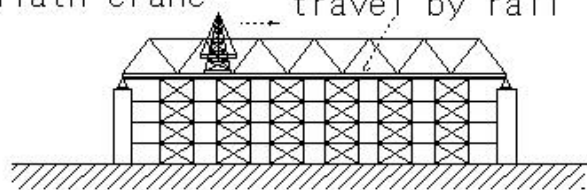
tower type

Working radius - large - hanging load - small

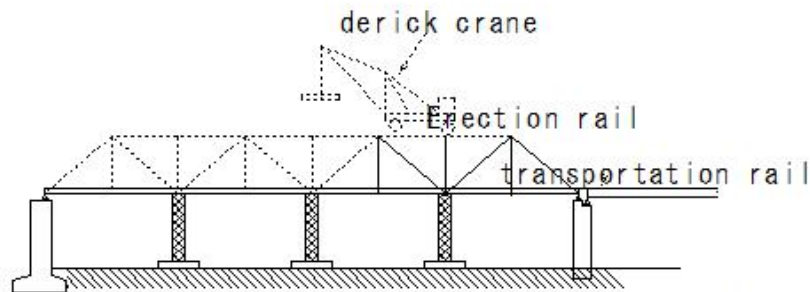


B225

goliath crane travel by rail



B201



B417

(M45)Earthmoving machinery-transport machinery-Crawler crane

(M45)Earthmoving machinery-transport machinery-Crawler crane

construction machinery

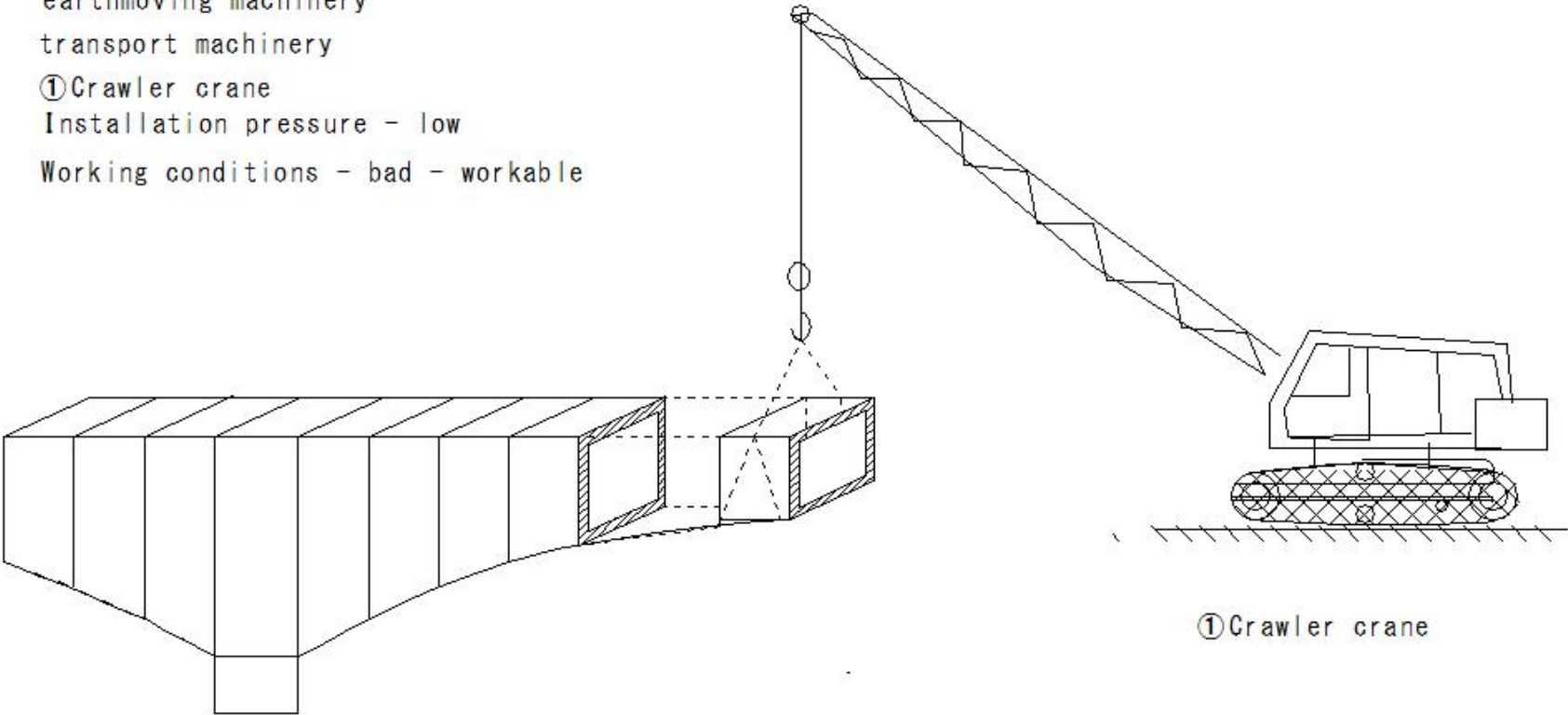
earthmoving machinery

transport machinery

①Crawler crane

Installation pressure - low

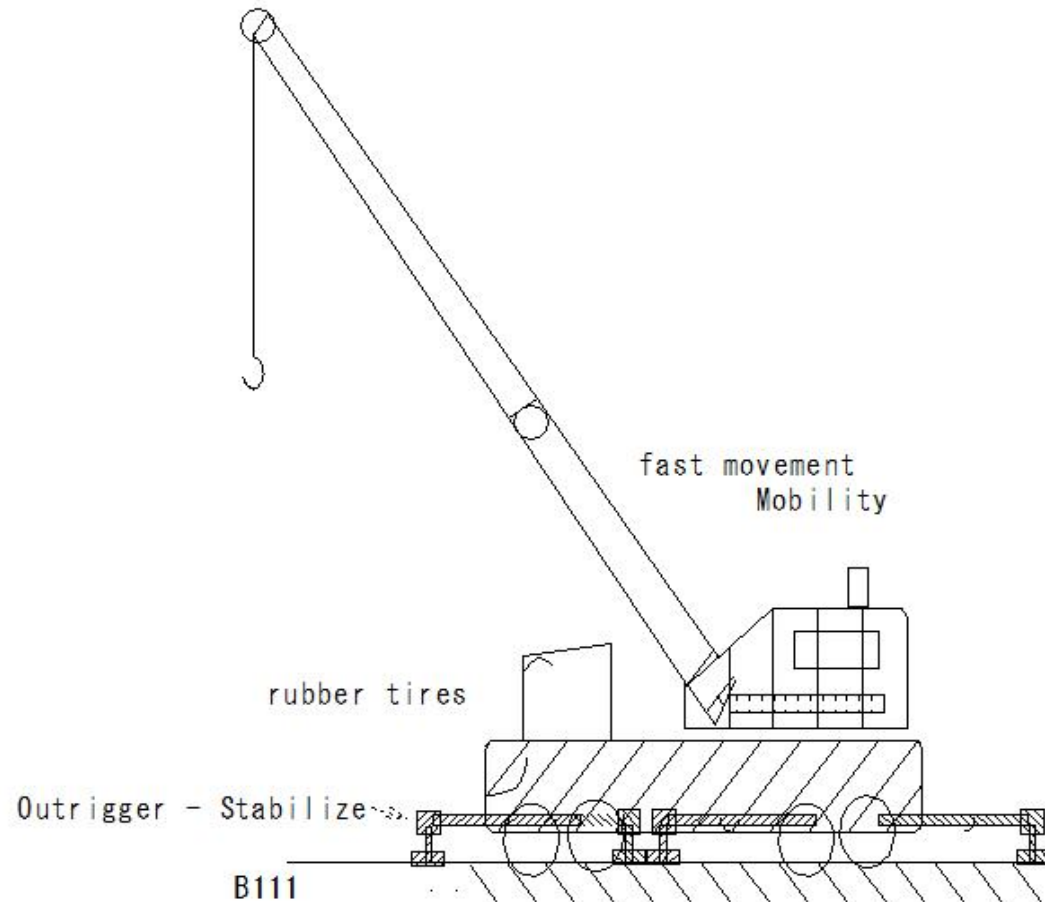
Working conditions - bad - workable



(M46)Earthmoving machinery-transport machinery-Truck crane

(M46)Earthmoving machinery-transport machinery-Truck crane

- construction machinery
- earthmoving machinery
- transport machinery
- ②Truck crane

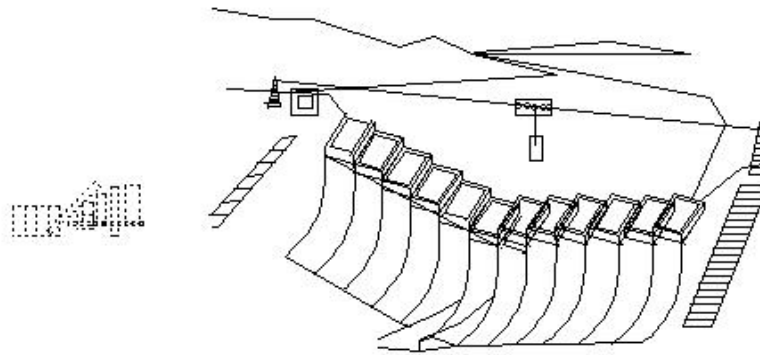


(M47)Earthmoving machinery-transport machinery-Cable crane

(M47)Earthmoving machinery-transport machinery-Cable crane

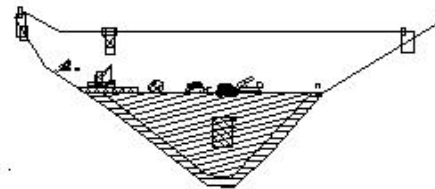
construction machinery
earthmoving machinery
transport machinery
③ Cable crane
between two branches
track crane type
trolley
Transportation work

cable crane



D269

cable crane



D24

(M48)Earthmoving machinery-transport machinery-Jib crane

(M48) Earthmoving machinery-transport machinery-Jib crane

construction machinery

earthmoving machinery

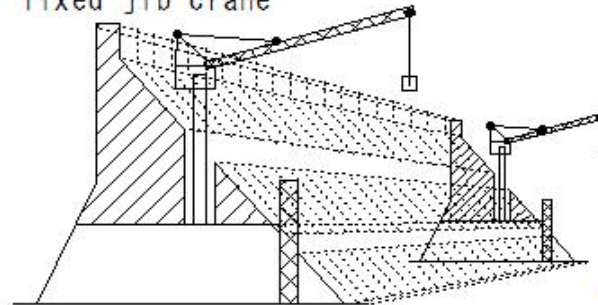
transport machinery

④Jib crane

Easy to assemble and disassemble

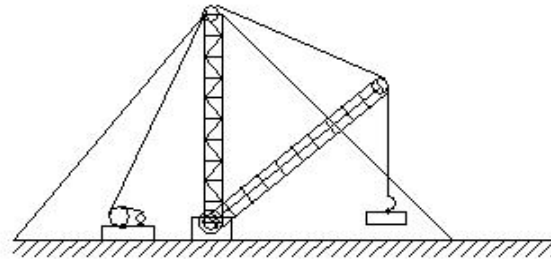
large to small

fixed jib crane



C1036

jib crane

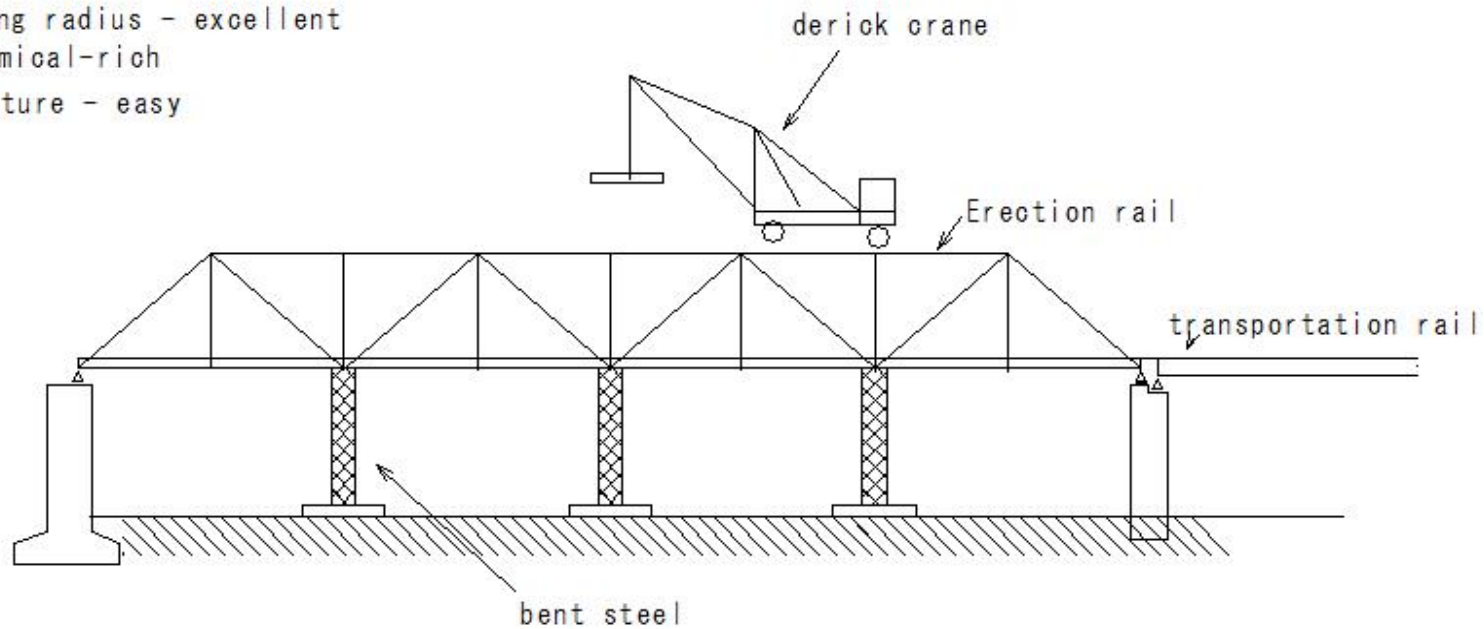


D189

(M49)Earthmoving machinery-transport machinery-Derick crane

(M49) Earthmoving machinery-transport machinery-Derick crane

construction machinery
earthmoving machinery
transport machinery
⑤ Derick crane
load capacity
Working radius - excellent
Economical-rich
Structure - easy

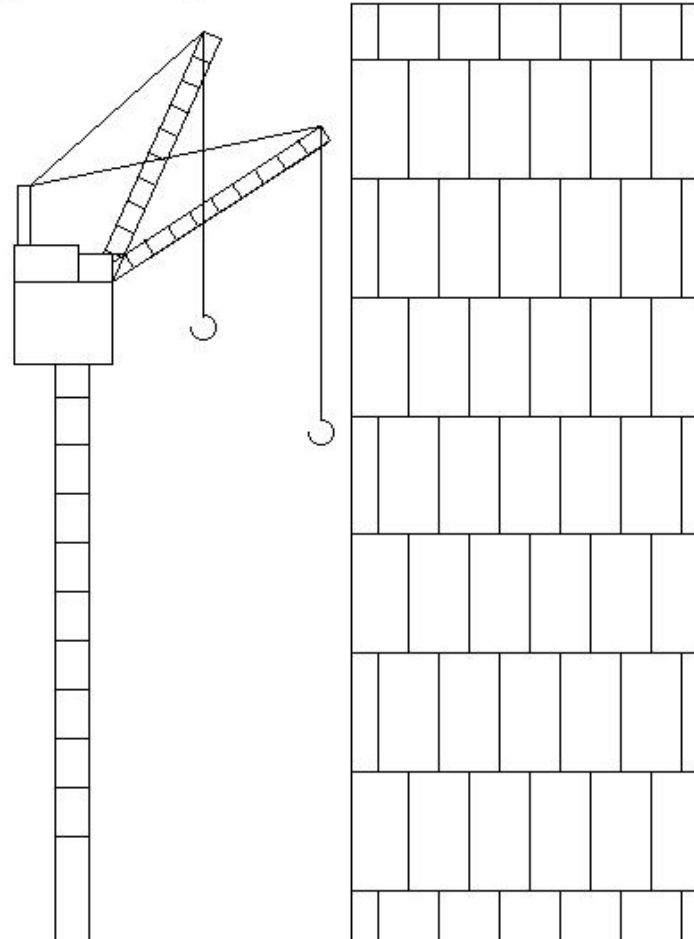


B417

(M50)Earthmoving machinery-transport machinery-Tower crane

(M50) Earthmoving machinery-transport machinery-Tower crane

construction machinery
earthmoving machinery
transport machinery
⑥ Tower crane
high-rise buildings
wide working area
High efficiency crane



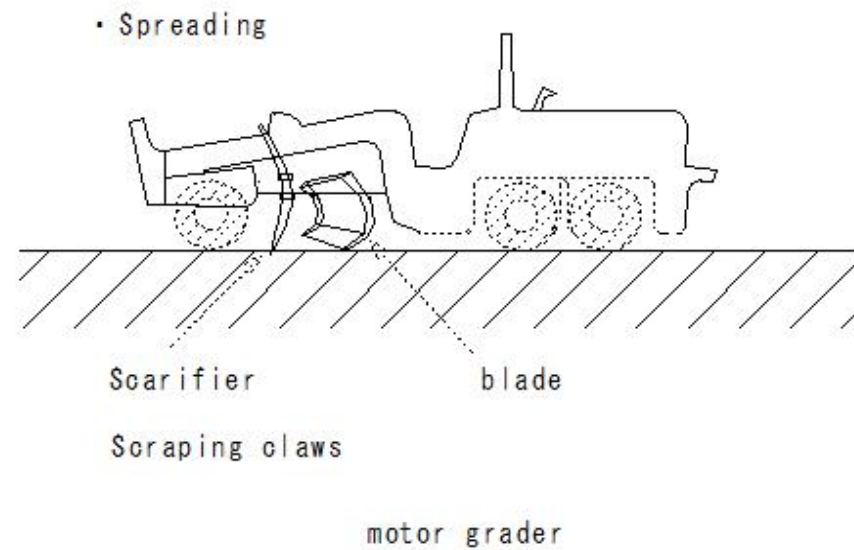
(M51)Earthmoving machinery-transport machinery-Motor grader

(M51)Earthmoving machinery-transport machinery-Motor grader

Earthmoving machinery

Transport machinery

- Motor grader
- Scarifier
- Scraping claws
- blade
 - 3.7m class: large
 - 3.1m class: medium size
 - 2.5m class: small size



(M52)Earthmoving machinery-Compaction machines

(M52) Earthmoving machinery-Compaction machines

Earthmoving machinery

Compaction machines

• Types of compaction machines

- ① Compaction machine
 - ② Static
 - ⑤ Iron wheel (road roller)
 - ⑫ Self-propelled (21) Macadam roller
 - (22) Tandem roller
 - (23) 3-axis tandem roller
 - ⑬ Towed style
 - ⑥ Tire (tire roller)
 - ⑭ Self-propelled
 - ⑮ Towed style
 - ⑦ Iron wheel + tire (combined roller)
 - ⑧ Iron wheel (road roller)
 - ⑯ Self-propelled
 - ⑰ Towed style
 - ⑱ Band guide type
 - ⑨ Tire (vibrating roller)
 - ⑲ Self-propelled
 - ⑳ Towed style
- ③ Dynamic
 - ⑩ Flat plate (vibrating compactor)
 - ⑪ Flat plate (tamper, rammer)
- ④ Shocking

(M53)Earthmoving machinery-Compaction machines(Road roller)

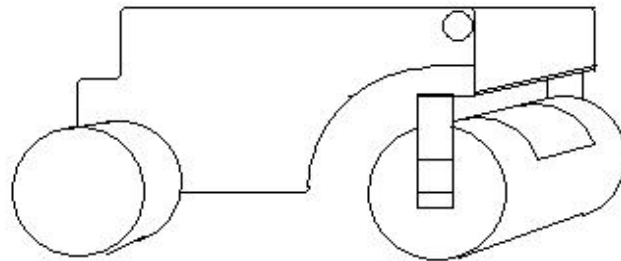
(M53)Earthmoving machinery-Compaction machines(Road roller)

Earthmoving machinery

Compaction machines

Road roller

- Macadam roller (two-axle three-wheeled)
- Weight can be adjusted
- Guide wheel (1 wheel side) Linear pressure is low
- Initial compaction Initial compaction with drive wheels



macadam roller

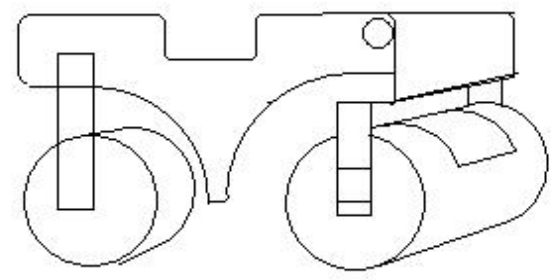
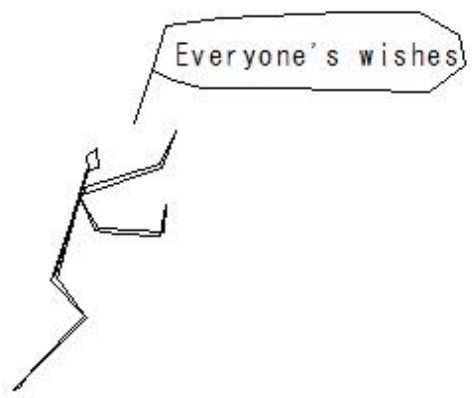
(M54)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)

(M54)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)

Earthmoving machinery

Compaction machines

- Tandem roller (two axes and two wheels)
- Anteroposterior axis - independent
- Asphalt pavement finish



- Tandem roller (two axes and two wheels)

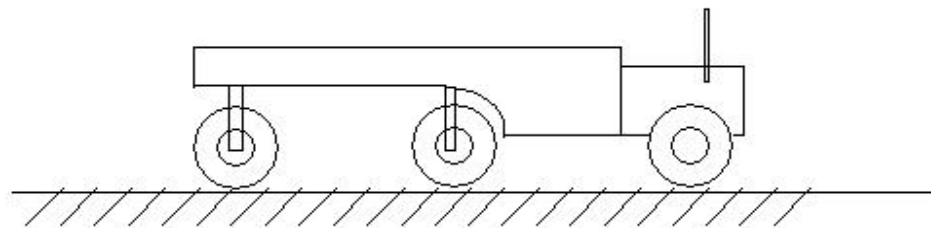
(M55)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)

(M55) Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)

Earthmoving machinery

Compaction machines

- Three-axis tandem roller (three-axis three-wheel)
- Flatness - improved compaction



Three-axis tandem roller (three-axis three-wheel)

(M56)Earthmoving machinery-Compaction machines-Tamping roller

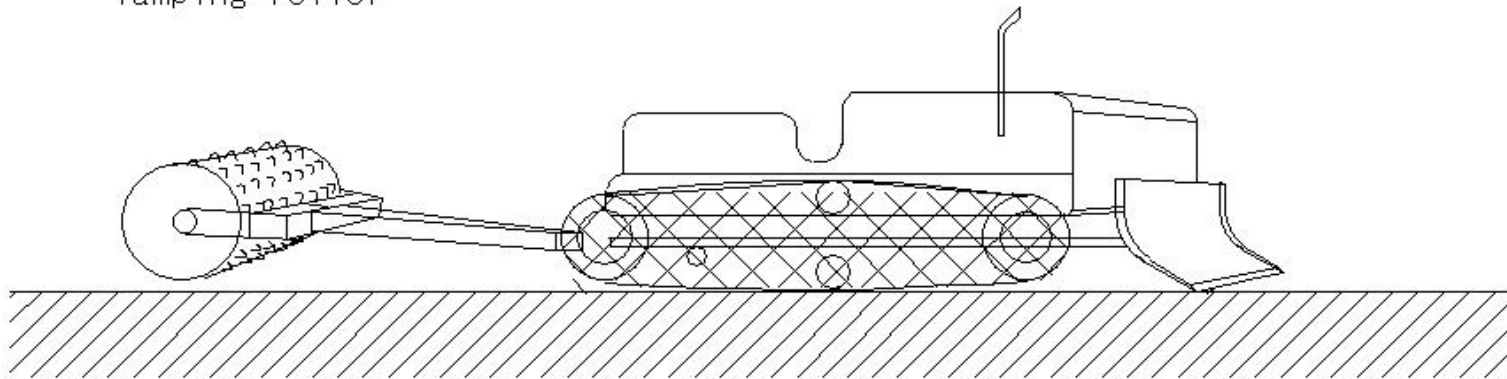
(M56) Earthmoving machinery-Compaction machines-Tamping roller

Earthmoving machinery

Compaction machines

- Tamping roller
- Compaction of hard clay

Tamping roller



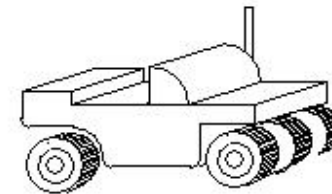
(M57)Earthmoving machinery-Compaction machines-Tire roller

(M57)Earthmoving machinery-Compaction machines-Tire roller

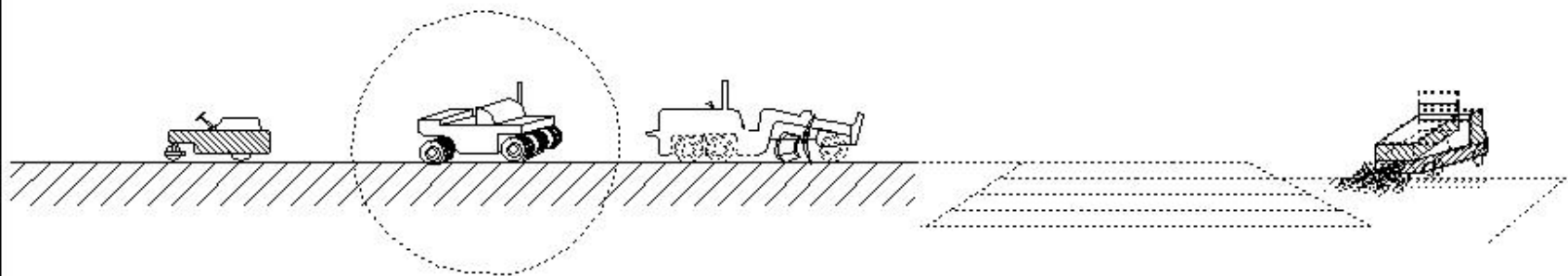
Earthmoving machinery

Compaction machines

- Tire roller
- Air pressure adjustment Linear pressure adjustment
- Raise ballast (weight) – line pressure –
- Rolling from relatively soft ground to hard ground
- Not suitable for compacting soft soil



Tire roller



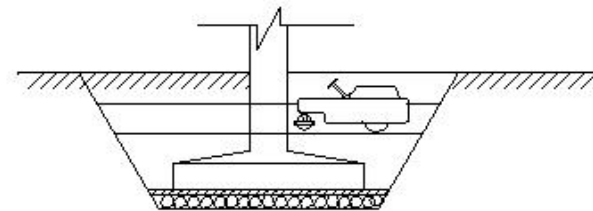
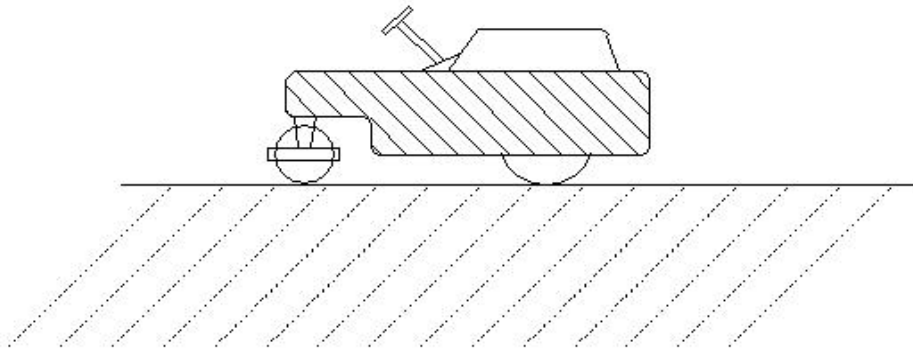
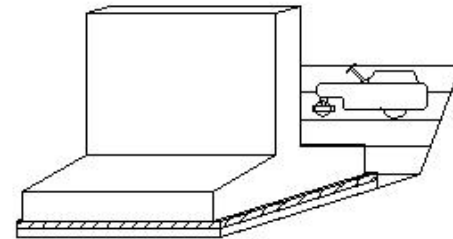
(M58)Earthmoving machinery-Compaction machines-Vibration roller

(M58)Earthmoving machinery-Compaction machines-Vibration roller

Earthmoving machinery

Compaction machines

- Vibration roller
- Lack of own weight
- Supplement with Vibration
- Small machines
- Compaction of gravel and sandy soil



Vibration roller

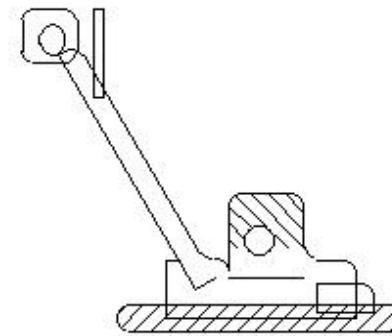
(M59)Earthmoving machinery-Compaction machines-Vibration compactor

(M59)Earthmoving machinery-Compaction machines-Vibration compactor

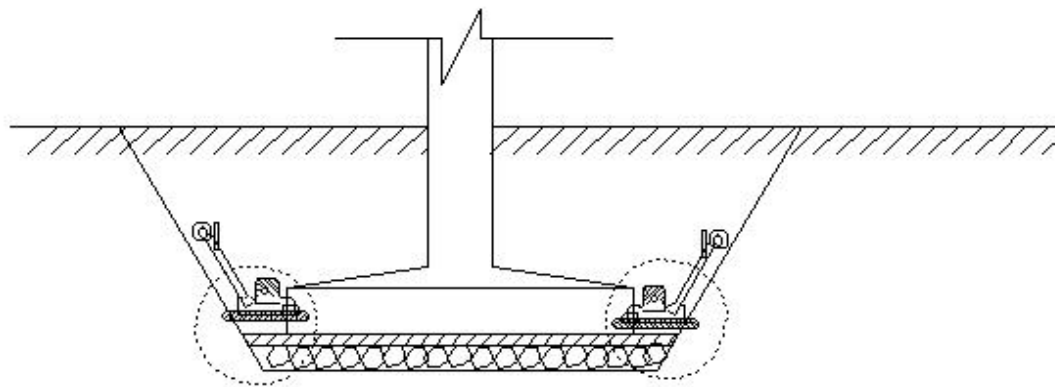
Earthmoving machinery

Compaction machines

- Vibration compactor
- Work place - narrow space



vibrating compactor



F170

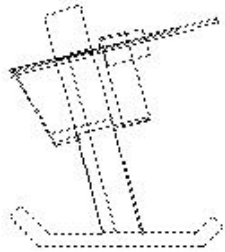
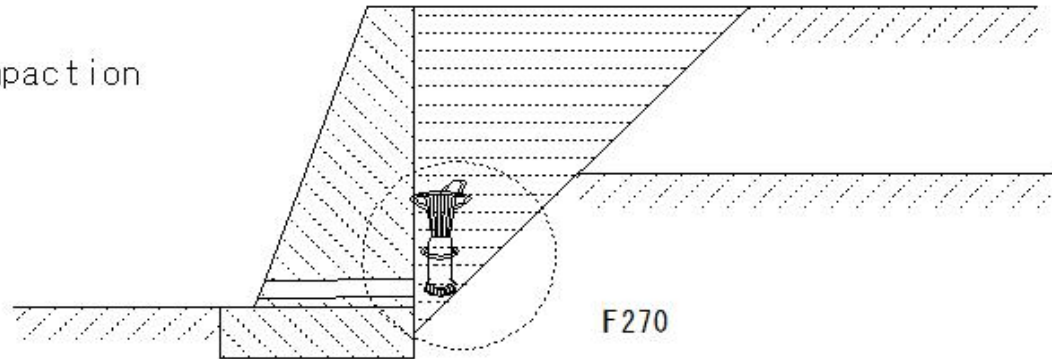
E317

(M60)Earthmoving machinery-Compaction machines-Vibration compactor

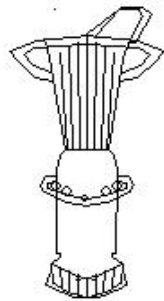
(M60)Earthmoving machinery-Compaction machines-Vibration compactor

Earthmoving machinery
Compaction machines

- Tampa Ranma
- Increased impact load - compaction
- Soft soil - unsuitable



Tampa Ranma



E318

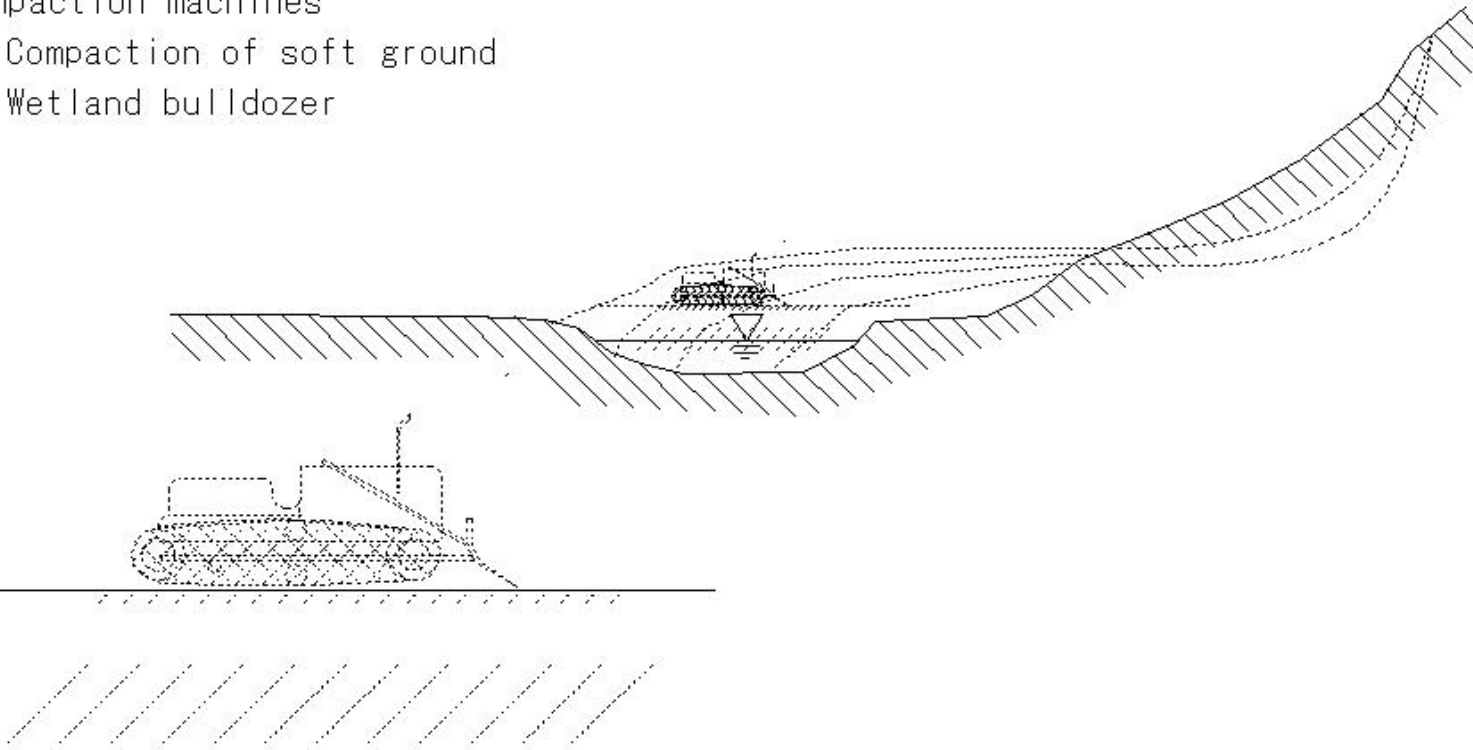
(M61)Earthmoving machinery-Compaction machines-Wetland bulldozer

(M61)Earthmoving machinery-Compaction machines-Wetland bulldozer

Earthmoving machinery

Compaction machines

- Compaction of soft ground
- Wetland bulldozer



wetland bulldozer

(M62) Foundation construction machinery(Ready-made piles)

(M62) Foundation construction machinery(Ready-made piles)

Construction plan for piles and caissons

Foundation construction machinery

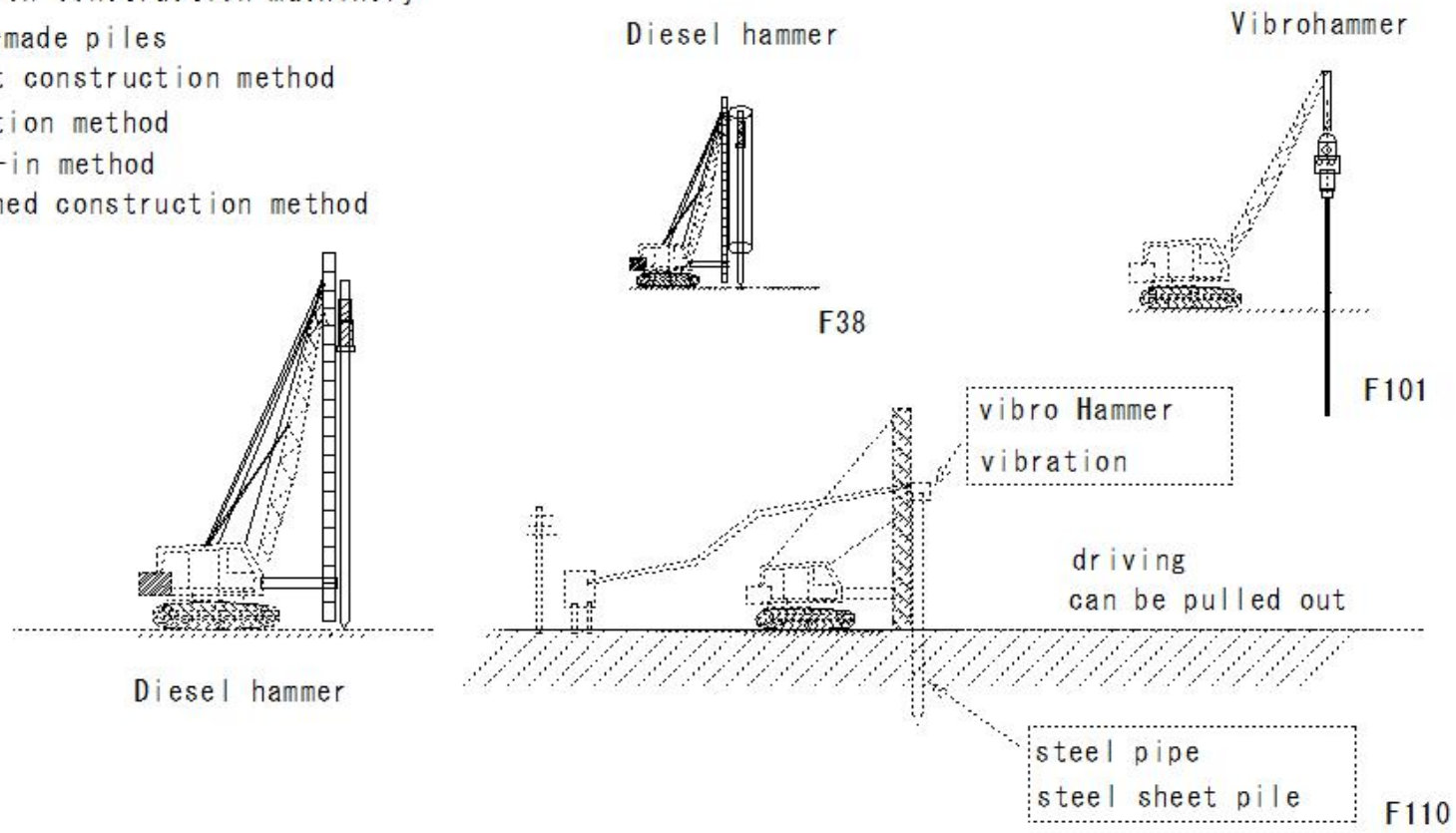
① Ready-made piles

Impact construction method

Vibration method

Press-in method

Combined construction method



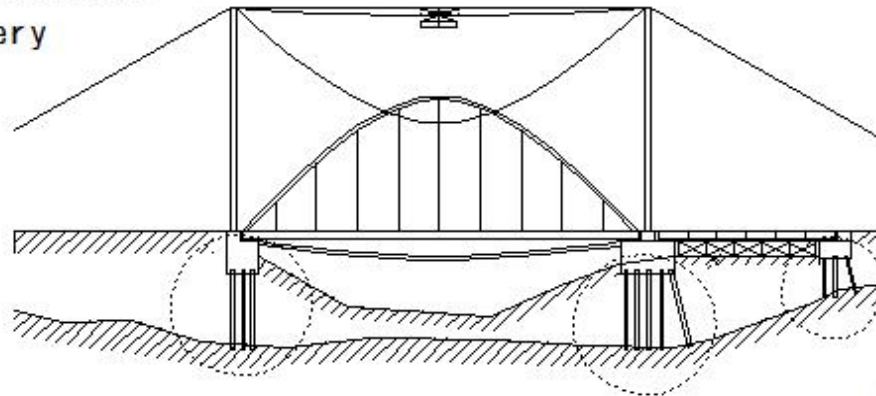
(M63)Foundation construction machinery(Cast-in-place piles)

(M63)Foundation construction machinery(Cast-in-place piles)

Construction plan for piles and caissons

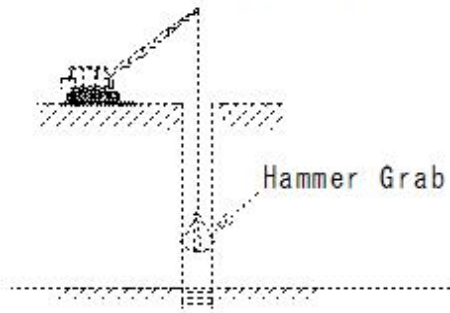
Foundation construction machinery

② Cast-in-place piles



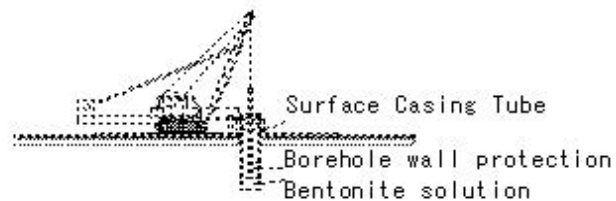
F1

All-casing method(Benoto method)



Hammer Grab

earth drill method

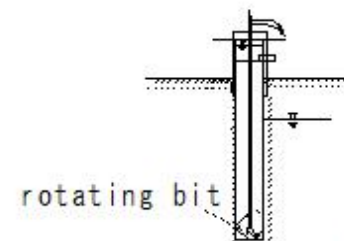


Surface Casing Tube

Borehole wall protection

Bentonite solution

Reverse circulation method



rotating bit

F111

(M64)Foundation construction machinery(Features of steel piles)

(M64)Foundation construction machinery(Features of steel piles)

Features of ready-made piles

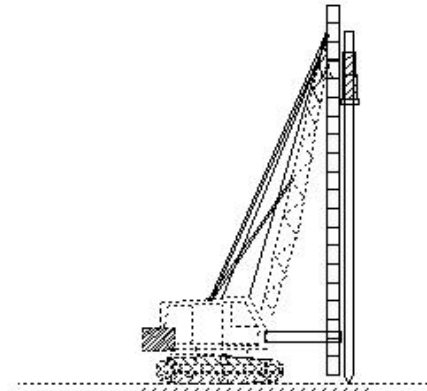
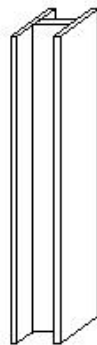
- Characteristics of steel piles
 - Withstands large impact forces
 - Supporting capacity - large
 - High bending strength

steel pipe

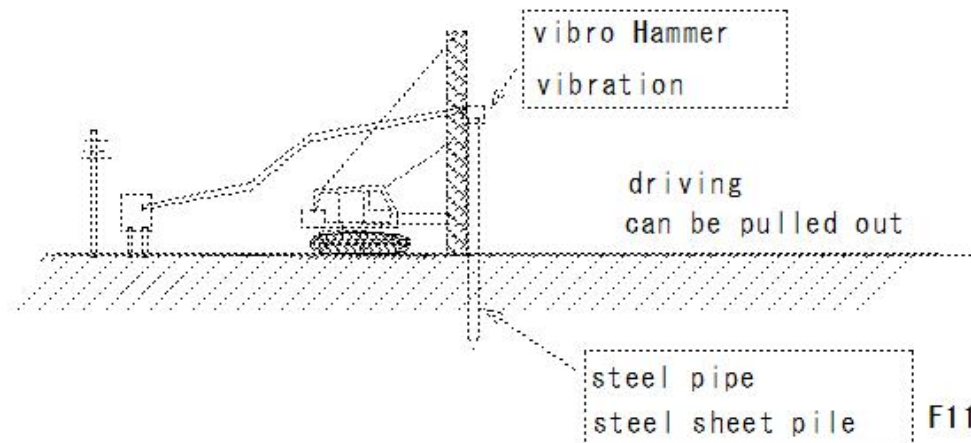


F112

H steel



Diesel hammer



(M65)Foundation construction machinery(concrete piles)

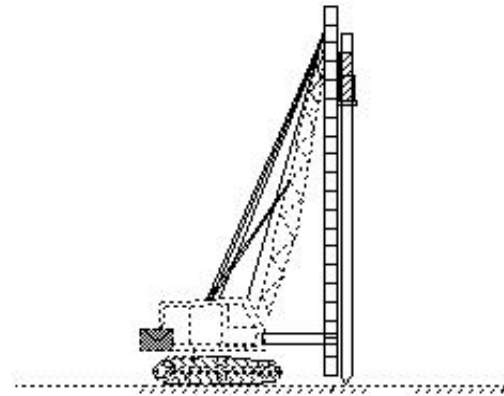
(M65)Foundation construction machinery(concrete piles)

Construction plan for piles and caissons

Foundation construction machinery

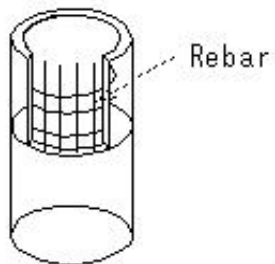
Characteristics of concrete piles

- Does not corrode
- High strength
- Easy to work

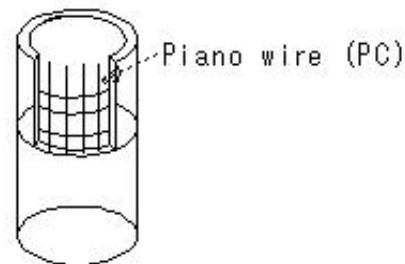


F41

Rebar RC

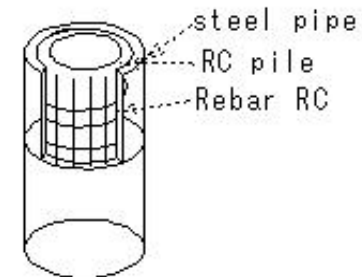


Piano wire (PC)



composite pile

Reinforce the outer periphery
of RC piles with steel pipes



F113

(M66)Foundation construction machinery(Diesel pile hammer)

(M66)Foundation construction machinery(Diesel pile hammer)

construction machinery

Foundation construction machinery

Machine for ready-made piles

pile driver

①Diesel pile hammer

Hitting power - big

Breakdowns - few

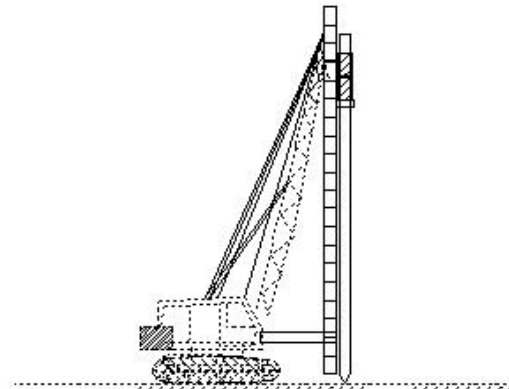
Mobility - Rich

Damage to pile cap - little

Noise - loud

Diesel hammer size:

10 times the ram weight



F30

F30 F100 F180

(M67) Foundation construction machinery (Vibrating pile hammer)

(M67) Foundation construction machinery (Vibrating pile hammer)

construction machinery

Foundation construction machinery

Machine for ready-made piles

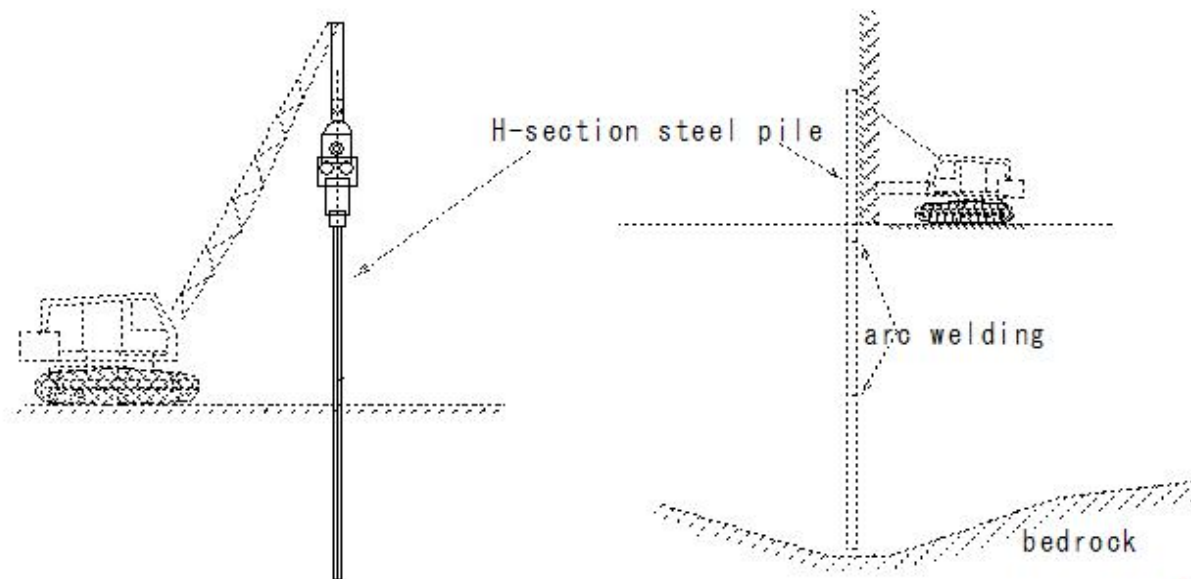
pile driver

② Vibrating pile hammer

Vibrator - vertical vibration force

Frictional force around piles - reduction

Power - Electricity



F101

(M68)Foundation construction machinery(Drop hammer)

(M68) Foundation construction machinery (Drop hammer)

construction machinery

Foundation construction machinery

Machine for ready-made piles

pile driver

③ Drop hammer

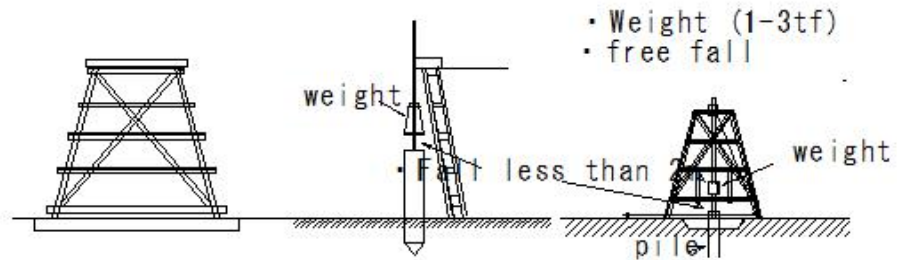
Ram weight: 1-3 times the pile weight

Falling height: 1-2m

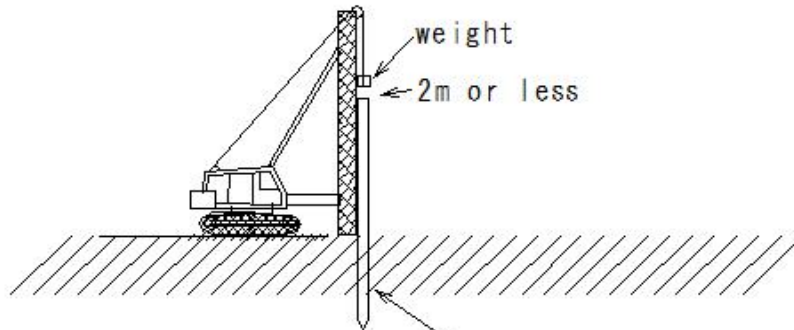
Number of blows per unit time: small

Deformation of pile cap: large

Not suitable for diagonal piles



F182



Wooden pile

RC Pile

Less pollution, noise and vibration F254

(M69)Foundation construction machinery(Machine for press-in method)

(M69)Foundation construction machinery(Machine for press-in method)

construction machinery

Foundation construction machinery

Machine for ready-made piles

pile driver

④Machine for press-in method

Hydraulic/hydraulic jack

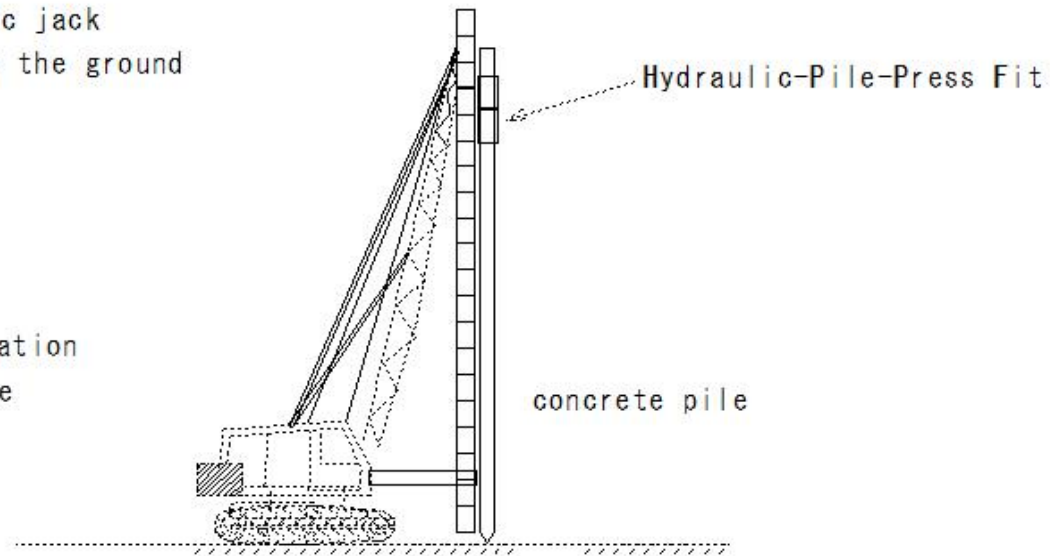
push the pile into the ground

No noise

No vibration

No vibration

No noise



(M70)Foundation construction machinery(Cast-in-place pile machine)

(M70)Foundation construction machinery(Cast-in-place pile machine)

construction machinery

Foundation construction machinery
Cast-in-place pile machine
large civil engineering structures

No noise

No vibration

Urban construction

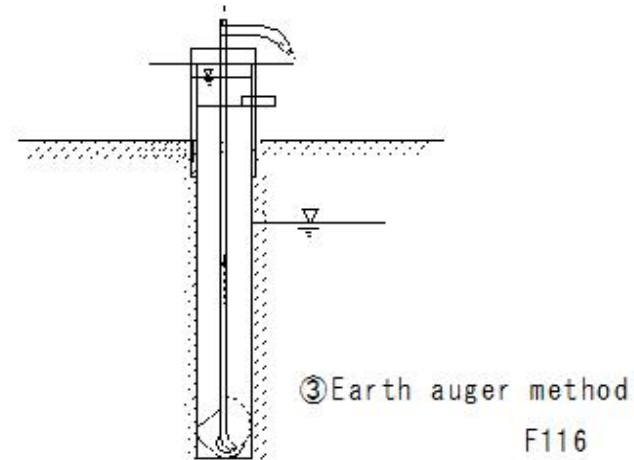
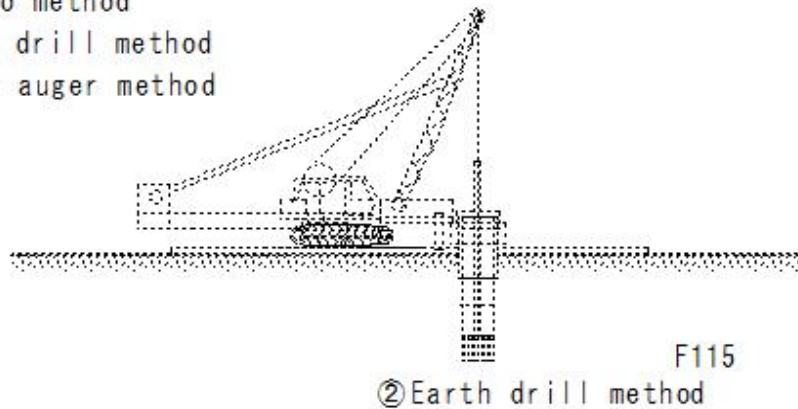
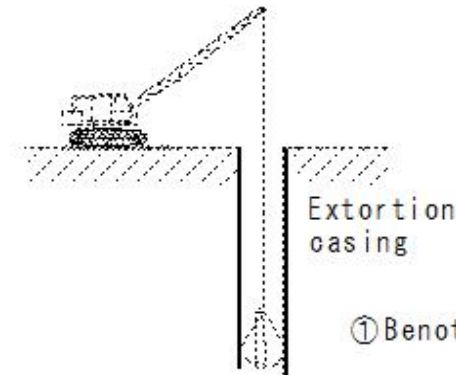
Special machine-drilled hole

Reinforced cage - built-in
concrete placement

large diameter pile

- ① Benoto method
- ② Earth drill method
- ③ Earth auger method

All-casing method



(M71)Foundation construction machinery(Cast-in-place pile machine)

(M71)Foundation construction machinery(Cast-in-place pile machine)
 Construction plan for piles and caissons

Foundation construction machinery

- Benoto method
- Large diameter pile
- 6 degree and 12 degree diagonal piles - possible

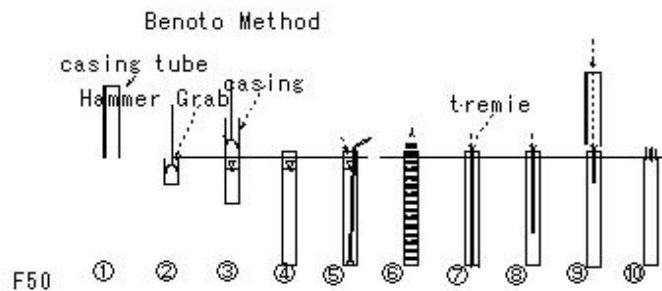
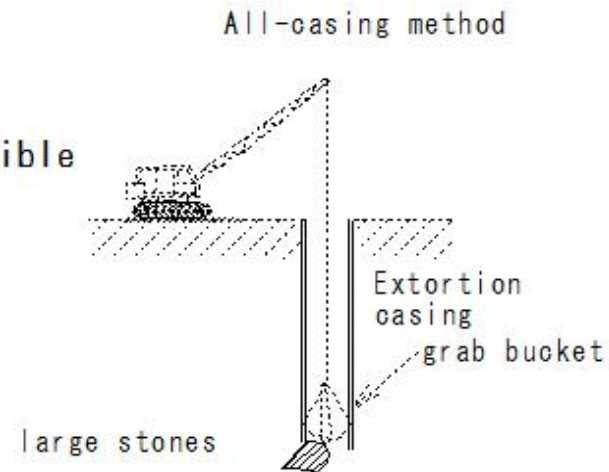
Strong Points

- Hard ground can be excavated
- Soft ground, no landslides

- Completed pile -no cracks

weak point

- Large machine required
- Casing tube - difficult to pull out
- Difficult to excavate with large stones



- ① Casing Foundation Pile Center
- ② excavation-Hammer Grab
- ③ excavation-Hammer Grab
- ④ excavation-completed
- ⑤ Water-muddy water-Mud Water Pump
- ⑥ Rebar cage
- ⑦ Tremie tube
- ⑧ Ready-mixed concrete
- ⑨ Pulling out casing
- ⑩ Burials

(M72) Foundation construction machinery (Earth drill method)

(M72) Foundation construction machinery (Earth drill method)

Construction plan for piles and caissons

Foundation construction machinery

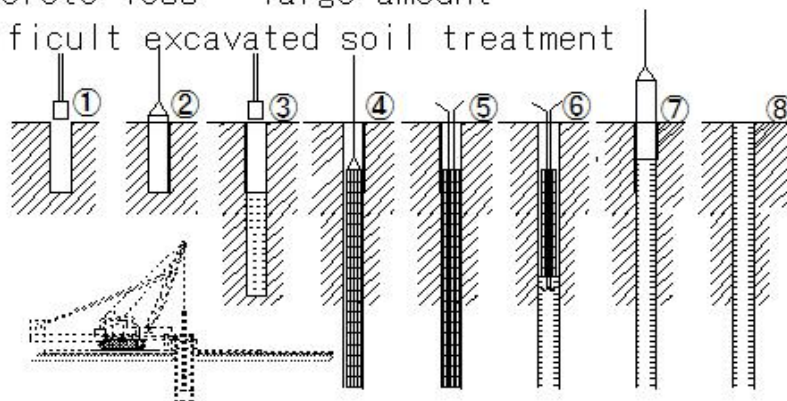
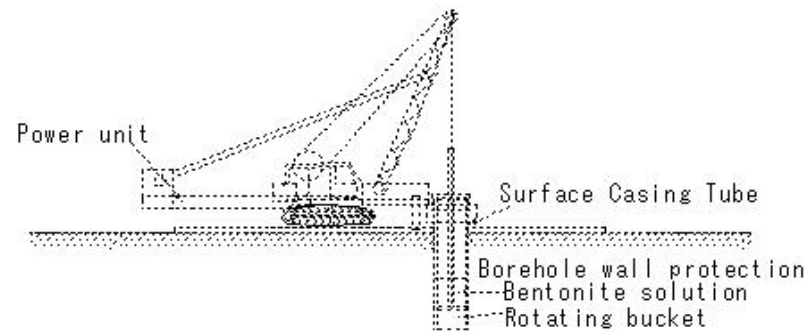
Earth drill method

Strong Points

- The price of piles is low
- Mobility available
- Supporting layer - excavated sand
- can be confirmed

weak points

- Large machine required
- Rolling stones - excavation - difficult
- Concrete loss - large amount
- Difficult excavated soil treatment



- ① Drilling
- ② Casing tube insertion
- ③ Bentonite solution - injection
- ④ Erection of rebar
- ⑤ Built-in tremmy tube
- ⑥ Ready-mixed concrete pouring
- ⑦ Casing tube pull-out
- ⑧ Sediment reburials

F50
F115

(M73)Foundation construction machinery(Reverse circulation method)

(M73)Foundation construction machinery(Reverse circulation method)

Construction plan for piles and caissons

Foundation construction machinery

- Reverse circulation method

Strong Points

- ① Preventing hole wall collapse due to muddy water

No casing required

- ② Excavation depth-large

- ③ Pore size -freely selectable

weak points

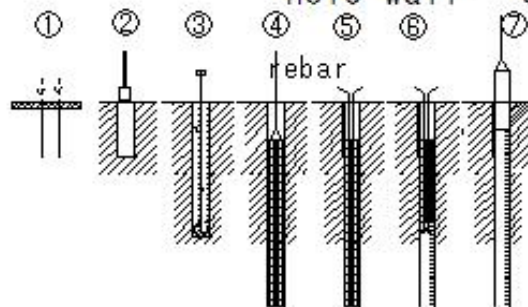
- ① Water Sedimentation tank - required

Narrow space - disadvantage

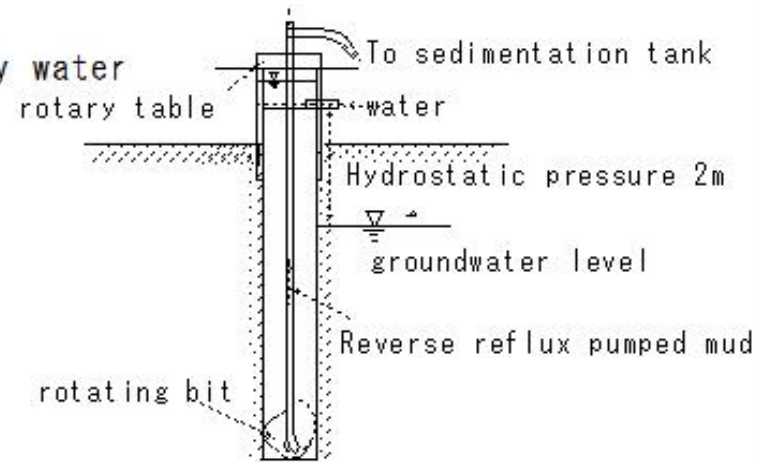
- ② Obstacles - Difficult to excavate

- ③ Permeable layer - water level drop -

hole wall - collapse



Reverse circulation method



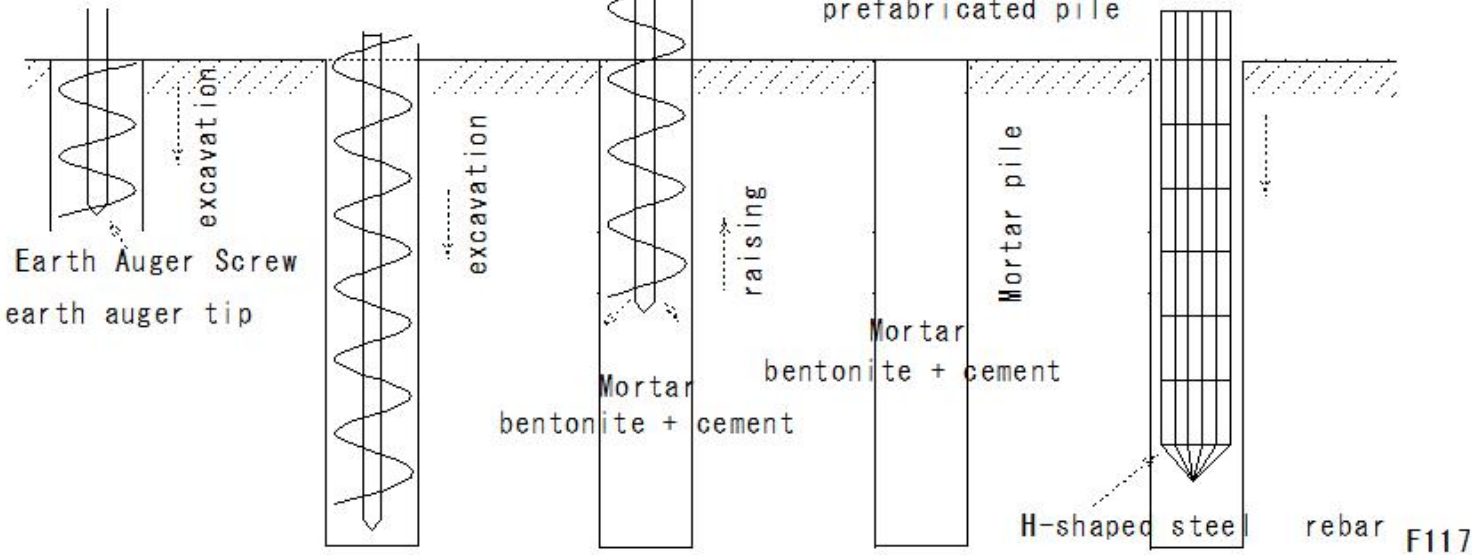
- ① Installing stand pipe
- ② Internal excavation with bucket
- ③ Excavation using leavers method
- ④ Reinforcement installation
- ⑤ Suck up sediment-Built-in tremie pipe
- ⑥ Concrete pouring
- ⑦ Pull out the stand pipe

(M74) Foundation construction machinery(Earth auger method)

(M74) Foundation construction machinery(Earth auger method)

Construction plan for piles and caissons
 Foundation construction machinery
 Earth auger method
 rotary press-fitting machine
 send up soil
 pile in the ground

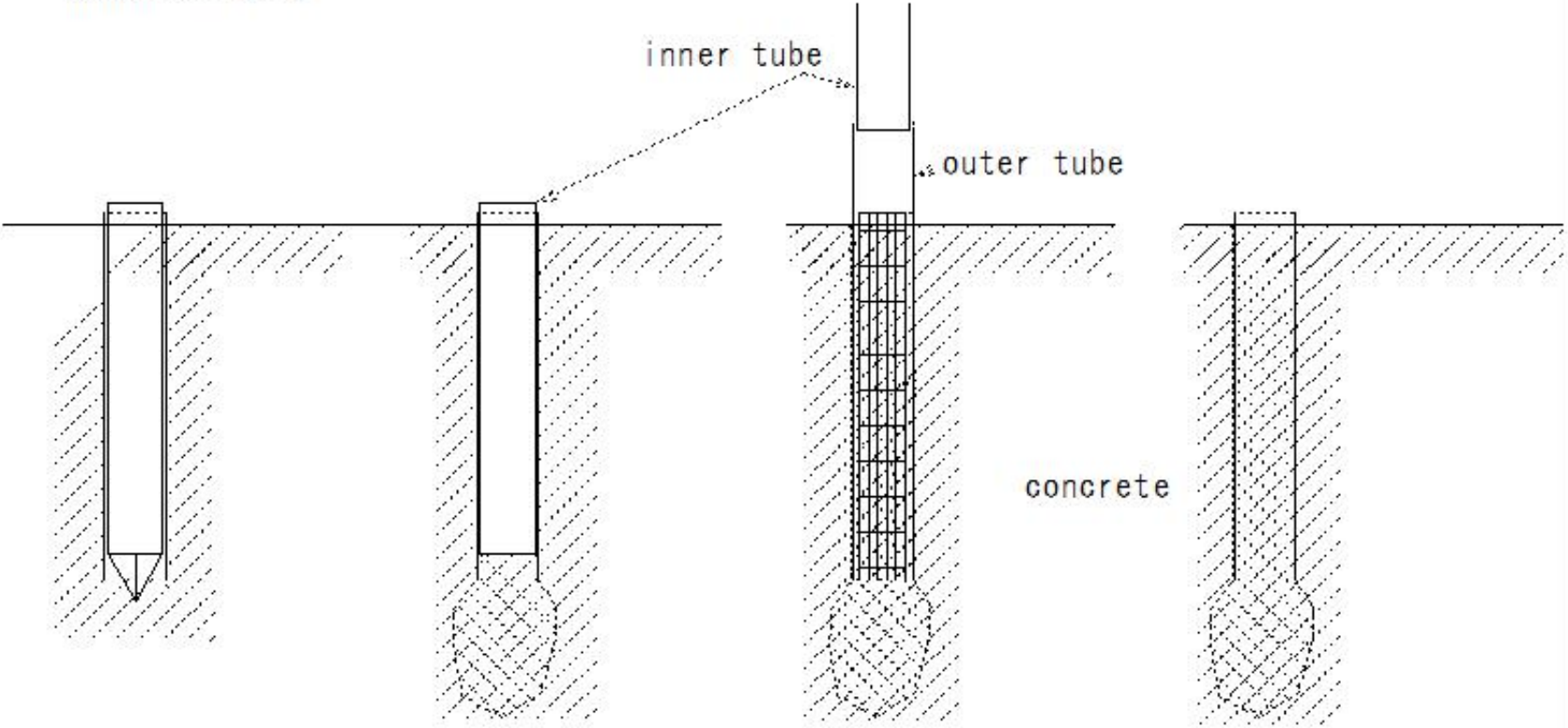
Cast-in-place concrete pile



(M75)Foundation construction machinery(Pedestal method)

(M75)Foundation construction machinery(Pedestal method)

pedestal pile



Bulb pile Pedestal pile

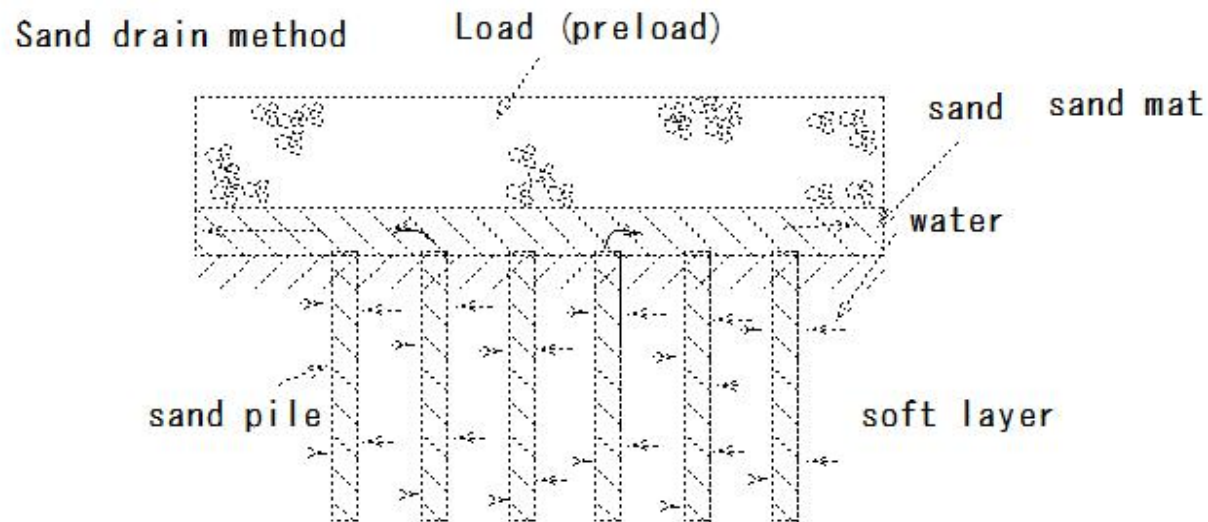
(M76)Earthmoving machinery-Ground improvement machine-Sand drain method

(M76)Earthmoving machinery-Ground improvement machine-Sand drain method

Earthmoving machinery

Ground improvement machine

- Sand drain method
 - Steel pipe - driven into the ground
 - Add sand
 - Steel pipe - drawing
 - Sand pile construction

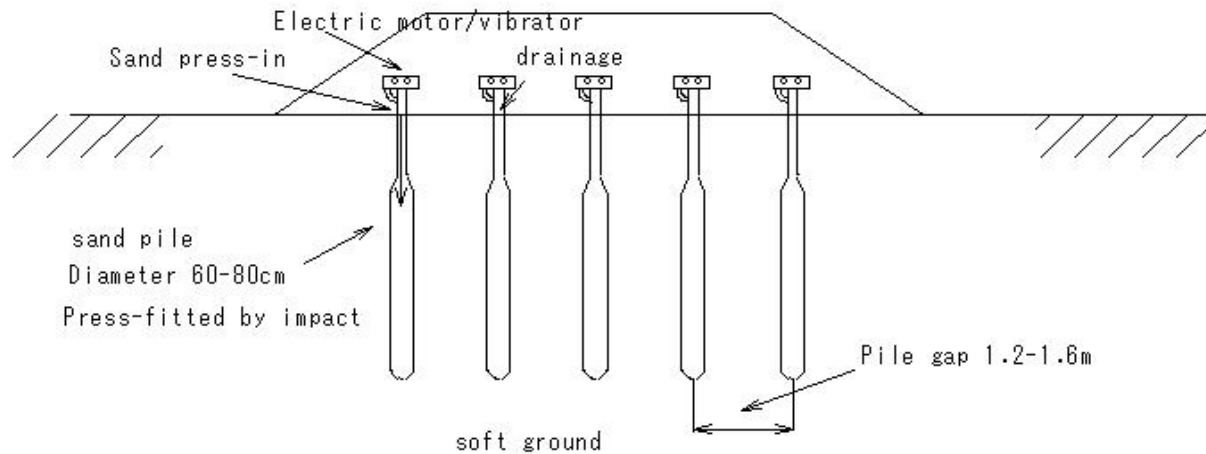


(M77)Earthmoving machinery-Ground improvement machine-Sand compaction method

(M77)Earthmoving machinery-Ground improvement machine-Sand compaction method
Earthmoving machinery

Ground improvement machine

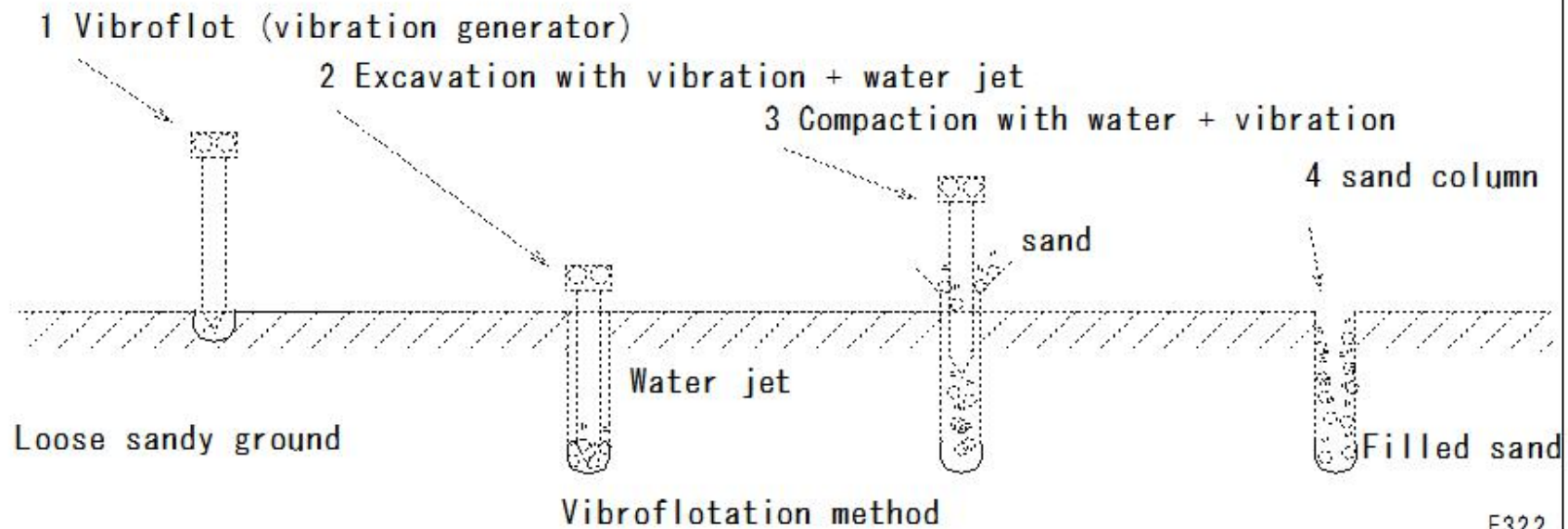
- Sand compaction method
- (Vibro Composer method)
- Electric motor/vibrator
- Tamp the ground
- Much sand pile construction
- Increased ground strength
- Settlement reduction



(M78)Earthmoving machinery-Ground improvement machine-Vibroflotation method

(M78)Earthmoving machinery-Ground improvement machine-Vibroflotation method

Earthmoving machinery
Ground improvement machine

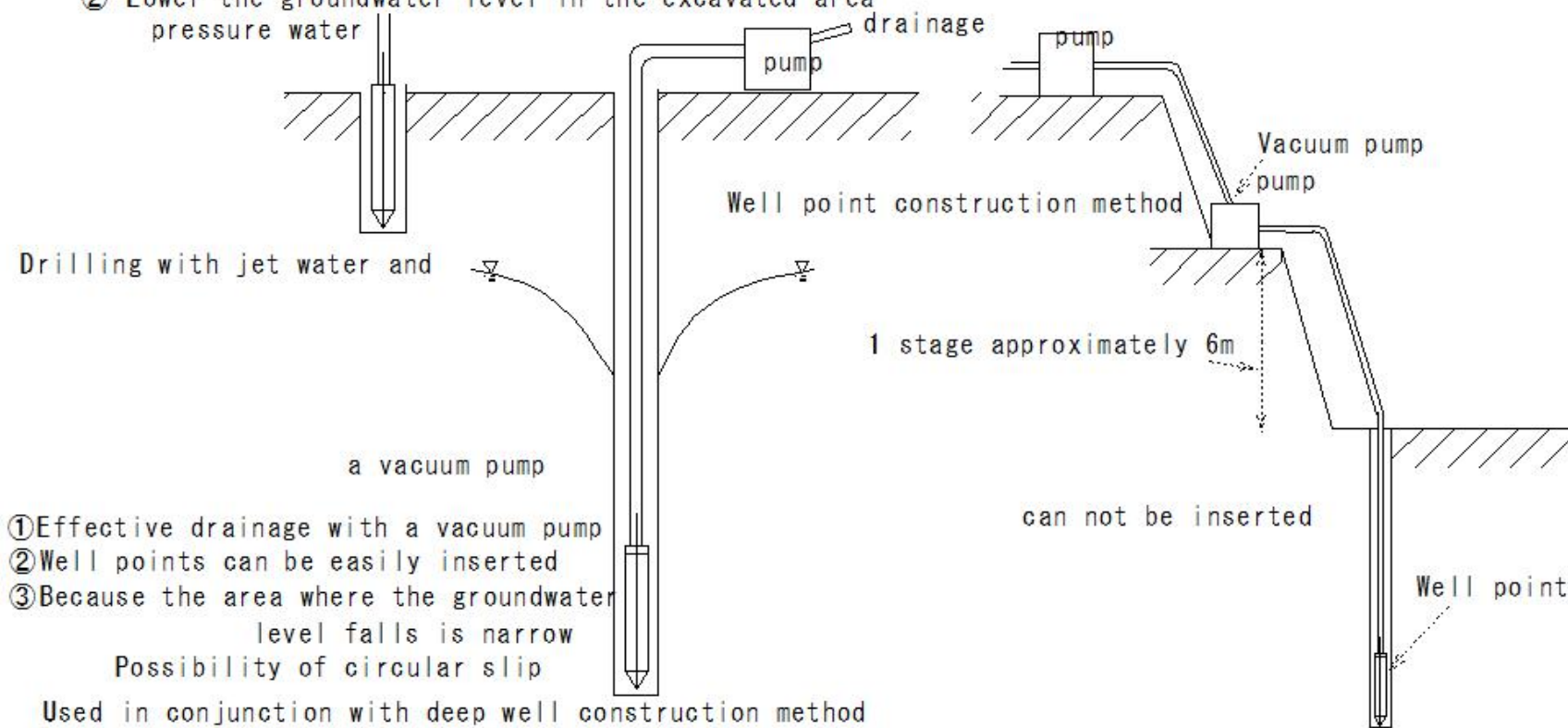


(M79)Earthmoving machinery-Ground improvement machine-Wellpoint construction method

(M79)Earthmoving machinery-Ground improvement machine-Wellpoint construction method

Well point construction method

- ① Well point Inserted into the ground by jet water
- ② Lower the groundwater level in the excavated area



- ① Effective drainage with a vacuum pump
- ② Well points can be easily inserted
- ③ Because the area where the groundwater level falls is narrow
Possibility of circular slip

Used in conjunction with deep well construction method

- ④ Thick rock layer -jet water can not be inserted

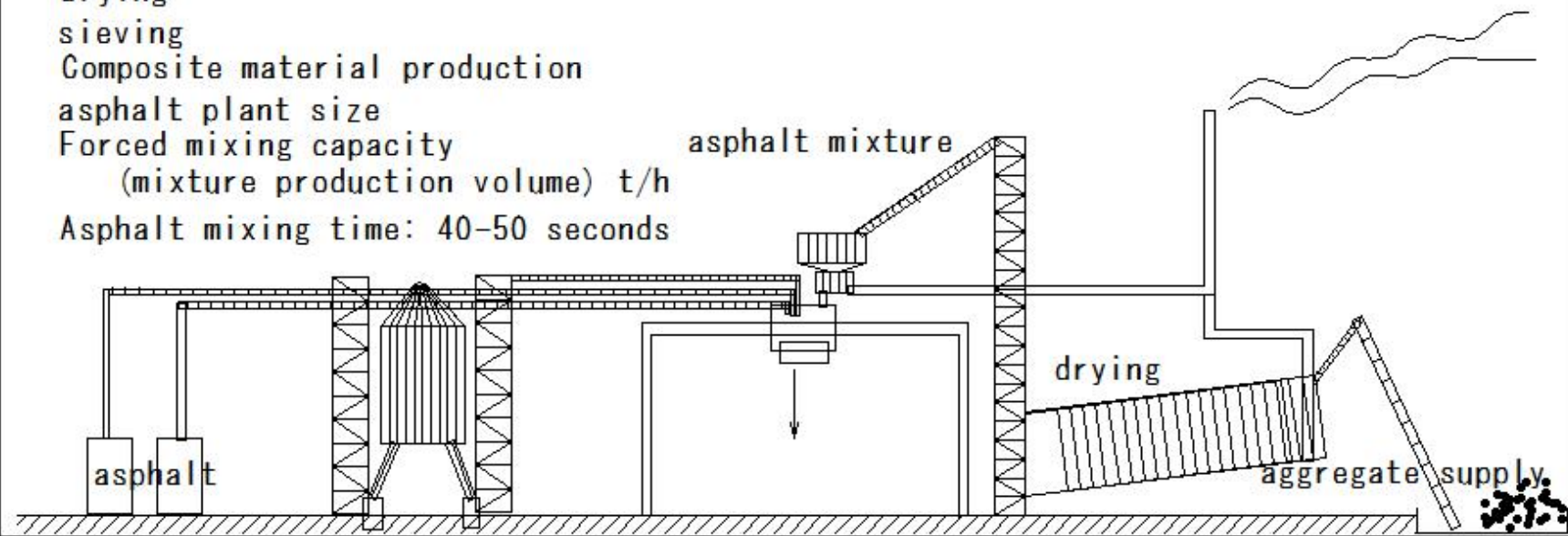
E323

(M80)paving machine-asphalt paving machine(Asphalt plant)

(M80) paving machine-asphalt paving machine(Asphalt plant)

construction machinery-paving machine
paving machine
asphalt paving machine
①Asphalt plant
asphalt mixture
aggregate supply
heating
drying
sieving
Composite material production
asphalt plant size
Forced mixing capacity
(mixture production volume) t/h
Asphalt mixing time: 40-50 seconds

①Asphalt plant



(M81)paving machine-asphalt paving machine(Asphalt finisher)

(M81)paving machine-asphalt paving machine(Asphalt finisher)

construction machinery

paving machine

asphalt paving machine

②Asphalt finisher

crawler type

tire type

asphalt mixture

Spread on the roadbed

Predetermined thickness: spread evenly

screed

asphalt pavement

spread screw

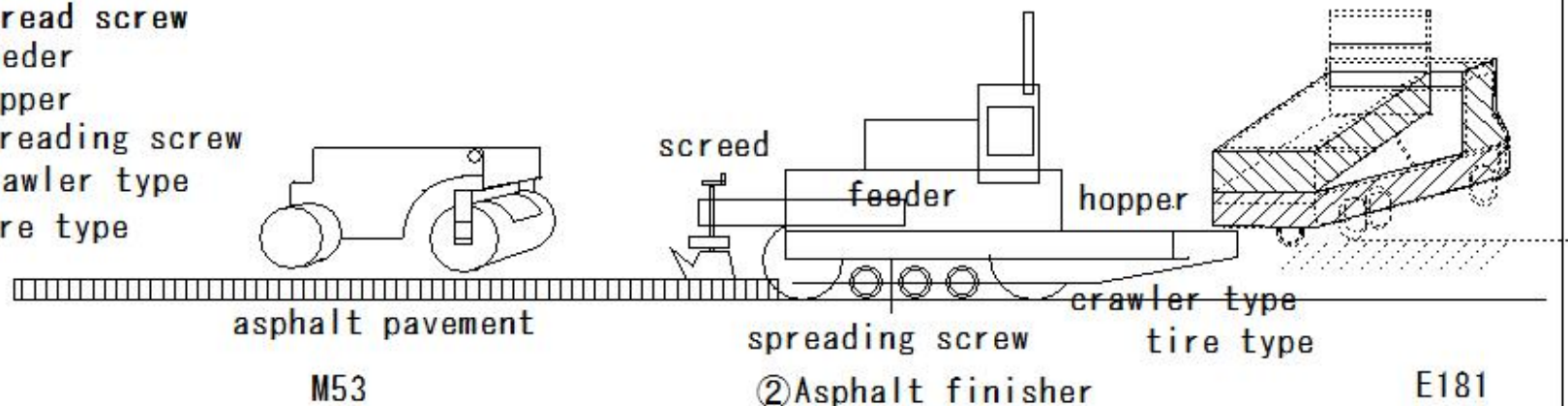
feeder

hopper

spreading screw

crawler type

tire type



(M82)paving machine-asphalt paving machine(Asphalt spreader)

(M82)paving machine-asphalt paving machine(Asphalt spreader)

construction machinery

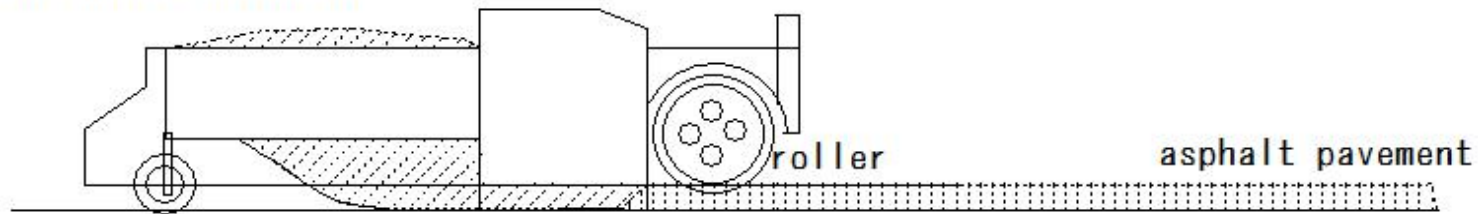
paving machine

asphalt paving machine

③ Asphalt spreader

Used for small-scale paving work

Composite material



③ Asphalt spreader

(M83)paving machine-asphalt paving machine(Asphalt sprayer)

(M83)paving machine-asphalt paving machine(Asphalt sprayer)

construction machinery

paving machine

asphalt paving machine

④ Asphalt sprayer

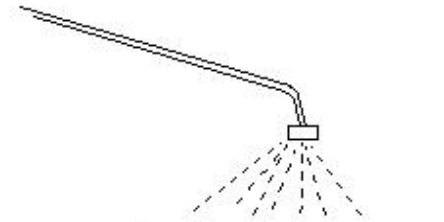
asphalt distributor

man power - Spreading - Asphalt sprayer

Heating burner/asphalt tank

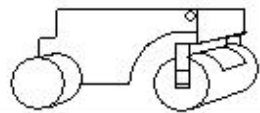
Travel equipment - Pressure spreading -

Asphalt distributor

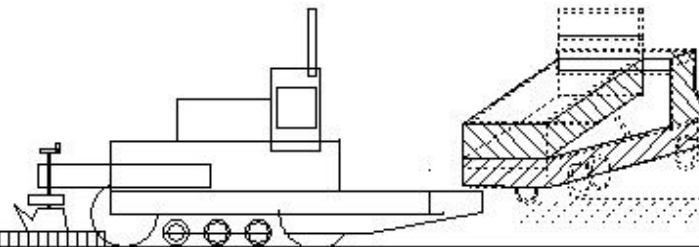


man power-Spreading

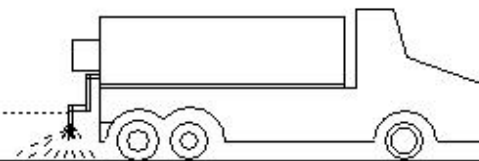
asphalt pavement



M53



Asphalt finisher



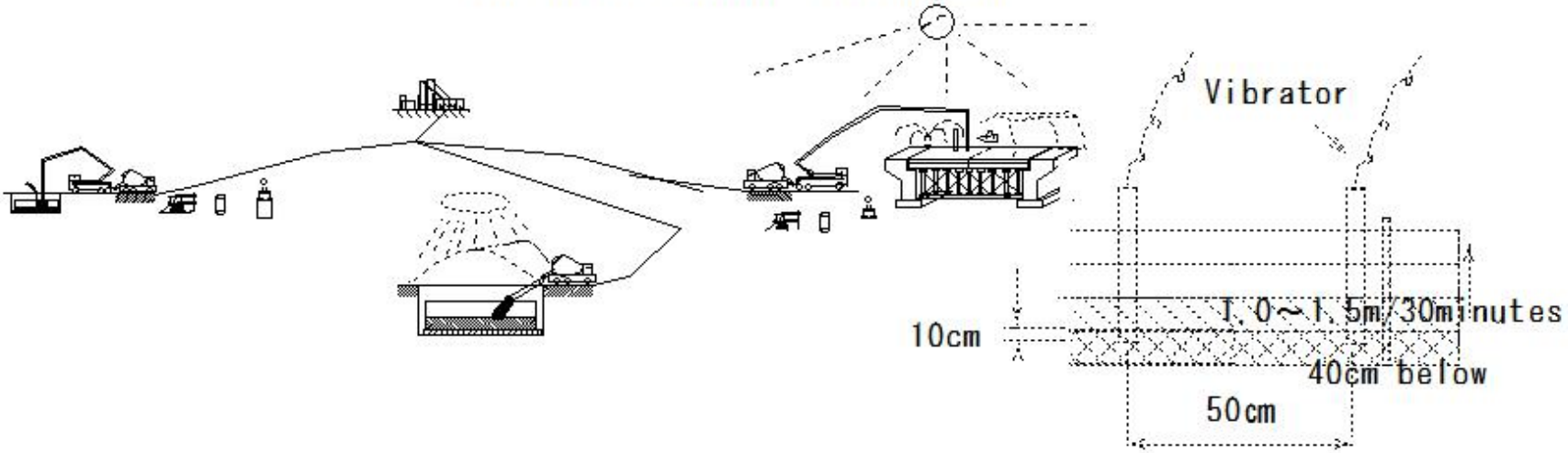
E181

④ Asphalt sprayer

M81

(M84)Internal vibrator

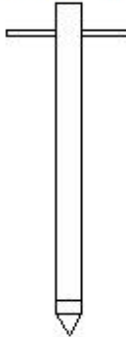
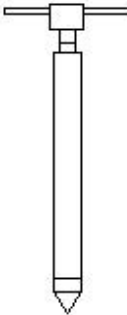
(M84)Internal vibrator



①Flexible

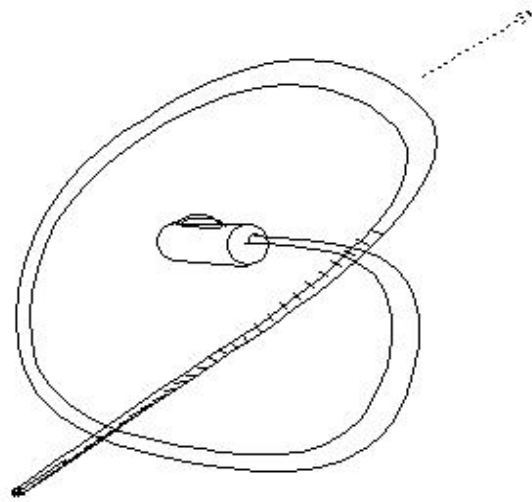
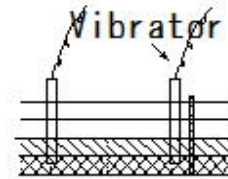


③Built-in direct-coupled motor



(M85)concrete compaction

(M85)concrete compaction



concrete compaction
bar vibrator

C1102

(M86)dredger(Pump dredger)

(M86) dredger (Pump dredger)

construction machinery

work boat

Types of dredgers

① Pump dredger

Sediment from the ocean floor - cut with a cutter

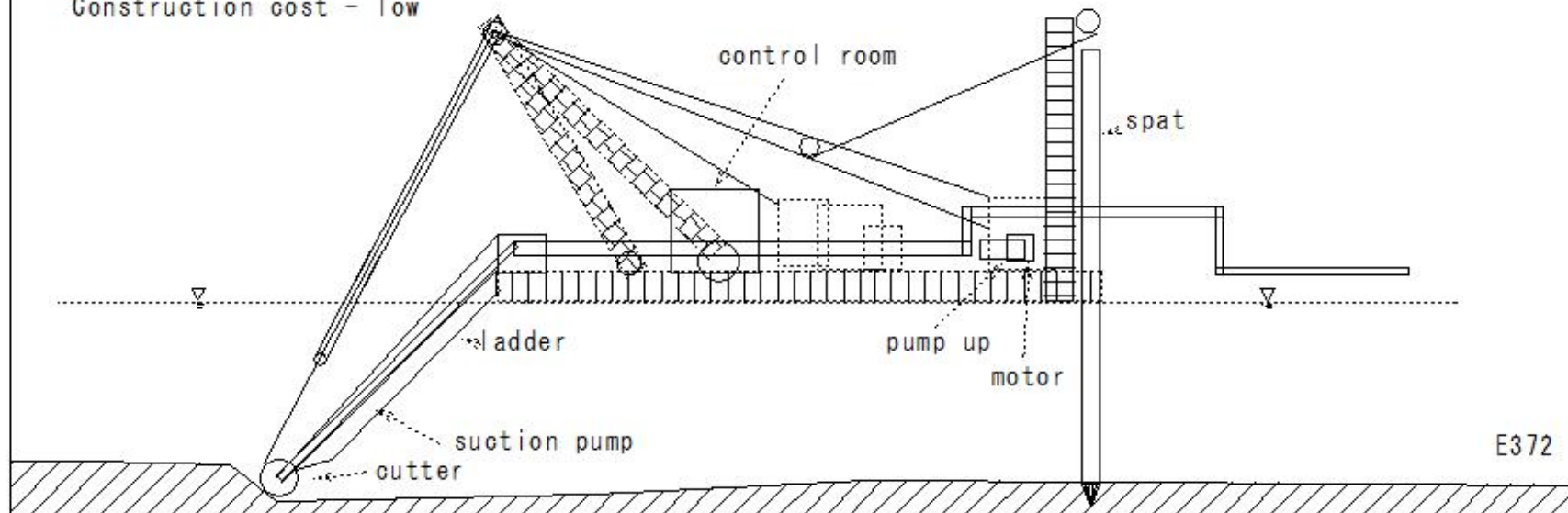
pump up

Pipeline - mud pumping

efficient

Construction cost - low

• Pump dredger



(M87)dredger(Bucket dredger)

(M87) dredger (Bucket dredger)

construction machinery

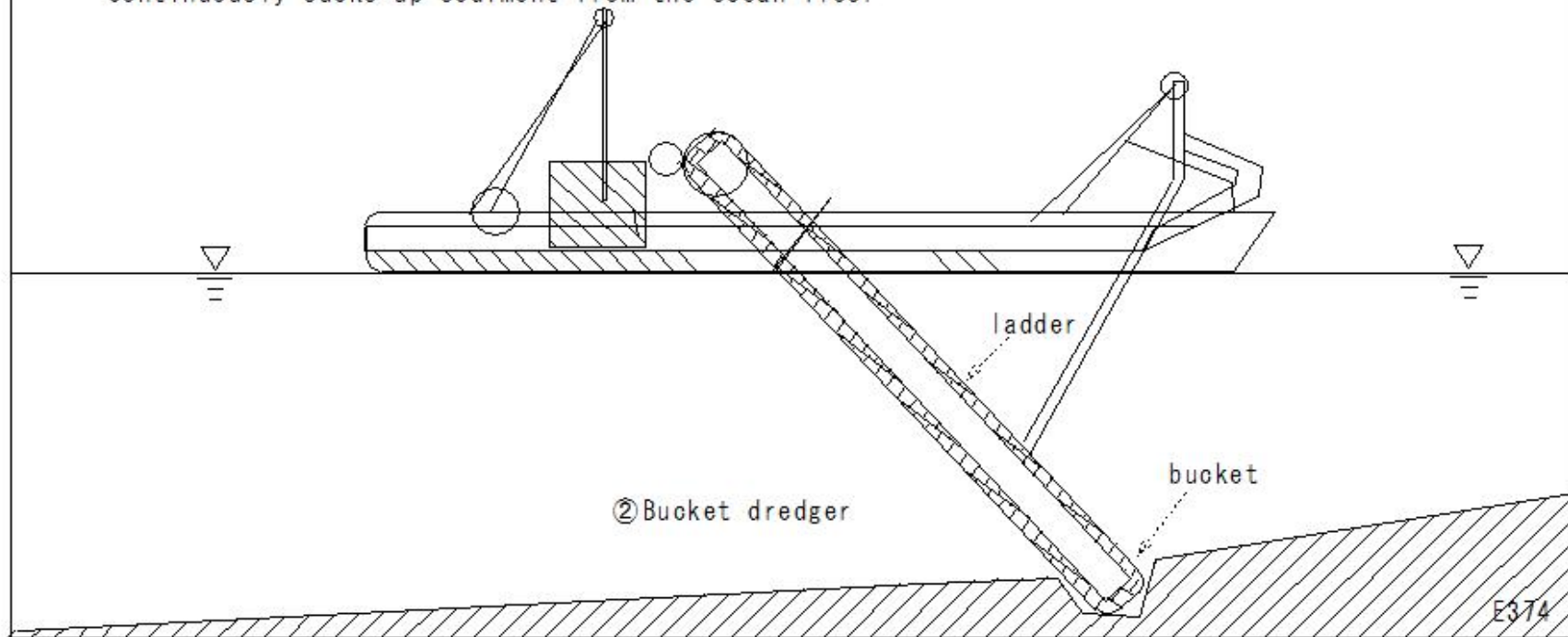
work boat

Types of dredgers

② Bucket dredger

bucket conveyor

Continuously sucks up sediment from the ocean floor



(M88)dredger(Dipper dredge boat)

(M88) dredger (Dipper dredge boat)

construction machinery
work boat

Types of dredgers

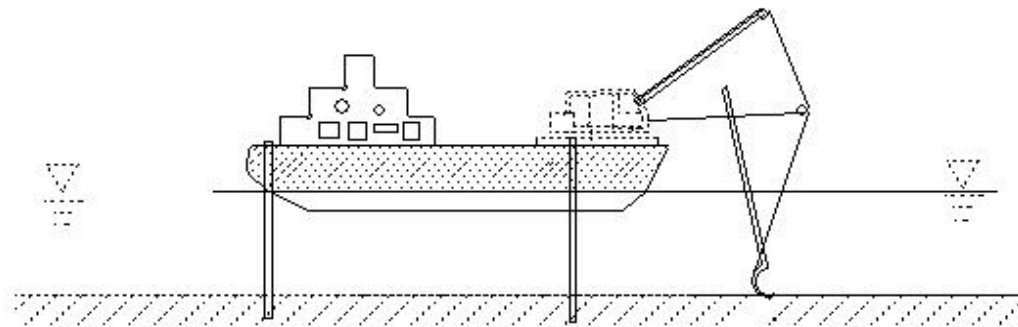
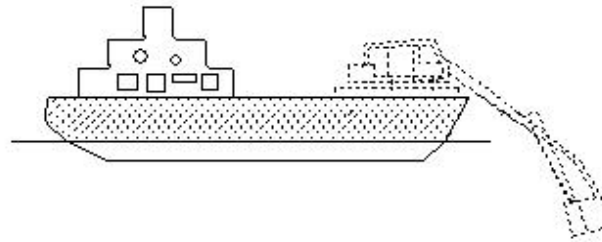
③Dipper dredge boat

long reach power shovel

scoop up dirt

hard ground

Can also be used on crushed rocks, etc.



③Dipper dredge boat

E375
R27
R379

(M89)dredger(Grab dredger)

(M89) dredger (Grab dredger)

construction machinery

work boat

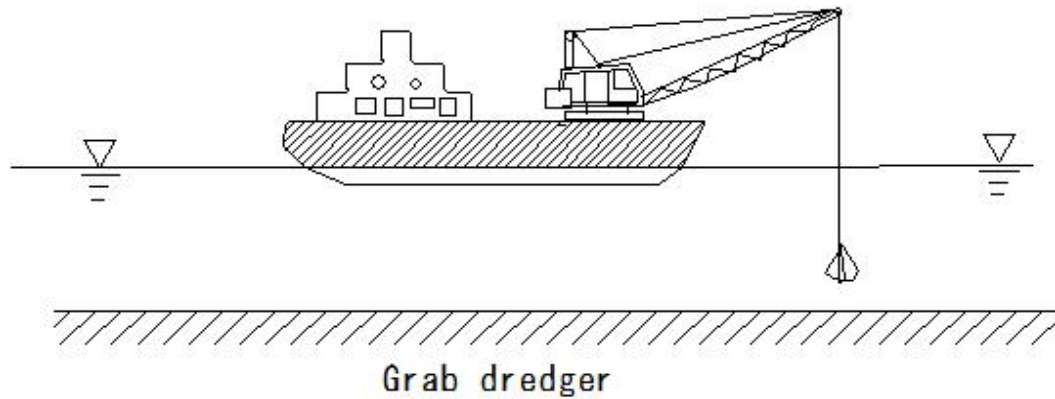
Types of dredgers

④ Grab dredger

grab bucket

sediment on the ocean floor

Dredging depth - subject to restrictions



E373
R26
R378

(M90)dredger(Non-seaworthy pump ship)

(M90) dredger (Non-seaworthy pump ship)

construction machinery

work boat

Advantages and disadvantages of dredgers

Non-seaworthy pump ship

Strong Points

- ① Can be sent directly via sand removal pipe
- ② Large dredging capacity

disadvantages

- ① Maintenance of the sand discharge pipe is difficult.
- ② Limited to removal distance

(M91)dredger(self-propelled pump ship)

(M91)dredger (self-propelled pump ship)

construction machinery

work boat

Advantages and disadvantages of dredgers

self-propelled pump ship

Strong Points

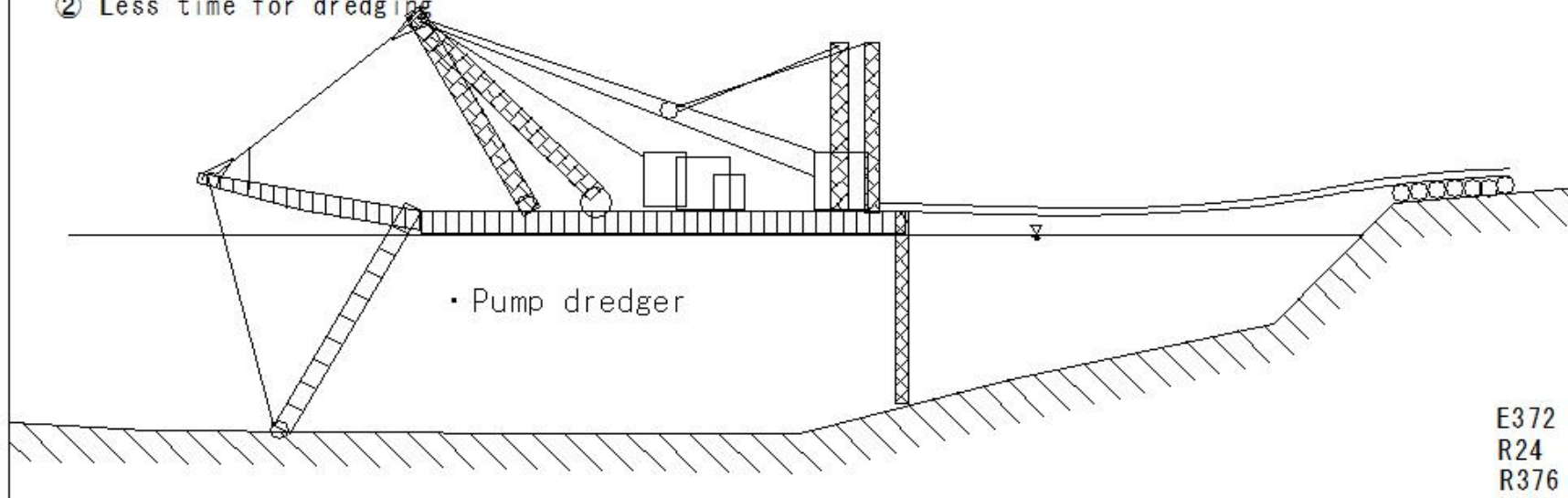
① Channel dredging: It is advantageous if the construction areas are scattered

② A long-distance soil dumping site is fine.

disadvantages

① Not suitable for hard soil

② Less time for dredging



(M92)dredger(grab dredger)

(M92) dredger (grab dredger)

construction machinery

work boat

Advantages and disadvantages of dredgers

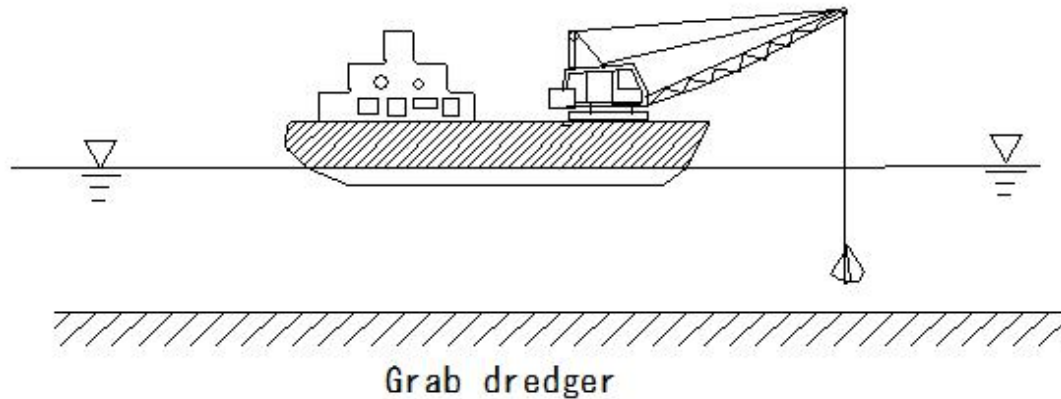
grab dredger

Strong Points

- ① Good for small spaces
- ② Good for small-scale construction

disadvantages

- ① Dredging capacity is intermittent and small
- ② Not suitable for hard boards



E373
R26
R378

(M93)dredger(grab dredger)

(M93) dredger (grab dredger)

construction machinery

work boat

Advantages and disadvantages of dredgers

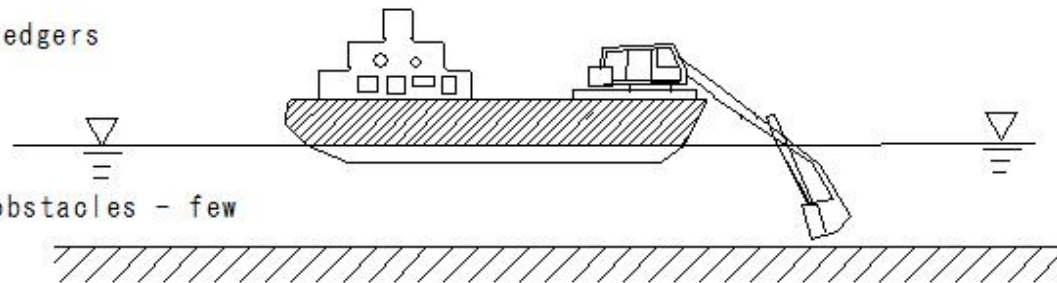
Dipper dredge boat

Strong Points

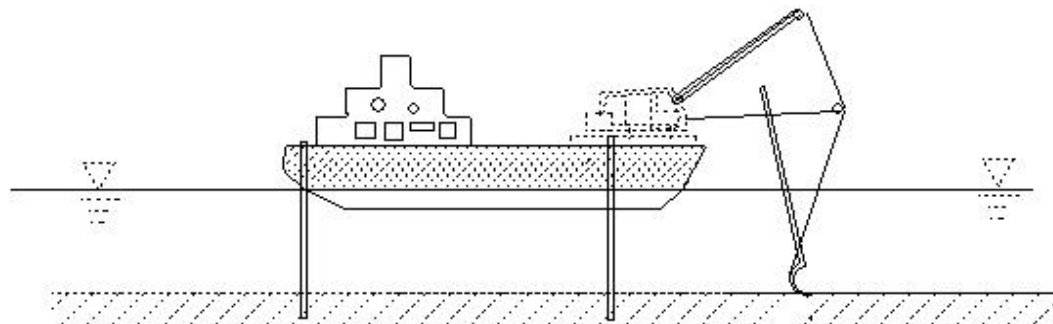
- ① Drilling power - large
- ② No anchoring - navigational obstacles - few

disadvantages

- ① Poor efficiency
- ② Unit price is high



Dipper dredger



Dipper dredger

E375
R26
R379

(M94)dredger(bucket dredger)

(M94) dredger (bucket dredger)

construction machinery

work boat

Advantages and disadvantages of dredgers

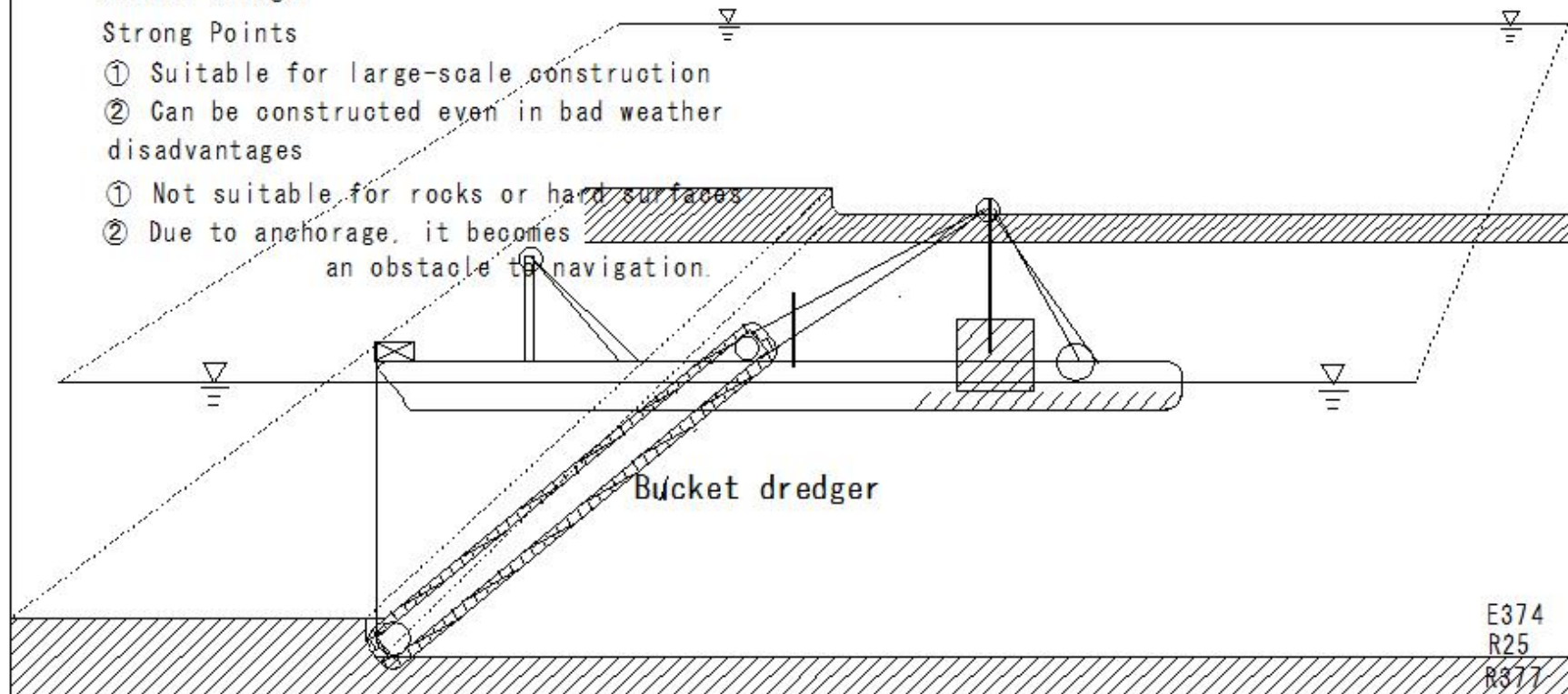
bucket dredger

Strong Points

- ① Suitable for large-scale construction
- ② Can be constructed even in bad weather

disadvantages

- ① Not suitable for rocks or hard surfaces
- ② Due to anchorage, it becomes an obstacle to navigation.



E374
R25
R377

(M95)construction machinery(bulldozer/rake dozer)

(M95) construction machinery(bulldozer/rake dozer)

construction machinery

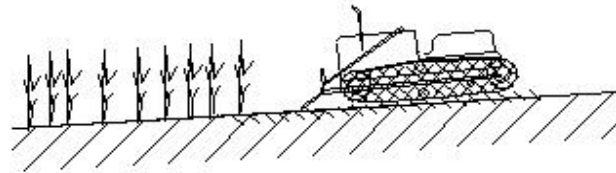
Appropriate machines for each task

clearing

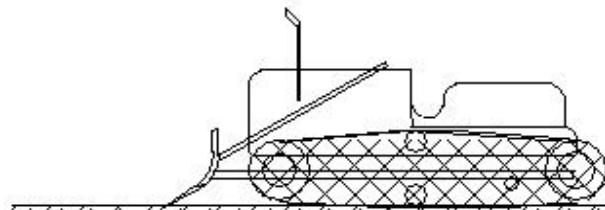
bulldozer

rake dozer

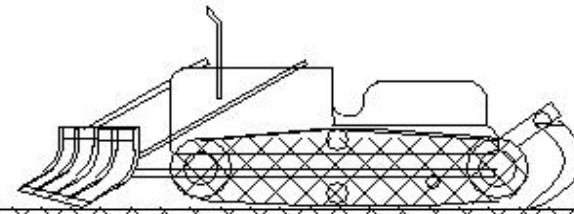
clearing



bulldozer



rake dozer



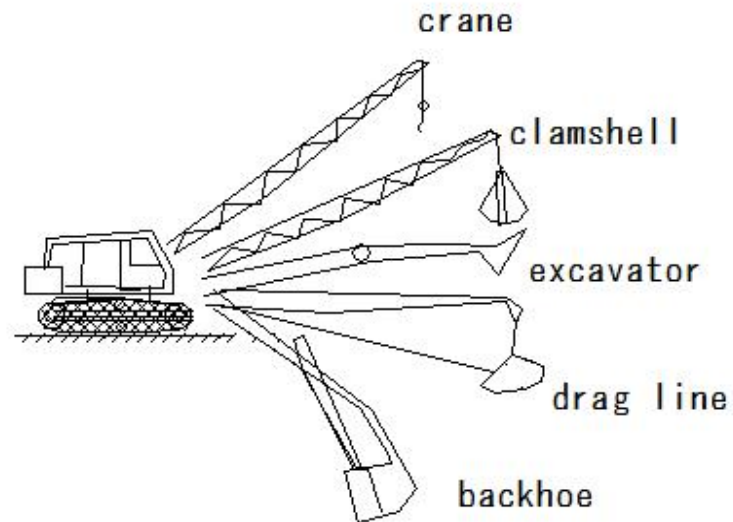
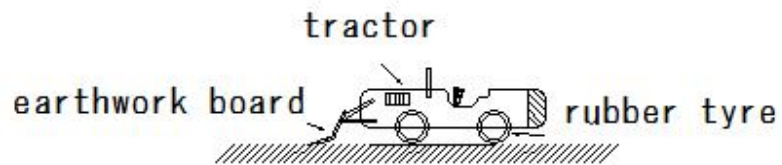
(M96)construction machinery(power shovel/backhoe/drag line/clamshell)

(M96)construction machinery(power shovel/backhoe/drag line/clamshell)

Appropriate machines for each task

Excavation

- excavator
- backhoe
- drag-in
- clamshell
- tractor excavator
- bulldozer



(M97)construction machinery>Loading)

(M97) construction machinery (Loading)

construction machinery

Appropriate machine for each task

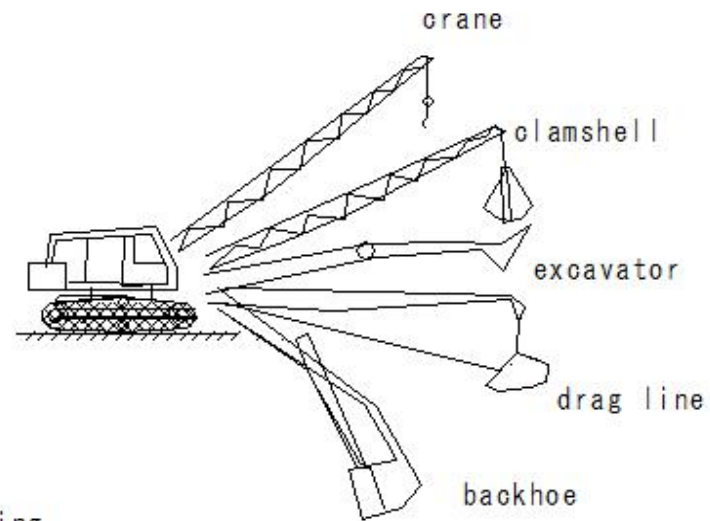
Loading

Excavator

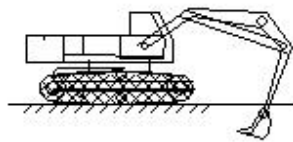
backhoe

drag line

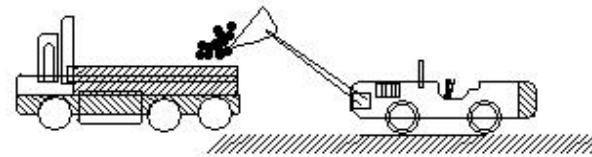
clamshell



Loading



backhoe



tractor excavator

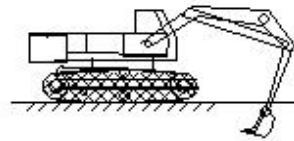
(M98)construction machinery(Excavation/loading)

(M98) construction machinery (Excavation/loading)

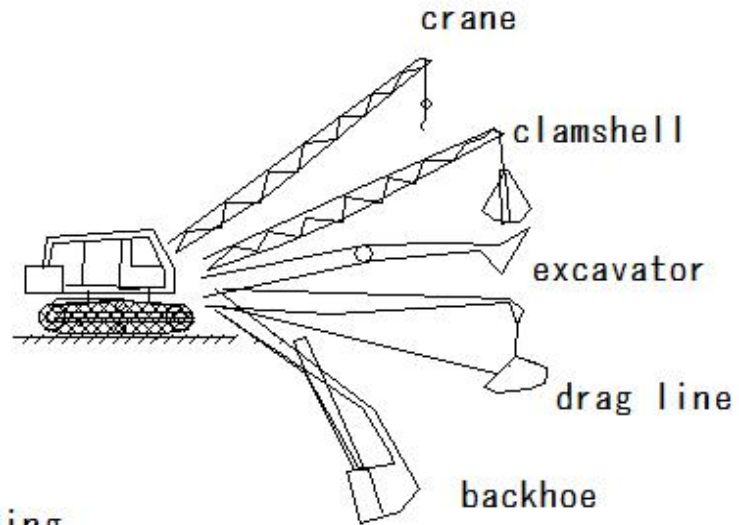
Appropriate machines for each task

Excavation/loading

- Excavator
- backhoe
- drag line
- clamshell
- tractor excavator
- dredger
- bucket excavator

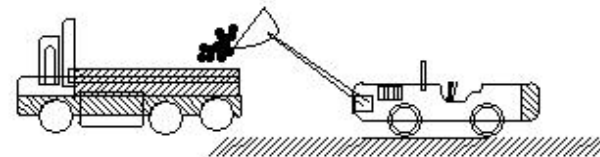
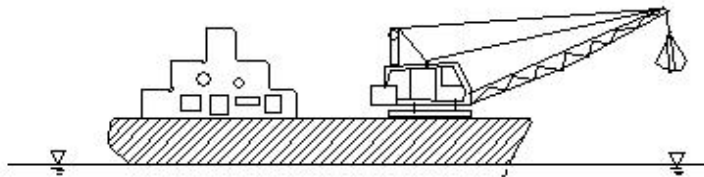


backhoe



Loading

- dredger
- bucket excavator



tractor excavator

E230

(M99)construction machinery(Excavation/Transportation)

(M99) construction machinery (Excavation/Transportation)

Appropriate machines for each task

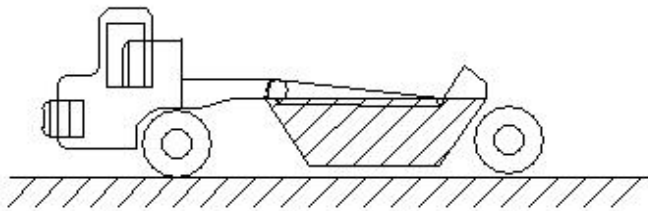
Excavation/Transportation

bulldozer

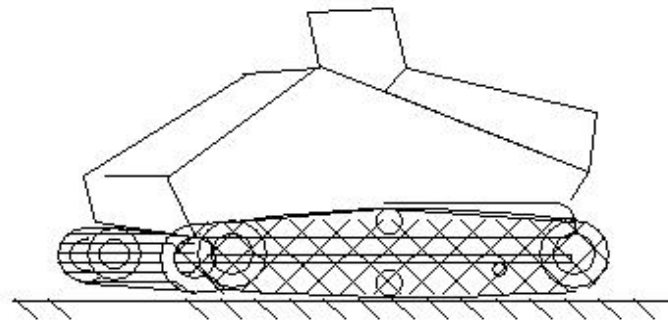
scrape dozer

scraper

tractor excavator



Motor Scraper



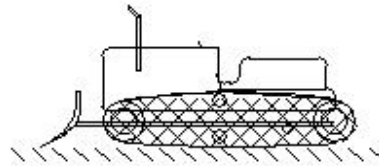
Scrape dozer

(M100) construction machinery (transportation)

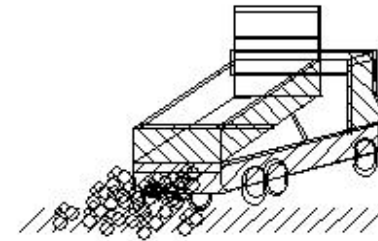
(M100) construction machinery (transportation)

Appropriate machines for each task
transportation

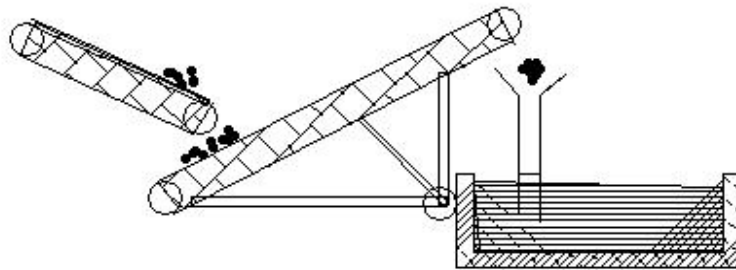
- bulldozer
- dump truck
- belt conveyor
- aerial cableway



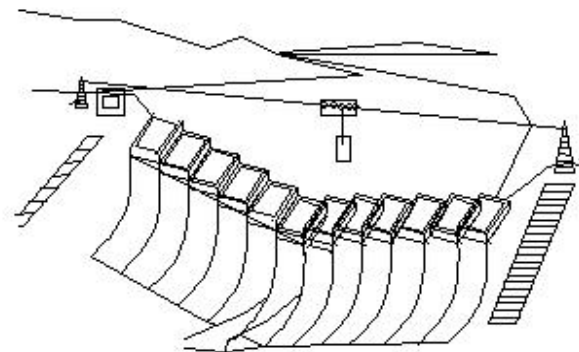
bulldozer



dump truck



belt conveyor



aerial cableway

(M101)construction machinery(spreading)

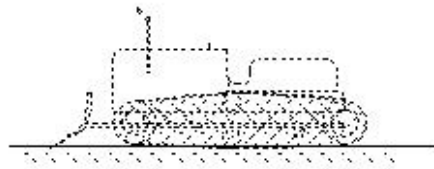
(M101)construction machinery(spreading)

Appropriate machines for each task

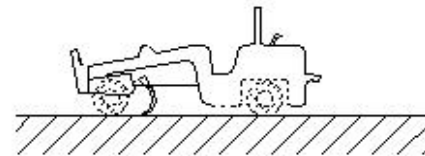
leveling(spreading)

bulldozer

motor grader



bulldozer



motor grader

(M102)construction machinery(compaction)

(M102) construction machinery (compaction)

Appropriate machines for each task

compaction

tire roller

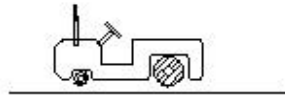
tamping roller

vibrating roller

vibrating compactor

rammer

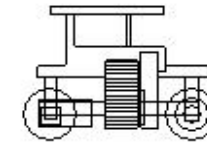
bulldozer



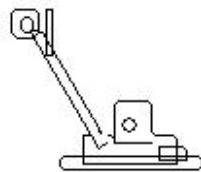
tire roller



tamping roller



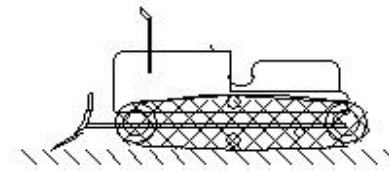
vibrating roller



vibrating compactor



rammer



bulldozer

(M103)construction machinery(Leveling the ground)

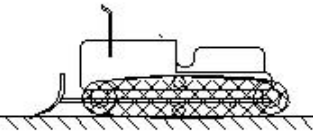
(M103) construction machinery(Leveling the ground)

Appropriate machines for each task

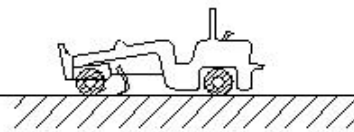
Leveling the ground

bulldozer

motor grader

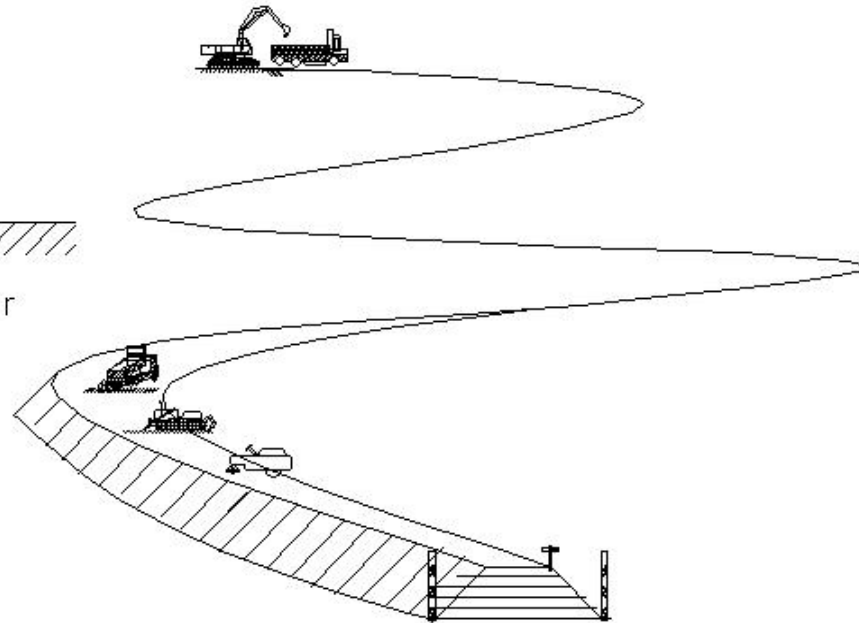


bulldozer



motor grader

E235



E623

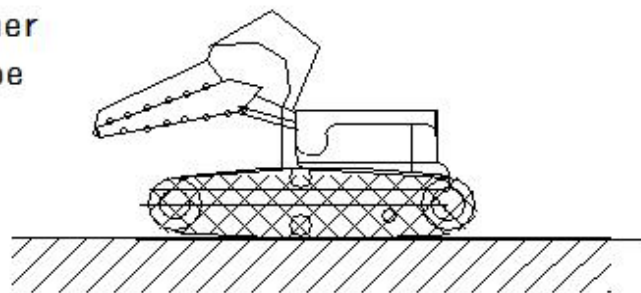
(M104)construction machinery(Leveling the ground)

(M104) construction machinery (Leveling the ground)

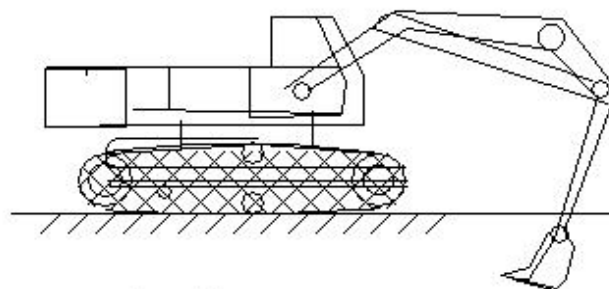
Appropriate machines for each task

trench

trencher
backhoe

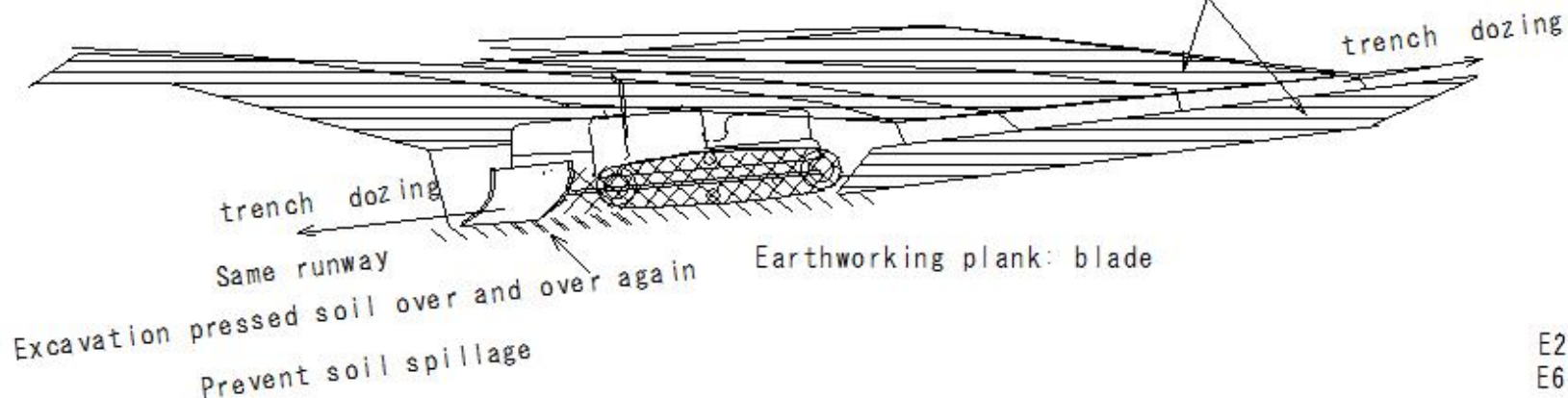


trencher



backhoe

Both sides - Rise



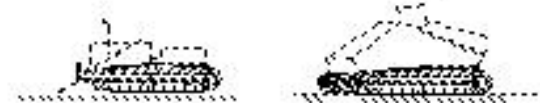
E236
E627

(M105)construction machinery(Transportation distance)

(M105) construction machinery (Transportation distance)

Transportation distance and construction equipment

Types of transport machinery	Applicable transport distance
bulldozer	60m or less
scrape dozer	40-250m
Towed scraper	60 - 400m
self-propelled scraper	200-1200m
Shovel type excavator tractor excavator Dump truck	100m or more

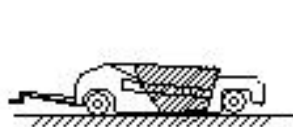


bulldozer scrape dozer



tractor excavator bucket dozer

E237



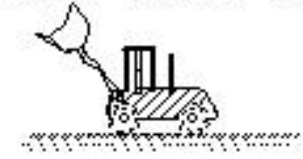
Towed scraper



scrape dozer

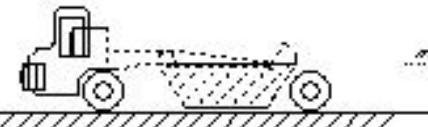


motor scraper



Tractor excavator
+ dump truck

E238



motor scraper



shovel type excavator
+ dump truck



tractor excavator
+ dump truck

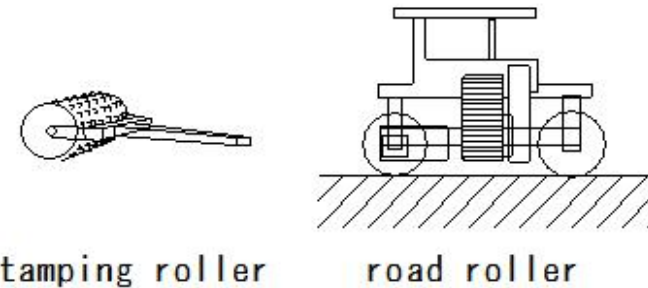
E239

(M106)construction machinery(Compaction machinery)

(M106) construction machinery (Compaction machinery)

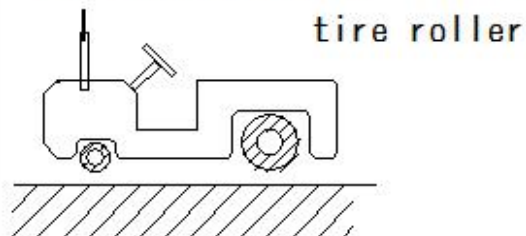
Compaction machinery and soil quality

machine	Soil quality
tamping roller	hard clay
road roller	cobblestone-sandy soil
tire roller	gravel soil-clay soil
vibrating roller	cobblestone-sandy soil
vibrating compactor	gravel soil - sandy soil
rammer	gravel soil - sandy soil
bulldozer	cobblestone-sandy soil
Wetland bulldozer	soft clay

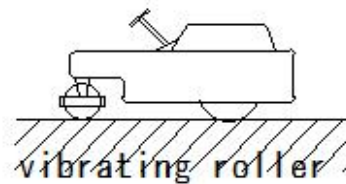


tamping roller

road roller



tire roller



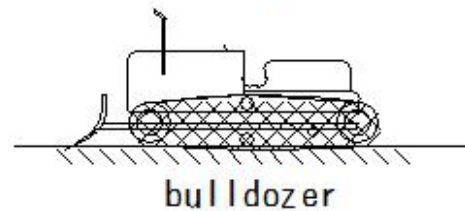
vibrating roller



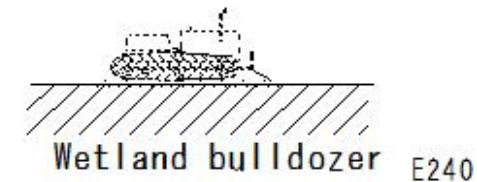
vibrating compactor



rammer



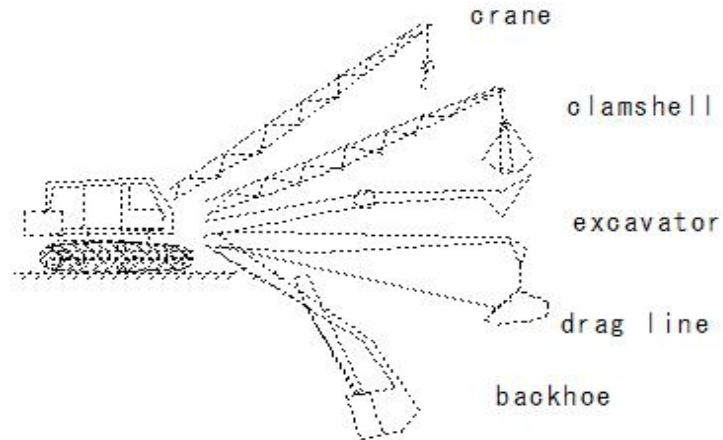
bulldozer



Wetland bulldozer

(M107)Front attachment and aptitude work

(M107)Front attachment and aptitude work



E241

Front attachment and aptitude work

		excavator	backhoe	drag line	clamshell
digging power		big	big	small	small
• drilling material	hard soil/rock	⊙	⊙	x	x
	underwater drilling	x	○	⊙	⊙
• drilling position	higher than the ground	⊙	x	x	○
	lower than the ground	x	⊙	⊙	○
	precise drilling	⊙	⊙	x	○
	wide area	x	x	⊙	⊙
• adaptation work	cutting at high places	⊙	x	x	x
	Narrow V-shaped ditch	x	⊙	x	○
	Topsoil removal and leveling	○	x	⊙	x
	Lifting winch work	x	x	○	⊙

⊙: Extremely suitable

○: Aptitude

x: Inappropriate

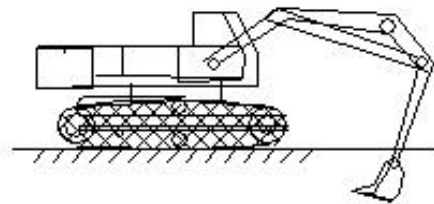
(M108)construction machinery(Display method)

(M108)construction machinery(Display method)

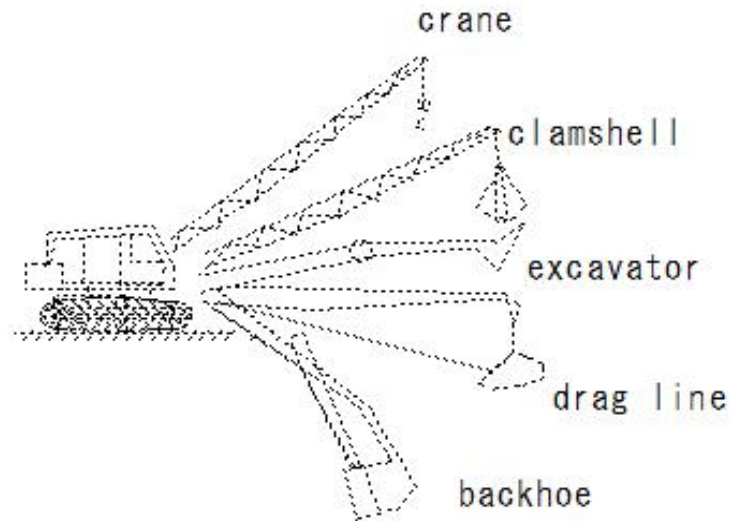
construction machinery

construction machinery display

construction machinery	Display method
1 power shovel	m3 flat bucket capacity
2 backhoe	m3 flat bucket capacity
3 drag lines	m3 Bucket capacity
4 clamshell	m3 Bucket capacity



backhoe



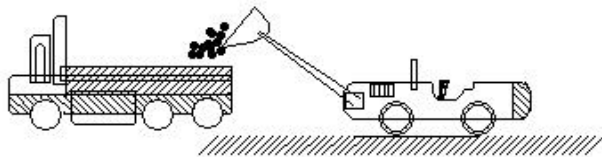
(M109)construction machinery(Display method)

(M109) construction machinery (Display method)

construction machinery

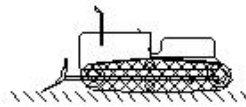
construction machinery display

construction machinery	Display method
5 tractor excavator	m3 piled bucket capacity
6 bulldozer	tf weight
7 scraper	m3 bowl capacity
8 scrape dozer	tf weight



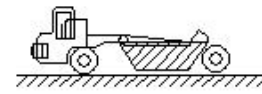
tractor excavator

E229

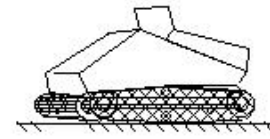


bulldozer

E240



Motor Scraper



Scrape dozer

E231

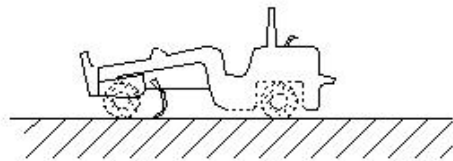
(M110)construction machinery(Display method)

(M110) construction machinery (Display method)

construction machinery

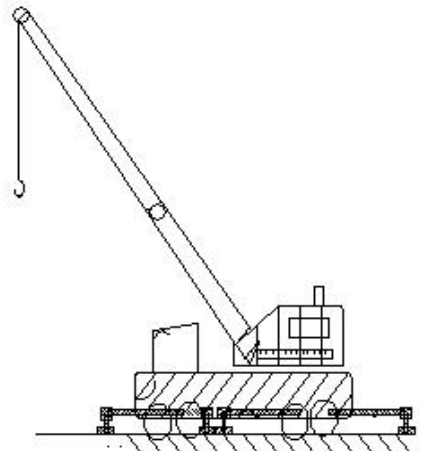
construction machinery display

construction machinery	Display method
9 motor grader	m Blade length
10 cranes	tf Hanging load
11 roller vibrating roller	tf Weight tf Weight and excitation force tf
12 Stabilizer	m Mixing width and mm Mixing depth



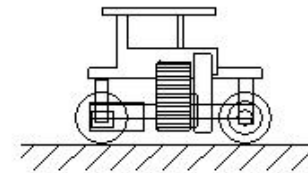
motor grader

E235



cranes

B111



vibrating roller

E234

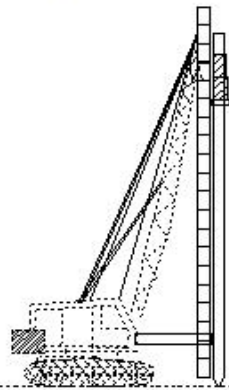
(M111)construction machinery(Display method)

(M111) construction machinery (Display method)

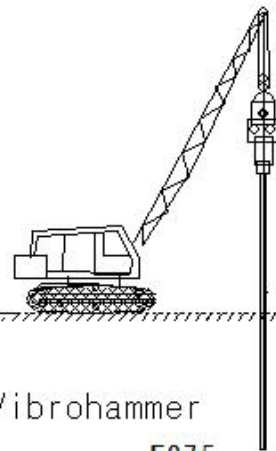
construction machinery

construction machinery display

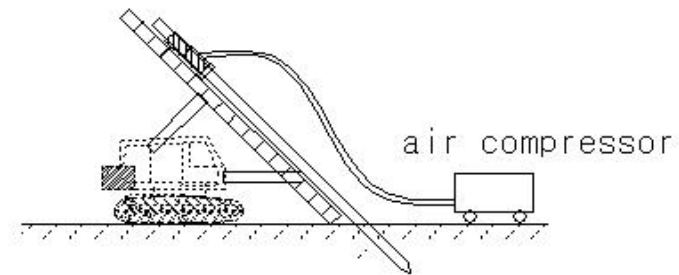
construction machinery	Display method
13 diesel hammer	tf ram weight
14 vibro hammer	kW Power
15 air compressor	m ³ /min Discharge amount
16 plants	m ³ /h kneading capacity



Diesel pile hammer
F30



Vibrohammer
F375



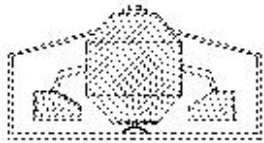
air compressor
F31

(M112)construction machinery(Display method)

(M112) construction machinery (Display method)

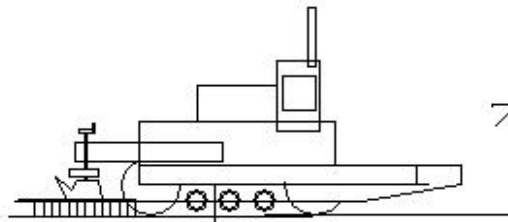
construction machinery display

construction machinery	Display method
17 mixer	m ³ /h kneading capacity
18 finisher	m Pavement width
19 pump	m ³ /h Pumping capacity



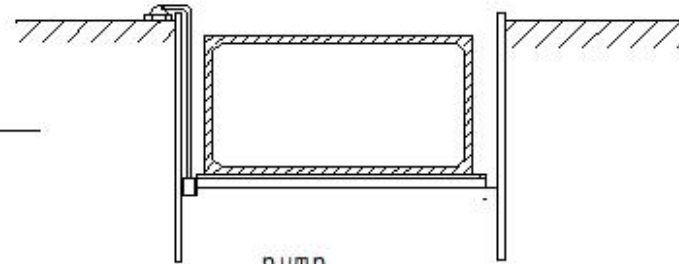
forced mixer

C1300



Asphalt finisher

M81



pump

C1289

(M113)Earthworks-Characteristics of Earthmoving Machinery

(M113)Earthworks-Characteristics of Earthmoving Machinery

Characteristics of Earthmoving Machinery

1 Work 2 model 3 Transportation 4 Soil quality 5 Work conditions

1-1 Loading and transportation

2-1 Motor scraper

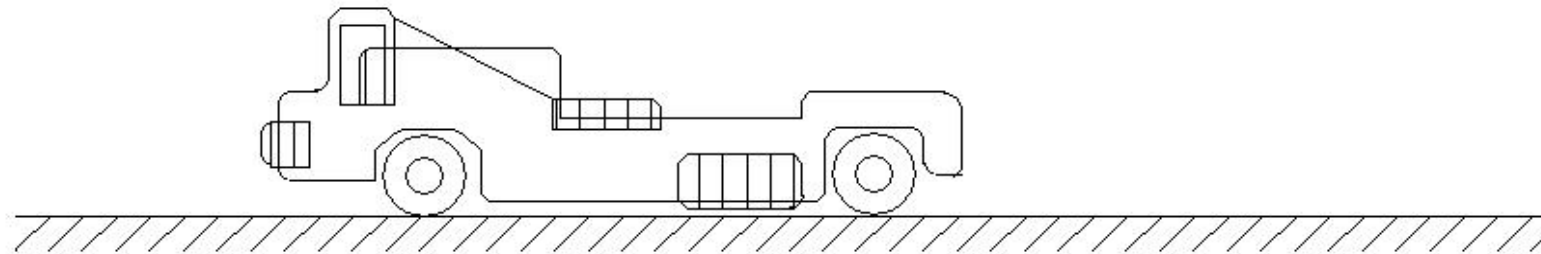
3-1 200-1200m medium distance

4-1 Cobble stones - few Cone index $q_c = 10$ or more Cone index $q_c = 10$ or more

Suitable for sandy soil and gravel soil

5-1 Ensuring traffic availability on transportation routes

Securing a workspace for changing direction, etc.

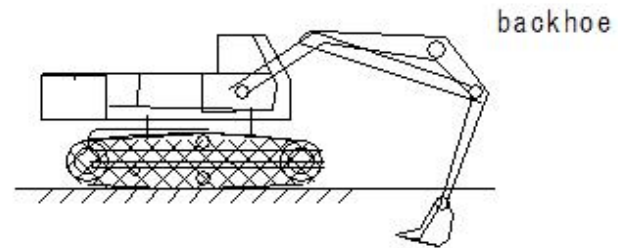
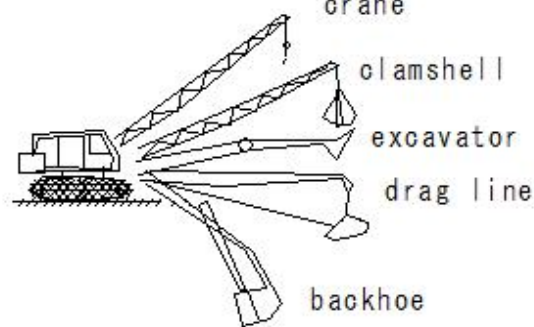


Motor scraper

(M114)Earthworks-Characteristics of Earthmoving Machinery

(M114) Earthworks-Characteristics of Earthmoving Machinery

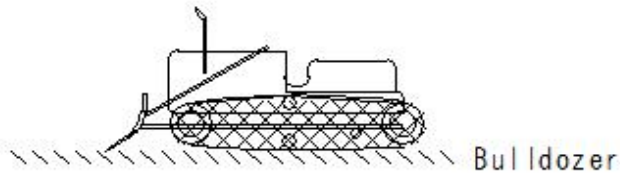
Characteristics of Earthmoving Machinery				
①Work	②model	③Transportation	④Soil quality	⑤Work conditions
①-2 Excavation/loading				
		③-2 Combination with dump truck		
		③-2 Transportation distance 70m or more		
			④-2 Cone index $q_c = 12$ or more	
			④-2 The excavated soil can be either hard or soft.	
	②-2 Backhoe			⑤-2 Excavation location - lower than the ground
	②-2 Clamshell			⑤-2 Underwater drilling -drilling at great depths
	②-2 drag line			⑤-2 Wide areas such as rivers
	②-2 Excavator	⑤-2 Where the excavation point is higher than the ground		



(M115)Earthworks-Characteristics of Earthmoving Machinery

(M115)Earthworks-Characteristics of Earthmoving Machinery

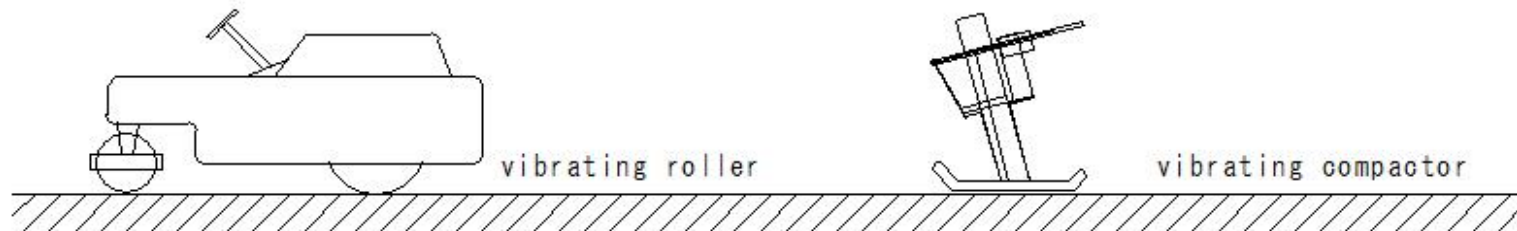
Characteristics of Earthmoving Machinery				
①Work	②model	③Transportation	④Soil quality	⑤Work conditions
①-3 Excavation/Dossing				
	②-3 Bulldozer			
		③-3 Short-distance excavation transportation		
			④-3 Cone index	
			Ordinary bulldozer qc = 5-7 or more	
		③-3 Transportation distance of 70m or less		
			④-3Wetland bull qc = 3 or more	
			Super wetlands qc = 2 or more	
				⑤-3 qc = 3 (2) or less Unable to drive



(M116)Earthworks-Characteristics of Earthmoving Machinery

(M116)Earthworks-Characteristics of Earthmoving Machinery

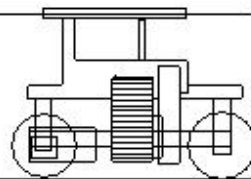
Characteristics of Earthmoving Machinery				
①Work	②model	③Transportation	④Soil quality	⑤Work conditions
①-4 Compaction (centrifugal force)	②-4 vibrating roller	③-4 Working speed 0.9km/h	④-4 Gravel soil/sandy soil	⑤-4 large work area
①-4 Compaction (centrifugal force)	②-4 vibrating compactor	③-4 Working speed 0.6-0.8km/h	④-4 Gravel soil/sandy soil	⑤-4 narrow workplace space



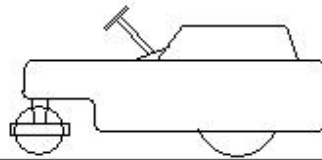
(M117)Earthworks-Characteristics of Earthmoving Machinery

(M117)Earthworks-Characteristics of Earthmoving Machinery

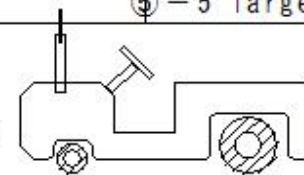
Characteristics of Earthmoving Machinery				
① Work	② model	③ Transportation	④ Soil quality	⑤ Work conditions
① - 5 static pressure				
	② - 5 macadam roller			
		③ - 5 Working speed 2km/h		
			④ - 5 Rock mass, gravel, sand, sandy soil	
				⑤ - 5 large work area
① - 5 static pressure				
	② - 5 tandem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



macadam roller



tandem roller



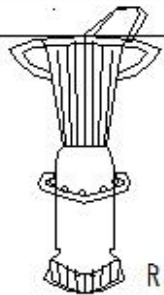
tire roller

E186

(M118)Earthworks-Characteristics of Earthmoving Machinery

(M118)Earthworks-Characteristics of Earthmoving Machinery

Characteristics of Earthmoving Machinery				
① Work	② model	③ Transportation	④ Soil quality	⑤ Work conditions
① - 6 impact				
	② - 6 Ranma			
			④ - 6 Grassy soil, sand, sandy soil	
				⑤ - 6 narrow workplace space
① - 6 impact				
	② - 6 tampa			
			④ - 6 Grassy soil, sand, sandy soil	
				⑤ - 6 narrow workplace space
① - 6 impact				
	② - 6 tamping road			
			④ - 6 hard clay clay soil	
				⑤ - 6 narrow workplace space

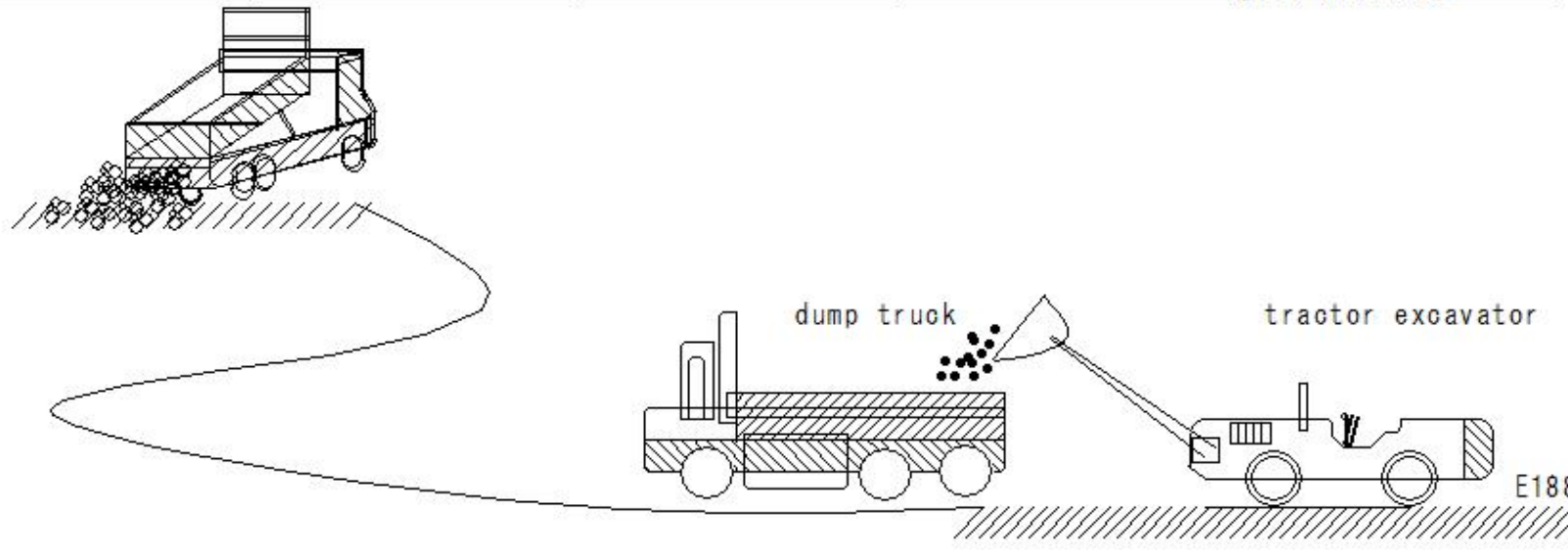


Ranma

(M119)Earthworks-Characteristics of Earthmoving Machinery

(M119)Earthworks-Characteristics of Earthmoving Machinery

Characteristics of Earthmoving Machinery				
① Work	② model	③ Transportation	④ Soil quality	⑤ Work conditions
①-7 Excavation/loading				
	②-7 tractor excavator			
		③-7 combination with dump truck		
			④-7 Suitable for excavation and loading of soft soil	
			⑤-7 Suitable for excavating in low places	
				good mobility

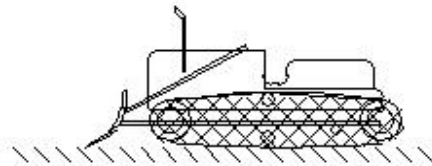


(M120)Earthworks-Excavation and transportation method

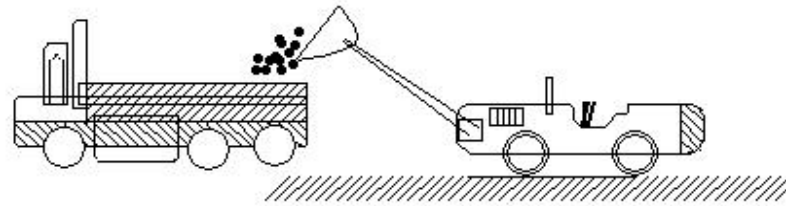
(M120)Earthworks-Excavation and transportation method

Excavation and transportation method

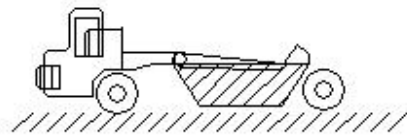
- ① Bulldozer method (70m or less)
- ② Excavator and dump truck (70m or more)
- ③ Towed scraper (about 500m)
- ④ Scrape dozer method (Suitable for cohesive soil (70 m or more)
- ⑤ Water content adjustment: Plow, desk harrow, motor grader, sprinkler truck



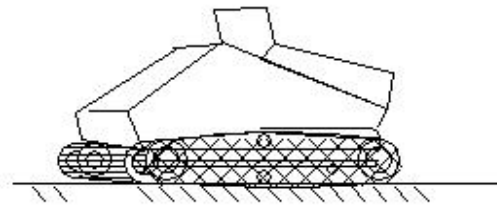
Bulldozer



Excavator and dump truck



Motor Scraper



Scrape dozer

(M121)Embankment construction-Compaction machine

(M121)Embankment construction-Compaction machine

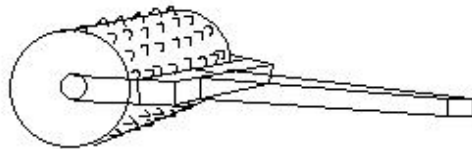
Embankment construction
compaction machine

①Tamping roller

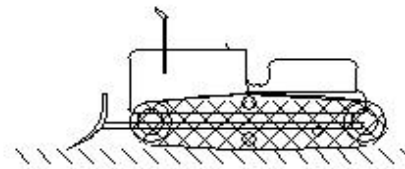
Compaction of hard clay/clay soil

②Wetland bulldozer

Compaction of very soft clay/cohesive soil



Tamping roller



Wetland bulldozer

(M122)Tire roller/vibration roller

(M122) Tire roller • vibration roller

Tire roller/vibration roller

① Tire roller

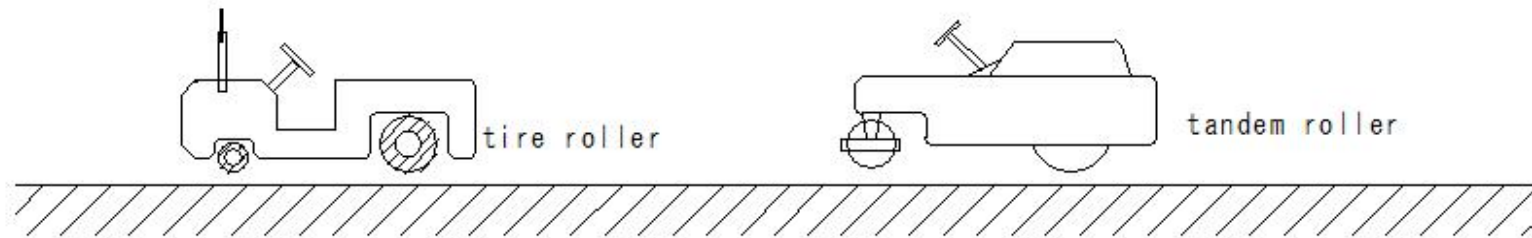
rubber tire roller

gravity of rollers etc.

compacti on

② Vibrating roller

Iron wheel roller vertical vibration compacti on sandy soil compacti on



E215

(M123)Construction plan-Appropriate machines for each task

(M123)Construction plan-Appropriate machines for each task

Appropriate machines for each task

Excavation

excavator

backhoe

drag-in

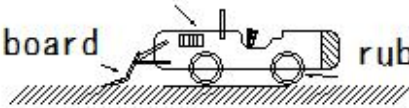
clamshell

tractor excavator

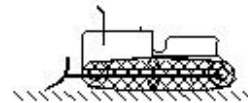
bulldozer

tractor

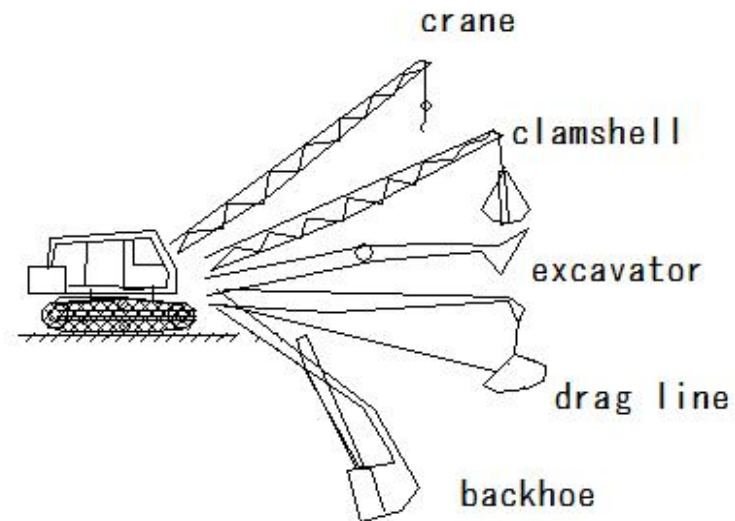
earthwork board



rubber tyre



bulldozer



crane

clamshell

excavator

drag line

backhoe

(M124)Construction plan-Appropriate machines for each task

(M124)Construction plan-Appropriate machines for each task

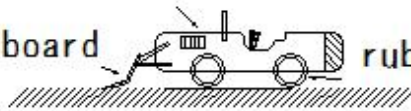
Appropriate machines for each task

Excavation

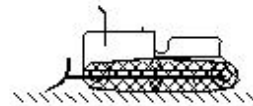
- excavator
- backhoe
- drag-in
- clamshell
- tractor excavator
- bulldozer

tractor

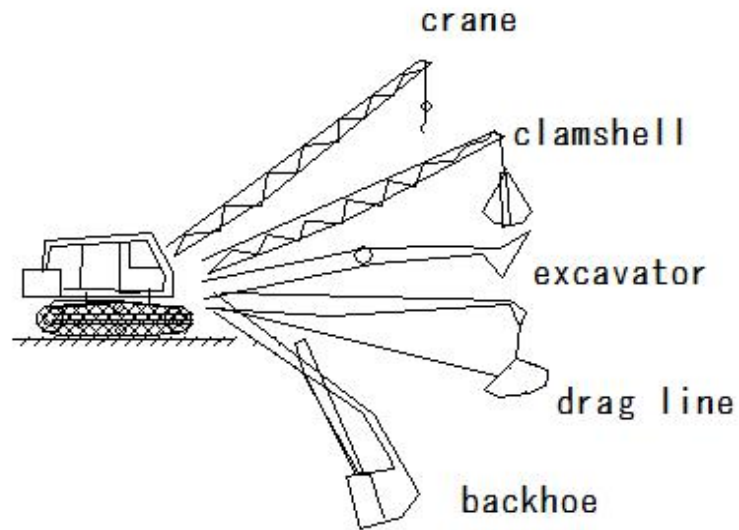
earthwork board



rubber tyre



bulldozer



crane

clamshell

excavator

drag line

backhoe

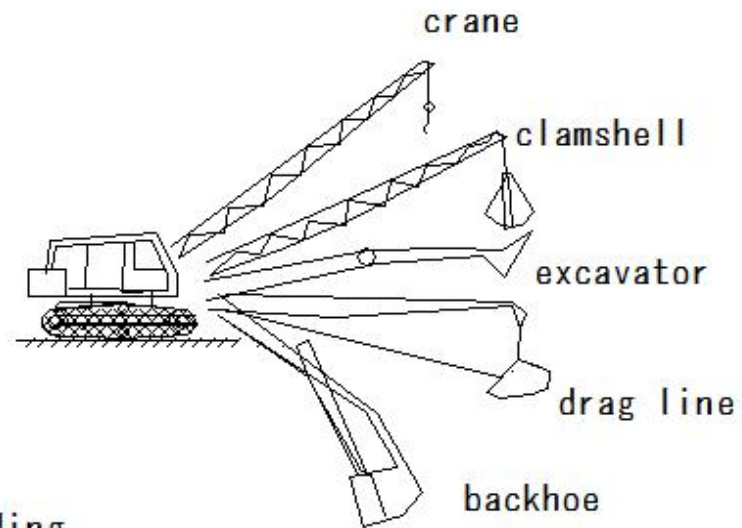
(M125)Construction plan-Appropriate machines for each task

(M125) Construction plan-Appropriate machines for each task

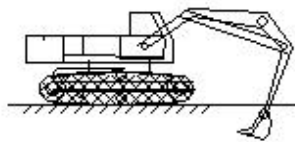
Appropriate machines for each task

Loading

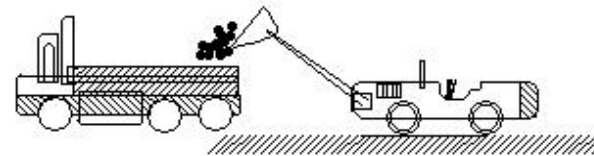
- Excavator
- backhoe
- drag line
- clamshell



Loading



backhoe



tractor excavator

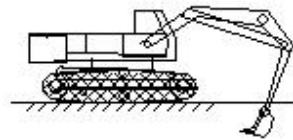
(M126)Construction plan-Appropriate machines for each task

(M126) Construction plan-Appropriate machines for each task

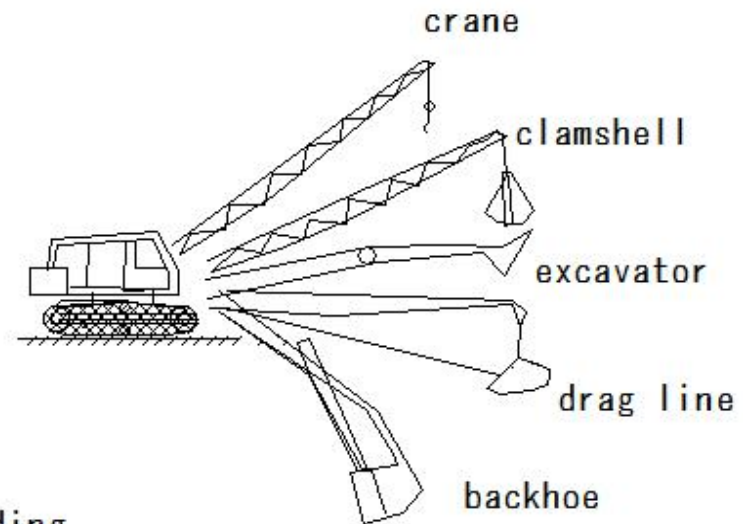
Appropriate machines for each task

Excavation/loading

- Excavator
- backhoe
- drag line
- clamshell
- tractor excavator
- dredger
- bucket excavator

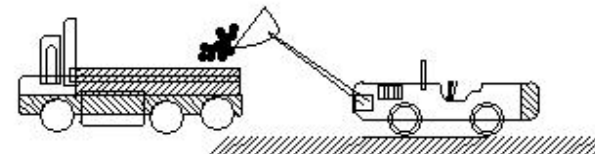
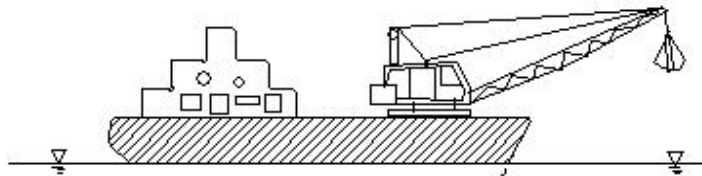


backhoe



Loading

- dredger
- bucket excavator



tractor excavator

(M127)Construction plan-Appropriate machines for each task

(M127)Construction plan-Appropriate machines for each task

Appropriate machines for each task

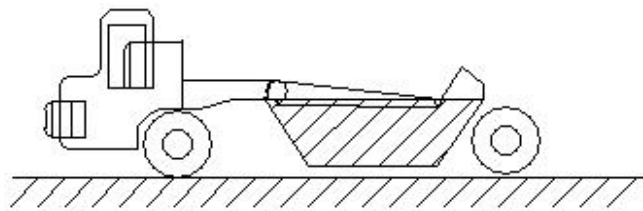
Excavation/Transportation

bulldozer

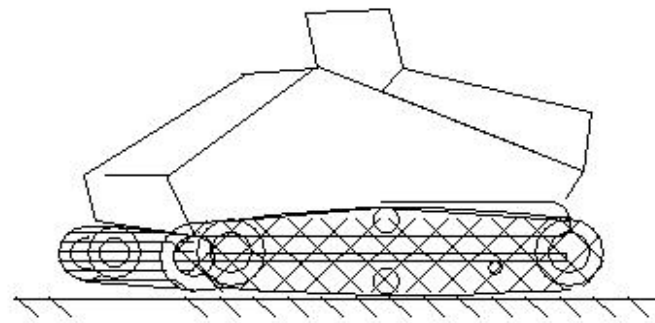
scrape dozer

scraper

tractor excavator



Motor Scraper



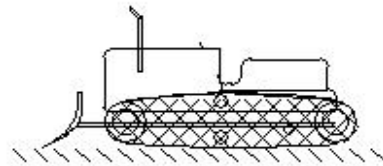
Scrape dozer

(M128)Construction plan-Appropriate machines for each task

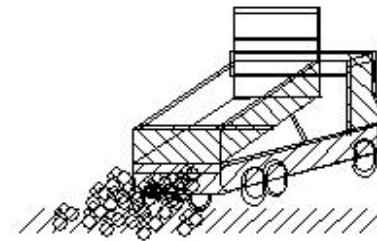
(M128)Construction plan-Appropriate machines for each task

Appropriate machines for each task
transportation

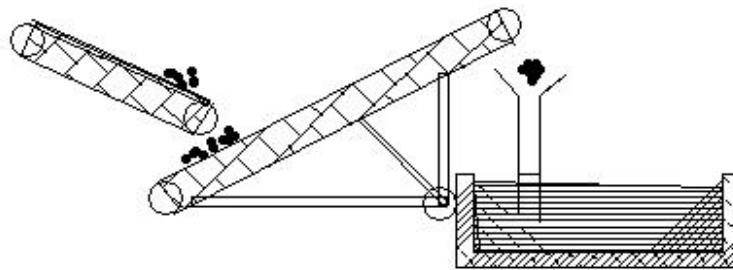
- bulldozer
- dump truck
- belt conveyor
- aerial cableway



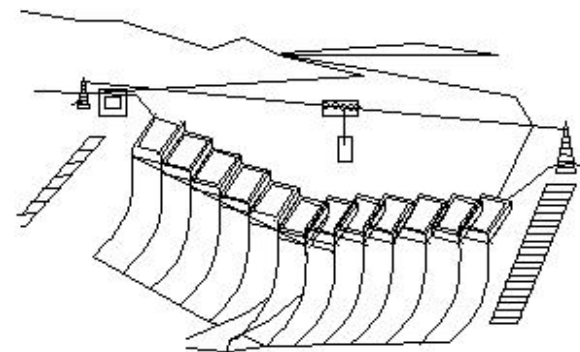
bulldozer



dump truck



belt conveyor



aerial cableway

(M129)Construction plan-Appropriate machines for each task

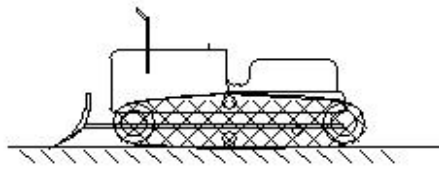
(M129) Construction plan-Appropriate machines for each task

Appropriate machines for each task

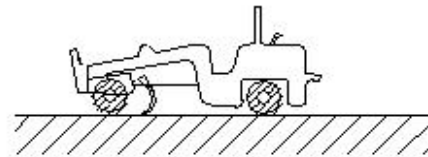
leveling (spreading)

bulldozer

motor grader



bulldozer



motor grader

(M130)Construction plan-Appropriate machines for each task

(M130) Construction plan-Appropriate machines for each task

Appropriate machines for each task

compaction

tire roller

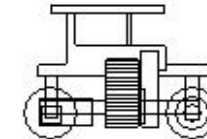
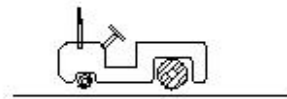
tamping roller

vibrating roller

vibrating compactor

rammer

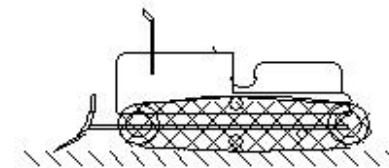
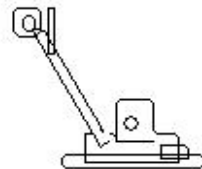
bulldozer



tire roller

tamping roller

vibrating roller



vibrating compactor

rammer

bulldozer

(M131)Construction plan-Appropriate machines for each task

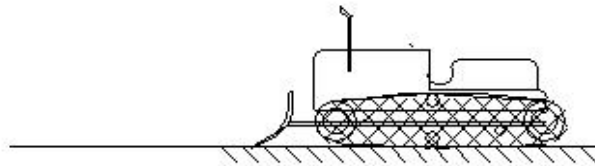
(M131)Construction plan-Appropriate machines for each task

Appropriate machines for each task

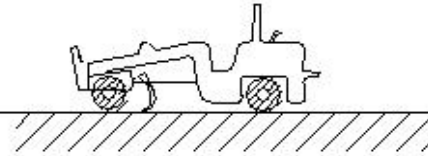
Leveling the ground

bulldozer

motor grader



bulldozer



motor grader

(M132)Construction plan-Appropriate machines for each task

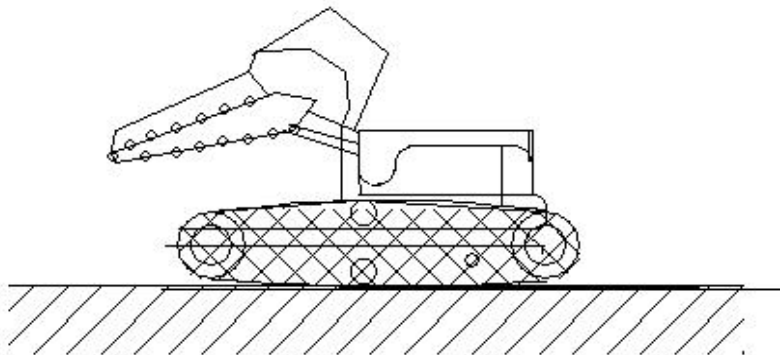
(M132)Construction plan-Appropriate machines for each task

Appropriate machines for each task

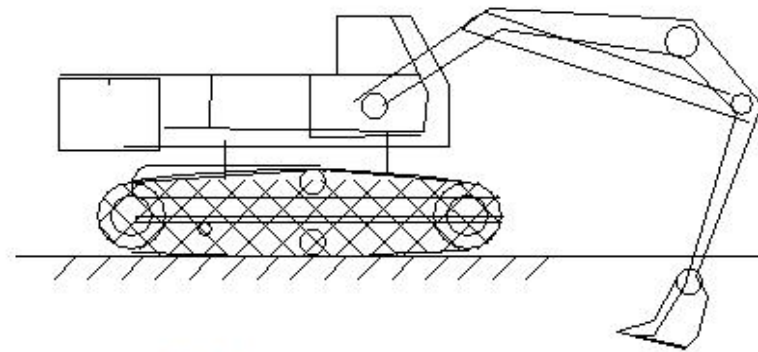
trench

trencher

backhoe



trencher



backhoe

(M133)Transport distance and applicable machine type

(M133)Transport distance and applicable machine type

Transport distance and applicable machine type

short distance

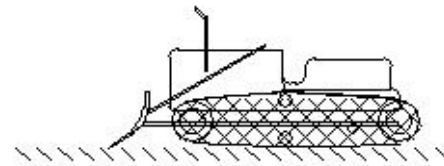
70m or less

bulldozer

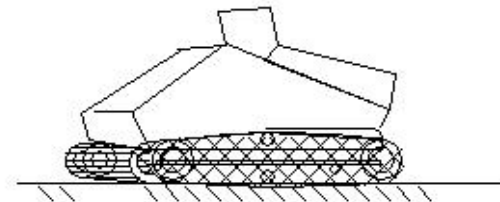
scrape dozer

tractor excavator

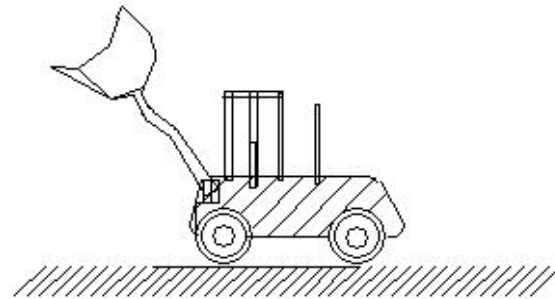
bucket dozer



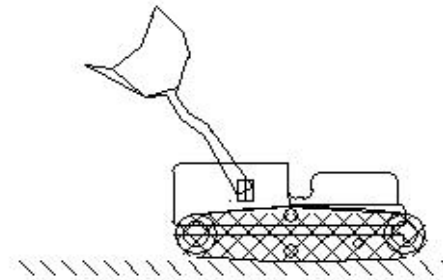
bulldozer



scrape dozer

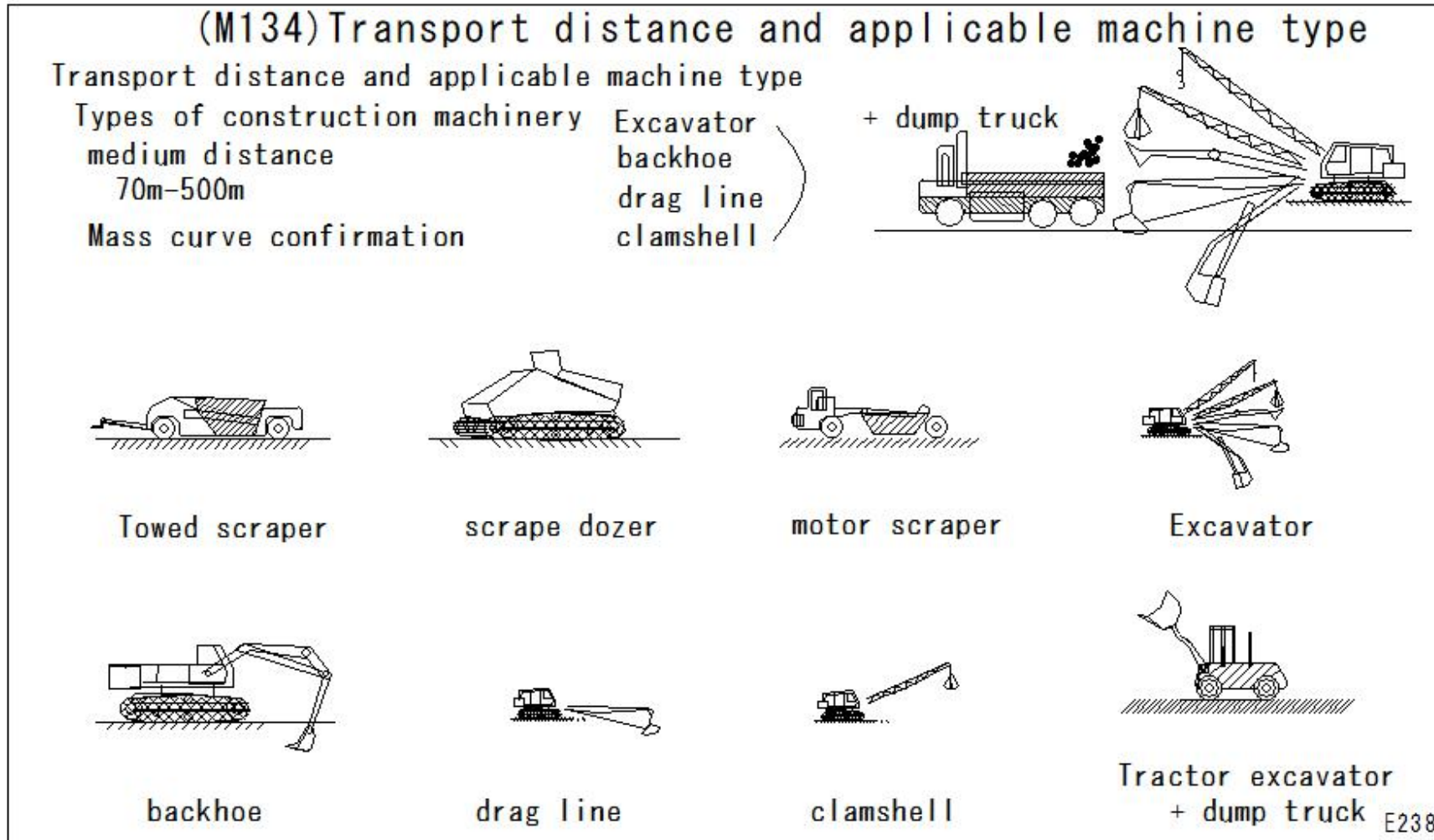


tractor excavator



bucket dozer E237

(M134)Transport distance and applicable machine type



(M135)Transport distance and applicable machine type

(M135)Transport distance and applicable machine type

Transport distance and applicable machine type

Types of construction machinery

long distance

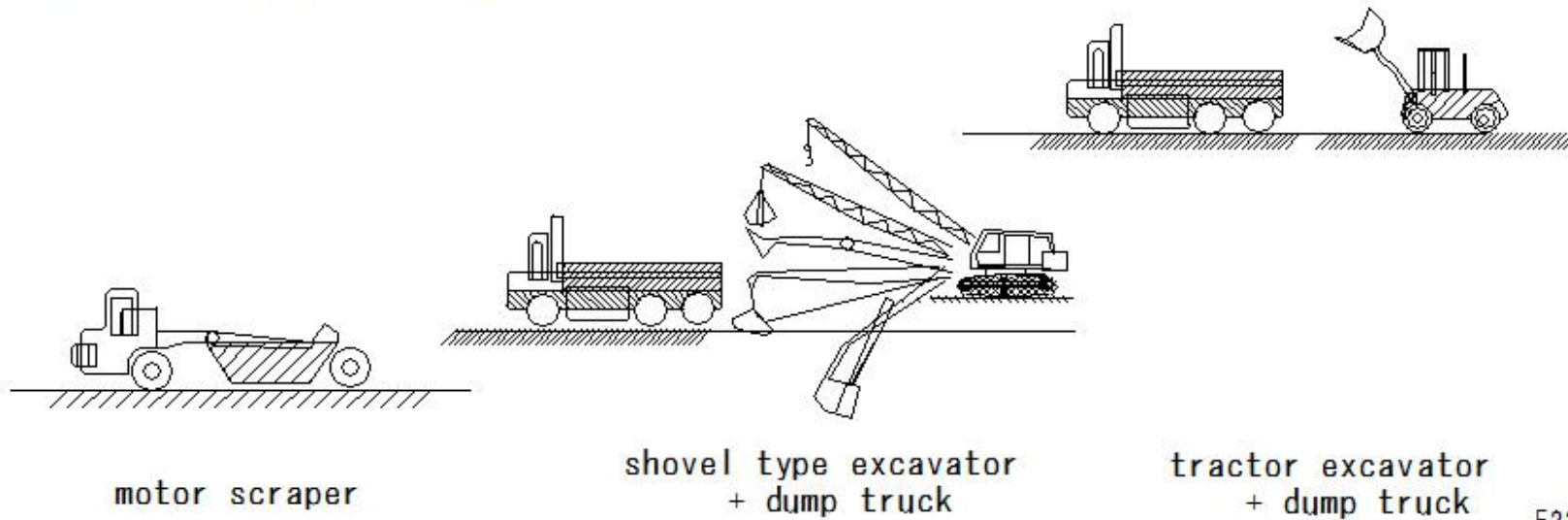
500m or more

motor scraper

shovel type excavator + dump truck

tractor excavator + dump truck

Mass curve confirmation



motor scraper

shovel type excavator
+ dump truck

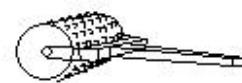
tractor excavator
+ dump truck

(M136)Compaction machinery and soil quality

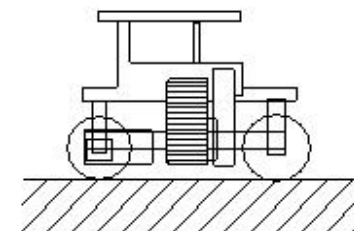
(M136) Compaction machinery and soil quality

Compaction machinery and soil quality

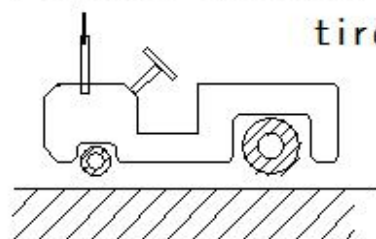
machine	Soil quality
tamping roller	hard clay
road roller	cobblestone-sandy soil
tire roller	gravel soil-clay soil
vibrating roller	cobblestone-sandy soil
vibrating compactor	gravel soil - sandy soil
rammer	gravel soil - sandy soil
bulldozer	cobblestone-sandy soil
Wetland bulldozer	soft clay



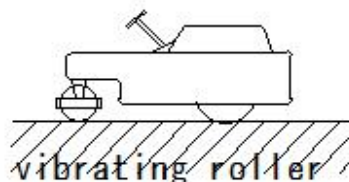
tamping roller



road roller



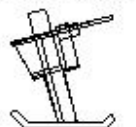
tire roller



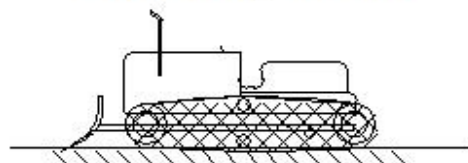
vibrating roller



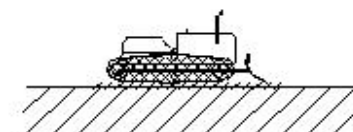
vibrating compactor



rammer

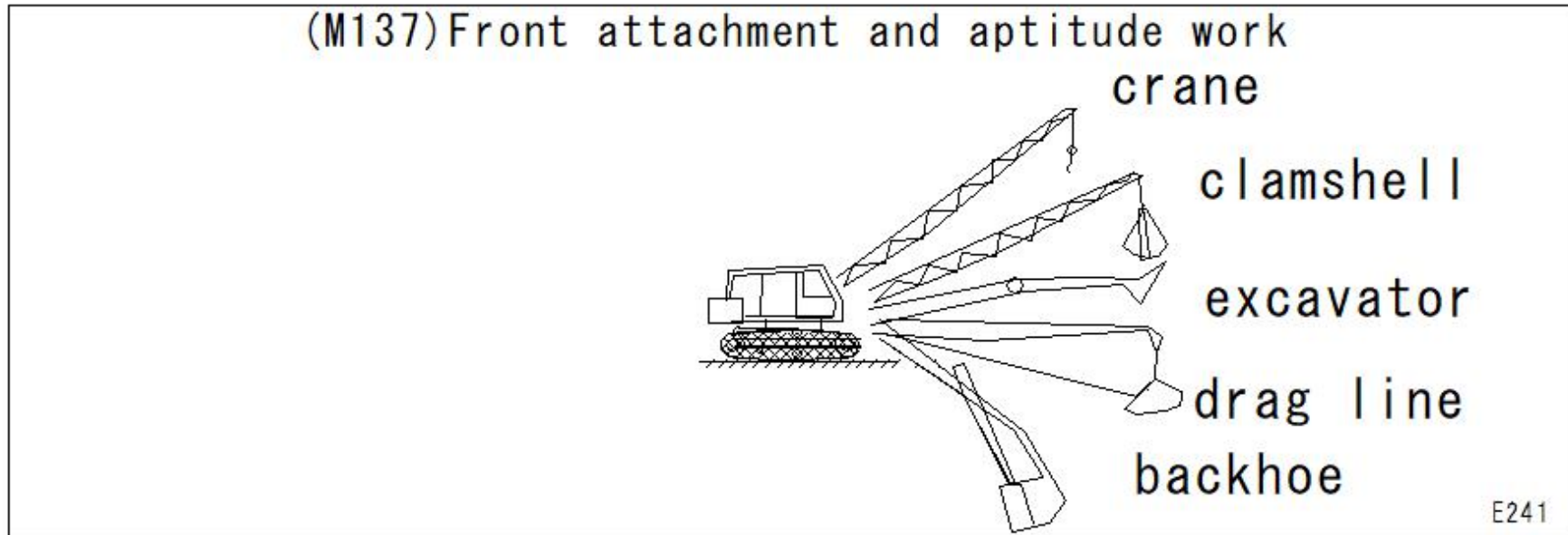


bulldozer



Wetland bulldozer E240

(M137)Front attachment and aptitude work



Front attachment and aptitude work

		excavator	backhoe	drag line	clamshell
digging power		big	big	small	small
▪ drilling material	hard soil/rock	◎	◎	x	x
	underwater drilling	x	○	◎	◎
▪ drilling position	higher than the ground	◎	x	x	○
	lower than the ground	x	◎	◎	○
	precise drilling	◎	◎	x	○
	wide area	x	x	◎	◎
▪ adaptation work	cutting at high places	◎	x	x	x
	Narrow V-shaped ditch	x	◎	x	○
	Topsoil removal and leveling	○	x	◎	x
	Lifting winch work	x	x	○	◎

◎: Extremely suitable
○: Aptitude
x: Inappropriate

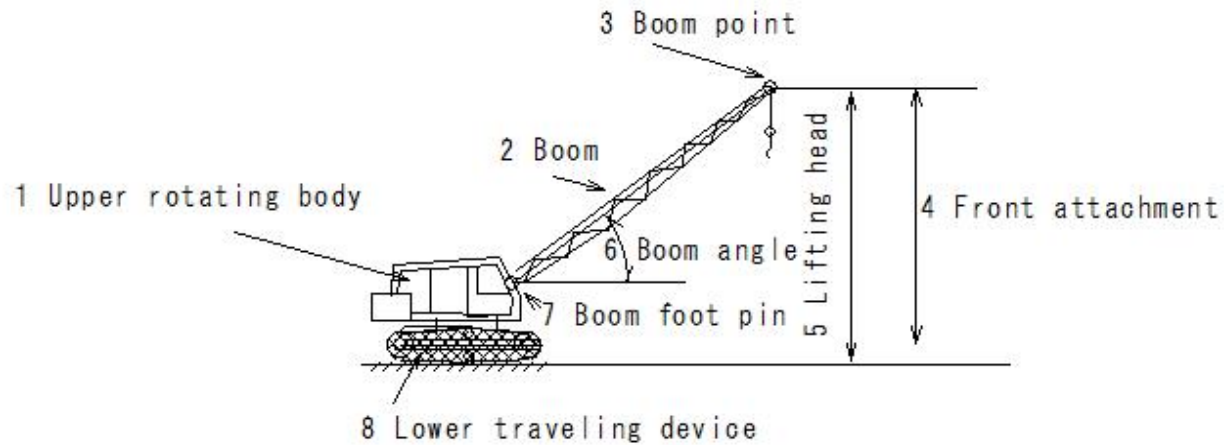
(M138)Earthmoving machinery-Excavating machine

(M138) Earthmoving machinery-Excavating machine

Earthmoving machinery

Excavating machine

- ① Shovel type excavator
- ② Bulldozer type excavator Excavation + transportation work
- ③ Continuous bucket excavator



Shovel type excavator

(M139)Earthmoving machinery-Excavating machine

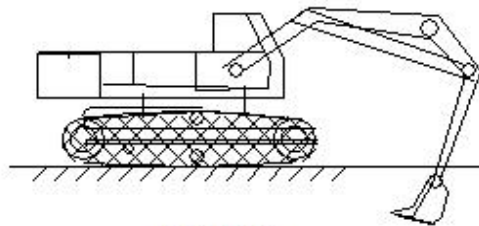
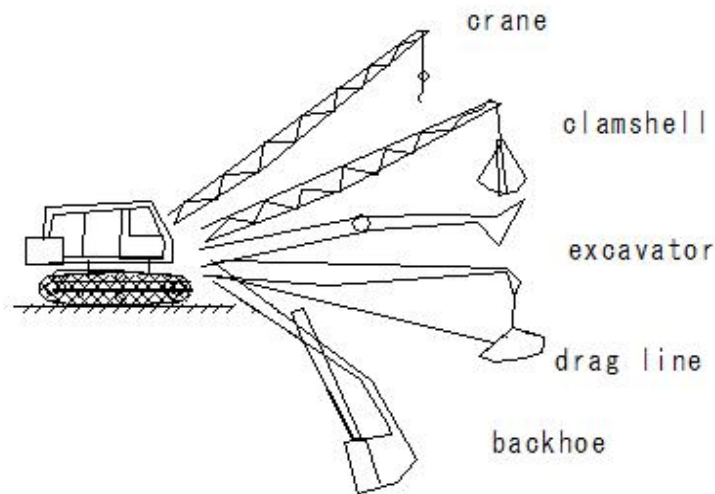
(M139)Earthmoving machinery-Excavating machine

Earthmoving machinery

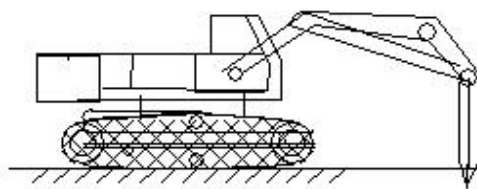
Excavating machine

Shovel type excavator

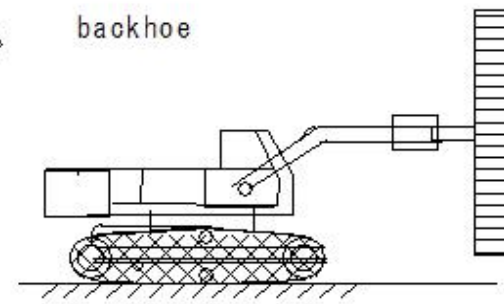
Front attachment type



backhoe



hydraulic breaker



concrete crusher

(M140)Earthmoving machinery-loading machine-Crawler type tractor excavator

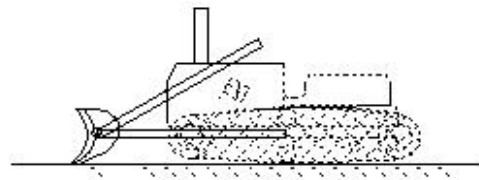
(M140)Earthmoving machinery-loading machine-Crawler type tractor excavator

Earthmoving machinery

loading machine

Crawler type tractor excavator

- Based on bulldozer
- Installing a bucket instead of a blade
- Excavating power - inferior
- Ground pressure - low
- Good running performance on soft ground and uneven ground



Crawler type tractor excavator

(M141)Earthmoving machinery-loading machine-Wheeled tractor excavator

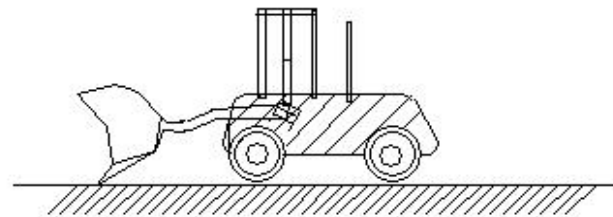
(M141)Earthmoving machinery-loading machine-Wheeled tractor excavator

Earthmoving machinery

Loading machine

Wheeled tractor excavator

- Running speed - fast
- High mobility
- Paved roads - do not damage the road surface
- work freely



tractor excavator

(M142)Earthmoving machinery-loading machine-Loading method

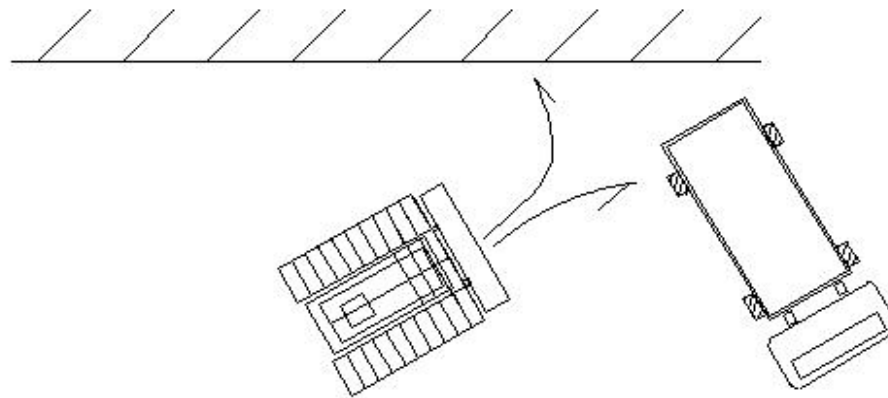
(M142)Earthmoving machinery-loading machine-Loading method

Earthmoving machinery

Loading method

- V shape

Soil to be loaded



tractor excavator

Dump truck

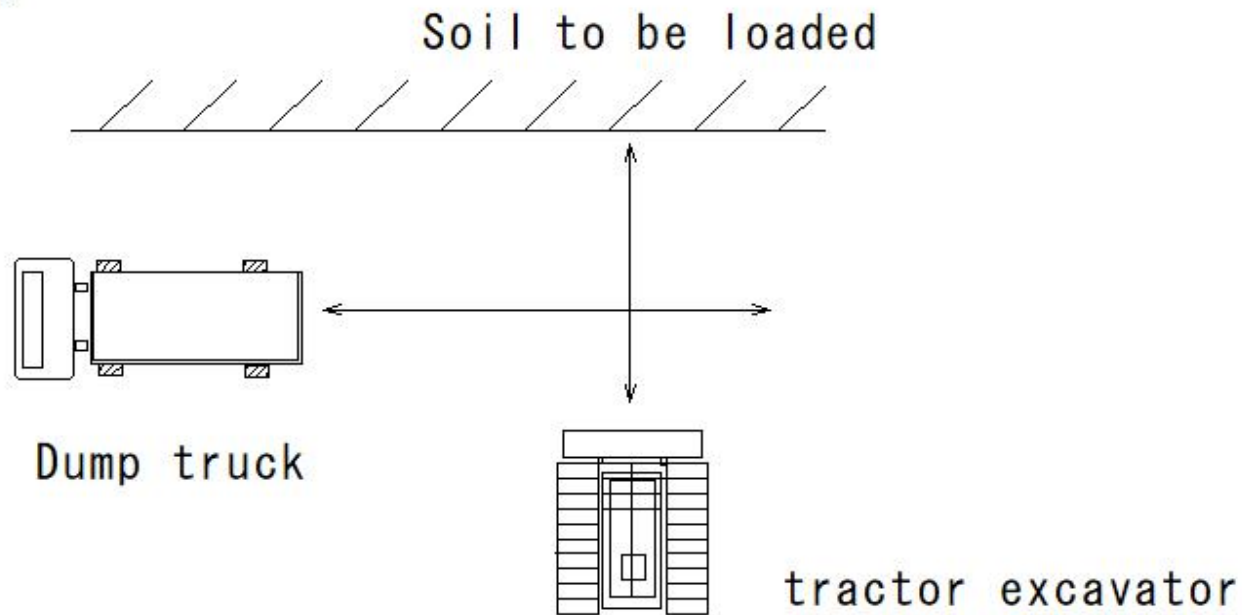
(M143)Earthmoving machinery-loading machine-Loading method

(M143)Earthmoving machinery-loading machine-Loading method

Earthmoving machinery

Loading method

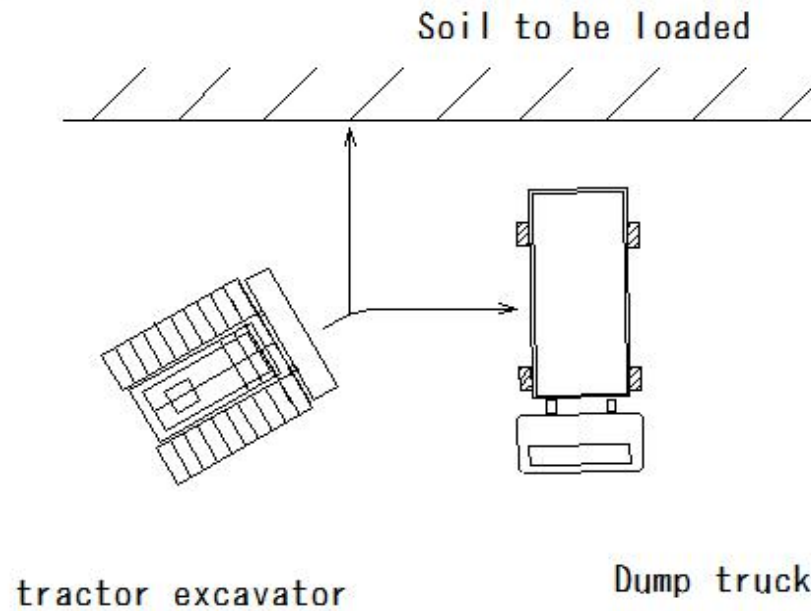
- I shape



(M144)Earthmoving machinery-loading machine-Loading method

(M144) Earthmoving machinery-loading machine-Loading method

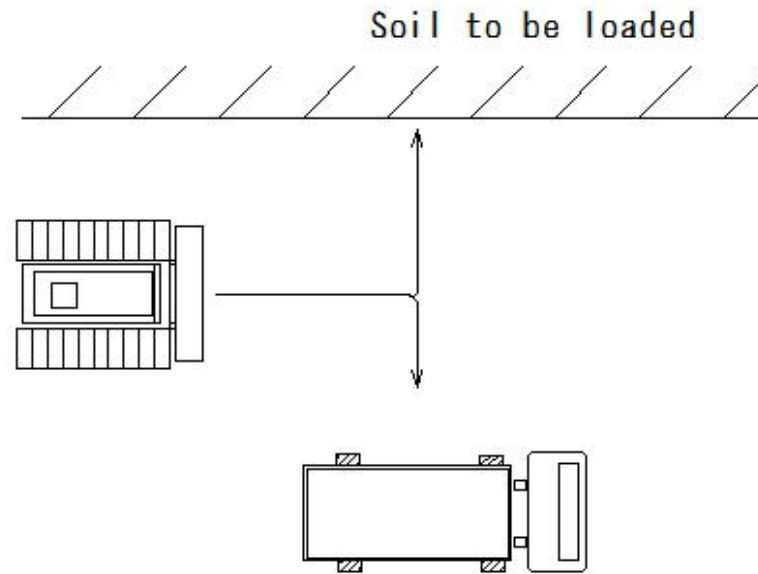
Earthmoving machinery
Loading method
• L shape



(M145)Earthmoving machinery-loading machine-Loading method

(M145)Earthmoving machinery-loading machine-Loading method

Earthmoving machinery
Loading method
• T shape



tractor excavator

Dump truck

E296

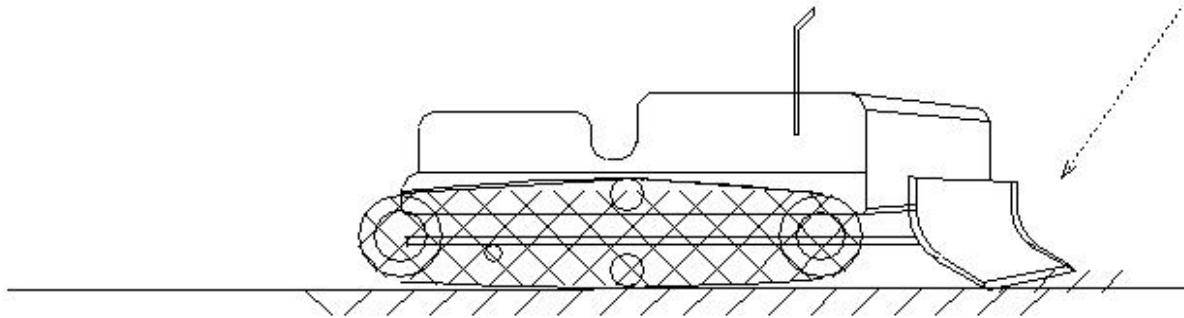
(M146)Earthmoving machinery-transport machinery-Straight dozer

(M146) Earthmoving machinery-transport machinery-Straight dozer

Earthmoving machinery

Transport machinery

- Straight dozer
- Angle is fixed
- Attach the soil removal plate (blade) at right angles to the direction of travel.
- Suitable for heavy excavation



(M147)Earthmoving machinery-transport machinery-Angle dozer

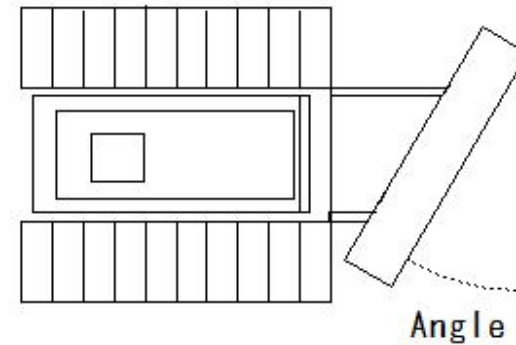
(M147)Earthmoving machinery-transport machinery-Angle dozer

Earthmoving machinery

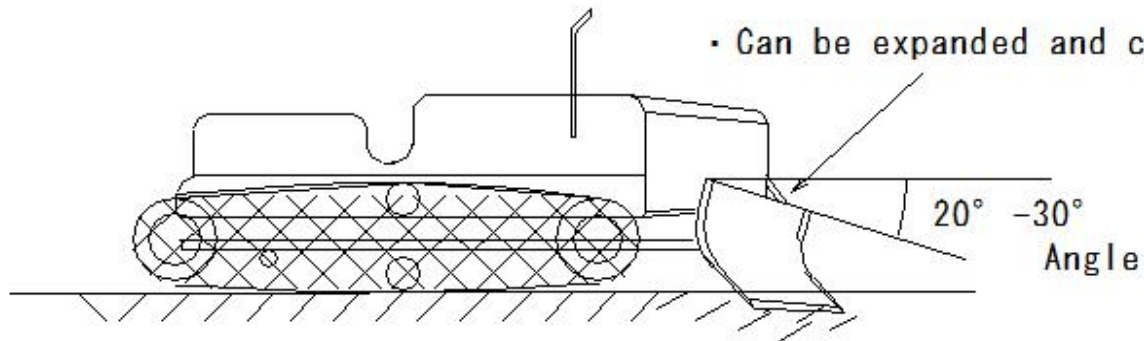
Transport machinery

- Angle dozer
- Slope excavation/ground leveling
- Not suitable for heavy excavation

Plan view



• Can be expanded and contracted



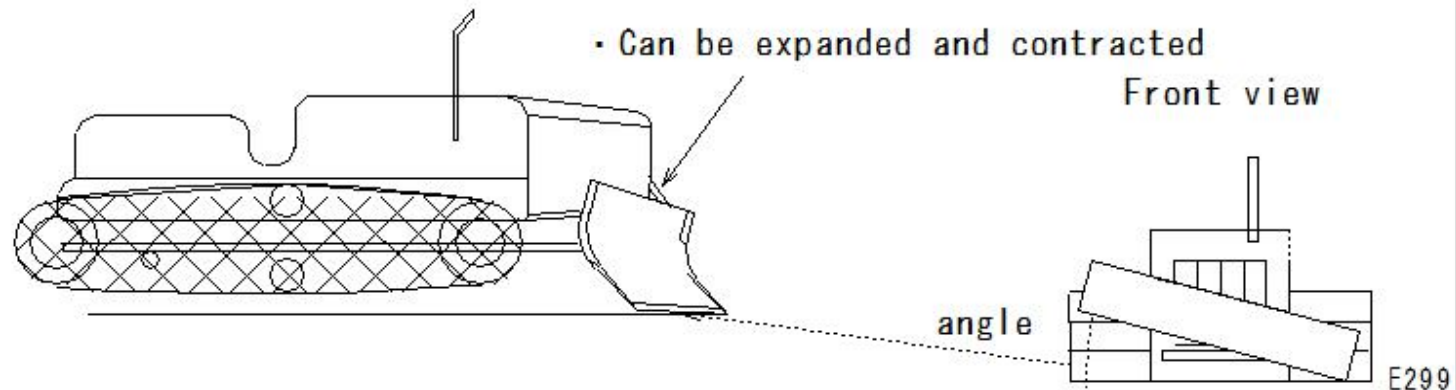
(M148)Earthmoving machinery-transport machinery-Tilt dozer

(M148)Earthmoving machinery-transport machinery-Tilt dozer

Earthmoving machinery

Transport machinery

- Tilt dozer
- Can be expanded and contracted
- Change the height of the left and right blades
- Ditching, cutting, hard soil excavation



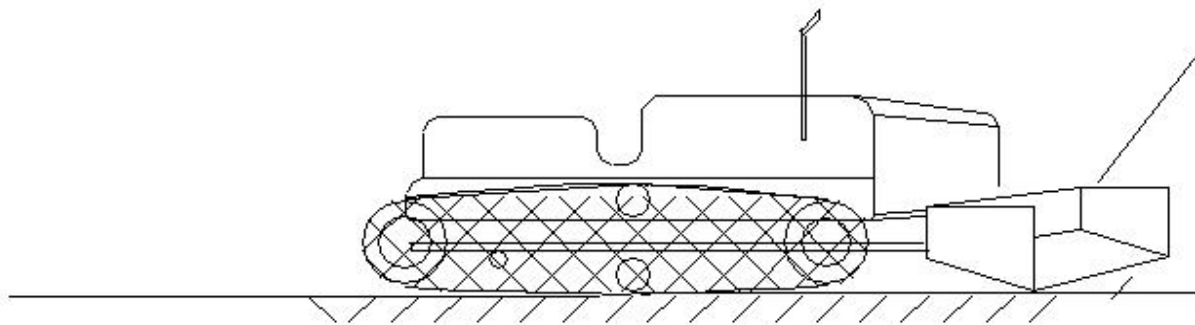
(M149)Earthmoving machinery-transport machinery-U dozer

(M149)Earthmoving machinery-transport machinery-U dozer

Earthmoving machinery

Transport machinery

- U dozer
- Improved soil transportation efficiency



- U shape
- don't spill soil

(M150)Earthmoving machinery-transport machinery-Rake dozer

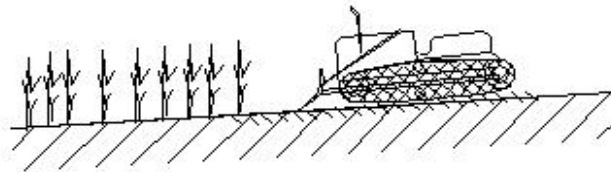
(M150)Earthmoving machinery-transport machinery-Rake dozer

Earthmoving machinery

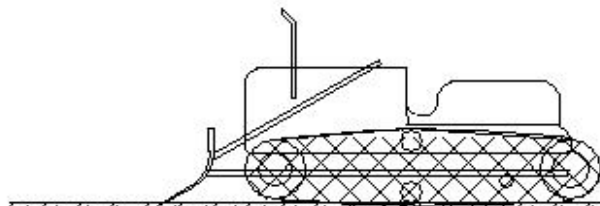
Transport machinery

• Rake dozer

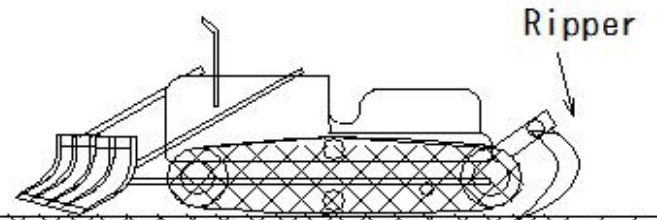
• Clearing and rock digging



bulldozer



rake dozer



E301

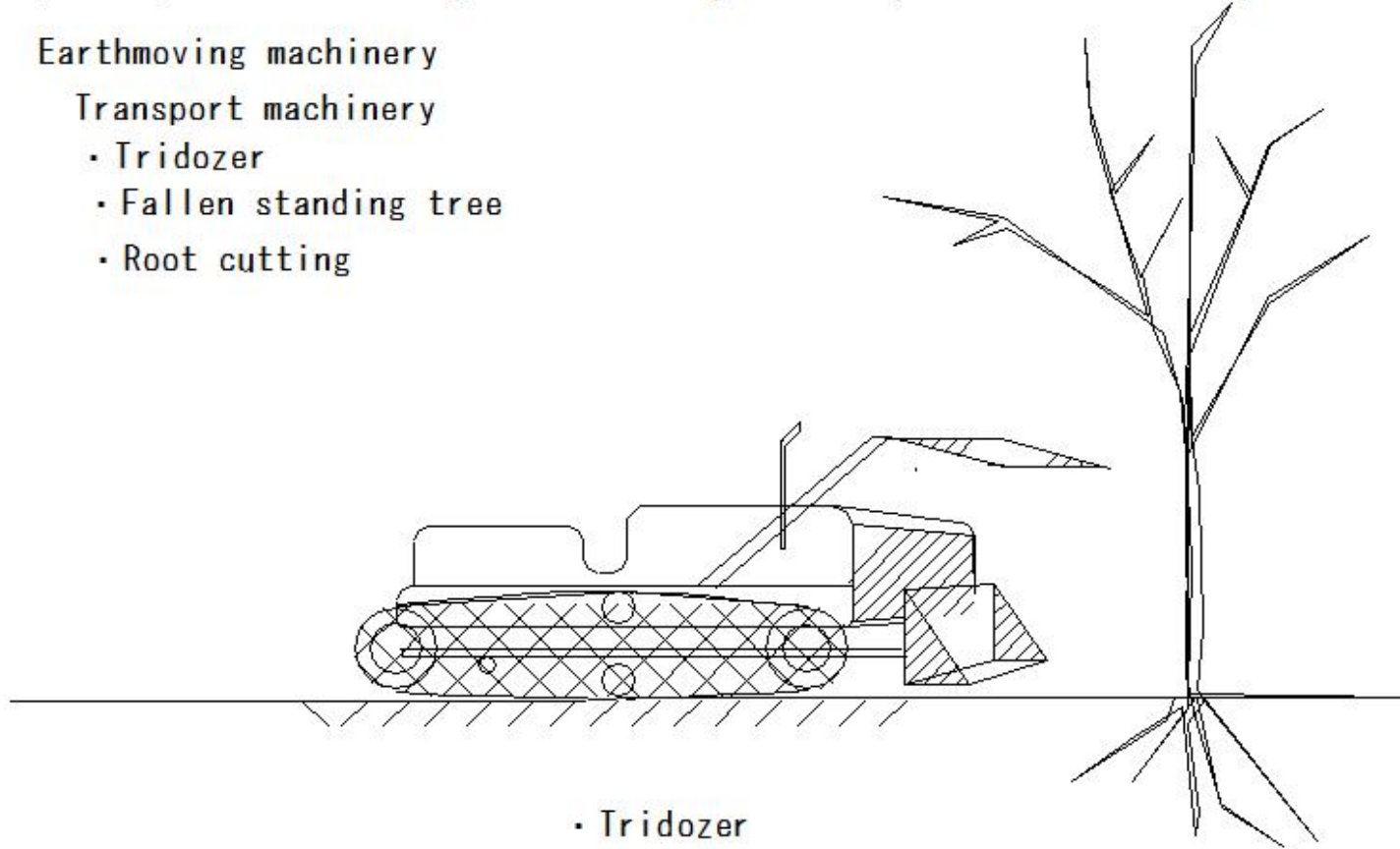
(M151)Earthmoving machinery-transport machinery-Tridozer

(M151)Earthmoving machinery-transport machinery-Tridozer

Earthmoving machinery

Transport machinery

- Tridozer
- Fallen standing tree
- Root cutting



E302

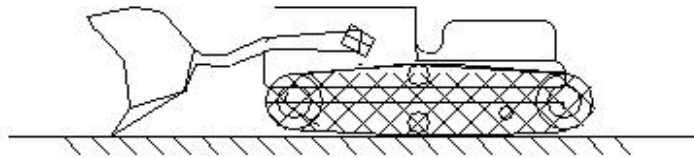
(M152)Earthmoving machinery-transport machinery-Bucket dozer

(M152)Earthmoving machinery-transport machinery-Bucket dozer

Earthmoving machinery

Transport machinery

- Bucket dozer
- Loading of earth and sand
- Transportation



bucket dozer

E303

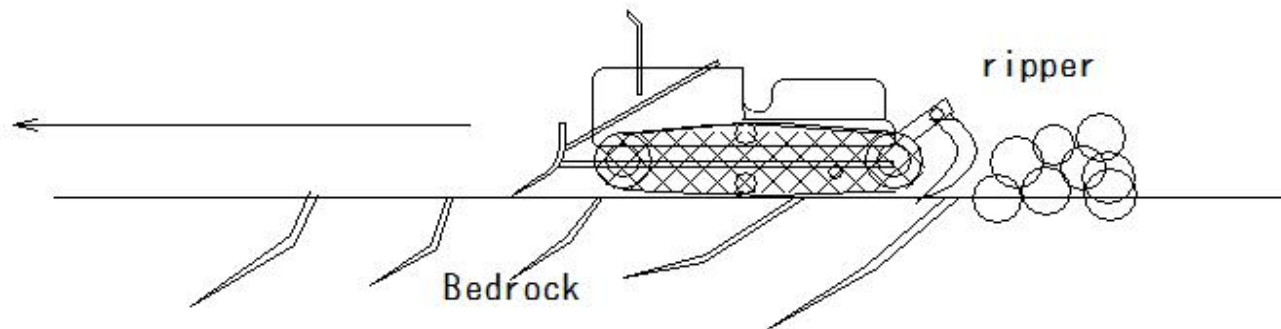
(M153)Earthmoving machinery-transport machinery-Ripper

(M153)Earthmoving machinery-transport machinery-Ripper

Earthmoving machinery

Transport machinery

- Ripper
- Bedrock excavation



E304

(M154)Earthmoving machinery-transport machinery-Installation pressure

(M154)Earthmoving machinery-transport machinery-Installation pressure

Earthmoving machinery

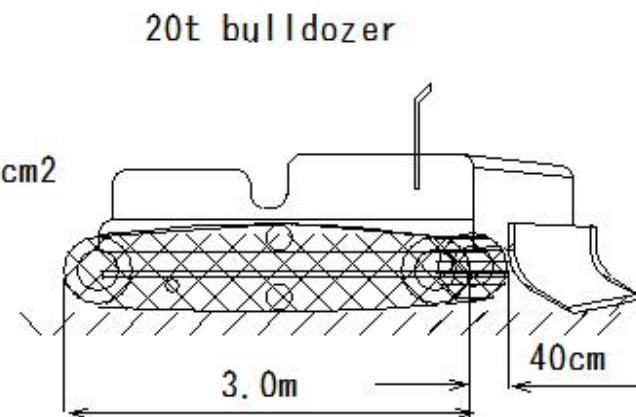
Transport machinery

- Installation pressure
 - Average installation pressure (kgf/cm²)
 - Operating and maintenance weight/total installation area
- = Total weight (kgf/cm²) / 2 x crawler width x ground contact length (cm)

example

- 20t bulldozer
- Width 40cm
- Length 3.0m

- Installation pressure
= 20000kgf / (2 × 40cm × 300cm) = 0.83kgf/cm²



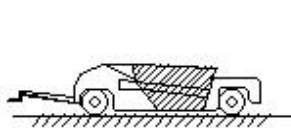
E305

(M155)Earthmoving machinery-transport machinery-Scraper

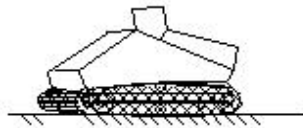
(M155)Earthmoving machinery-transport machinery-Scraper

Earthmoving machinery
Transport machinery

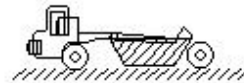
- Scraper
 - 1 cycle: excavation, loading, transportation, unrolling, leveling
 - Transportation at high speed and in large quantities
- ① Towed scraper
 - ② Self-propelled scraper (motor scraper)
 - ③ Scraper dozer: bulldozer + scraper



Towed scraper



scrape dozer



motor scraper

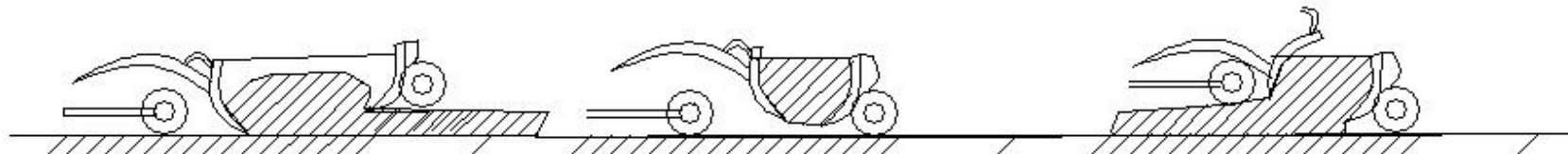
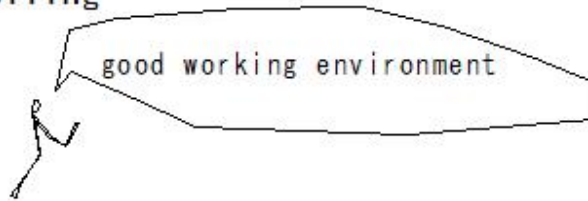
(M156)Earthmoving machinery-transport machinery-Scraper-Work procedure

(M156)Earthmoving machinery-transport machinery-Scraper-Work procedure

Earthmoving machinery
Transport machinery

- scraper
- Work procedure

- ① Excavation/loading
- ② Transportation
- ③ Unrolling



① Excavation/loading

② Transportation

③ Unrolling

(M157)Earthmoving machinery-transport machinery-Scraper-Type of scraper

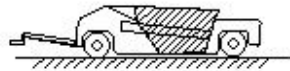
(M157)Earthmoving machinery-transport machinery-Scraper-Type of scraper

Earthmoving machinery

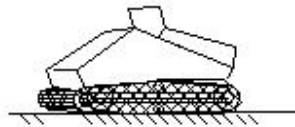
Transport machinery

- scraper
- Type of scraper

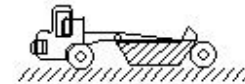
- ① Towed scraper
- ② Self-propelled scraper (motor scraper)
- ③ Scraper dozer: bulldozer + scraper



Towed scraper



scrape dozer



motor scraper



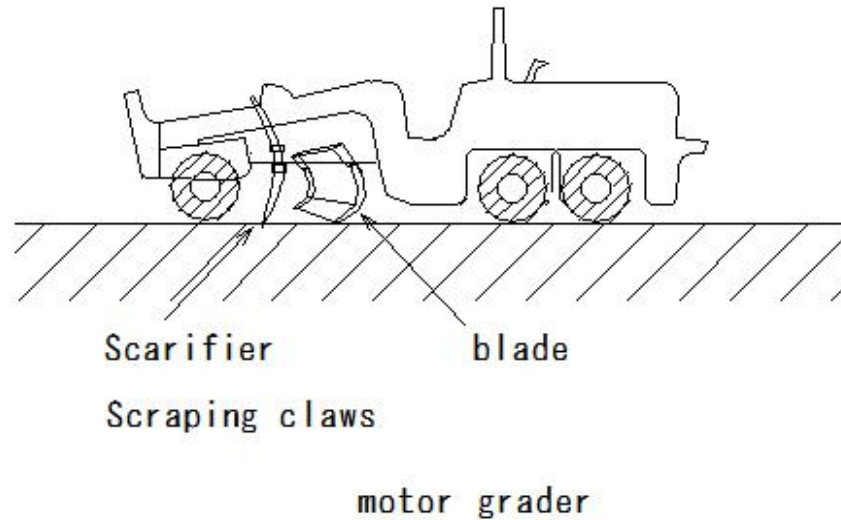
(M158)Earthmoving machinery-transport machinery-Motor grader

(M158) Earthmoving machinery-transport machinery-Motor grader

Earthmoving machinery

Transport machinery

- Spreading
- Motor grader



E309

(M159)Earthmoving machinery-Compaction machines-Road roller

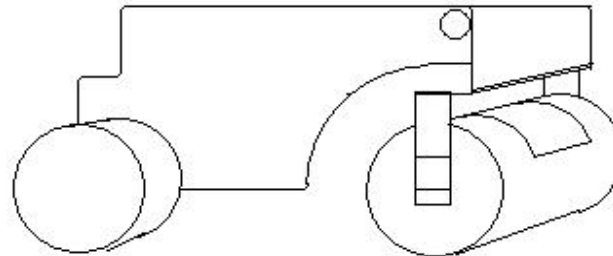
(M159) Earthmoving machinery-Compaction machines-Road roller

Earthmoving machinery

Compaction machines

Road roller

- Macadam roller (two-axle three-wheeled)
- Weight can be adjusted
- Guide wheel (1 wheel side) Linear pressure is low
- Initial compaction Initial compaction with drive wheels



macadam roller

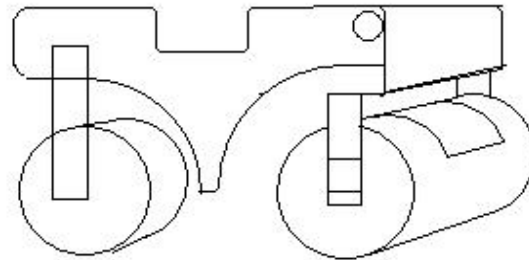
(M160)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)

(M160)Earthmoving machinery-Compaction machines-Tandem roller (two axes and two wheels)

Earthmoving machinery

Compaction machines

- Tandem roller (two axes and two wheels)
- Anteroposterior axis - independent
- Asphalt pavement finish



- Tandem roller (two axes and two wheels)

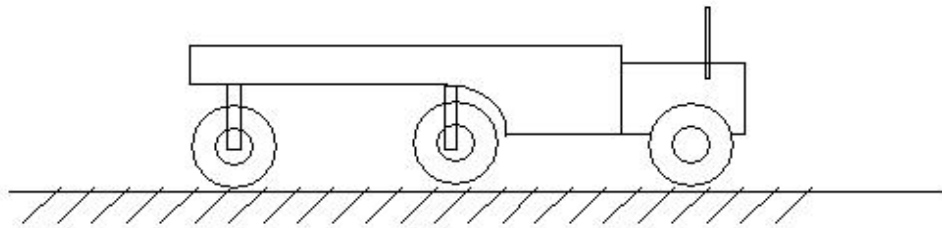
(M161)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)

(M161)Earthmoving machinery-Compaction machines-Three-axis tandem roller (three-axis three-wheel)

Earthmoving machinery

Compaction machines

- Three-axis tandem roller (three-axis three-wheel)
- Flatness - improved compaction



Three-axis tandem roller (three-axis three-wheel)

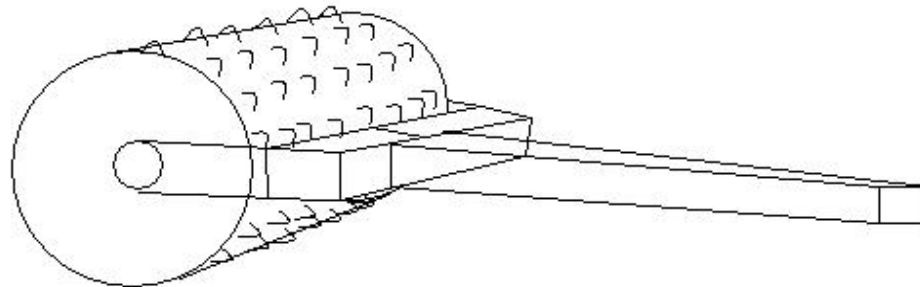
(M162)Earthmoving machinery-Compaction machines-Tamping roller

(M162) Earthmoving machinery-Compaction machines-Tamping roller

Earthmoving machinery

Compaction machines

- Tamping roller
- Compaction of hard clay



Tamping roller

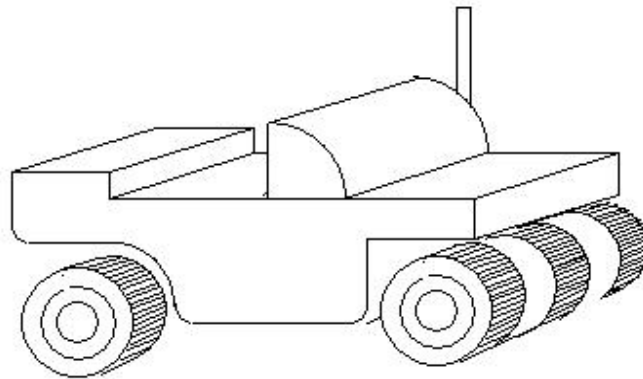
(M163)Earthmoving machinery-Compaction machines-Tire roller

(M163)Earthmoving machinery-Compaction machines-Tire roller

Earthmoving machinery

Compaction machines

- Tire roller
- Air pressure adjustment Linear pressure adjustment
- Raise ballast (weight) - line pressure -
- Rolling from relatively soft ground to hard ground
- Not suitable for compacting soft soil



Tire roller

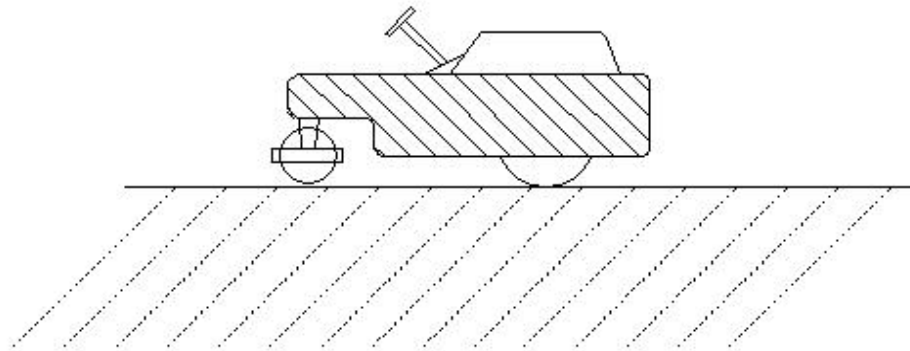
(M164)Earthmoving machinery-Compaction machines-Vibration roller

(M164)Earthmoving machinery-Compaction machines-Vibration roller

Earthmoving machinery

Compaction machines

- Vibration roller
- Lack of own weight
- Supplement with Vibration
- Small machines
- Compaction of gravel and sandy soil



Vibration roller

E316

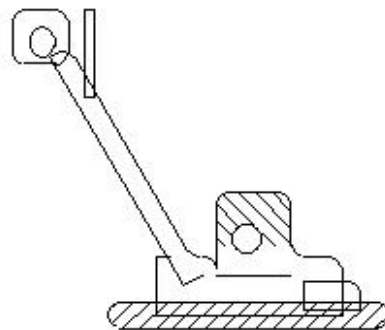
(M165)Earthmoving machinery-Compaction machines-Vibration compactor

(M165)Earthmoving machinery-Compaction machines-Vibration compactor

Earthmoving machinery

Compaction machines

- Vibration compactor
- Work place – narrow space



vibrating compactor

E317

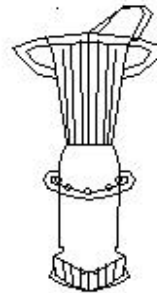
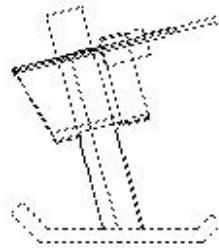
(M166)Earthmoving machinery-Compaction machines-Vibration compactor

(M166)Earthmoving machinery-Compaction machines-Vibration compactor

Earthmoving machinery

Compaction machines

- Tampa Ranma
- Increased impact load - compaction
- Soft soil - unsuitable



Tampa Ranma

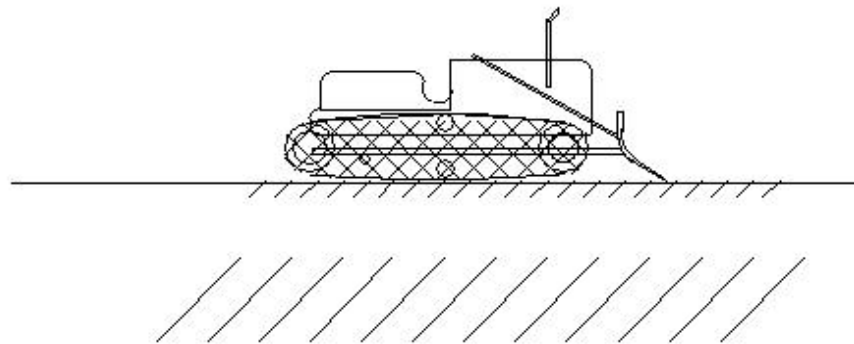
(M167)Earthmoving machinery-Compaction machines-Wetland bulldozer

(M167)Earthmoving machinery-Compaction machines-Wetland bulldozer

Earthmoving machinery

Compaction machines

- Compaction of soft ground
- Wetland bulldozer



wetland bulldozer

E319

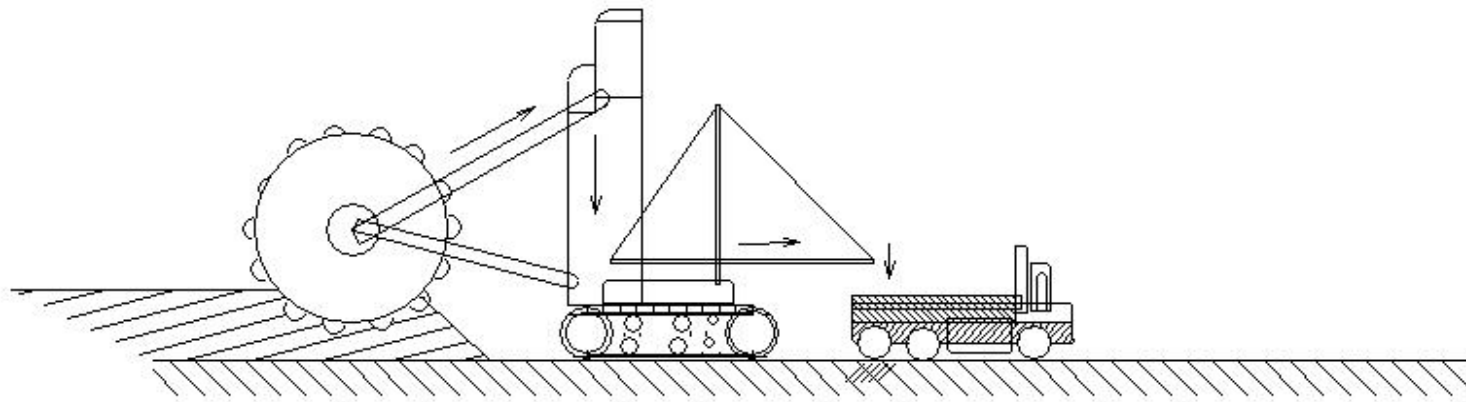
(M168)Earthmoving machinery-Transport machinery-Bucket wheel excavator

(M168)Earthmoving machinery-Transport machinery-Bucket wheel excavator

Earthmoving machinery

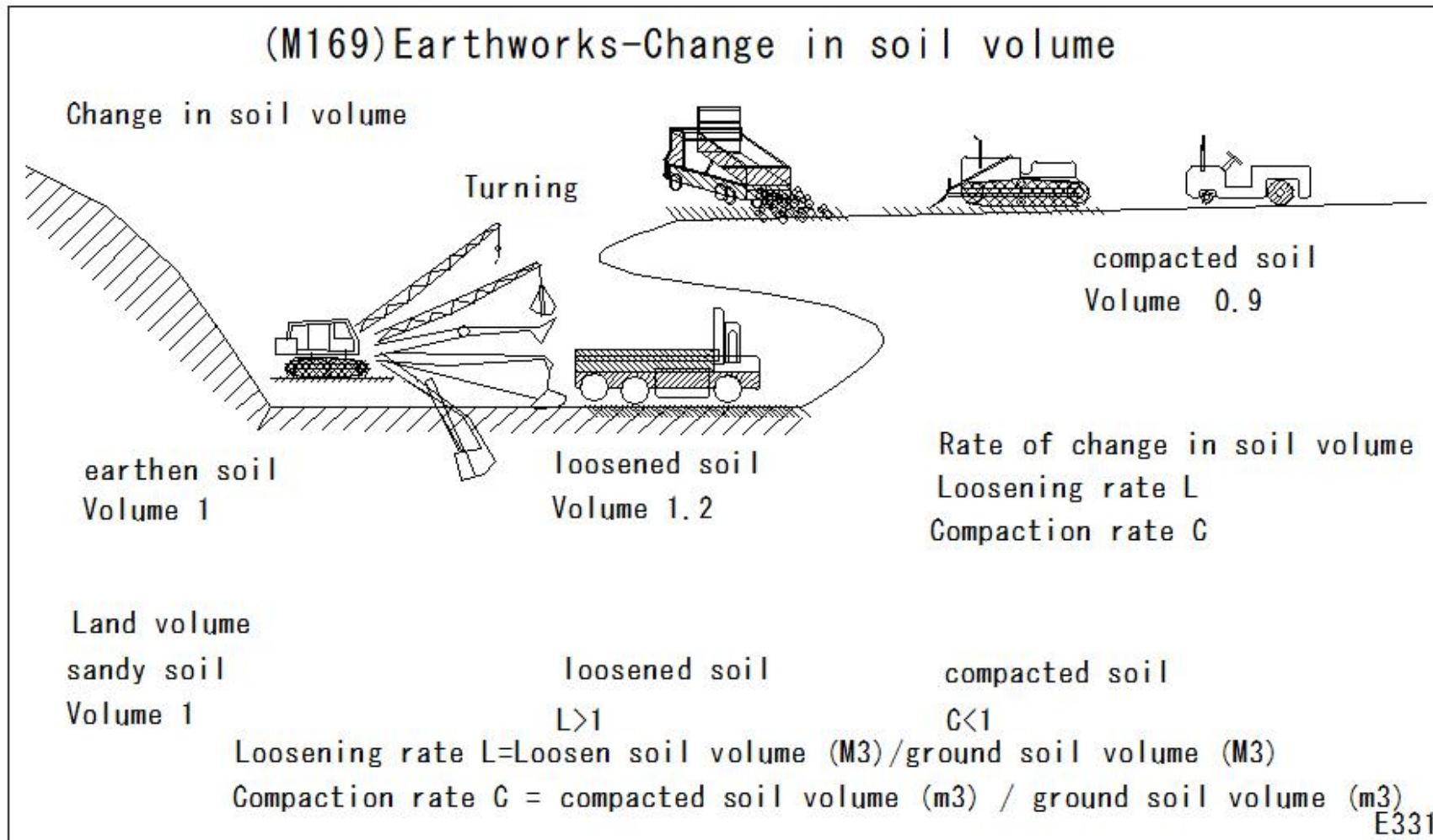
Transport machinery

- Bucket wheel excavator
- Bucket wheel
- Large-scale civil engineering work
- Use of large residential land development



Bucket wheel excavator

(M169)Earthworks-Change in soil volume



(M170)Earthworks-Change in soil volume-Calculation of loosened soil volume

(M170)Earthworks-Change in soil volume-Calculation of loosened soil volume

Change in soil volume

Calculation of loosened soil volume

Earth: 1000m³

Dump truck: 6m³ How many ?

Loosening rate L=1.2

① Amount of soil loosened - standard

$$1000 \times 1.2 = 1200 \text{m}^3$$

Required number

$$N = 1200 / 6 = 200 \text{ times}$$

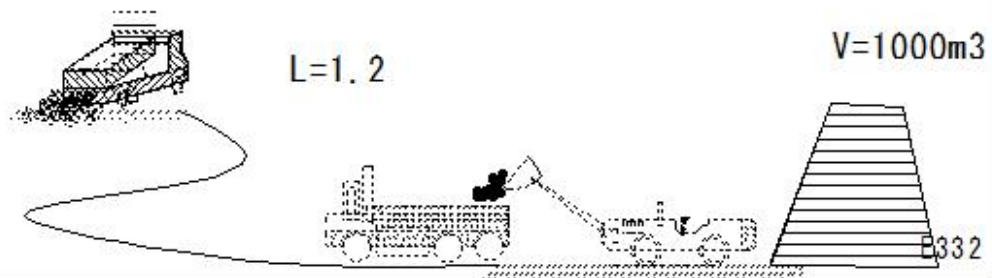
② Land volume - standard

Volume of soil transported per dump truck Q

$$Q = 6 \times 1/L = 6 \times 1/1.2 = 5 \text{m}^3$$

Required number of units $N = 1000/5 = 200$ units

$1/L$ = soil volume conversion factor f



(M171)Earthworks-Change in soil volume-Calculation of compacted soil volume

(M171)Earthworks-Change in soil volume-Calculation of compacted soil volume

Change in soil volume

Calculation of compacted soil volume

Earth volume - excavation: 200m³

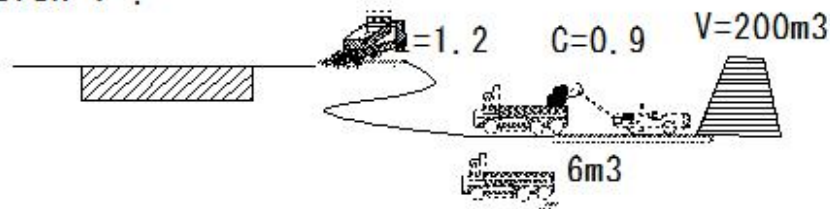
embankment

Transport of 2 dump trucks 6m³

Required number n ?

Volume of soil after compaction V ?

L=1.2 C=0.9



• Amount of ground that can be transported with one dump truck Q1

• $Q1 = f \times 6 = 1/1.2 \times 6 = 5m^3$

• Dump trucks 2 units ? Transport volume Q

• $Q = 2 \times Q1 = 2 \times 5 = 10m^3$

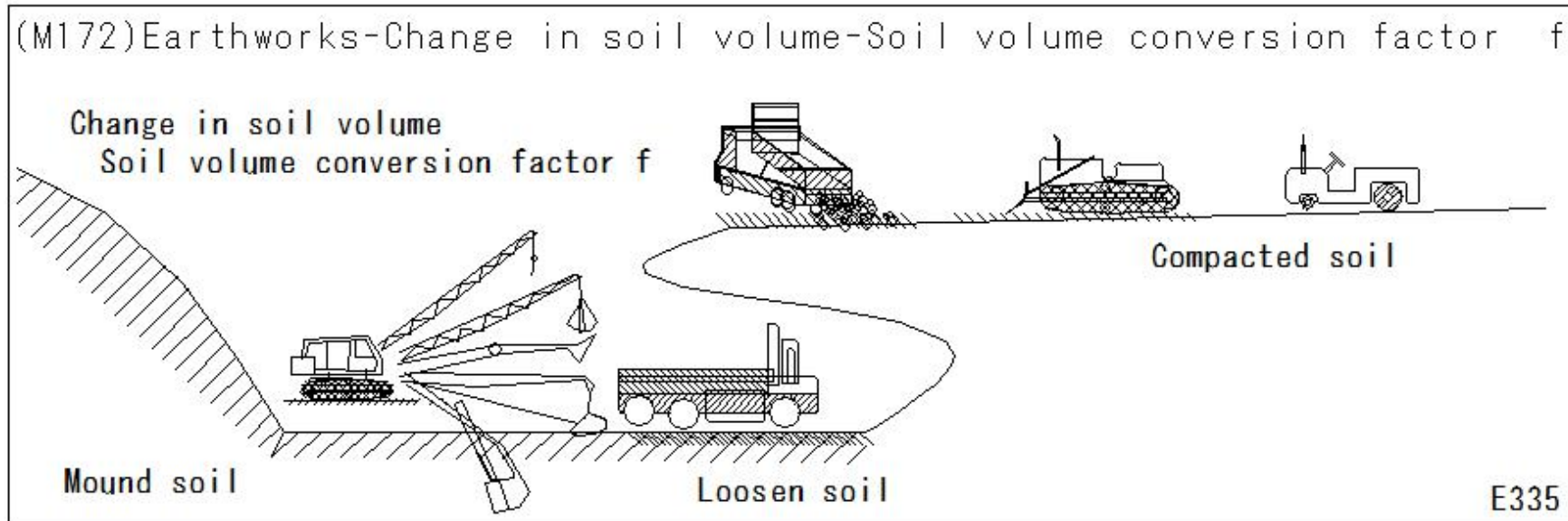
• Number of dump trucks transported n

• $n = 200/Q = 200/10 = 20$ units

Embankment - volume of soil after compaction V

$V = C \times 200 = 0.9 \times 200 = 180m^3$

(M172)Earthworks-Change in soil volume-Soil volume conversion factor f



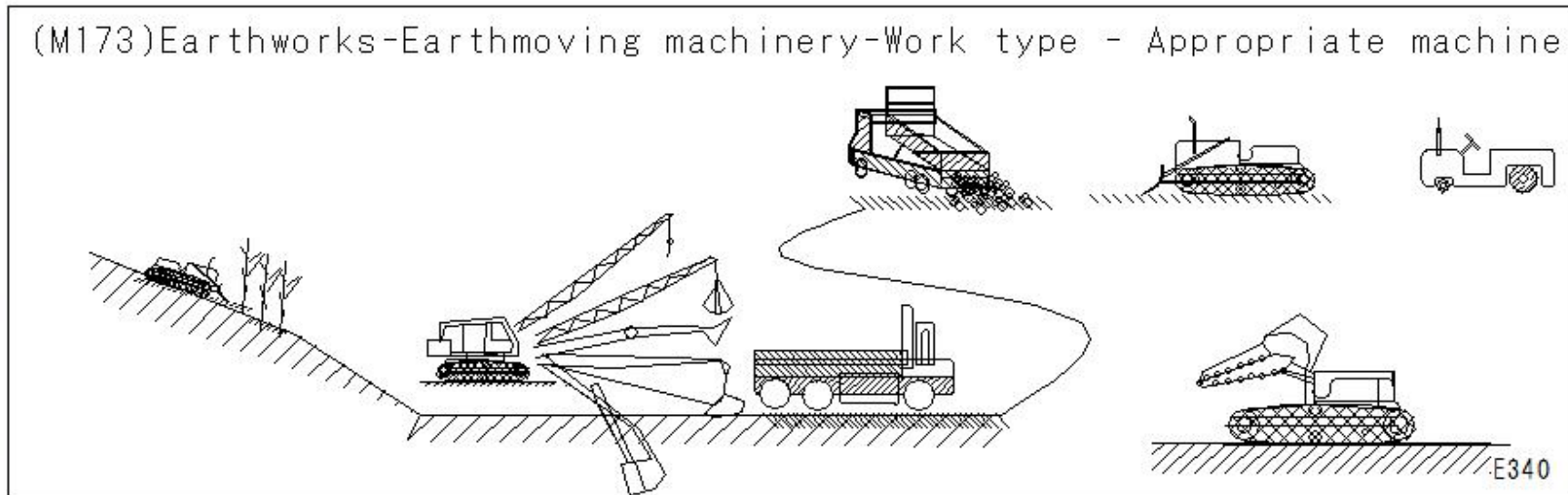
(M172)Earthworks-Change in soil volume-Soil volume conversion factor f

Change in soil volume

Soil volume conversion factor f

Soil condition when finding Q	Mound soil	Loosen soil	Compacted soil
Reference soil condition of q			
Mound soil	1	L	C
Loosen soil	1/L	1	C/L
Compacted soil	1/C	L/C	1

(M173)Earthworks-Earthmoving machinery-Work type - Appropriate machine

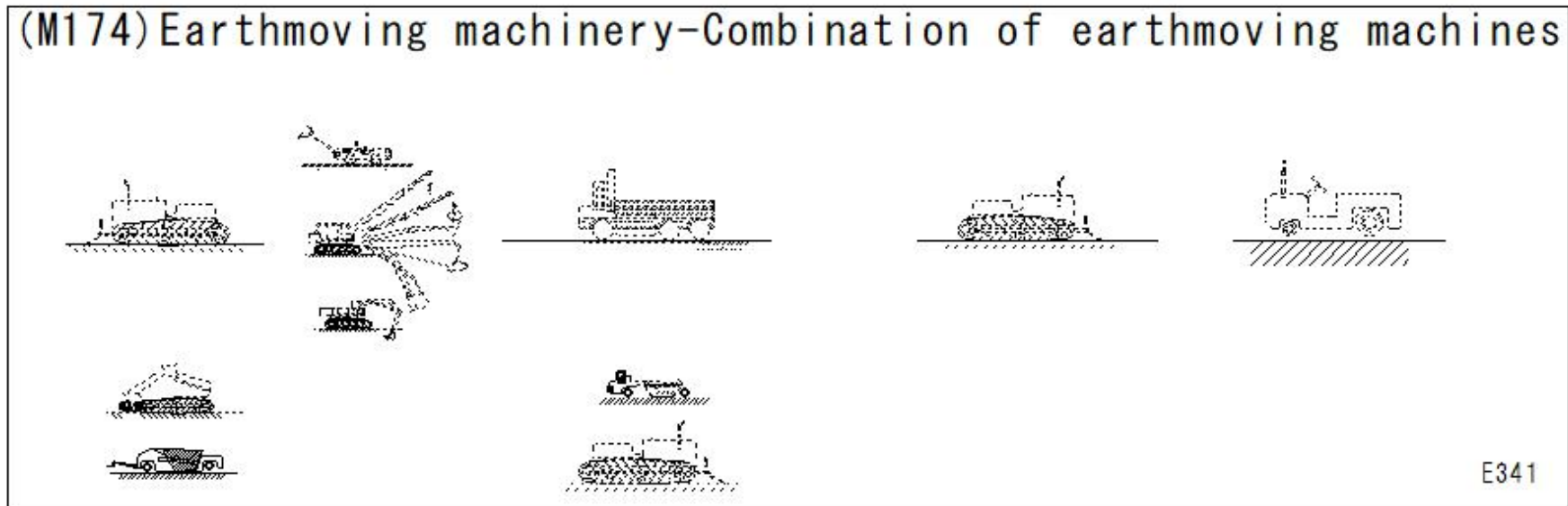


Earthmoving machinery

• Work type - Appropriate machine

1 Clearance	12 Bulldozer/Rakedozer
2. Excavation	13 Excavator type excavator (power shovel, backhoe, dragline, clamshell) Tractor excavator bulldozer ripper
3 Loading	14 Excavator type excavator Tractor excavator
4 Excavation/loading	15 Excavator type excavator Tractor excavator
5 Excavation/Transportation	16 Bulldozer, scrape dozer, scraper, tractor excavator
6 Transportation	17 Bulldozer, dump truck, belt conveyor, aerial cableway
7 Leveling the floor	18 Bulldozer, motor grader, spreader
8 Water content ratio adjustment	19 Stabilizer/Motor grader/Water truck
9 Compaction	20 Road roller, tire roller, tamping roller, vibrating roller, vibrating compactor, rammer, tamper, bulldozer
10 Land leveling	21 Bulldozer/motor grader
11 Trench	22 Trencher backhoe

(M174)Earthmoving machinery-Combination of earthmoving machines



(M174)Earthmoving machinery-Combination of earthmoving machines

Earthmoving machinery

- Combination of earthmoving machines
- Working Capacity/Combination Machine: Minimum Working Capacity - Determination
- Machine selection based on transport equipment

1 Excavation soil collection

2 Loading

3 Transport waste soil

4. Leveling the floor

5 Compaction

1-1 Bulldozer

2-1 Tractor shovel/power shovel

3-1 Dump truck

4-1 Bulldozer

5-1 Tire rollers and others

2-2 Tractor shovel/power shovel

4-2 Bulldozer

2-3 Scraper/motor scraper

3-2 Scoop dozer/bulldozer

5-2 Tire rollers and others

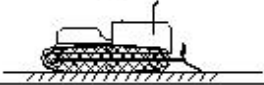
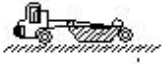
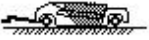

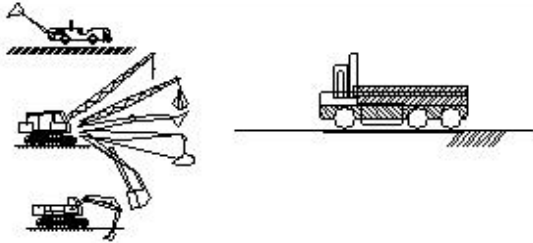
(M175)Earthmoving machinery-Machine selection based on transportation distance

(M175)Earthmoving machinery-Machine selection based on transportation distance

Earthmoving machinery

• Machine selection based on transportation distance

E342

	Distance (m)	Types of construction machinery	
Short distance	100m or less	Bulldozer	
Middle distance	50-500m	Scrape dozer	
	70-500m	Towed scraper	
Long distance	200-2000m	Motor scraper	
	70m or more	Excavator type excavator tractor excavator +dump truck	

(M176)Earthmoving machinery-Types of bulldozers-Straight dozer

(M176)Earthmoving machinery-Types of bulldozers-Straight dozer

Earthmoving machinery

- Types of bulldozers

- 1 Bulldozer: Excavation, dozing and transportation of soil

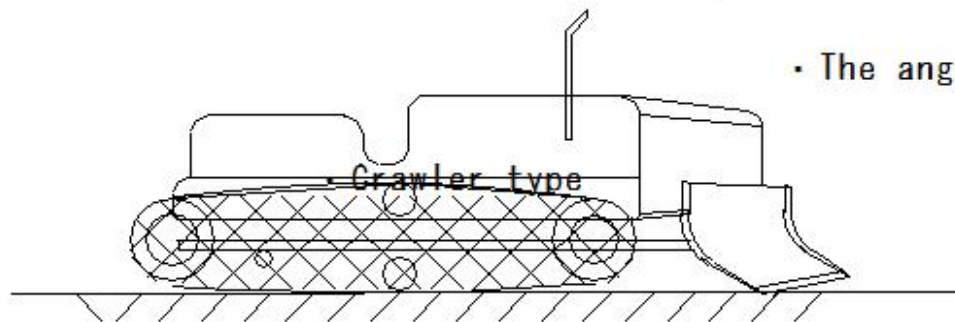
- 2 Suspension: crawler type/wheel type

- 3. Format of earthwork board

- Straight dozer

- Heavy excavation

Body: Tractor



Crawler type

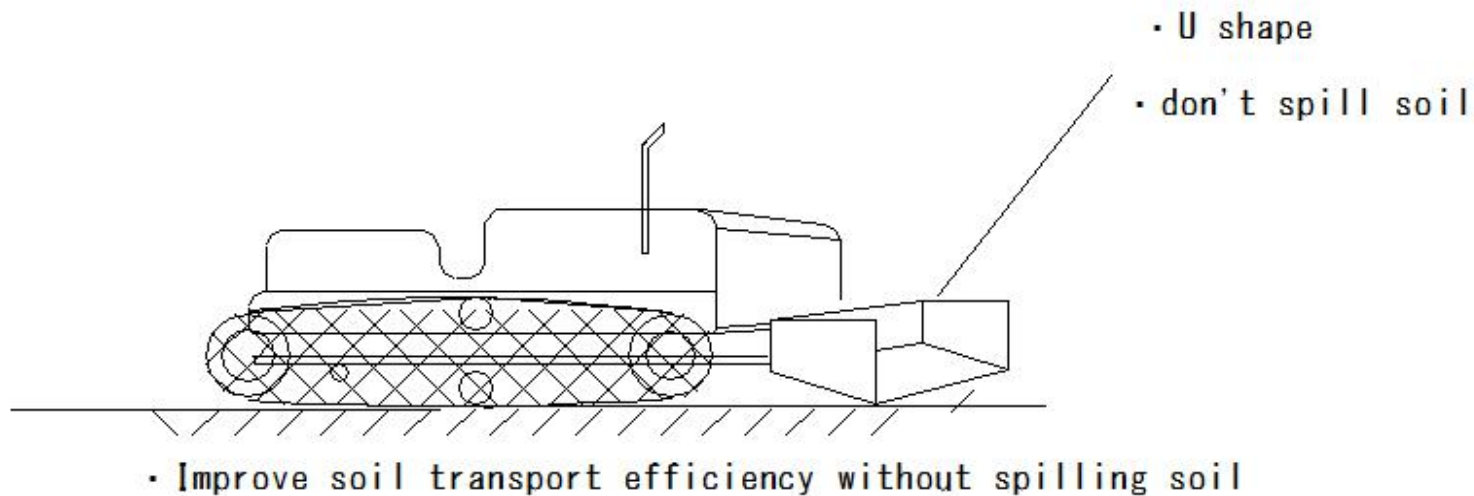
- The angle of the earthwork board is determined.

(M177)Earthmoving machinery-Types of bulldozers-U dozer

(M177)Earthmoving machinery-Types of bulldozers-U dozer

Earthmoving machinery

- Types of bulldozers
- U dozer



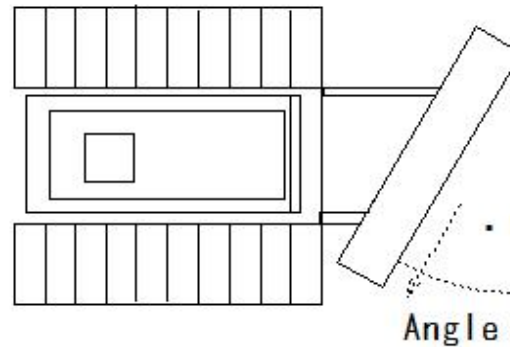
(M178)Earthmoving machinery-Types of bulldozers-Angle dozer

(M178)Earthmoving machinery-Types of bulldozers-Angle dozer

- Earthmoving machinery
- Types of bulldozers
 - Angle dozer

Plan view

• Direction of travel

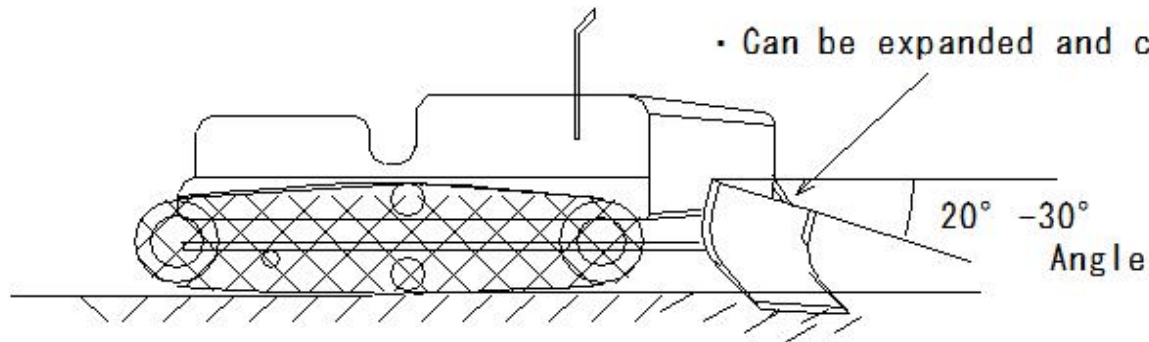


• Send the soil sideways

• Move earth and sand laterally

• Angle up to 30°

• Can be expanded and contracted



(M179)Earthmoving machinery-Types of bulldozers-Tridozer

(M179)Earthmoving machinery-Types of bulldozers-Tridozer

Earthmoving machinery

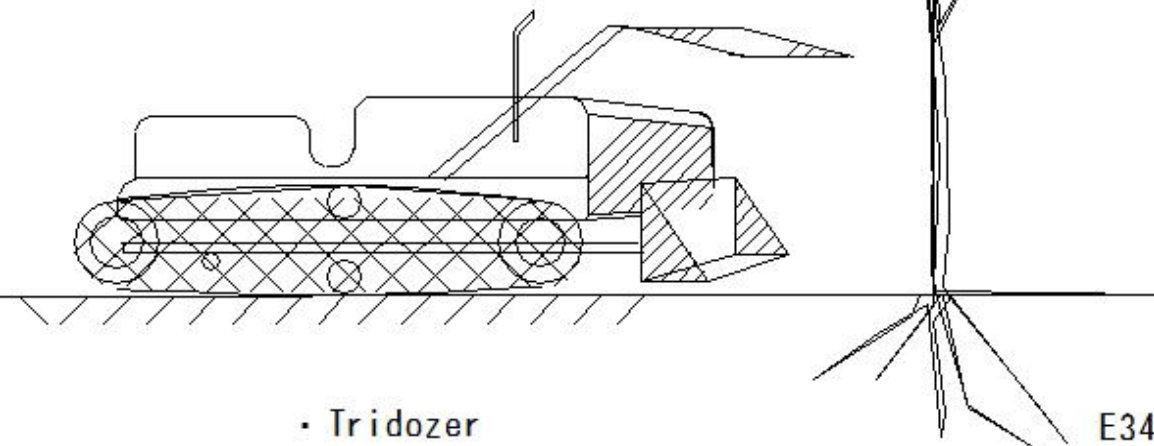
- Types of bulldozers
- Tridozer

- Fallen standing tree
- Root cutting

God sometimes forgets

• Suitable for fallen trees

Forgive Us



• Tridozer

E347

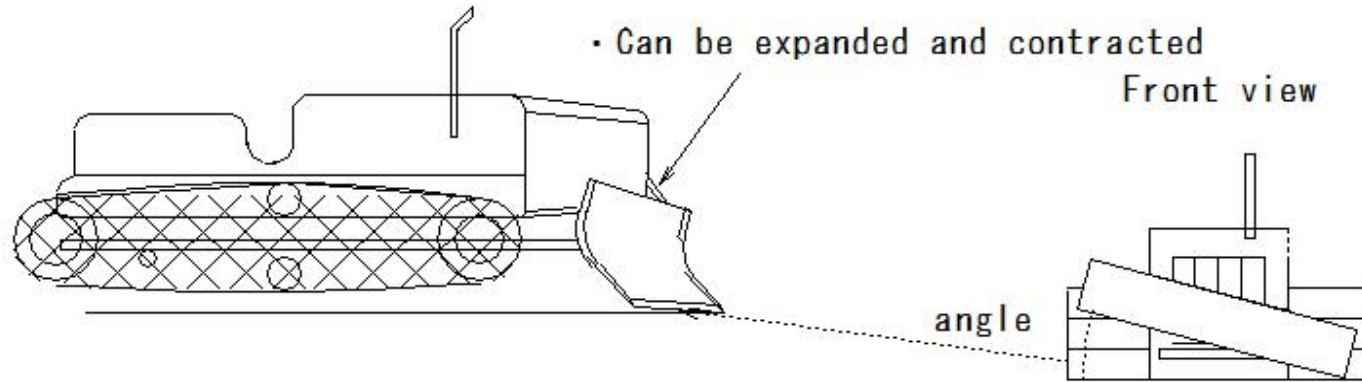
(M180)Earthmoving machinery-Types of bulldozers-Tilt dozer

(M180)Earthmoving machinery-Types of bulldozers-Tilt dozer

- Earthmoving machinery
- Types of bulldozers
 - Tilt dozer

- Ditching/excavation of hard soil

- Can be expanded and contracted



E348

(M181)Earthmoving machinery-Types of bulldozers-Rake dozer

(M181)Earthmoving machinery-Types of bulldozers-Rake dozer

Earthmoving machinery

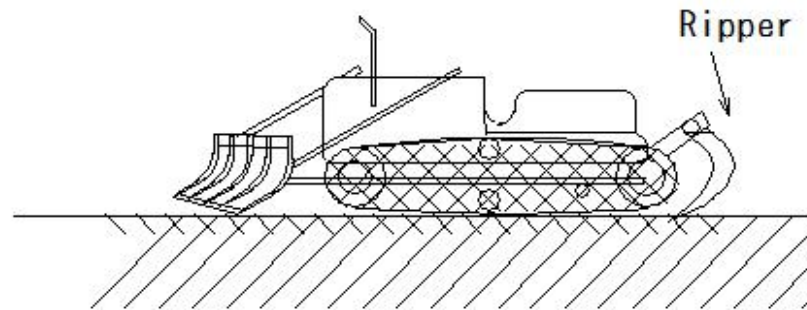
Transport machinery

- Rake dozer

- Suitable for clearing land and creating rock trenches

- Ripper Rake

Rake dozer



E349

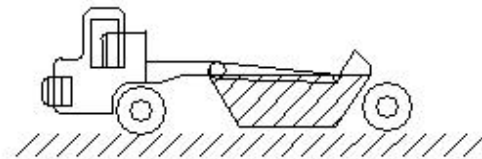
(M182)Earthmoving machinery-Scraper-Self-propelled motor scraper

(M182)Earthmoving machinery-Scraper-Self-propelled motor scraper

Earthmoving machinery

Transport machinery

- Excavation, loading, medium-distance transportation, leveling
- Self-propelled motor scraper
- Tractor-friendly: Covered scraper
- Transportation distance: 200-2000m, large amount of earth and sand, high-speed transportation



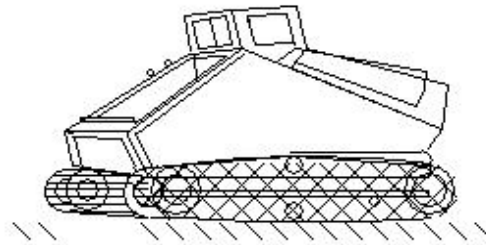
motor scraper

(M183)Earthmoving machinery-Scraper-Scraper + bulldozer combination

(M183)Earthmoving machinery-Scraper-Scraper + bulldozer combination

Earthmoving machinery

- Scrap dozer
- Scraper + bulldozer combination
- Can move forward/backward
- Earthwork work on soft ground
- Transportation distance: 500m or less



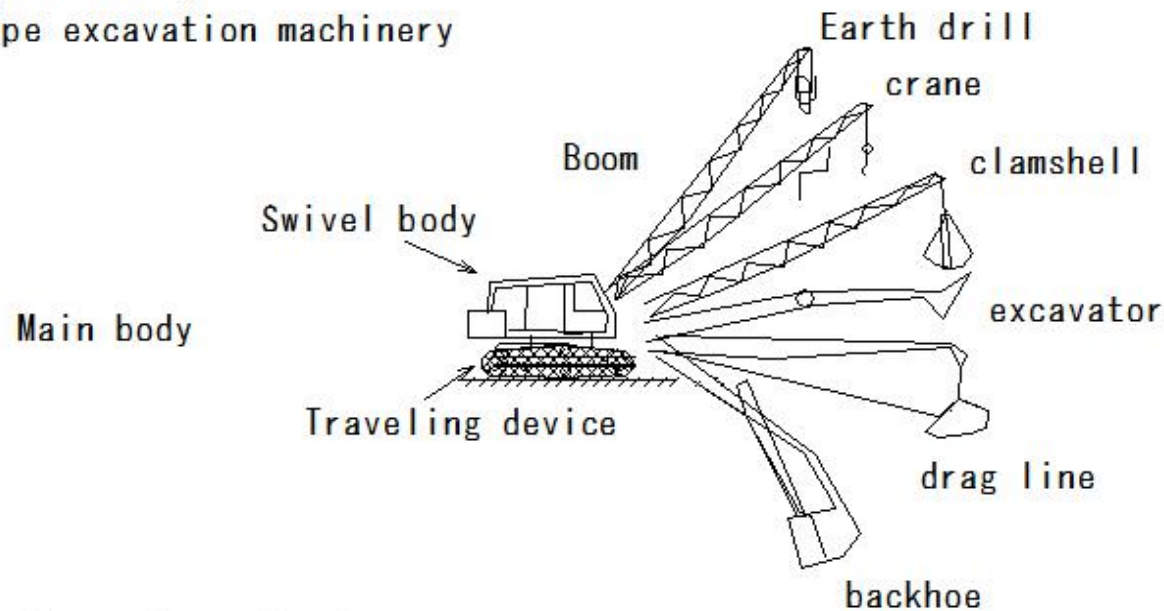
scrape dozer

(M184)Earthmoving machinery-Shovel type excavation machinery

(M184)Earthmoving machinery-Shovel type excavation machinery

Earthmoving machinery

Shovel type excavation machinery



- ① Attachment installation
- ② Excavation location - Machine position - High - Power shovel
- ③ Low place drag excavator (backhoe)
- ④ Underwater drilling dragline clamshell
- ⑤ Earth drill: Drilling holes for cast-in-place piles

E353

(M185)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method+Downhill construction method

(M185)Earthmoving machinery-How to excavate the ground (by machine)- Downhill construction method

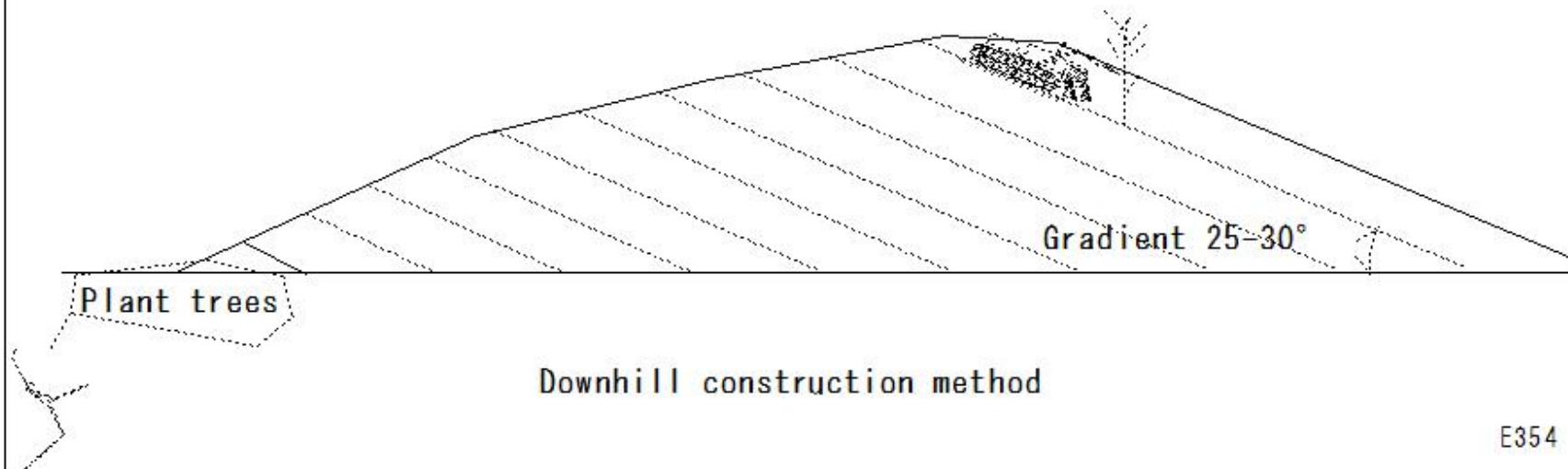
Earthmoving machinery

- How to excavate the ground (by machine)

Downhill construction method

- Bulldozer scraper scraper
- Work on a downhill slope
- Gradient 25-30°
- Starts from clearing and cutting roots

God Bless You



E354

(M186)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method

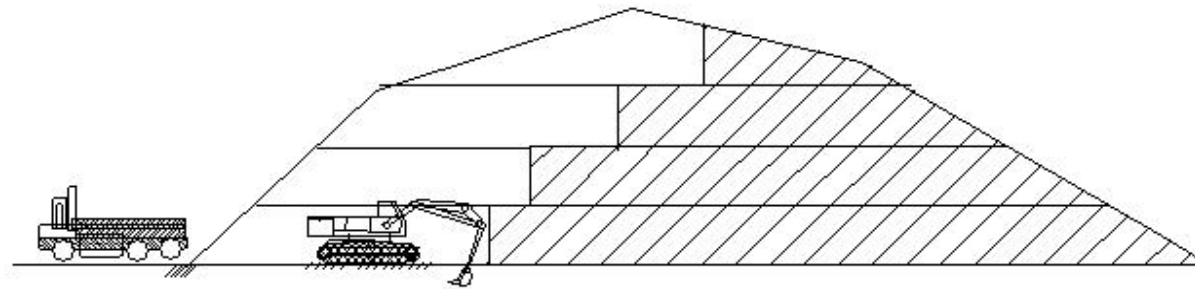
(M186)Earthmoving machinery-How to excavate the ground (by machine)- Bench cut method

Earthmoving machinery

- How to excavate the ground (by machine)

Bench cut method

- Step-type power shovel backhoe excavation
- Dump truck transportation
- Large-scale earthworks



Bench cut method

(M187)Earthmoving machinery-How to excavate the ground (by machine)-Combination method

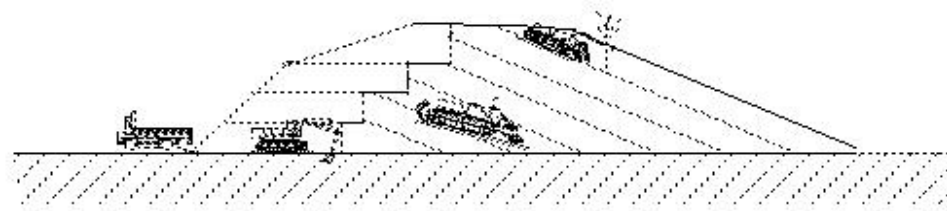
(M187)Earthmoving machinery-How to excavate the ground (by machine)-Combination method

Earthmoving machinery

- How to excavate the ground (by machine)

Combination method

- Bench cut method + downhill method
- Rock excavation: blasting method, ripper method



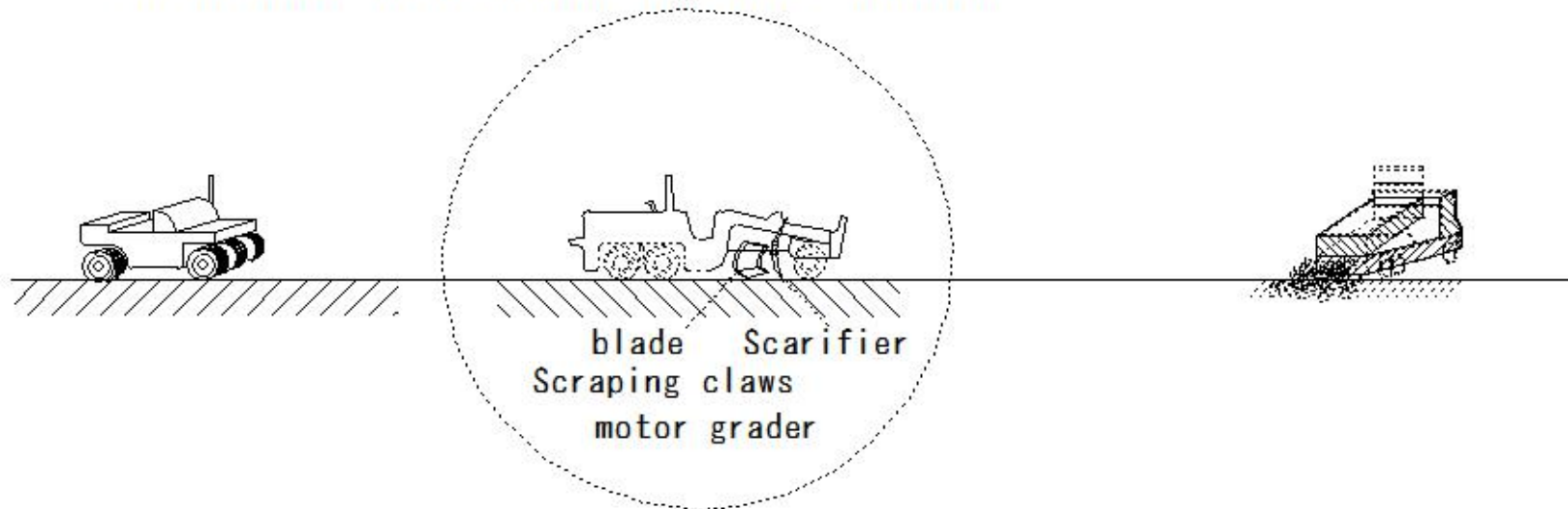
E355

(M188)Earthmoving machinery-Spreading Leveling/compaction-Motor grader

(M188)Earthmoving machinery-Spreading Leveling/compaction-Motor grader

Earthmoving machinery

- Spreading Leveling/compaction
- Motor grader
- Smoothing out uneven road surfaces
- Spreading Leveling of the roadbed
- Earthwork board: Up/down/left/right rotation
- Excavation to create a hard soil moat: Scarifier



E356

(M189)Earthmoving machinery-Compaction machine-Static pressure

(M189) Earthmoving machinery-Compaction machine-Static pressure

Earthmoving machinery

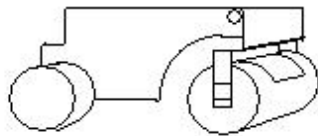
• Compaction machine

• Static pressure

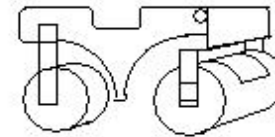
① Road roller macadam roller tandem roller

② Tire roller

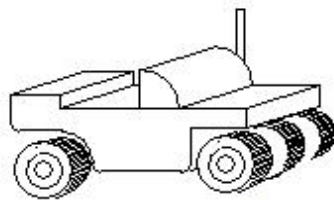
③ Tandem roller



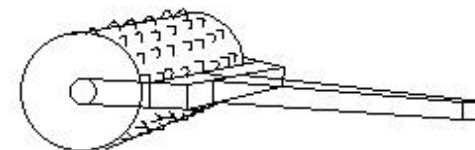
macadam roller



• Tandem roller (two axes and two wheels)



Tire roller



Tamping roller

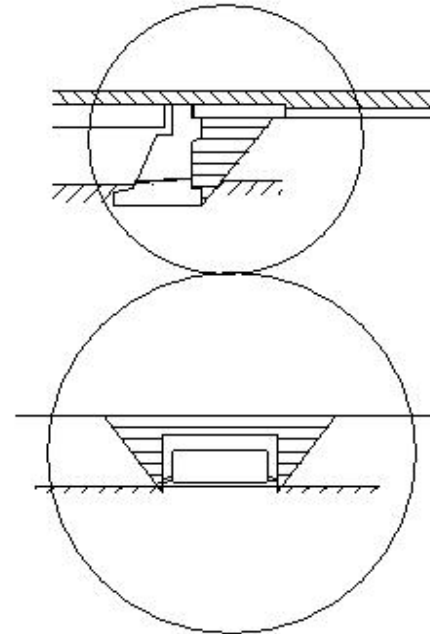
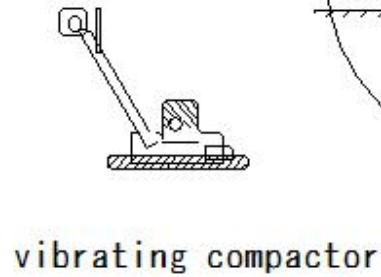
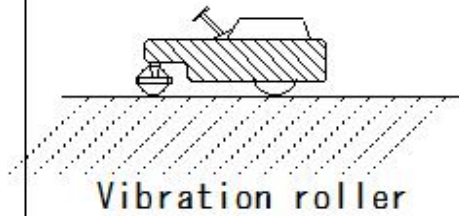
E357

(M190)Earthmoving machinery-Compaction machine-Vibration

(M190) Earthmoving machinery-Compaction machine-Vibration

Earthmoving machinery

- Compaction machine
- Vibration
- ①Vibration roller
- ②Vibration compactor



(M191)Earthmoving machinery-Compaction machine-Impact

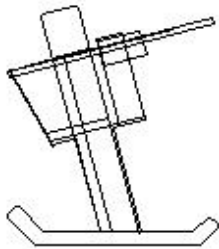
(M191)Earthmoving machinery-Compaction machine-Impact

Earthmoving machinery

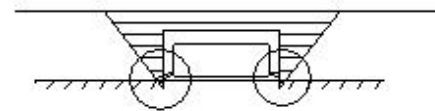
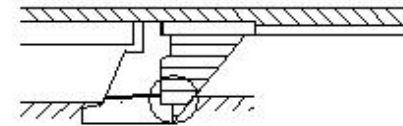
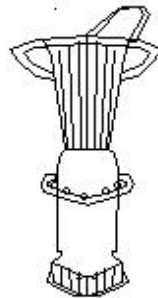
- Compaction machine

Impact

Rammer Soil compactor



Tampa Rammer

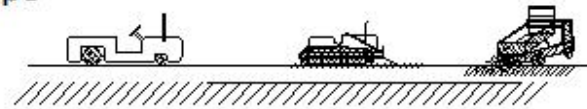


(M192)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

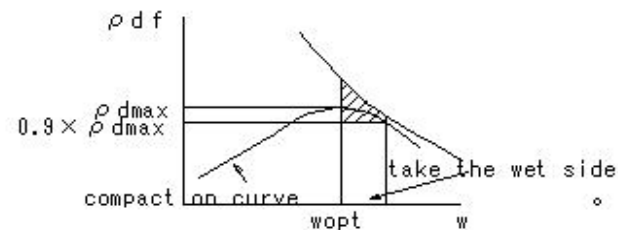
(M192)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

Earthmoving machinery

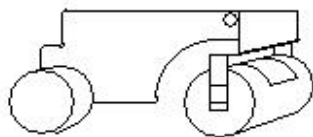
- Combination of compaction machine and soil type
- Compaction of embankment construction
- Adjust water content ratio
- Compaction machine selection
- Determine the rolling number and unrolling thickness



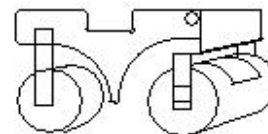
- Compaction machine
- Relationship with soil quality



- Road roller
 - Compaction of roadbed/roadbed
 - Finishing of embankment
 - Suitable for granular materials, cut gravel, and mixed sand



macadam roller



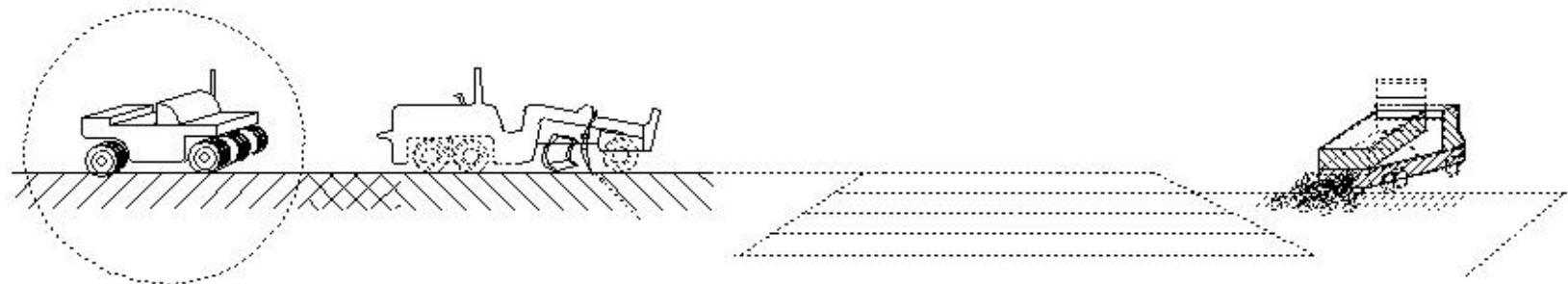
• Tandem roller (two axes and two wheels)

(M193)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

(M193)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

Earthmoving machinery

- Combination of compaction machine and soil type
 - Compaction machine
 - Relationship with soil quality
 - Tire roller
 - Sandy soil, gravel sand, mountain gravel, soil containing a moderate amount of fine particles
 - Ordinary soil



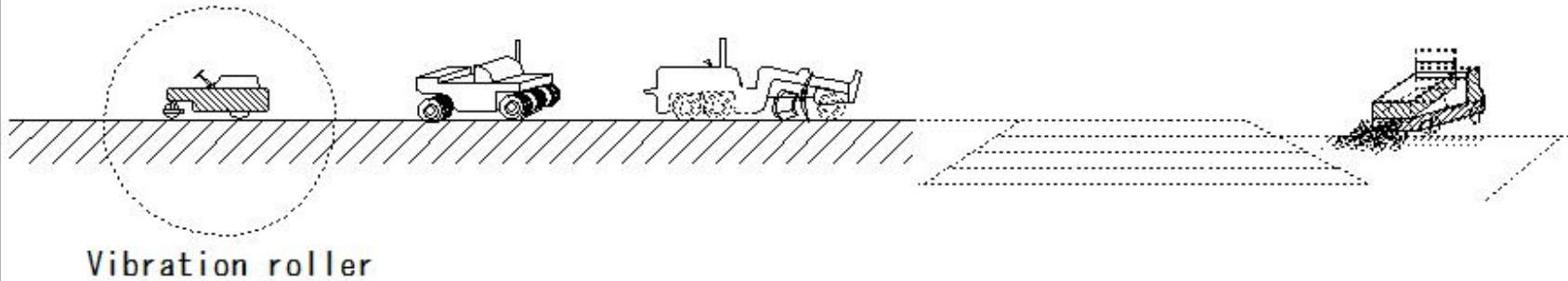
Tire roller

(M194)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

(M194)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

Earthmoving machinery

- Combination of compaction machine and soil type
 - Compaction machine
 - Relationship with soil quality
 - Vibration roller
 - Grused gravel, sandy soil
 - Compaction of slope surface



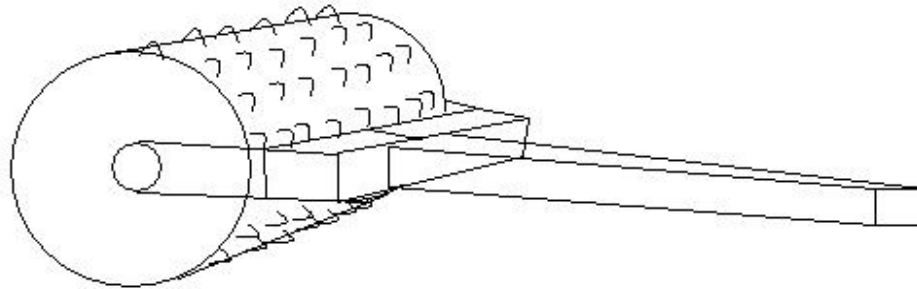
E362

(M195)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

(M195)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

Earthmoving machinery

- Combination of compaction machine and soil type
- Compaction machine
- Relationship with soil quality
 - Tamping roller
 - Weathered rock, Rock- clay soil, low sensitivity soil



Tamping roller

E363

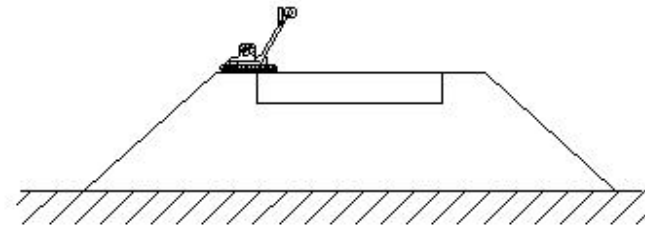
(M196)Earthmoving machinery-Combination of compaction machine and soil type-Combination of compaction machine and soil type

Earthmoving machinery

- Combination of compaction machine and soil type
 - Compaction machine
 - Relationship with soil quality
 - Vibration compactor Tamper • Tamba
 - Applicable to almost all soils
 - Narrow space
 - Apply shoulders on slope



vibrating compactor

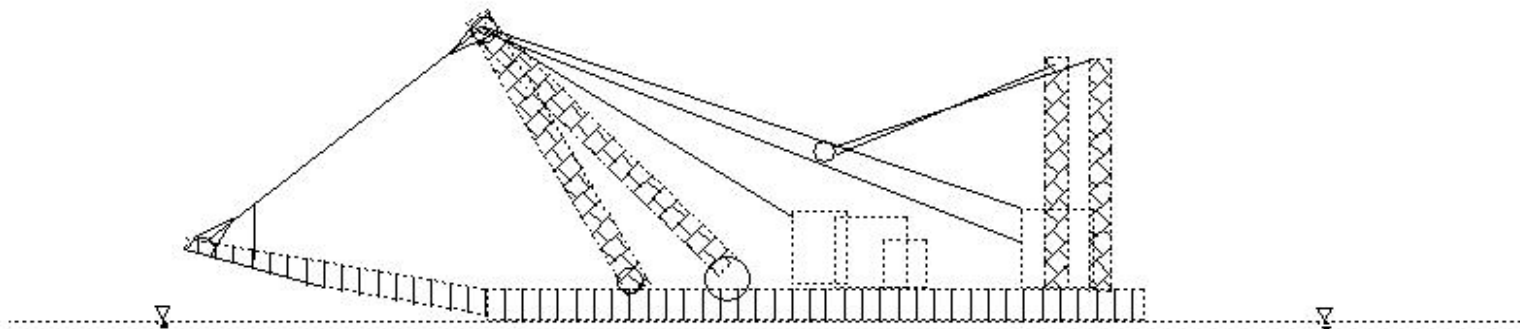


(M197)Dredging work-Pump dredger

(M197)Dredging work-Pump dredger

Dredging work

- Constant water depth in the channel within the port
- Sediment excavation on the seabed
 - Pump dredger
 - Large-scale dredging work



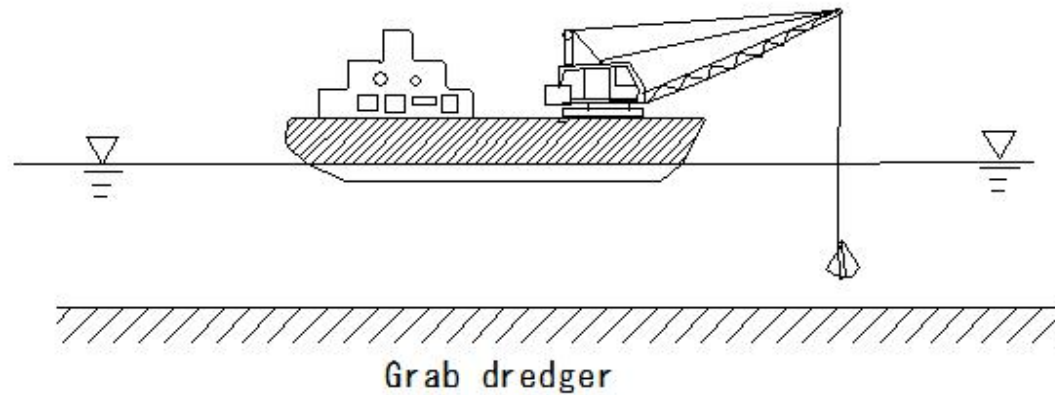
• Pump dredger

(M198)Dredging work-Grab dredger

(M198)Dredging work-Grab dredger

Dredging work

- Constant water depth in the channel within the port
- Sediment excavation on the seabed
 - Grab dredger
 - Small-scale dredging of narrow areas
 - Excavation of soft soil



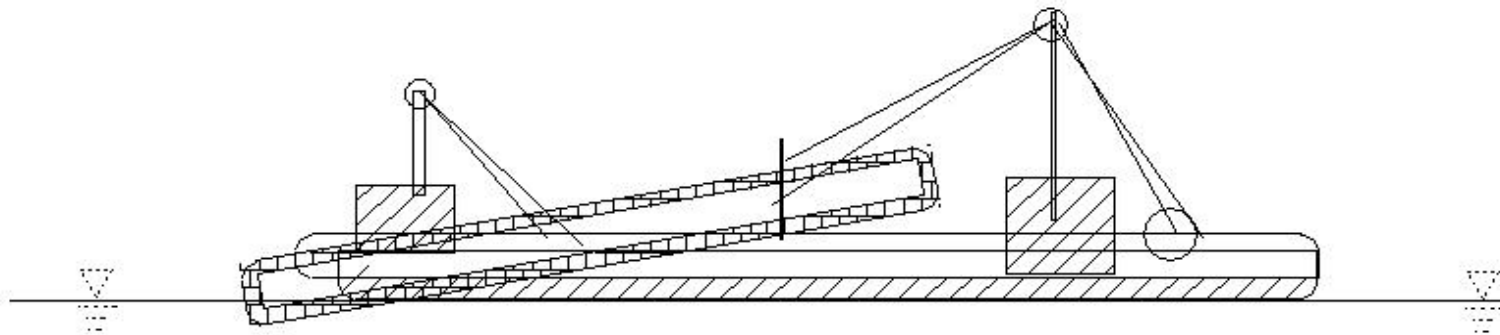
(M199)Dredging work-Bucket dredger

(M199)Dredging work-Bucket dredger

Dredging work

- Constant water depth in the channel within the port
- Sediment excavation on the seabed

Bucket dredger
stair bucket



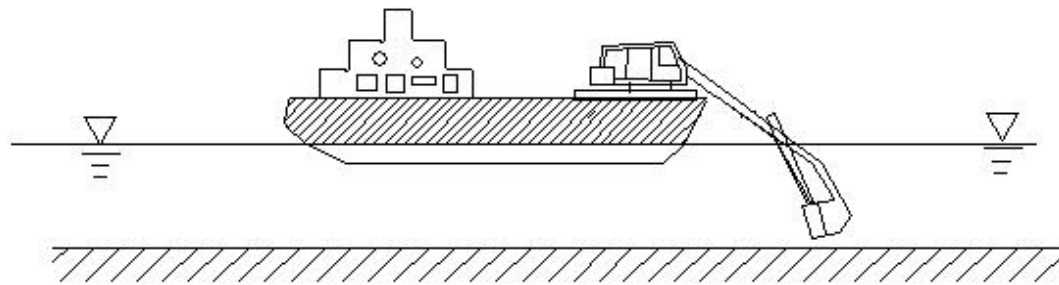
Bucket dredger

(M200)Dredging work-Dipper dredger

(M200)Dredging work-Dipper dredger

Dredging work

- Constant water depth in the channel within the port
- Sediment excavation on the seabed
 - Dipper dredger
 - Strong digging power
 - Solid ground



Dipper dredger

(M201)Dredging work-Pump ship • Grab ship • Dipper dredge • Bucket dredger

(M201)Dredging work-Pump ship • Grab ship • Dipper dredge • Bucket dredger

Dredging work

- Constant water depth in the channel within the port
- Sediment excavation on the seabed

Dredger

- Pump Dredger

Drag suction (self-propelled)

Pump dredger (non-propelled)

Pump sucks up sediment from the bottom of the water along with water

- Grab dredger

Non-self-propelled type

Attach the grab bucket to the tip of the jib

Dredging work using grab bucket

- Dipper dredger non-self-propelled type

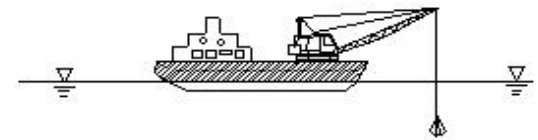
Attach the power shovel to the hull

- Bucket dredger non-self-propelled type

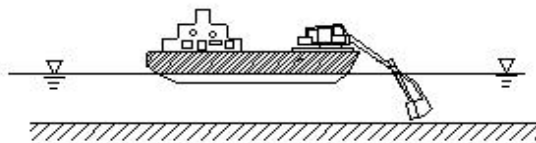
Continuously rotating multiple buckets to scoop up sediment from the bottom of the water



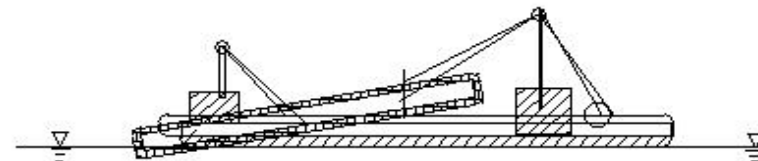
Pump dredger



Grab dredger



Dipper dredger



Bucket dredger

E376

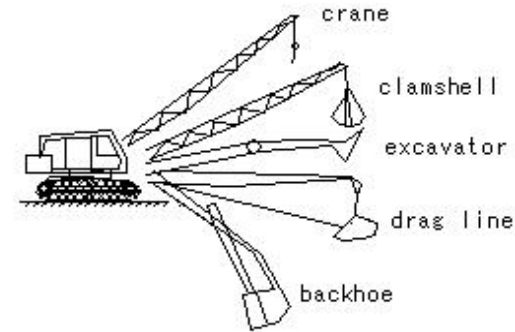
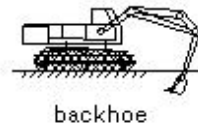
(M202)Earthwork planning/design-Working capacity of excavator type excavator

(M202) Earthwork planning/design-Working capacity of excavator type excavator

Earthwork planning/design

• Working capacity of excavator type excavator

Bucket coefficient K



E383

Working capacity of excavator type excavator

1 Type of soil	2 Backhoe	3 Clamshell	4 Power shovel
①Rocks/Boulders	0.45-0.75	0.40-0.70	0.50-0.80
②Soil mixed with gravel	0.50-0.90	0.45-0.85	0.60-1.00
③Sand	0.80-1.20	0.75-1.10	0.90-1.30
④ Ordinary soil	0.60-1.0	0.55-0.95	0.70-1.10
⑤ Clay soil	0.45-0.75	0.40-0.70	0.50-0.80

• Heaped voids - few excavation - easy: large coefficient

(M203)Earthwork planning/design-Cycle time Cm of excavator type excavator

(M203)Earthwork planning/design-Cycle time Cm of excavator type excavator

Earthwork planning/design
Cycle time Cm of excavator type excavator

The diagram illustrates a tracked excavator with four different attachments. From top to bottom, the attachments are labeled: crane, clamshell, drag line, and backhoe. To the left of this main diagram is a smaller diagram of a backhoe loader, labeled 'backhoe'.

E384

(E384)Earthwork planning/design-Cycle time Cm of excavator type excavator

Cycle time Cm of excavator type excavator

1 model	2 Backhoe	3 Clamshell	4 Power shovel
10 Excavation level (soil type) 6 Standards	7 Hydraulic crawler 0.3-0.7m ³ class	8 Mechanical crawler 0.8m ³ class	9 Mechanical crawler 0.6m ³ class
11 Easy excavation (sand)	20-29(s)	30-37(s)	14-23(s)
12 Medium excavation (normal soil)	23-32	33-42	16-27
13 Somewhat difficult excavation (clay soil, gravel soil)	27-36	37-46	19-32
14 Difficult excavation (rock mass/boulder)	31-41	42-48	21-35

5 Remarks

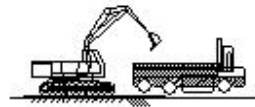
Large turning angle and excavation depth - Upper limit value

M204)Earthwork planning/design-Working capacity of excavator type excavator-Work load of power shove

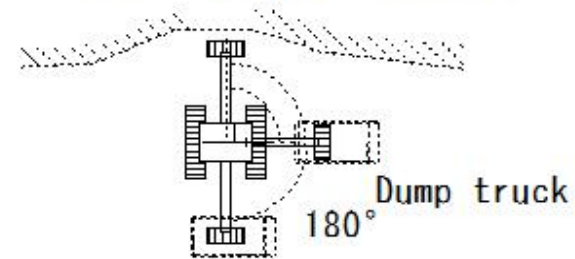
(M204)Earthwork planning/design-Working capacity of excavator type excavator-Work load of power shove

Earthwork planning/design

- Working capacity of excavator type excavator
- Work load of power shovel
 - Ordinary soil
 - 0.6m³ class power shovel
 - Calculated using ground volume
 - Turning angle 180 degrees
 - Work efficiency E=0.7
- Rate of change in soil volume L=1.30



0.6m³ class power shovel



Solution

- ① Bucket capacity $q_0=0.6\text{m}^3$
- ② Bucket coefficient $K=1.10$
- ③ Rate of change in soil volume $f=1/1.3=0.77$
- ④ Work efficiency $E=0.70$
- ⑤ Cycle time $C_m=23\text{sec}$
- ⑥ Volume of soil $Q=3600 \times 0.60 \times 1.10 \times 0.77 \times 0.7 / 23 = 55.7\text{m}^3/\text{h}$

(M205)Earthwork planning/design-Dump truck working capacity

(M205)Earthwork planning/design-Dump truck working capacity

Earthwork planning/design

- Dump truck working capacity
- 1 Medium-distance/long-distance transportation
- 2 Public roads/construction sites: Vehicles/driving conditions vary
- 3 Compliance with traffic laws
- 4 Work amount $Q=60 \times$

$$C_m = C_m s n / (60 E_s) + (T_1 + T_2 + t_1 + t_2 + t_3) (\text{min})$$

$C_m s$: Loading machine cycle time (sec)

n : Number of times loaded onto one dump truck

$$n = q_o / (q_s K)$$

q_o : Loading volume of dump truck (m³) (flat loading)

q_s : Loading machine bucket capacity (m³)

K : bucket coefficient

E_s : Loading machine work efficiency

T_1, T_2 : Dump truck travel time for outbound and return trips

$$T_i = (D / V_i) 60 \quad (i=1 \text{ or } 2)$$

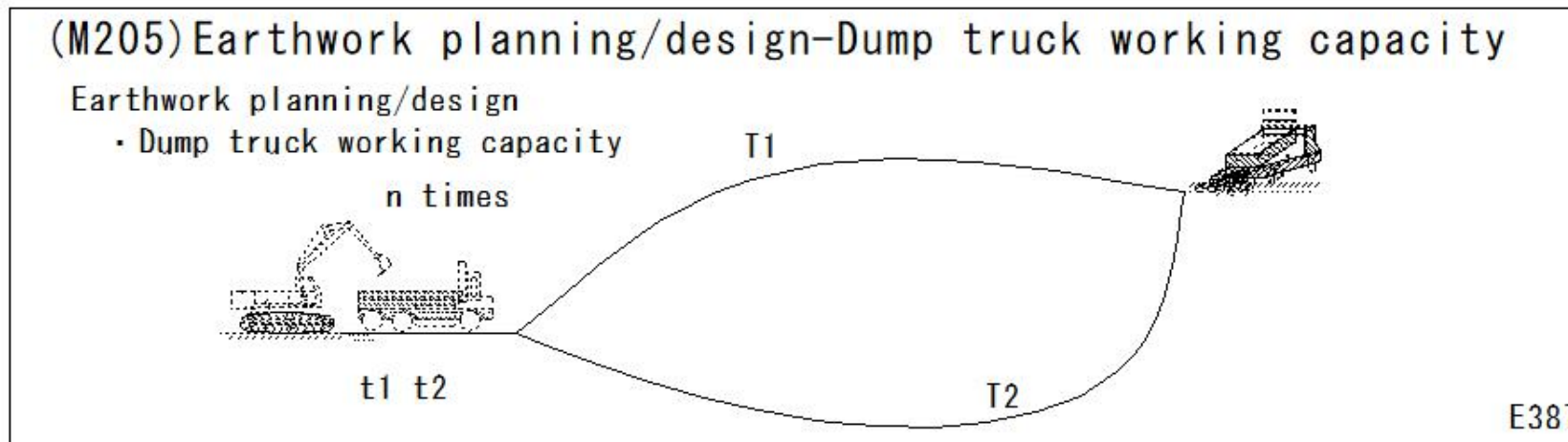
D : Travel distance for outbound and return trips (km)

V_i : Outbound trip, return trip, travel speed (km/h)

t_1, t_2 : Unloading/loading waiting time (min)

t_s : Sheet removal time (min)

E : Work efficiency depending on road conditions (roadside environment, road surface condition, day and night), etc. (generally 0.9)



(M206)Earthwork planning/design-Required number of dump trucks

(M206)Earthwork planning/design-Required number of dump trucks

Earthwork planning/design

- Required number of dump trucks
- Required number of combined dump trucks M

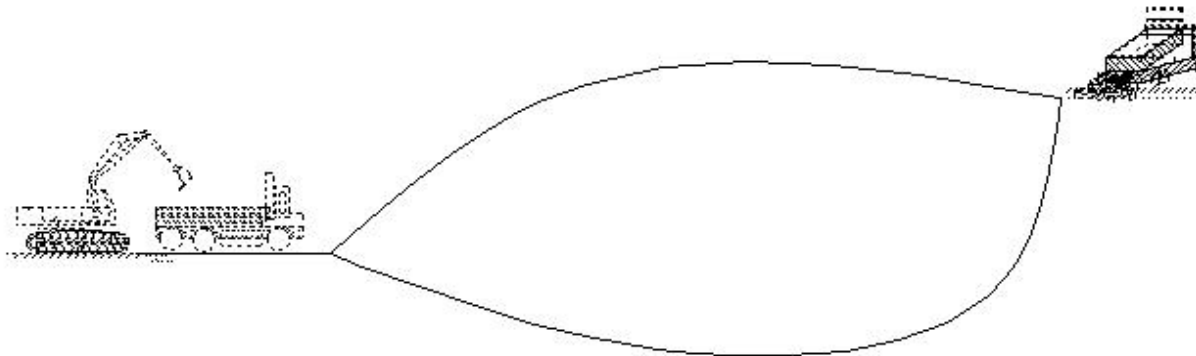
$$M=Q_s/QD$$

Q_s : Bucket capacity of loading machine (m³)

QD : Dump truck work volume (m³/h)

Dump truck standards

standard	Output (PS)	Maximum loading mass (t)	Flat stacking capacity (m ³)
2t class	98	2.0	1.54
4t class	170	4.0	2.66
8t class	222	8.0	5.26
11t class	315	11.0	7.27



(M207)Earthwork planning/design-Required number of dump trucks

(M207)Earthwork planning/design-Required number of dump trucks

Earthwork planning/design

- Required number of dump trucks
- Flat loading 0.6m³ power shovel
- 11t class dump truck
- Combination earthwork
- Gravel mixed soil
- Medium level of excavation
- Transportation road 2 lanes in good condition
- 2.5km embankment area
- Dump truck outward trip average speed 25km/h

Return trip Average speed 30km/h

- t₁=0.5min t₂=0.3min t₃=4min
- Work efficiency Es=0.9
- Required number of dump trucks
- Work efficiency of power shovel Es=0.55
- Rate of change in soil volume L=1.25
- Cycle time Cms=26sec

1 Dump truck loading capacity qo:7.27m³

Power shovel bucket coefficient K=0.80

2 Number of times the power shovel is loaded

$$N = 7.27 / (0.6 \times 0.80) = 16 \text{ times}$$

3 Dump truck cycle time

Outbound average speed T₁=(2.5/25)×60=6.0min

Return trip Average speed T₂=(2.5/30)×60=5.0min

C_m=26×16/(60×0.55)+6.0+5.0+0.5+0.3+4.0=28.4(min)

Rate of change in soil volume f=1/1.25=0.80

4 Work amount per hour of dump truck

QD=7.27×(60/28.4)×0.8×0.9=11.1m³/h

5 Work amount per hour of power shovel

Bucket capacity qo=0.6m³

K: Bucket coefficient K=0.80

Rate of change in soil volume f=1/1.25=0.80

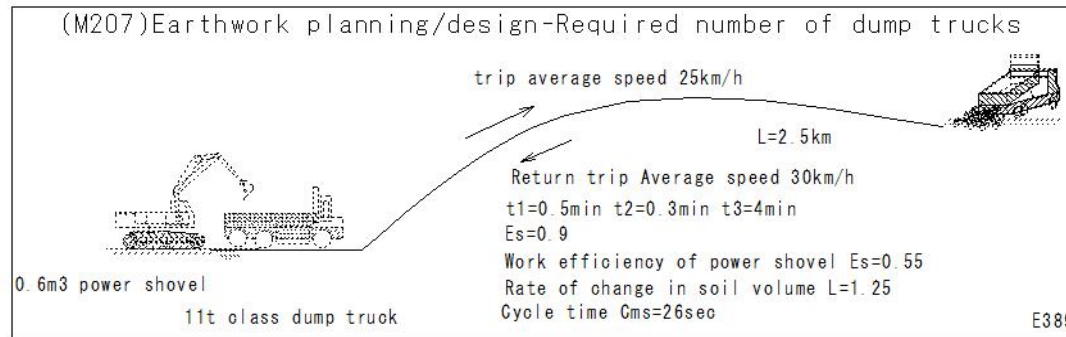
Work efficiency E=0.55

6 Cycle time C_m=26sec

7 Q=0.6×0.8×3600×0.80×0.55/26=29.3m³/h

8 Required number of dump trucks

M=29.2/11.1=2.6 3 including spares



(M208)Structure excavation-Structures - Excavation machine selection-Points to note during excavating

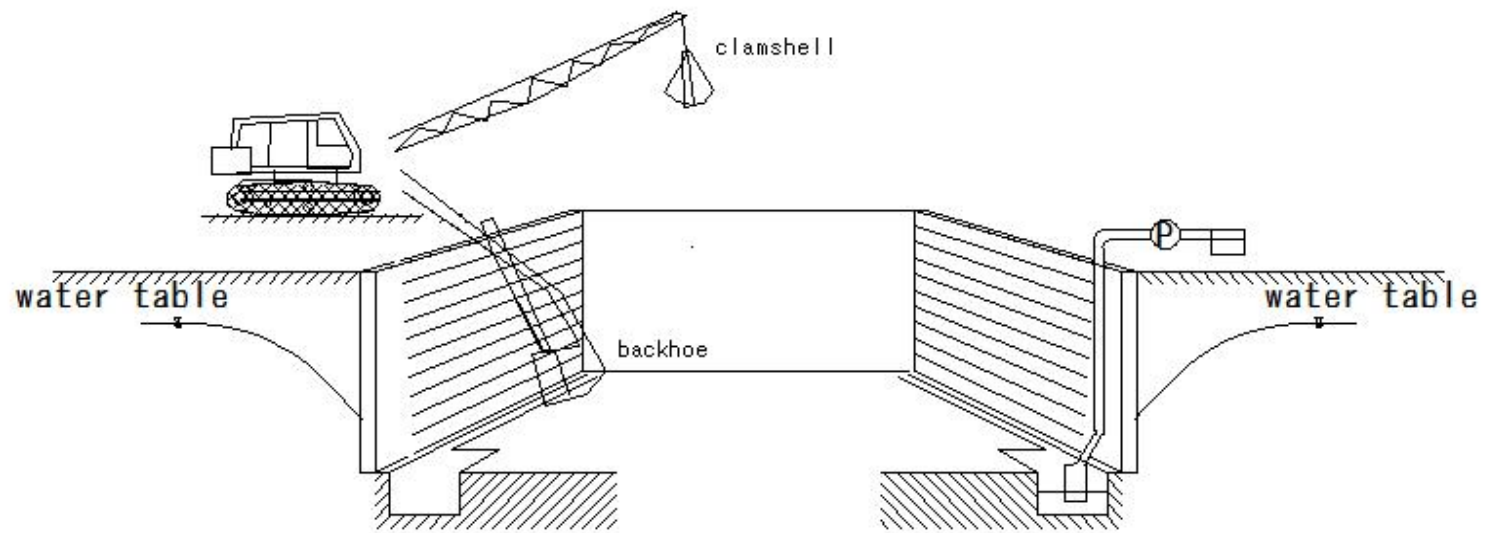
(M208) Structure excavation-Structures - Excavation machine selection-Points to note during excavating

Structures - Points to note during excavating

• The excavation method appropriate

1. Lowering the groundwater level below the excavation level

Avoid excavating in muddy water

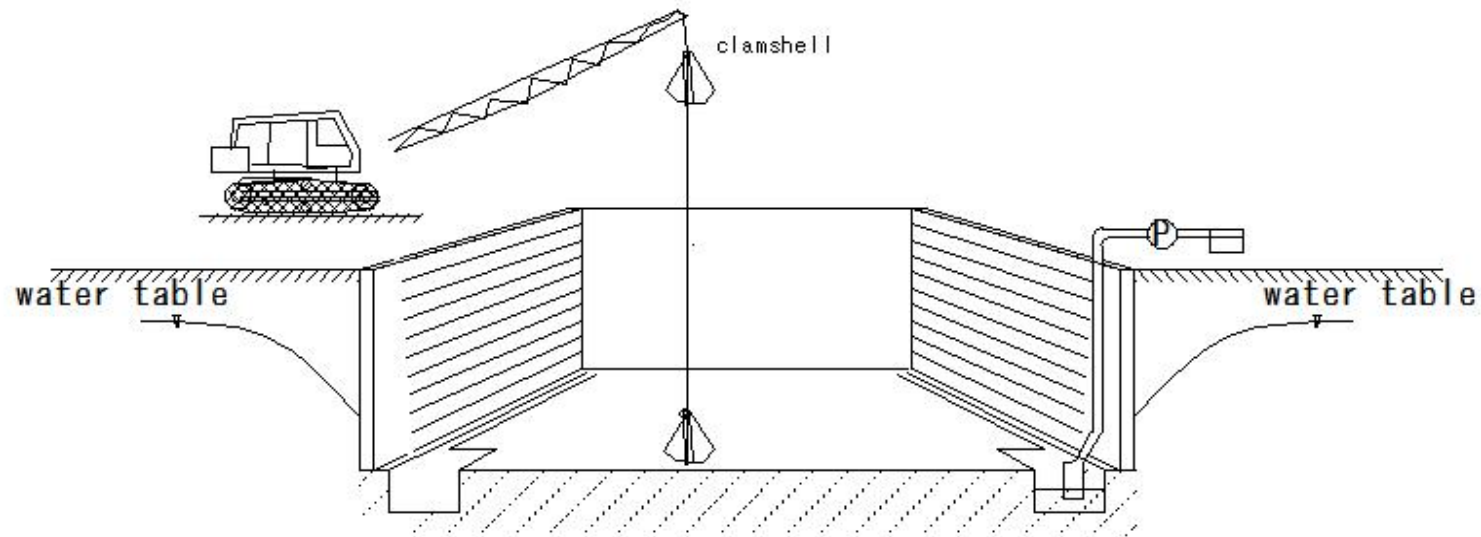


(M209)Structure excavation-Structures - Excavation machine selection-Points to note during excavating

(M209)Structure excavation-Structures - Excavation machine selection-Points to note during excavating

Structures - Points to note during excavating

- Is the excavation method appropriate?
- During excavating mechanically, do not drop the clamshell and stir the foundation ground.



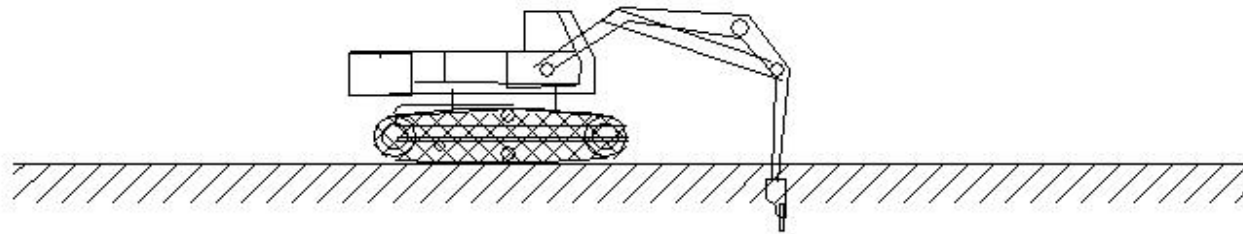
(M210)Structure excavation-Structures - Excavation machine selection-Points to note during excavating

(M210) Structure excavation-Structures - Excavation machine selection-Points to note during excavating

Structures - Points to note during excavating

- Is the excavation method appropriate?
- Consider large breakers for rock excavation

hydraulic breaker (800kg class)



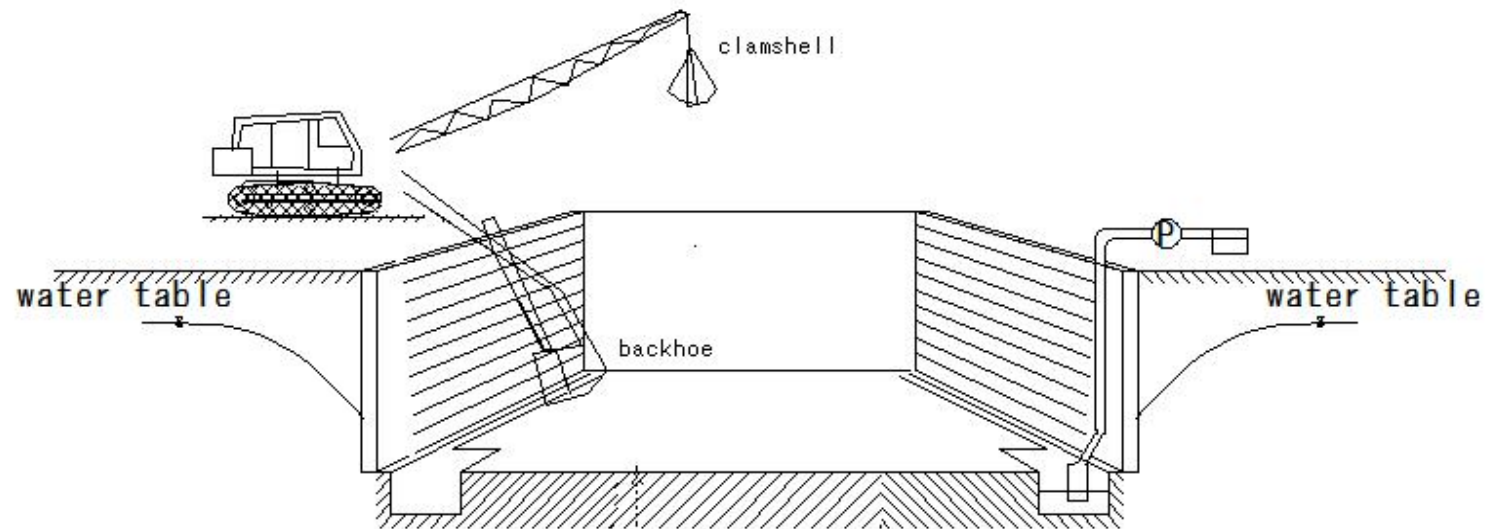
rock excavation

(M211)Structure excavation-bearing ground

(M211)Structure excavation-bearing ground

Structures - Points to note during excavating

- Is the excavation method appropriate?



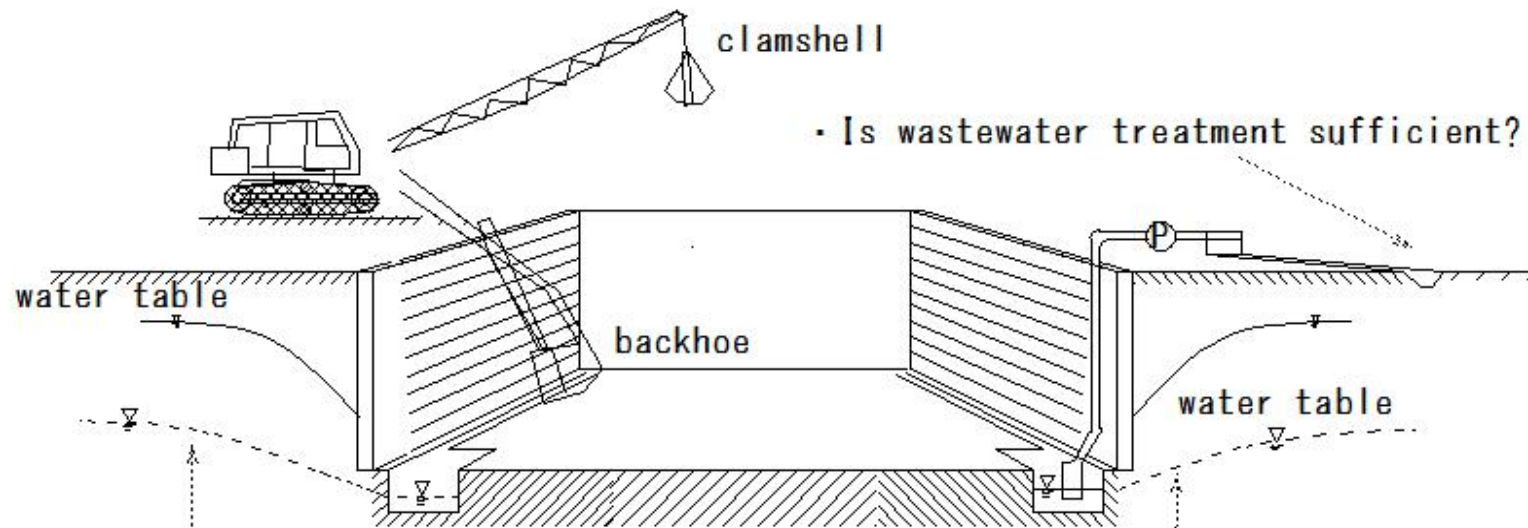
- Is the bearing ground not disturbed?
- Excavating too much?

(M212)Structure excavation-wastewater treatment

(M212)Structure excavation-wastewater treatment

Structures - Points to note during excavating

- Is the excavation method appropriate?



- Is wastewater treatment sufficient?

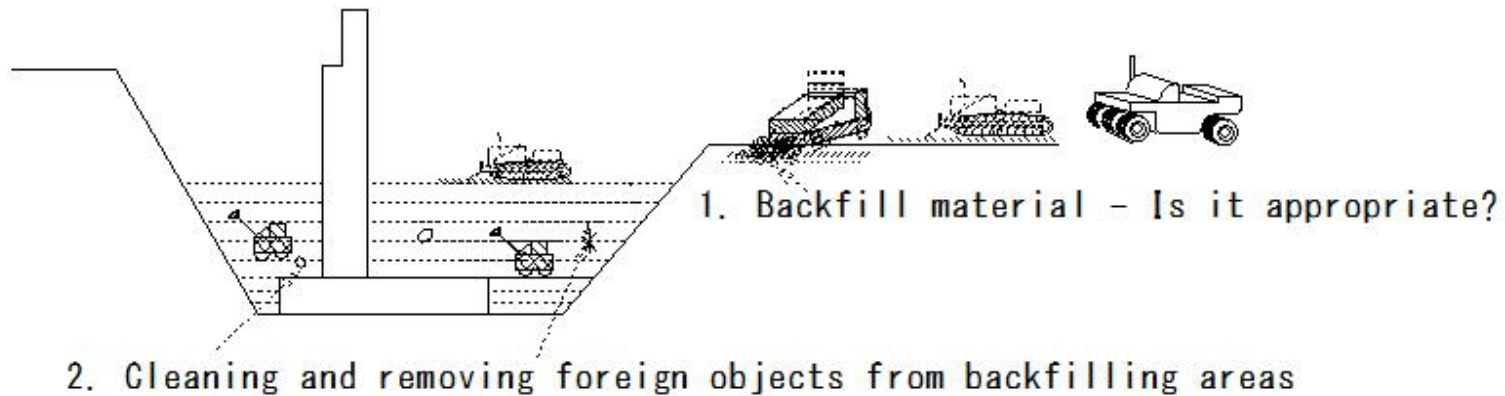
- Is there a groundwater level below the excavation depth at all times?

(M213)Structure excavation-Points to note regarding backfilling and backfilling soil

(M213)Structure excavation-Points to note regarding backfilling and backfilling soil

Structures - Points to note during excavating

- Points to note regarding backfilling and backfilling soil



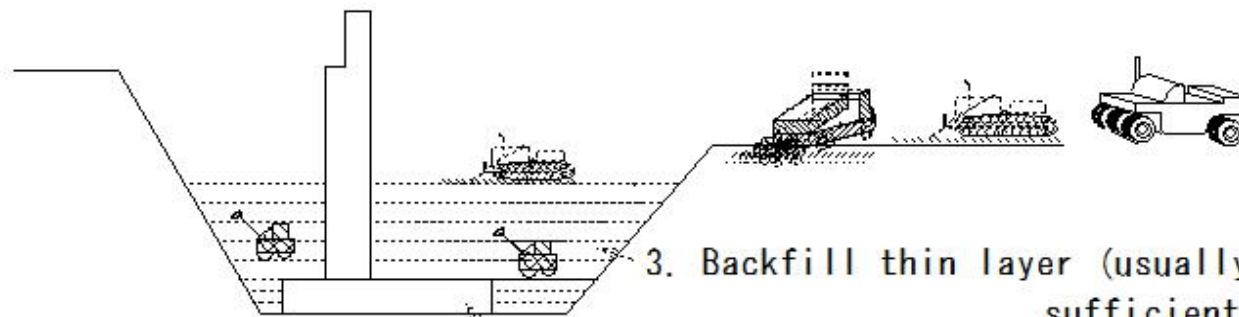
E443

(M214)Structure excavation-Points to note regarding backfilling and backfilling soil

(M214)Structure excavation-Points to note regarding backfilling and backfilling soil

Structures - Points to note during excavating

- Points to note regarding backfilling and backfilling soil



3. Backfill thin layer (usually 30cm) - sufficient compaction
4. Backfill structure: 75% or more of design strength

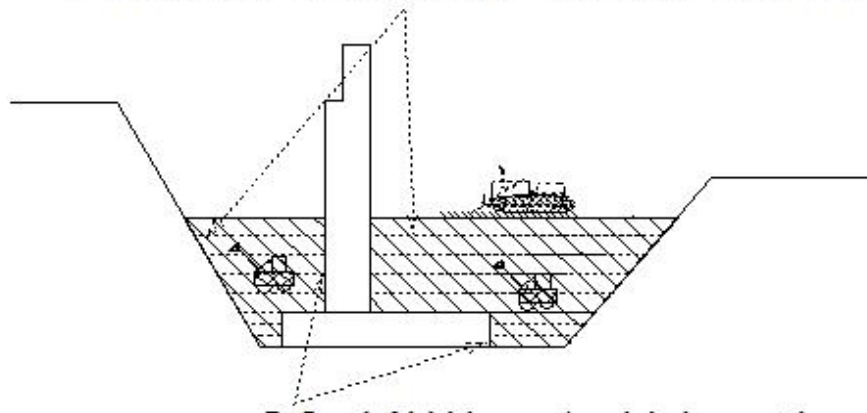
(M215)Structure excavation-Points to note regarding backfilling and backfilling soil

(M215) Structure excavation-Points to note regarding backfilling and backfilling soil

Structures - Points to note during excavating

- Points to note regarding backfilling and backfilling soil

6 Structure backfilling -Perform from both sides at the same time



5 Backfilling: Avoid impacting the structure

(M216)Structure excavation-Points to note regarding backfilling and backfilling soil

(M216) Structure excavation-Points to note regarding backfilling and backfilling soil

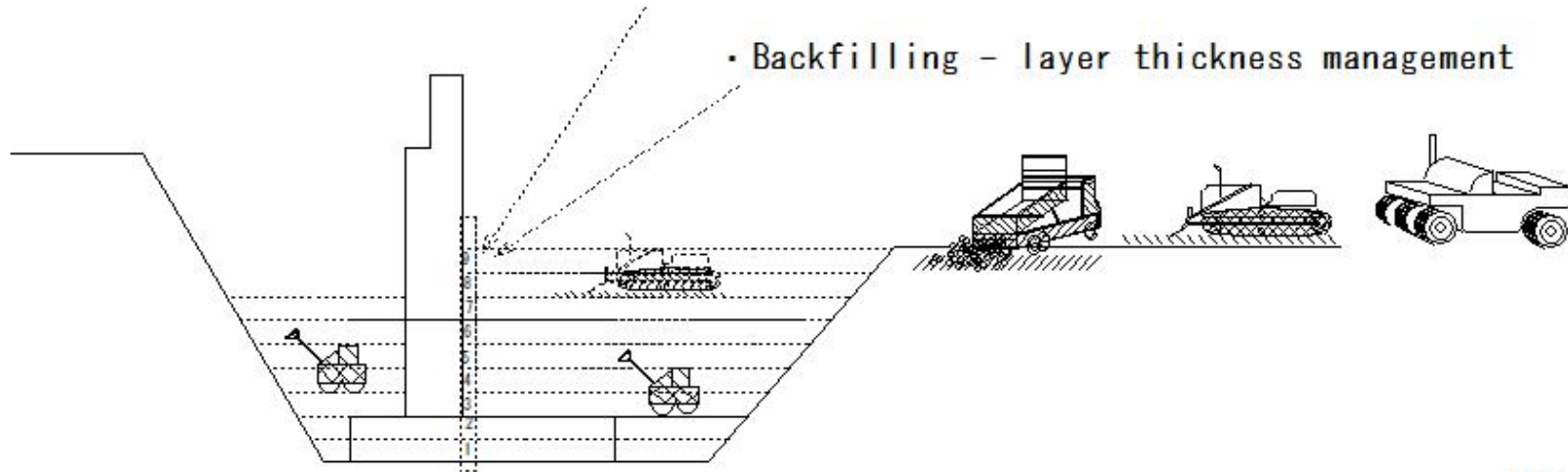
Structures - Points to note during excavating

- Points to note regarding backfilling and backfilling soil

- Layer thickness management

- So that you can understand the finished thickness (layer thickness)

- Backfilling - layer thickness management



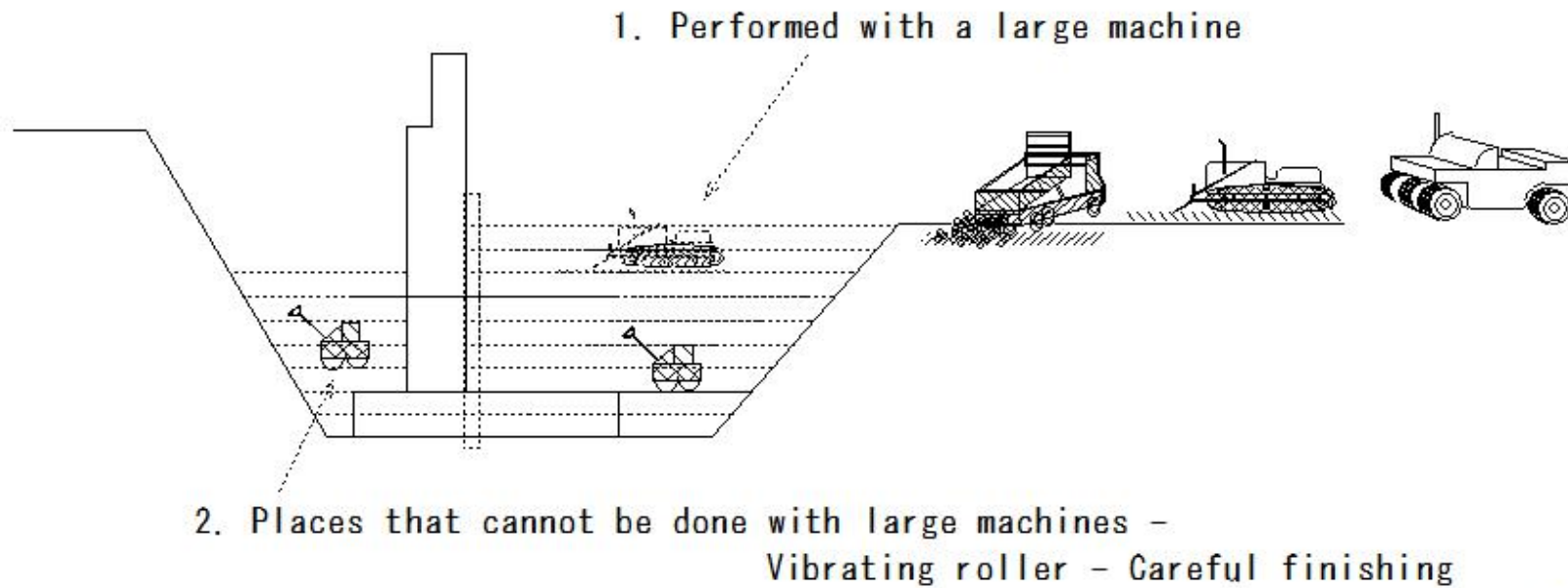
E447

(M217)Structure excavation-Points to note during excavating-compaction appropriate

(M217)Structure excavation-Points to note during excavating-compaction appropriate

Structures - Points to note during excavating

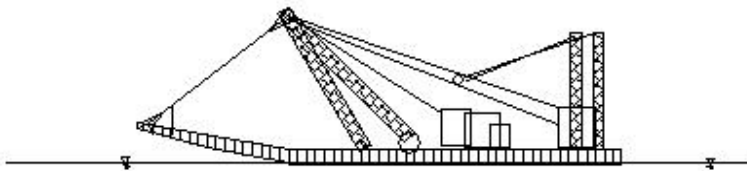
- Is compaction appropriate?



E448

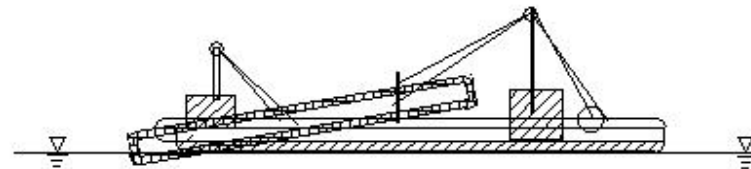
(M218)dredging

(M218) dredging



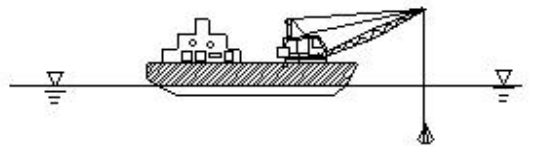
• Pump dredger

Pumping ship: Sucking up sediment with a pump



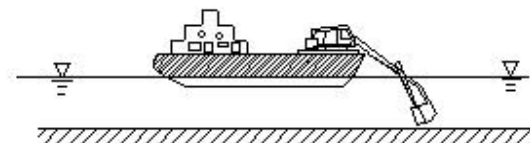
Bucket dredger

Bucket boat: Continuously excavating earth and sand



Grab dredger

Grab Ship Grab Bucket



Dipper dredger

Excavating hard soil

(M219)earthwork

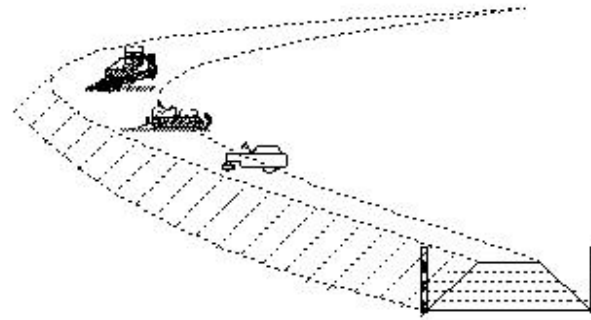
(M219) earthwork

Cutting and embankment of soil

Cut soil
transport
embankment

Compaction
Finish

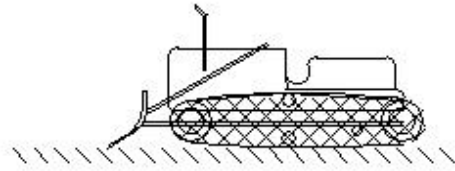
Mechanical earthwork



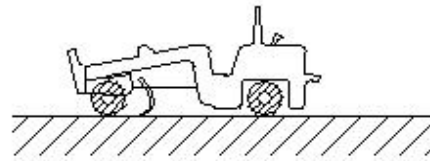
E577

(M220)blade bowl

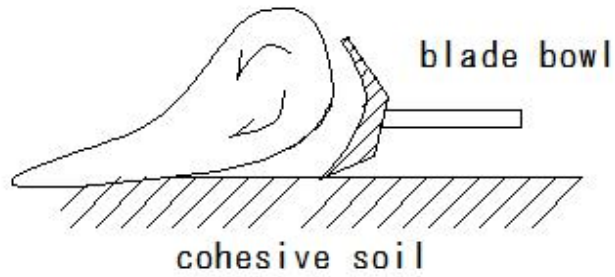
(M220)blade bowl



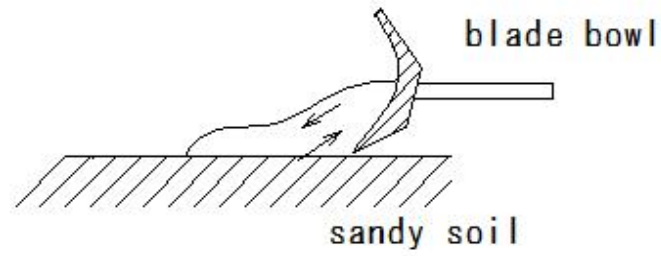
bulldozer



motor grader



cohesive soil



sandy soil

(M221)Trafficability

(M221)Trafficability

Trafficability

Degree of runnability of the machine

1 Wetland bulldozer

2 Scrape Dozer

3 Bulldozer

4 towed scraper

5 Motor Scraper

6 Dump Truck

Cone Index (kN/m²)

over 300

600 or more

500-700 or more

700-1000 or more

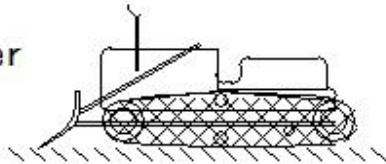
1000-1300 or more

1200-1500 or more

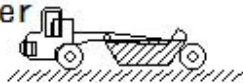
1 Wetland bulldozer



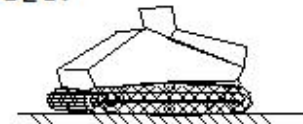
3 Bulldozer



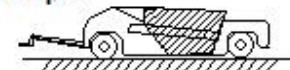
5 Motor Scraper



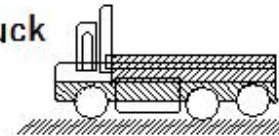
2 Scrape Dozer



4 towed scraper



6 Dump Truck



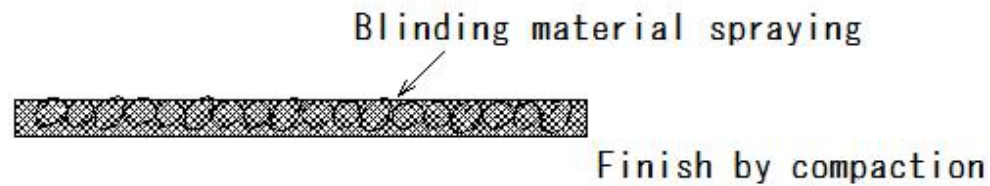
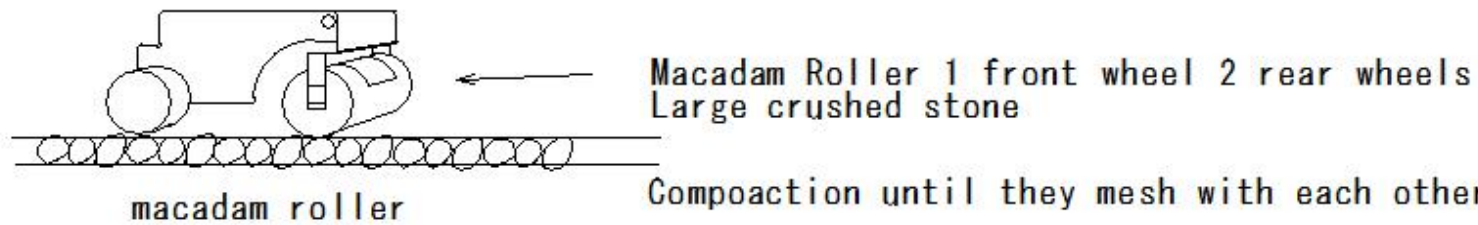
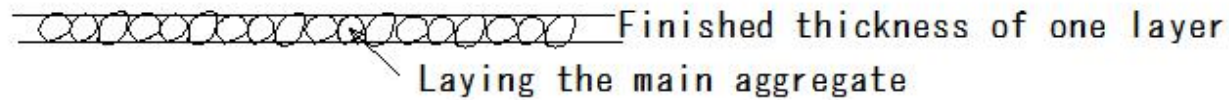
E585

(M222)macadam

(M222) macadam

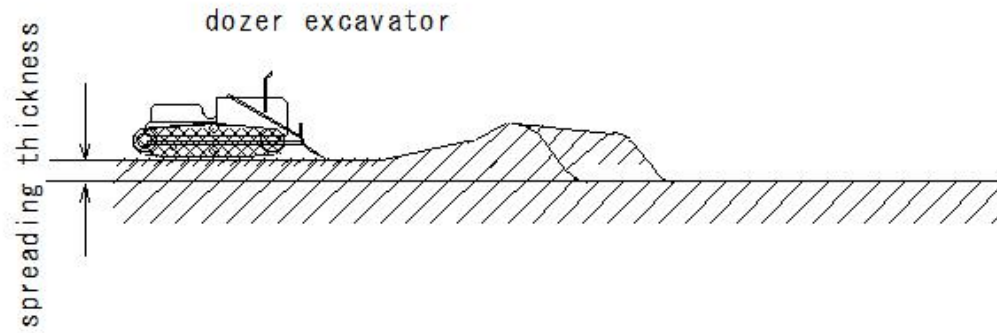
Macadam

Road-roadbed construction method



(M223)spreading

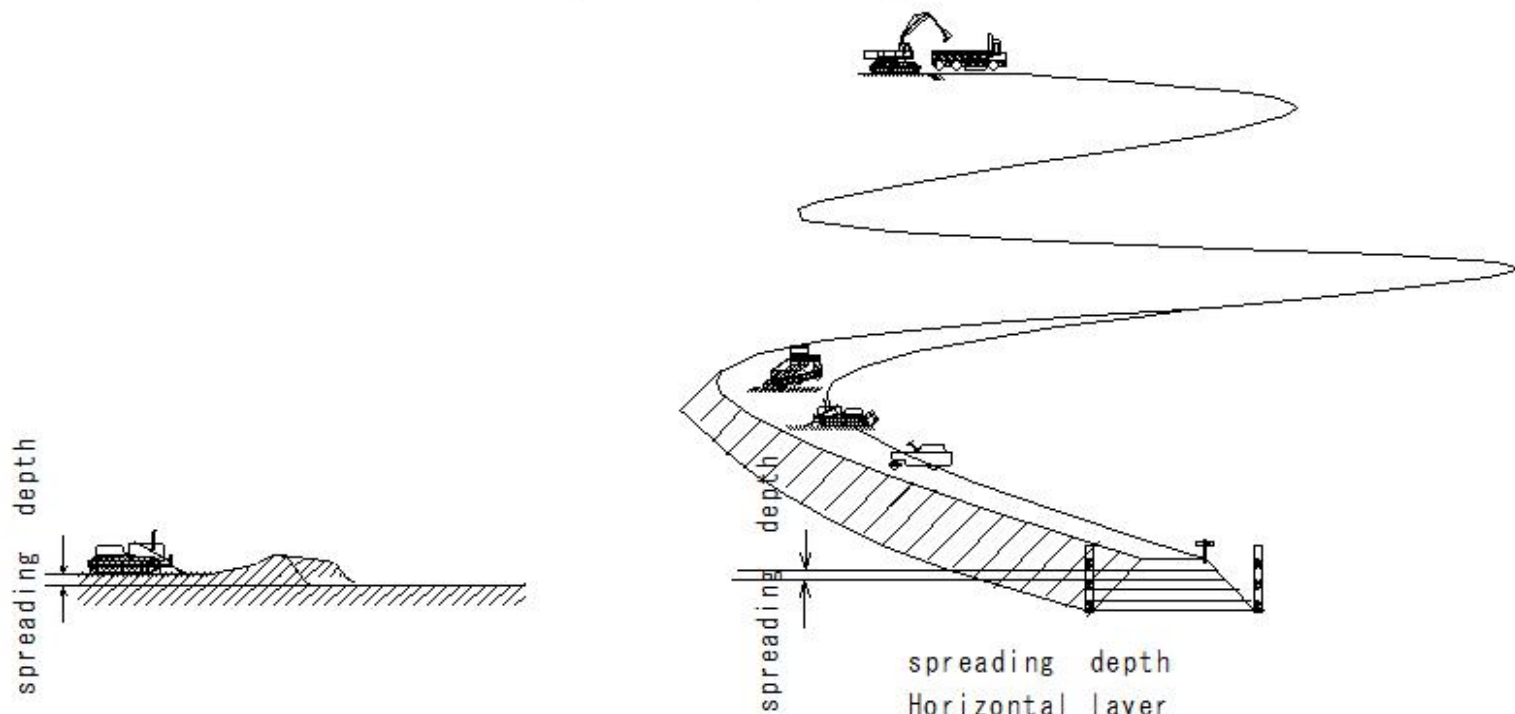
(M223) spreading



E622

(M224)spreading depth

(M224) spreading depth



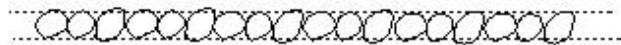
spreading depth
Horizontal layer
Compaction
30-50cm
Compaction thickness: 20cm or less
Road body: 30cm or more

E623

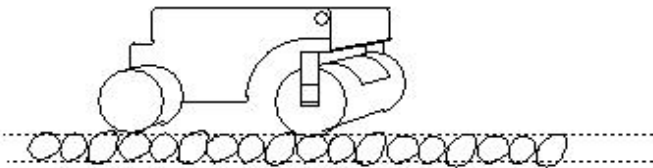
(M225)water bound macadam

(M225)water bound macadam

water bound macadam
Macadam method



Water + crushed stone mixture - spraying
Laying the main aggregate
Crushed stone (diameter 20 mm or less)



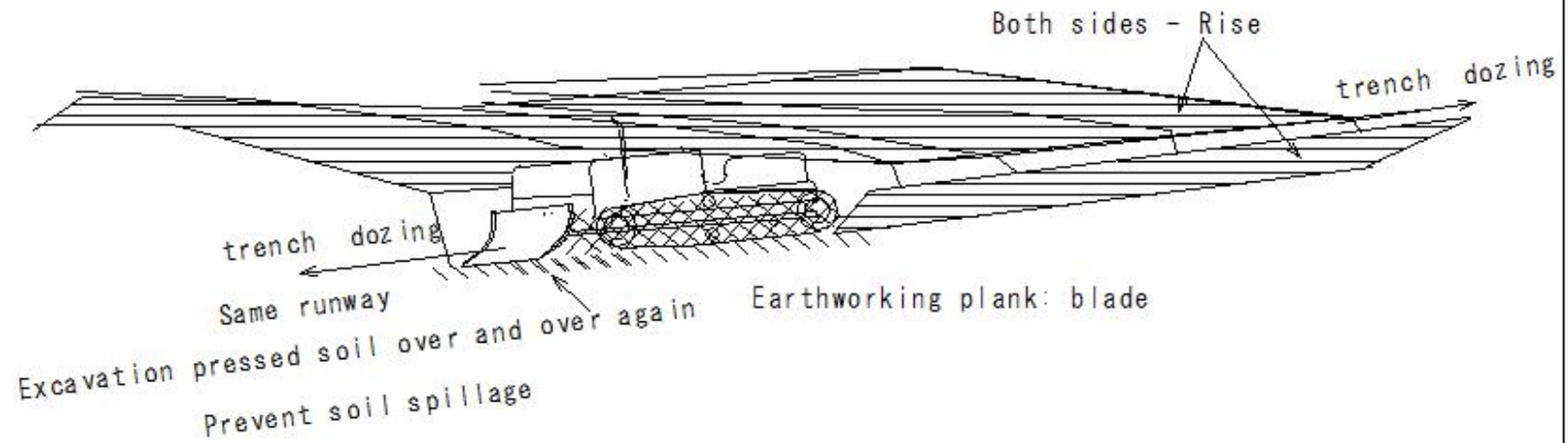
Compaction poured with water
Last-5-13mm crushed stone spraying finish
Compaction with macadam rollers

macadam roller



(M226)trench dozing

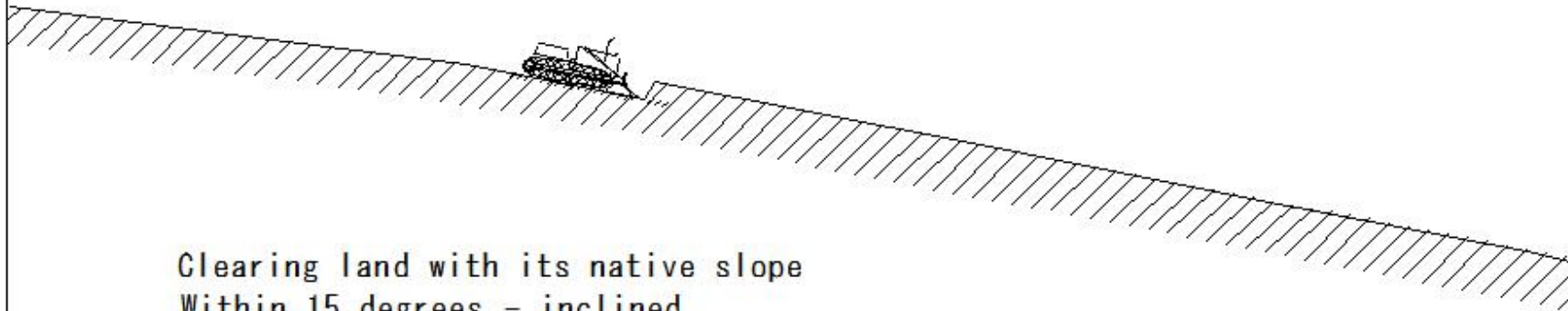
(M226) trench dozing



E627

(M227)land reclamation in natural slope

(M227)land reclamation in natural slope



Clearing land with its native slope

Within 15 degrees - inclined

Logging, cutting, burning, rooting, weed tree removal

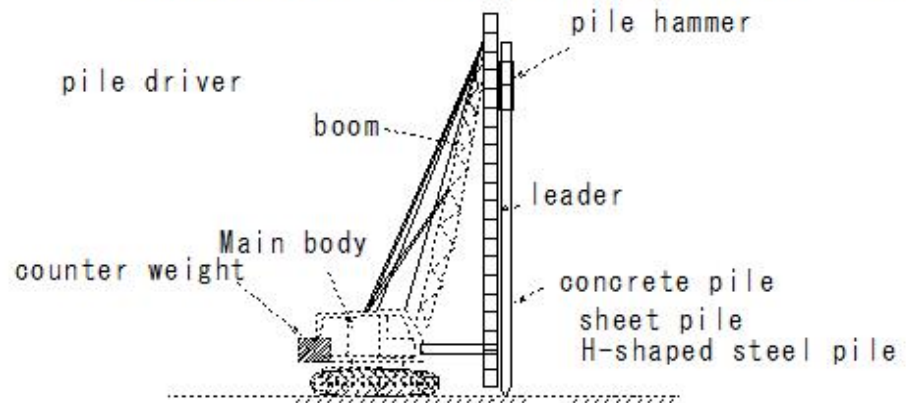
Loosening the ground

E632

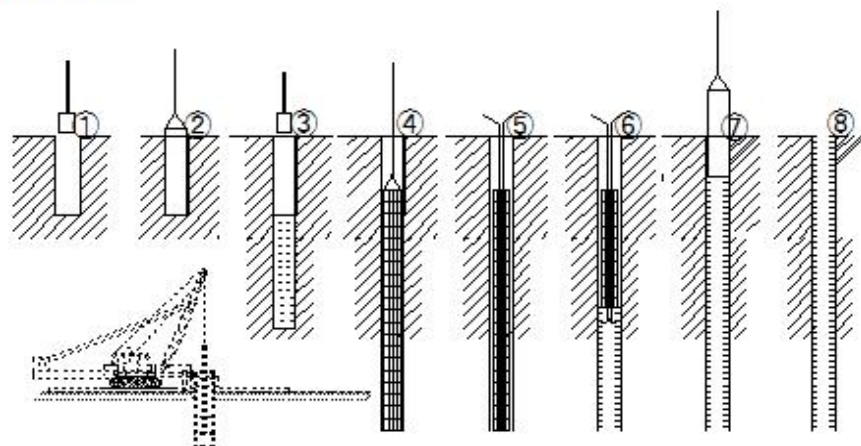
(M228)Foundation work-Pile foundation

(M228) Foundation work-Pile foundation

Ready-made piles



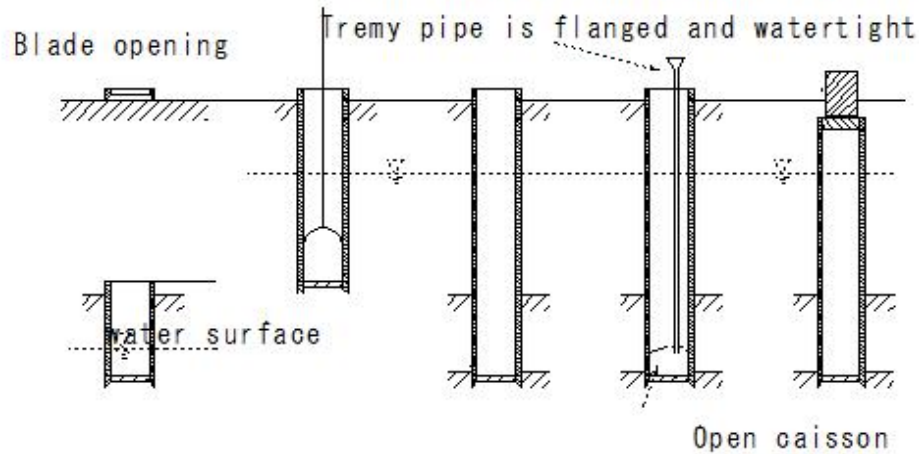
Benoto method



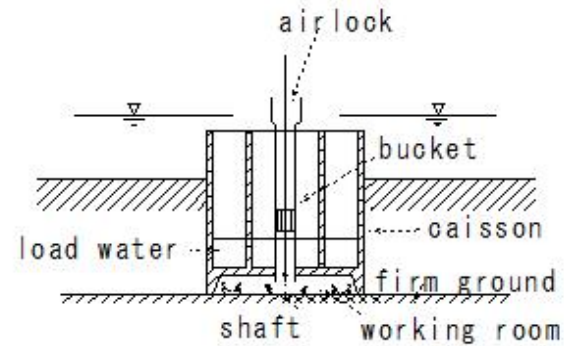
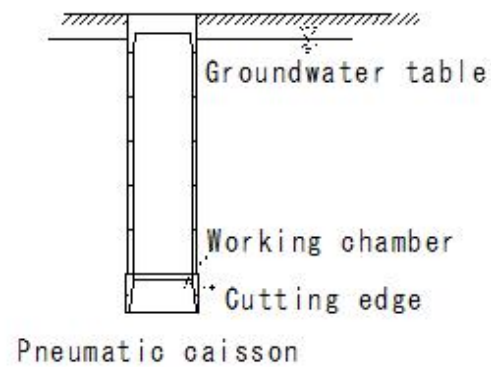
- ① Drilling
- ② Casing tube insertion
- ③ Bentonite solution - injection
hole wall prevention muddy water
- ④ Erection of rebar
- ⑤ Built-in tremmy tube rebar
- ⑥ Ready-mixed concrete pouring
- ⑦ Casing tube pull-out
- ⑧ Sediment reburials

(M229) Foundation work-Caisson foundation

(M229) Foundation work-Caisson foundation



Open caisson foundation
Sedimentation in the support layer



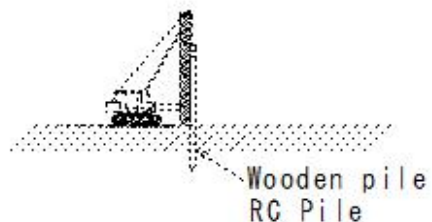
Pneumatic caisson

(M230) Foundation work-Classification of piles

(M230) Foundation work-Classification of piles

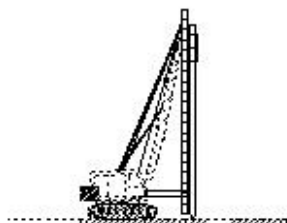
pile foundation
Classification of piles

① Classification by pile material

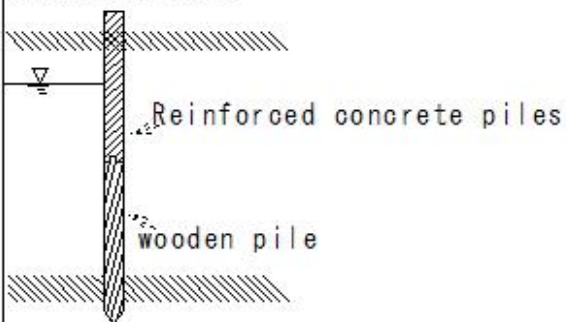


② Classification by construction method

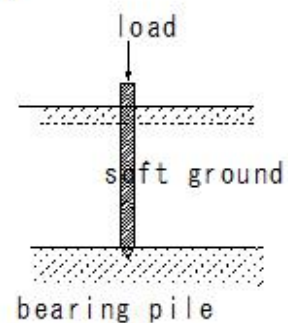
Ready-made pile foundation



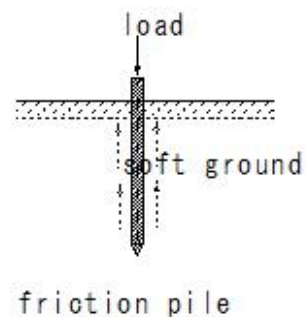
composite pile



③ Classification by support method



Open caisson foundation



(M231)Foundation work-Steel pile

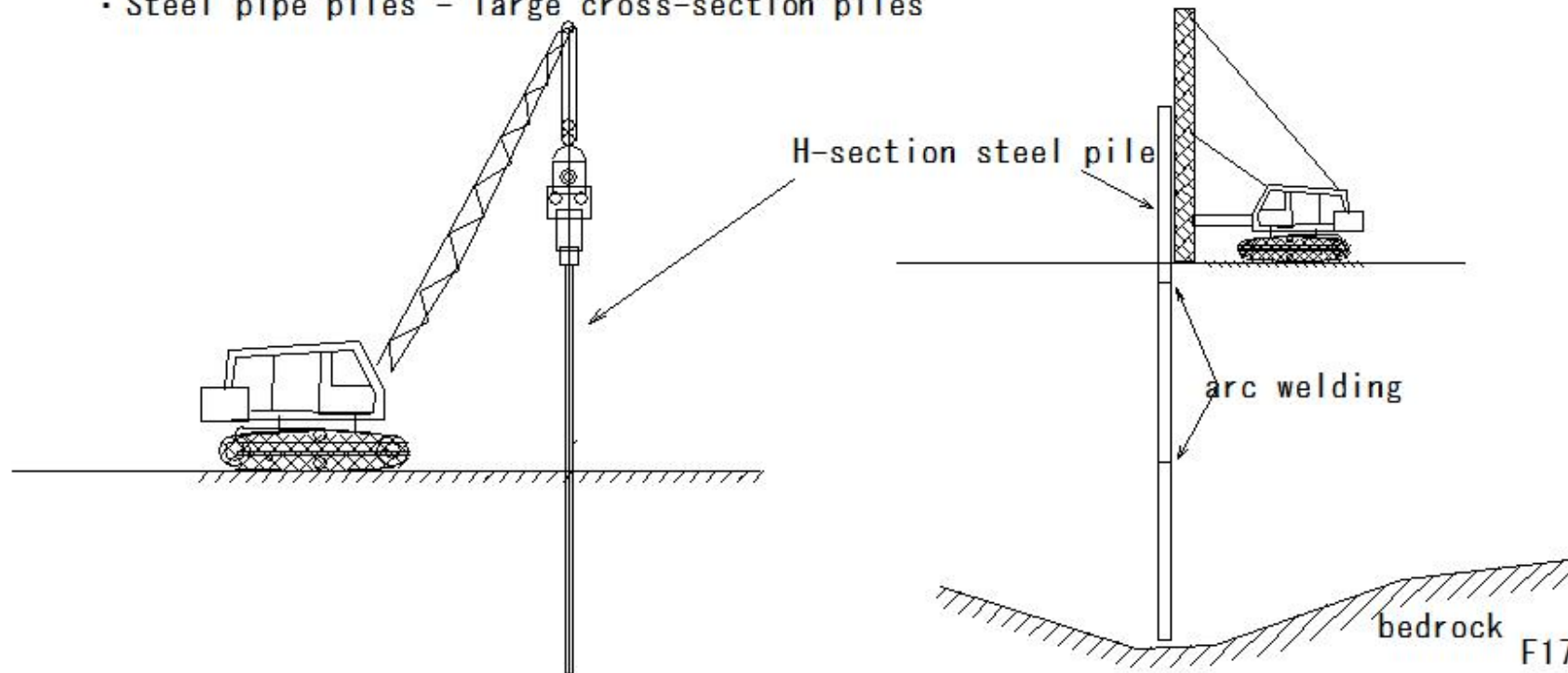
(M231)Foundation work-Steel pile

pile foundation

Classification of piles

① Steel pile

- H-steel piles - Foundation for temporary structures • Difficult geology to drive
- Steel pipe piles - large cross-section piles



(M232)Foundation work-RC pile (concrete pile) PC pile

(M232)Foundation work-RC pile (concrete pile) PC pile

pile foundation

Classification of piles

②RC pile (concrete pile)

- Precast pile: Factory production

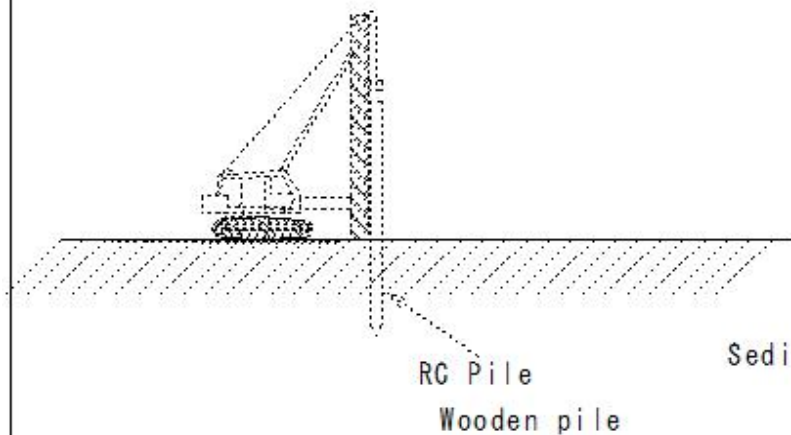
Basics of small structures

- Cast-in-place piles

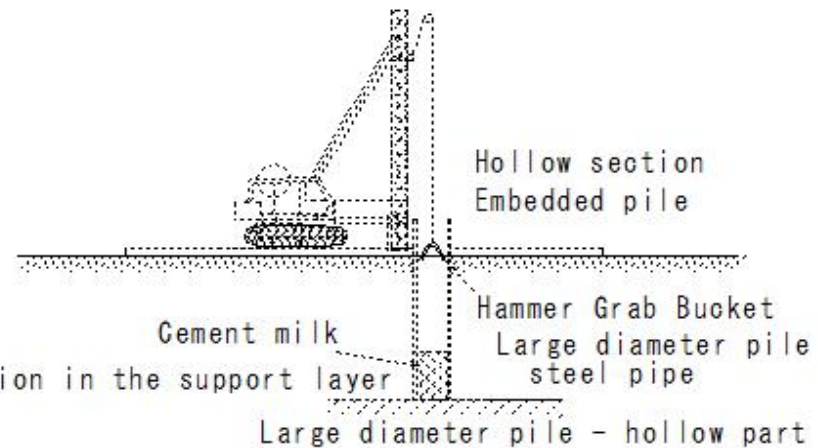
Pour concrete into a hole dug in the field

③PC pile

- prestressed piles



Hollow excavation pile method



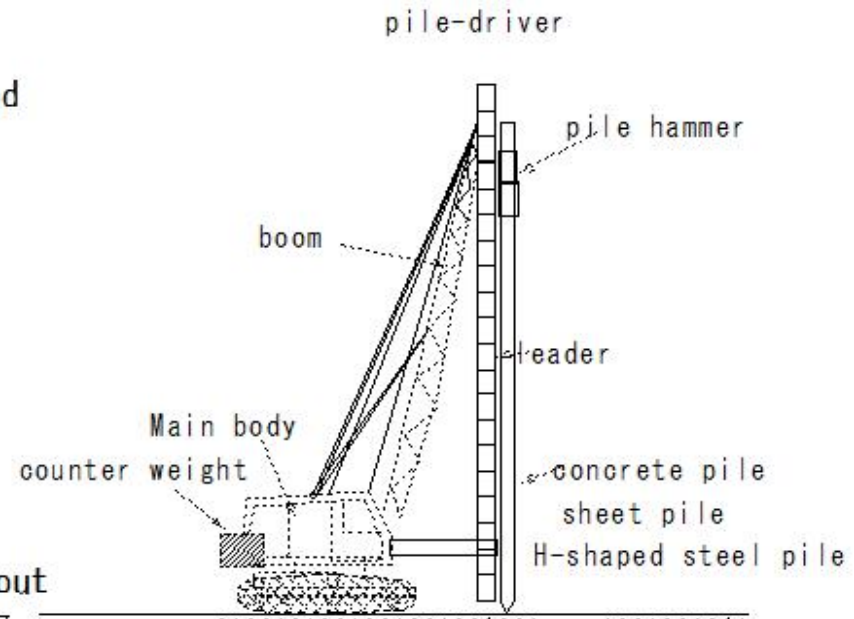
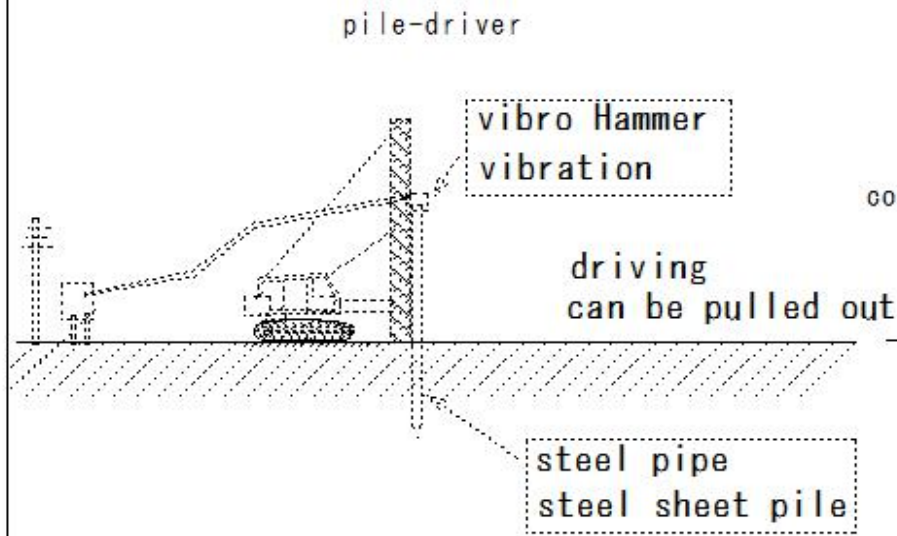
(M233)Foundation work-Ready-made pile construction method

(M233) Foundation work-Ready-made pile construction method

pile foundation

Classification of piles

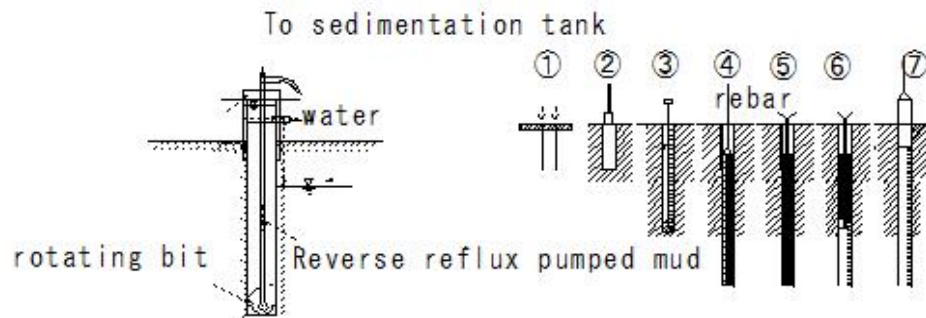
- Classification by construction method
- Ready-made pile construction method
- factory production
- steel R.C. PC composite



(M234)Foundation work-Cast-in-place pile method

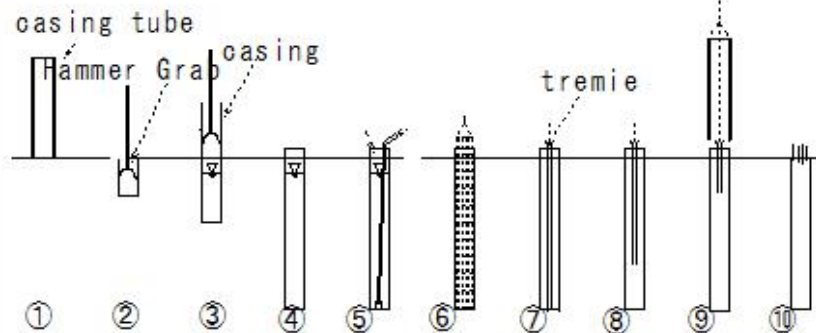
(M234) Foundation work-Cast-in-place pile method

Reverse circulation method



- ① Installing stand pipe
- ② Internal excavation with bucket
- ③ Excavation using leavers method
- ④ Reinforcement installation
- ⑤ Suck up sediment-Built-in tremie pipe
- ⑥ Concrete pouring
- ⑦ Pull out the stand pipe

All-casing method



- ① Casing Foundation Pile Center
- ② excavation-Hammer Grab
- ③ excavation-Hammer Grab
- ④ excavation-completed
- ⑤ Water-muddy water-Mud Water Pump
- ⑥ Rebar cage
- ⑦ Tremie tube
- ⑧ Ready-mixed concrete
- ⑨ Pulling out casing
- ⑩ Burials

(M235)pile foundation-Standard application of piles

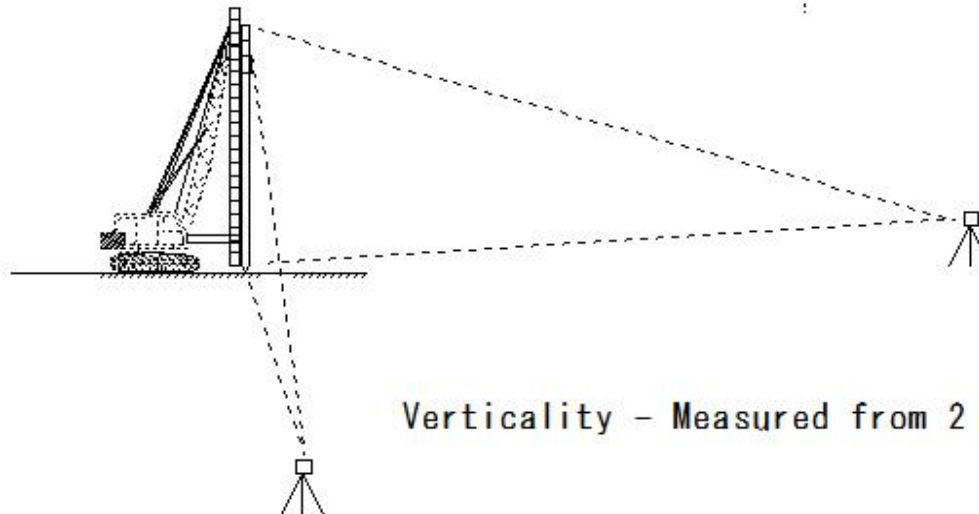
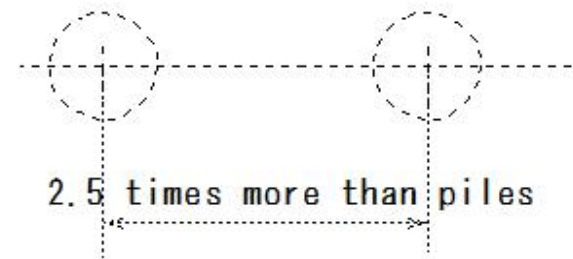
(M235)pile foundation-Standard application of piles

pile foundation

Standard application of piles

- Standard spacing of piles
2.5 times more than piles
- Erecting piles

Verticality - Measured from 2 directions



(M236)pile foundation-Driving ready-made piles-Diesel hammer

(M236)pile foundation-Driving ready-made piles-Diesel hammer

pile foundation

Driving ready-made piles

② Diesel hammer

- Hard ground Suitable for normal ground
- Number of blows

Steel pile: 3000 times or less

PC pile: 2000 times or less

RC pile: 1000 times or less

1 axis permissible inclination 1/100

2. Allowable deviation of driving position $D/4$ (10cm) or less

Diesel hammer

Do not set the piles at a settlement of less than 2 mm

Subsidence amount of 1mm or less at one time

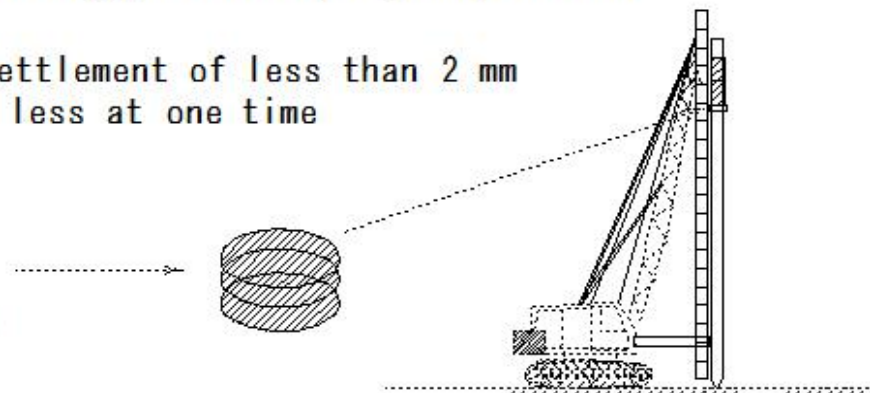
- Diesel damage
- Damage of piles

hammer cushion

Replace when it gets hard

cardboard paper

Pile diameter D



F30

(M237)pile foundation-Driving ready-made piles-Steam hammer/air hammer

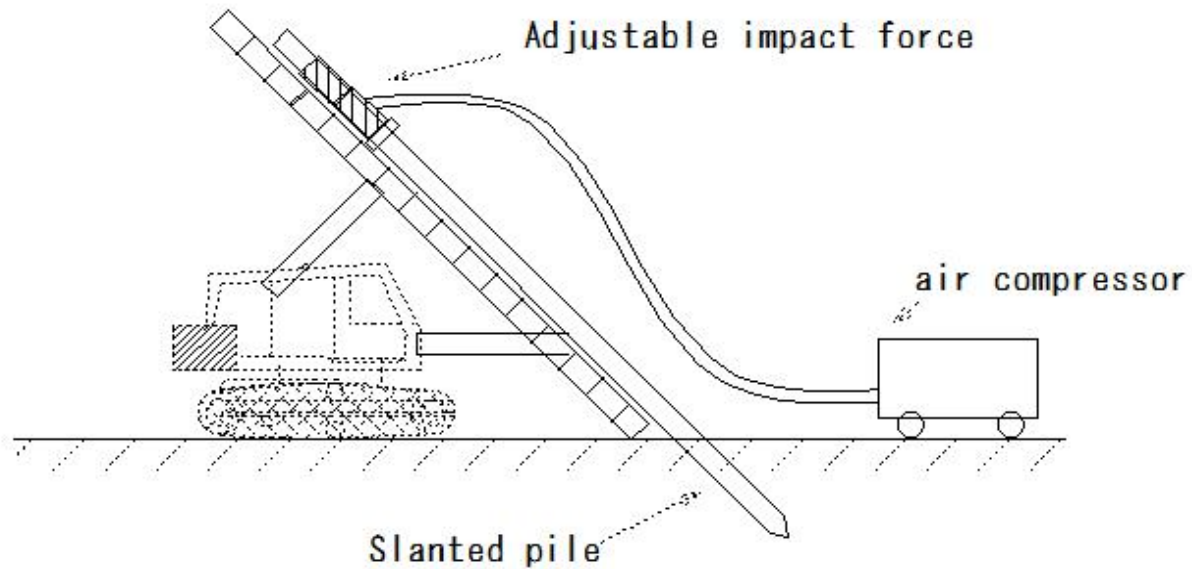
(M237)pile foundation-Driving ready-made piles-Steam hammer/air hammer

pile foundation

Driving ready-made piles

③ Steam hammer/air hammer

- Equipment - large scale
- Many piles
- Slanted piles can be driven underwater



(M238)pile foundation-Driving ready-made piles-Vibro hammer

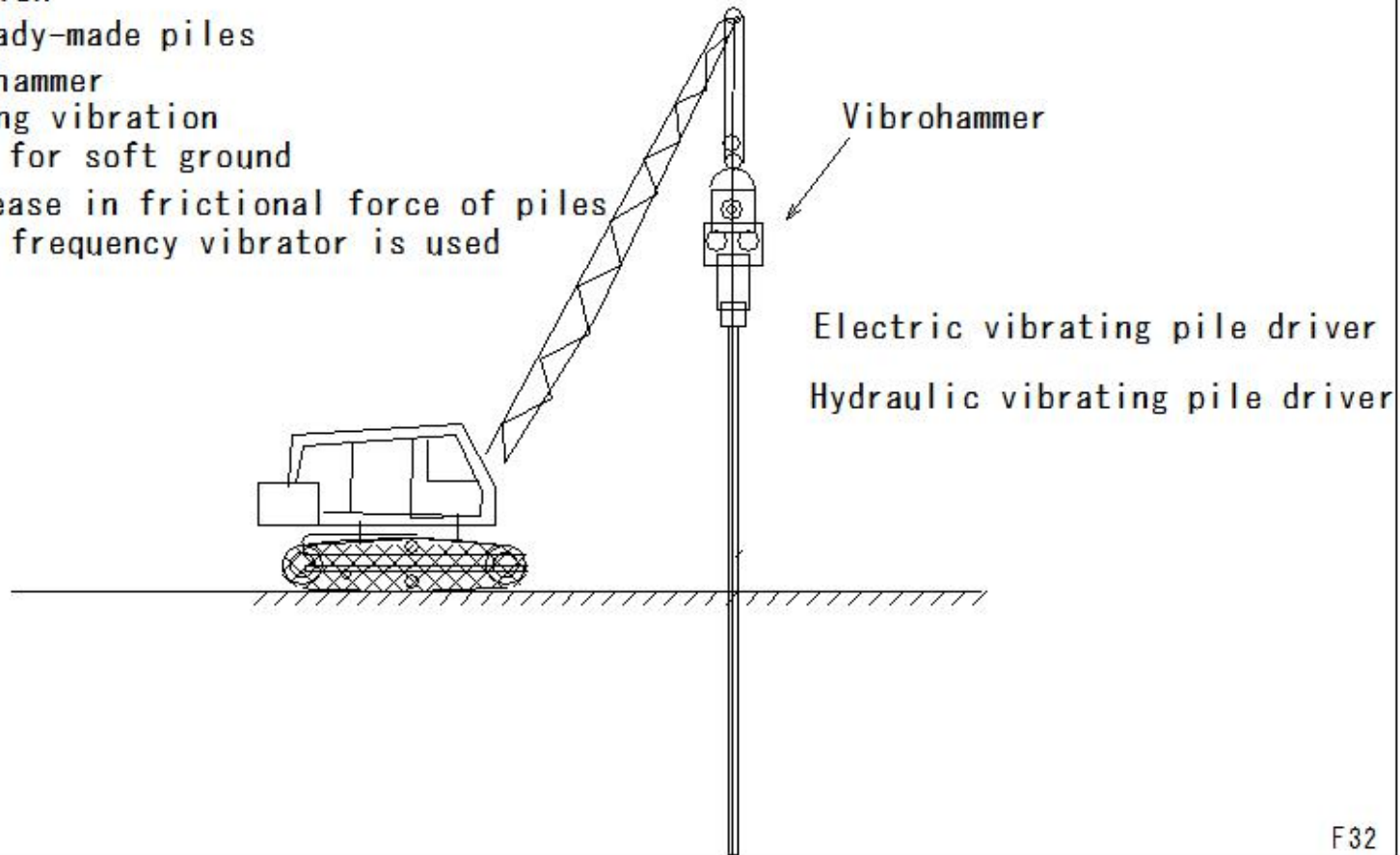
(M238)pile foundation-Driving ready-made piles-Vibro hammer

pile foundation

Driving ready-made piles

④Vibro hammer

- Strong vibration
- Good for soft ground
- Decrease in frictional force of piles
- High frequency vibrator is used



(M239)pile foundation-Driving ready-made piles-(Pre-boring method)

(M239)pile foundation-Driving ready-made piles-(Pre-boring method)

pile foundation

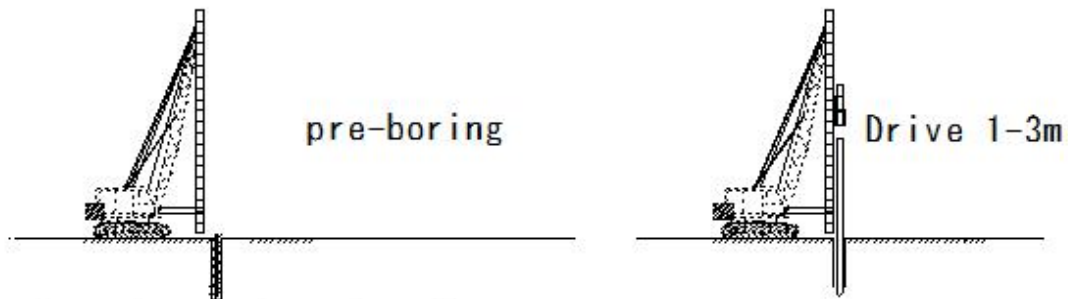
Pollution measures for ready-made piles

- diesel hammer
- Vibro hammer

Driving ready-made piles - noise and vibration

Low-pollution ready-made pile driving method

①Pre-boring method



Dig the hole for the ready-made pile
with an earth auger etc.

Place concrete in case not pouring

(M240)pile foundation-(Hollow excavation pile method/Prefabricated pile)

(M240)pile foundation-(Hollow excavation pile method/Prefabricated pile)

pile foundation

Pollution measures for ready-made piles

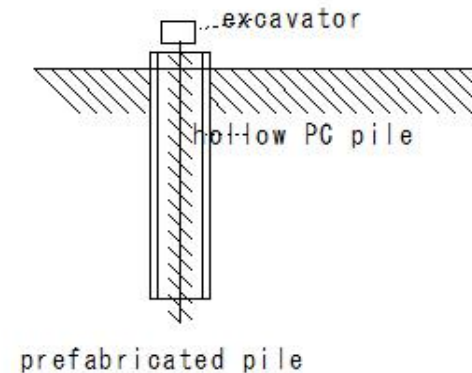
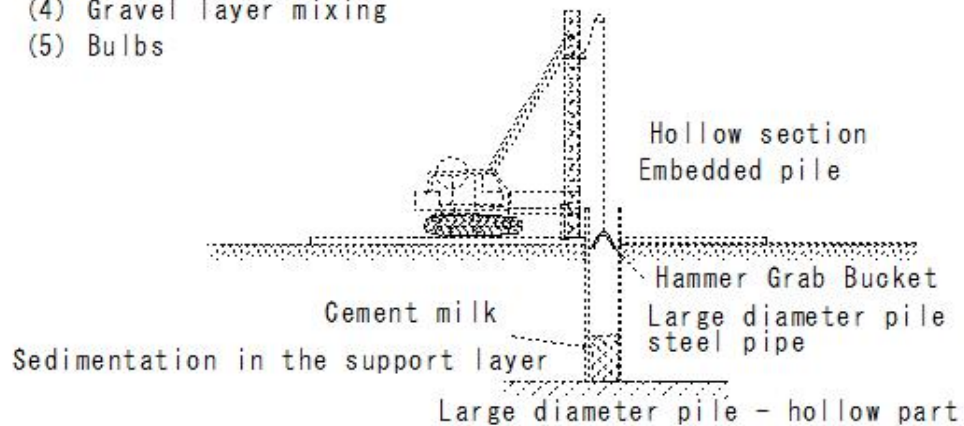
②Hollow excavation pile method/Prefabricated pile

Utilizing hollow parts of piles

Dig the hole for the ready-made pile with an earth auger etc.

Drilling and press-fitting with a bucket

- (1) Hammer Grab Bucket-drilling
- (2) Rotary press fitting
- (3) Tip - Cement milk squirting
- (4) Gravel layer mixing
- (5) Bulbs



(M241)pile foundation-(Jet method)

(M241)pile foundation-(Jet method)

pile foundation

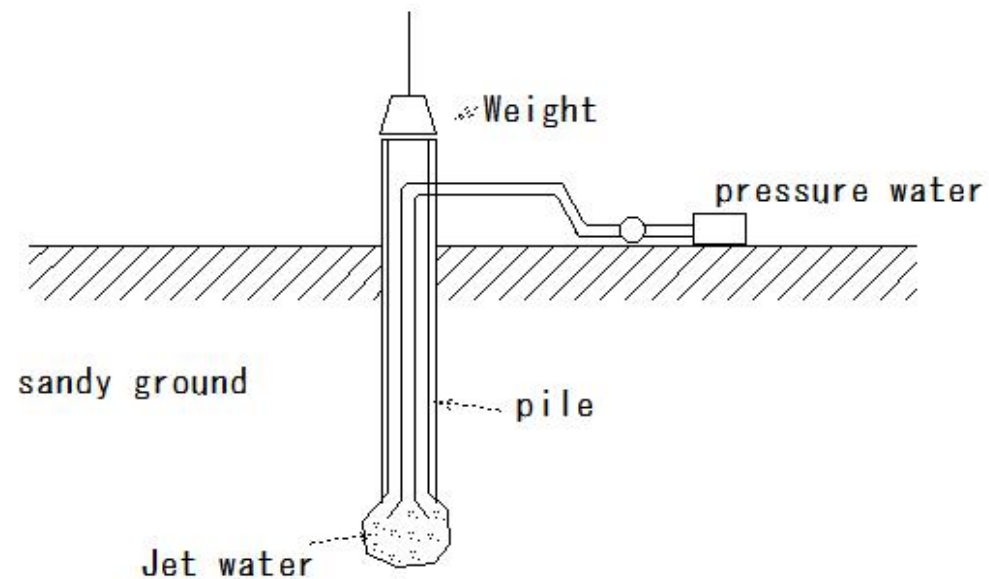
Pollution measures for ready-made piles

③ Jet method

Sand ground - High pressure water - Injection - Excavation

Eliminate friction between piles and the ground

Pile-press fit



(M242)pile foundation-(Hydraulic hammer press-in method)

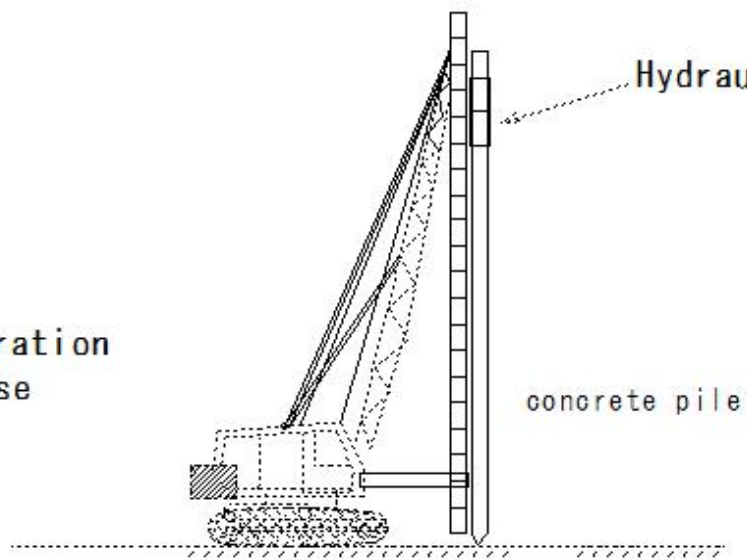
(M242)pile foundation-(Hydraulic hammer press-in method)

pile foundation

Pollution measures for ready-made piles

④Hydraulic hammer press-in method

No vibration
No noise



Hydraulic-Pile-Press Fit

concrete pile

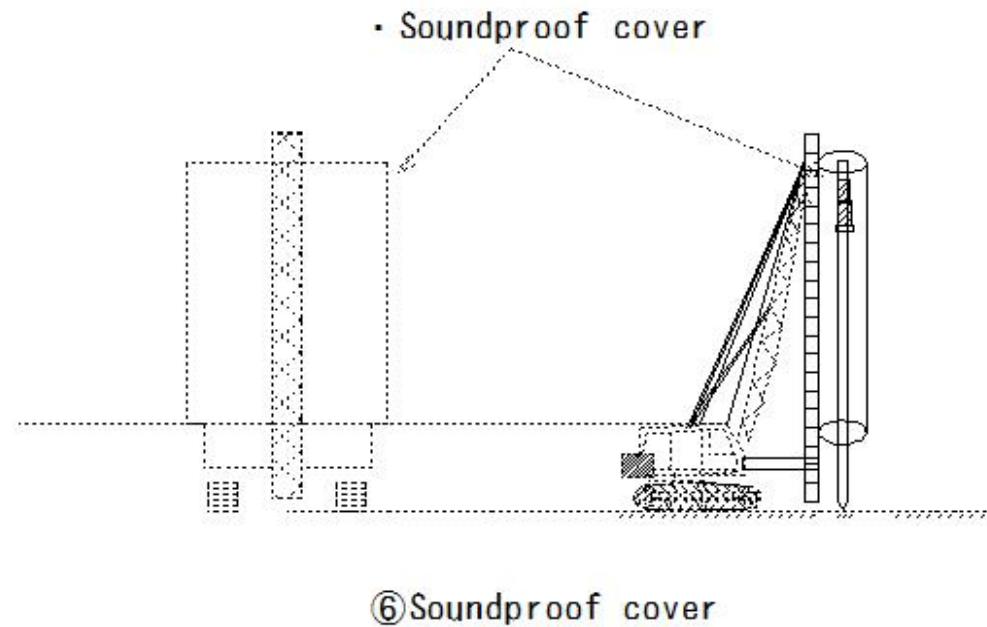
(M243)pile foundation-(Soundproof cover)

(M243)pile foundation-(Soundproof cover)

pile foundation

Pollution measures for ready-made piles

- ⑥ Soundproof cover
diesel hammer



M244)pile foundation-(Welding)

(M244)pile foundation-(Welding)

pile foundation

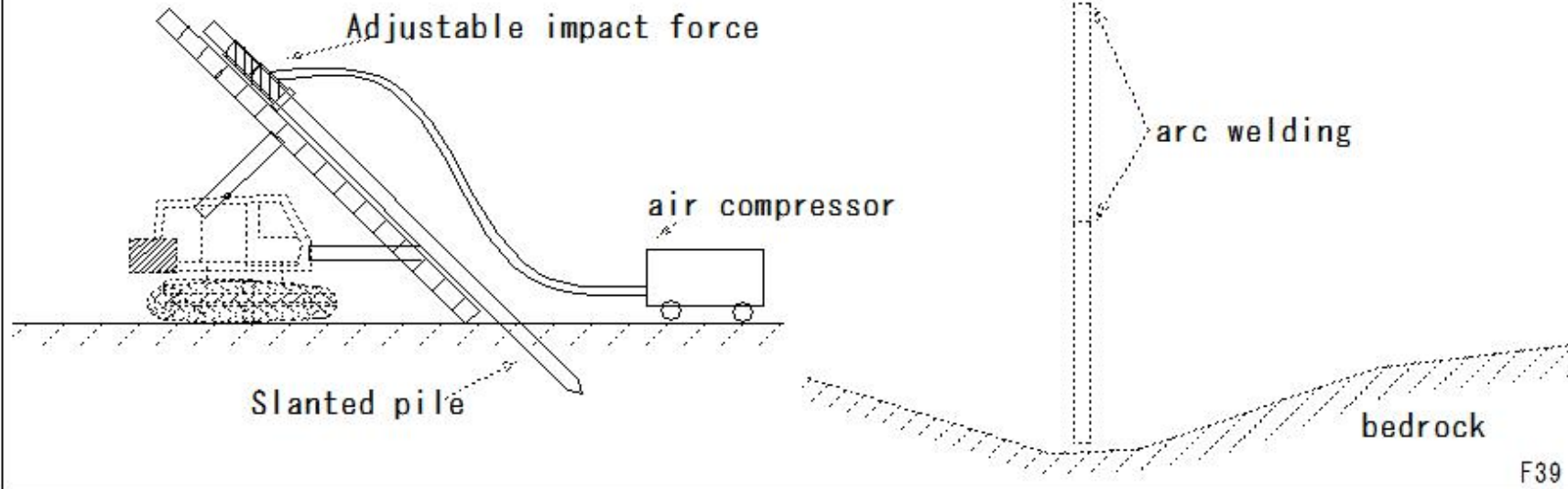
Construction management of ready-made piles

①Welding

- Welded joints - arc welding
- Welding inspection results-record
- Diagonal pile - Do it from the pulling side

Diagonal pile

H-section steel pile



(M245)pile foundation-(piling)

(M245)pile foundation-(piling)

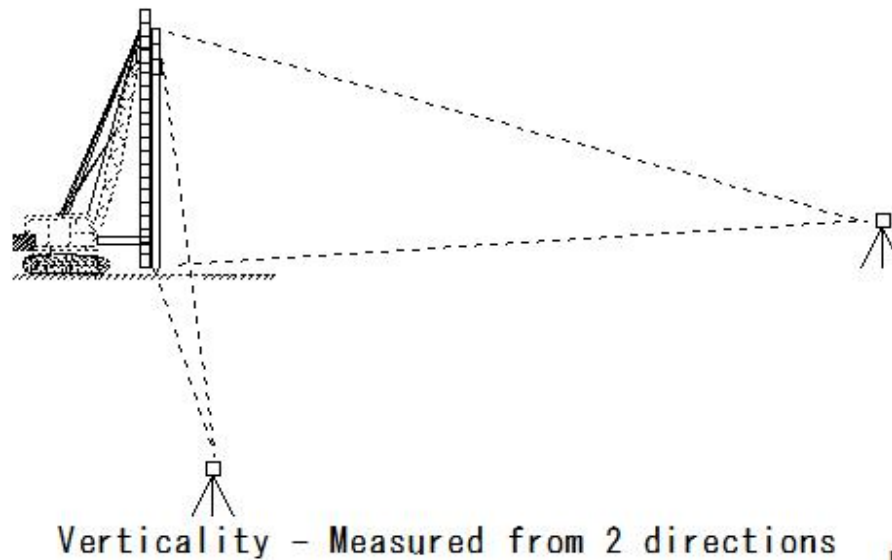
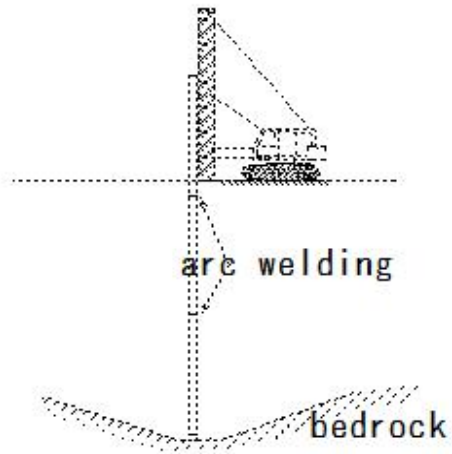
pile foundation

Construction management of ready-made piles

②piling

• Erection of ready-made piles -
inspection from two directions

• Welding inspection results-record



F40

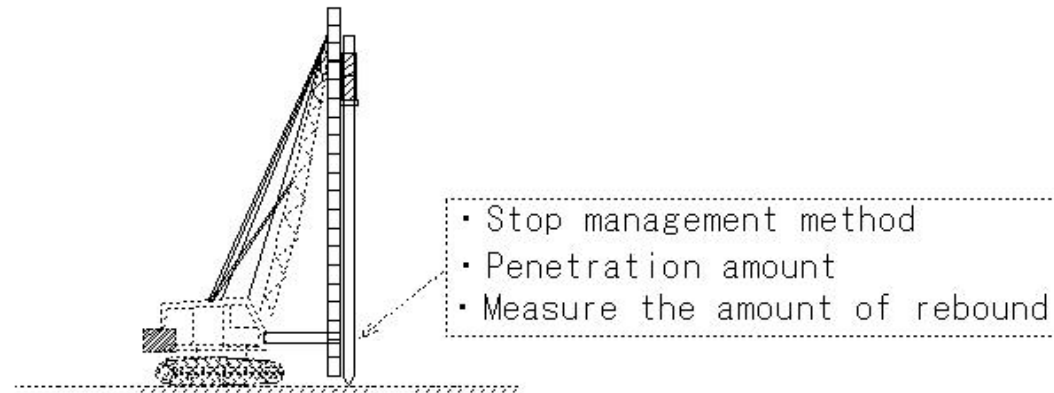
(M246)pile foundation-(Stopping piling)

(M246) pile foundation-(Stop piling)

pile foundation

Construction management of ready-made piles

③Stop piling



(M247)pile foundation-(cast-in-place pile)

(M247)pile foundation-(cast-in-place pile)

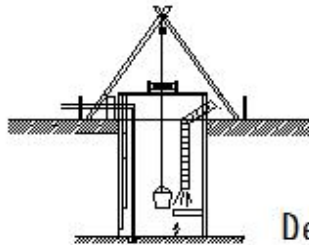
pile foundation

cast-in-place pile

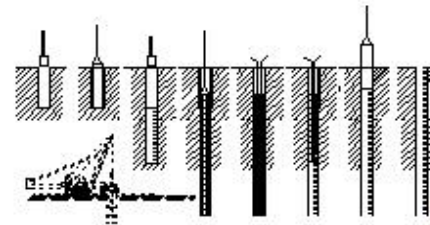
Noise/vibration pollution prevention

- Equipment - large
- Construction speed - slow
- Construction management-problems

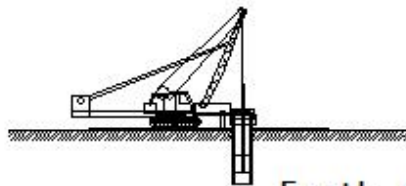
- ① Deep foundation construction method -manual excavation
- ② Benoto method / Earth drill method / Reverse method - Mechanical excavation



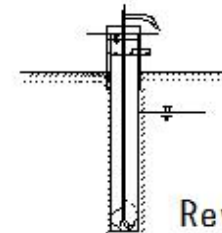
Deep foundation



Benoto method



Earth drill method



Reverse method

(M248)pile foundation-(Deep foundation)

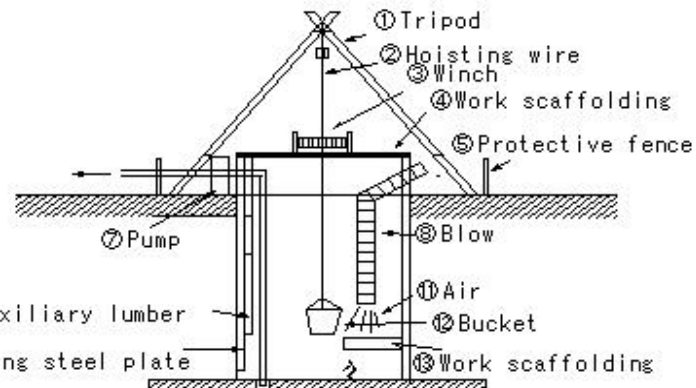
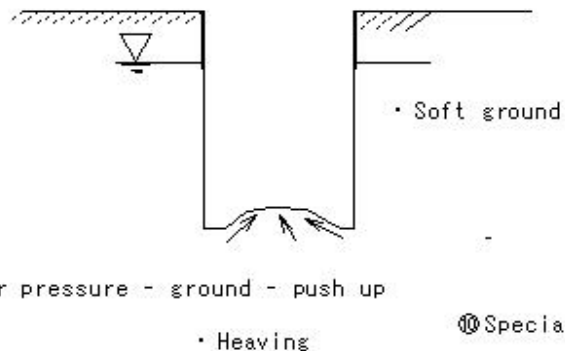
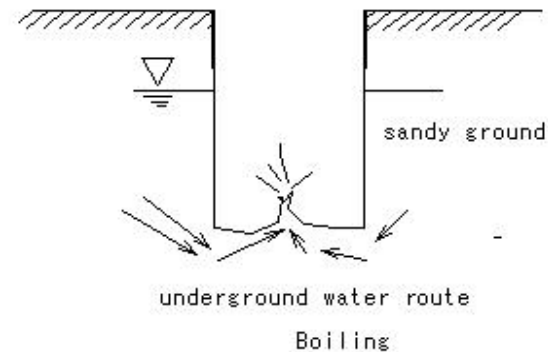
(M248)pile foundation-(Deep foundation)

pile foundation

cast-in-place pile

① Deep foundation construction method

- Manual excavation
- Groundwater exclusion
- Possible to blast leaves of rolling stones
- Drainage construction - boiling and heaving
- Confirmation of soil bearing capacity - easy



(M249)pile foundation-(Benoto method)

(M249)pile foundation-(Benoto method)

All-casing method
Benoto method

pile foundation
cast-in-place pile

② Benoto method

• France: Benoto - Developed

Benoto machine

• Steel tube: casing tube

• Fine sand layer containing water
5m below the groundwater level
construction impossible

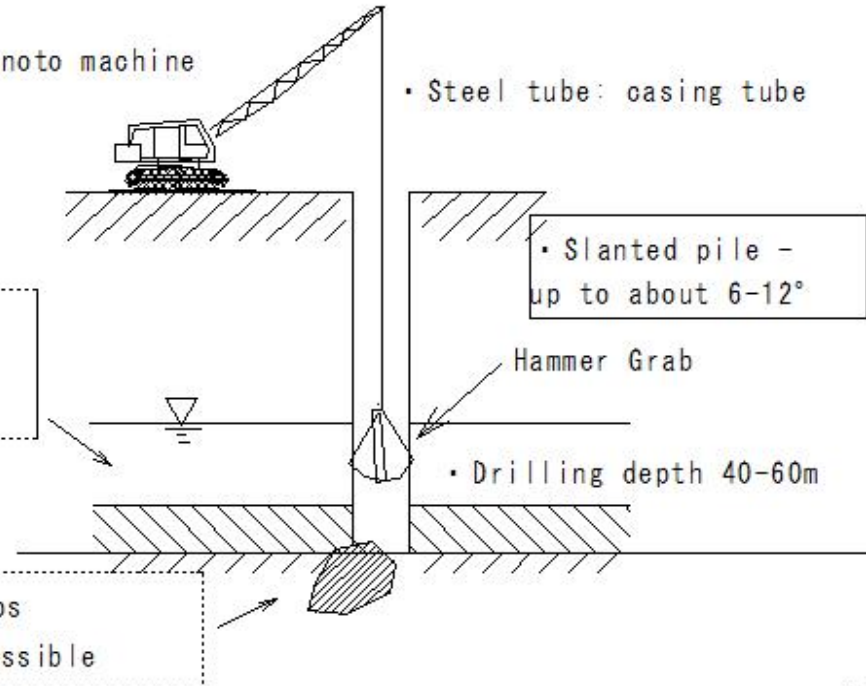
• Slanted pile -
up to about 6-12°

Hammer Grab

• Drilling depth 40-60m

big "rolling stone"

• Large boulders and wood chips
construction impossible



(M250)pile foundation-(Earth drill method)

(M250)pile foundation-(Earth drill method)

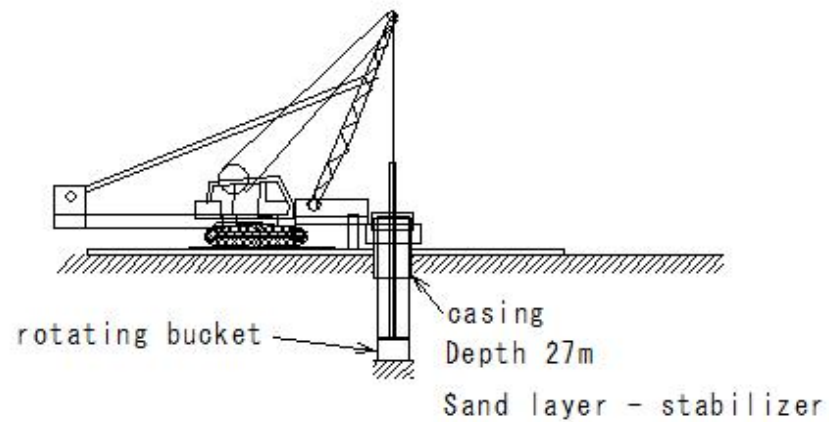
pile foundation

cast-in-place pile

③ Earth drill method

- Rotating bucket - excavation
- Construction speed - fast
- Low cost
- Drilling depth - 27m
- Suitable for clay layer
- Weak sandy ground - bentonite solution (stabilizing liquid)

Earth drill method



(M251)pile foundation-(Reverse circulation method)

(M251)pile foundation-(Reverse circulation method)

pile foundation

cast-in-place pile

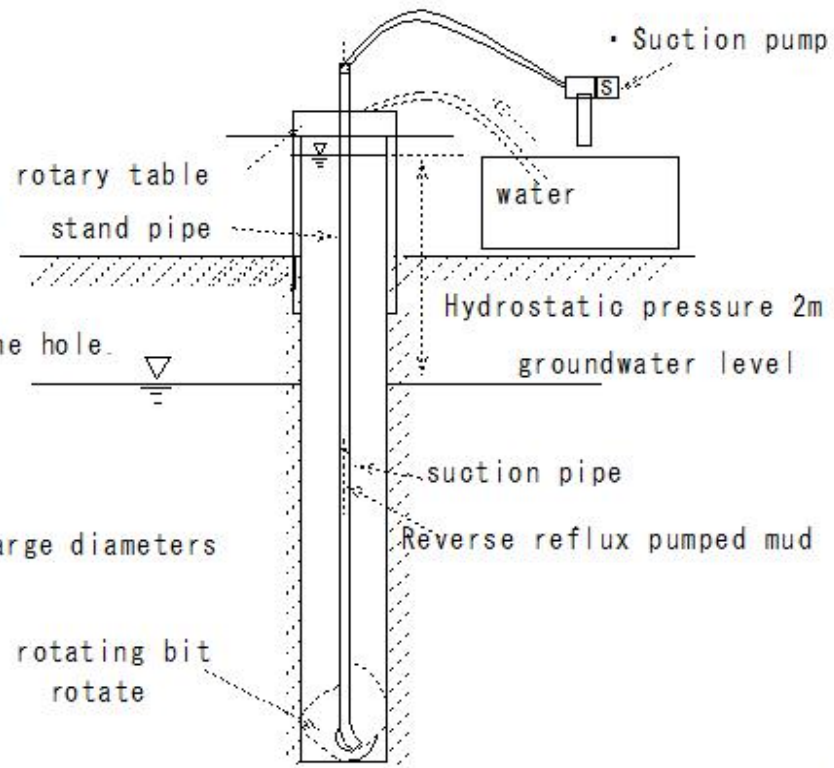
④ Reverse method

Reverse circulation method

- Big pile driving
- Continuous drilling
- Large boulders, pressurized water, underground water - construction difficult
- Water construction possible
- The water level inside the hole is 2m higher than the water level outside the hole.

• Good for long and large diameters

rotating bit



(M252)pile foundation-(Construction management of cast-in-place piles)

(M252)pile foundation-(Construction management of cast-in-place piles)

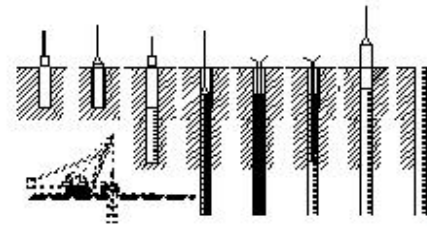
pile foundation

Construction management of cast-in-place piles

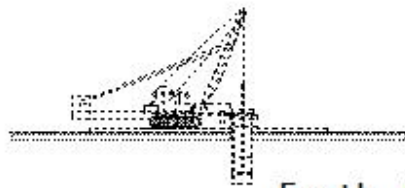
- ① Concrete management
- ② Slime processing
- ③ Treatment of hole walls
- ④ Pollution prevention management
- ⑤ Records of excavation, reinforcing cage installation, and concrete placement

Cast-in-place piles: Low noise and vibration

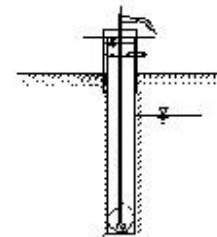
- Muddy water treatment-problems



Benoto method



Earth drill method



Reverse method

(M253)pile foundation-(Construction management of Benoto Earth Drill Reverse Method)

(M253)pile foundation-(Construction management of Benoto Earth Drill Reverse Method)

Construction management of cast-in-place piles

① Concrete management

Benoto Earth Drill Reverse Method

① Drilling

② Reinforcement cage insertion

③ Tremie tube arrangement

④ Drain the water in the tremie tube

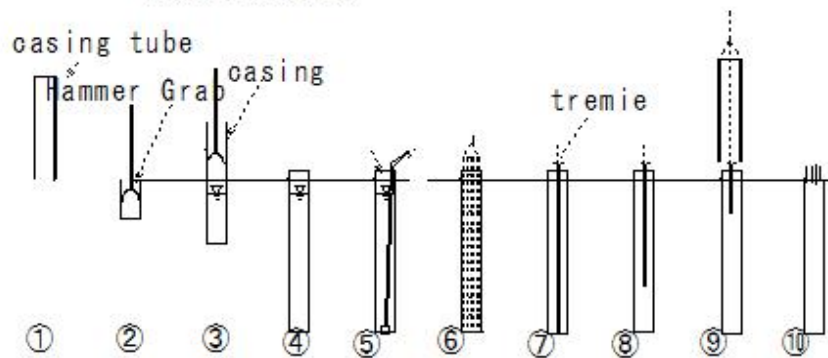
⑤ Underwater concrete placement (slump 17cm, cement amount 370kgf/m³ or more)

⑥ Pulling out the casing - Preventing reinforcing bars from rising together

⑦ Separator depth direction 3-5m interval

⑧ Hole wall protection Concrete top surface
Casing tube approximately 2m inserted

Benoto Method



① Casing Foundation Pile Center

② excavation-Hammer Grab

③ excavation-Hammer Grab

④ excavation-completed

⑤ Water-muddy water-Mud Water Pump

⑥ Rebar cage

⑦ Tremie tube

⑧ Ready-mixed concrete

⑨ Pulling out casing

⑩ Burials

(M254)pile foundation-(Construction management of Benoto piles)

(M254)pile foundation-(Construction management of Benoto piles)

pile foundation

Construction management of cast-in-place piles

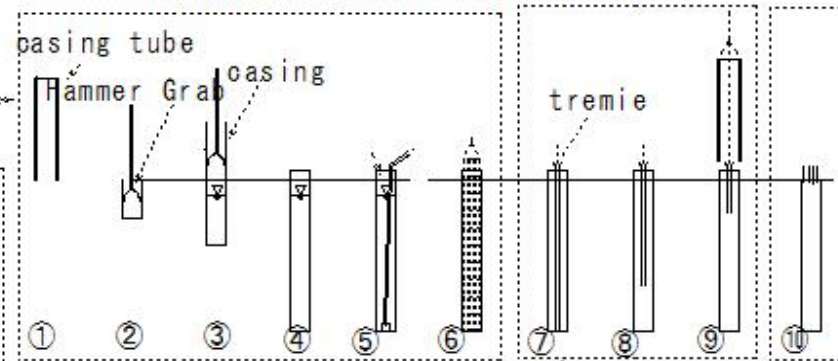
① Construction of Benoto piles

① Insert reinforcing bar cage
Groundwater casing

② Underwater concrete placement (slump 17cm,
cement amount 370kgf/m³ or more)
tremie tube is flanged and watertight.
Raise the casing approximately 2m
to protect the hole wall
Insert about 2 m on top of concrete

③ Slime (cutting residue) Mixed with muddy water
concrete curing
Must not be harmful due to temperature, load, shock, etc.
• Pile head
Add about 0.5m extra
there is muddy water, it is about 1m

Benoto Earth Drill Reverse Method



(M255)pile foundation-(Benoto piles Slime processing)

(M255)pile foundation-(Benoto piles Slime processing)

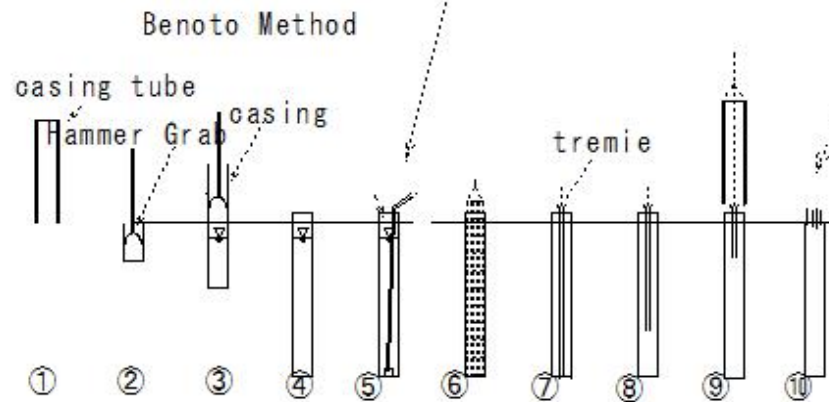
pile foundation

Construction management of cast-in-place piles

Benoto Method

② Slime processing

- Pile tip - Excavation residual soil, slime - Strength decrease and uneven settlement
- Slime processing
air lift pump



after pouring
slime mixed pile head 0.5-1.0m removed

- ① Casing Foundation Pile Center
- ② excavation-Hammer Grab
- ③ excavation-Hammer Grab
- ④ excavation-completed
- ⑤ Water-muddy water-Mud Water Pump
- ⑥ Rebar cage
- ⑦ Tremie tube
- ⑧ Ready-mixed concrete
- ⑨ Pulling out casing
- ⑩ Burials

(M256)pile foundation-(Earth drill method Treatment of hole walls)

(M256)pile foundation-(Earth drill method Treatment of hole walls)

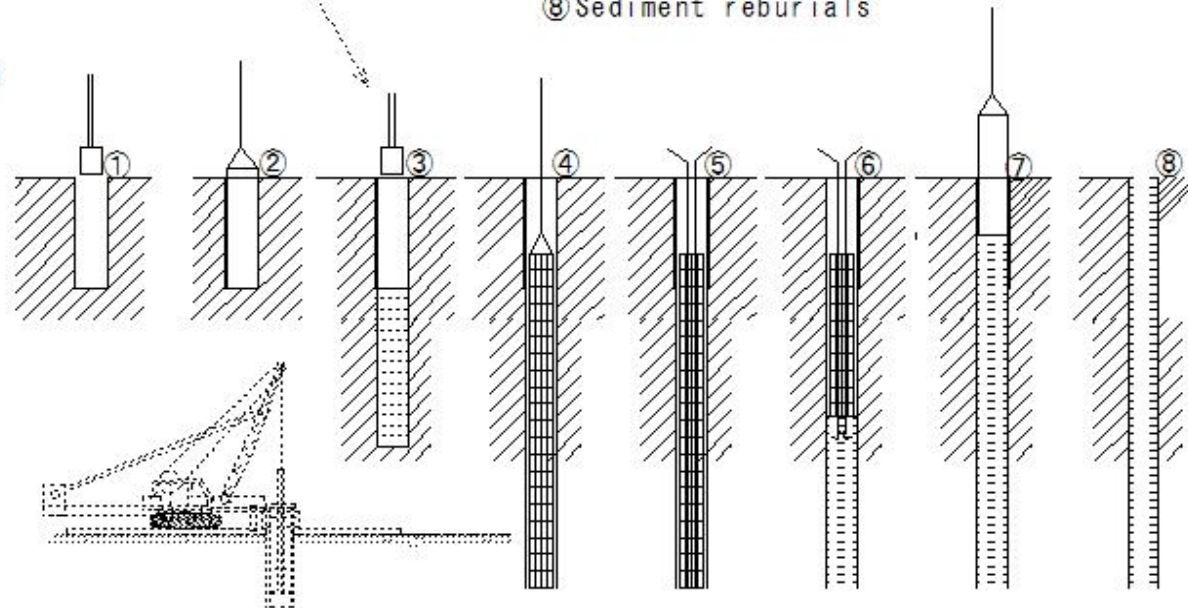
pile foundation

Construction management of cast-in-place piles

③ Treatment of hole walls
Treatment of hole walls - problems
Stabilizer treatment and management

- ① Drilling
- ② Casing tube insertion
- ③ Bentonite solution- injection
hole wall prevention
muddy water
- ④ Erection of rebar
- ⑤ Built-in tremie tube
- ⑥ Ready-mixed concrete pouring
- ⑦ Casing tube pull-out
- ⑧ Sediment reburials

Earth drill method



(M257)pile foundation-(cast-in-place piles Prevention of construction pollution)

(M257)pile foundation-(cast-in-place piles Prevention of construction pollution)

pile foundation

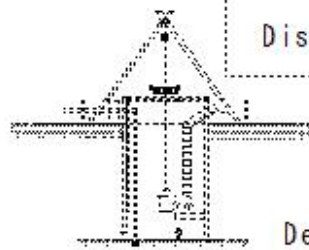
Construction management of cast-in-place piles

④Prevention of construction pollution

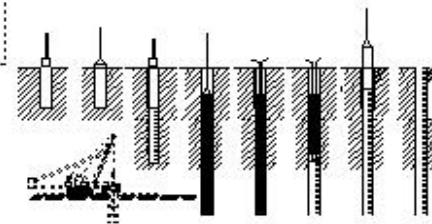
- Water pollution
- Disposed of as sludge and sand - industrial waste - as a landfill

Emission standards

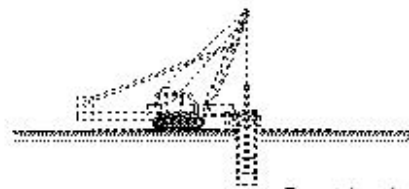
Water pollution
Disposed of as sludge and sand



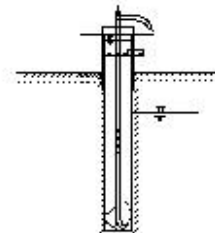
Deep foundation



Benoto method



Earth drill method

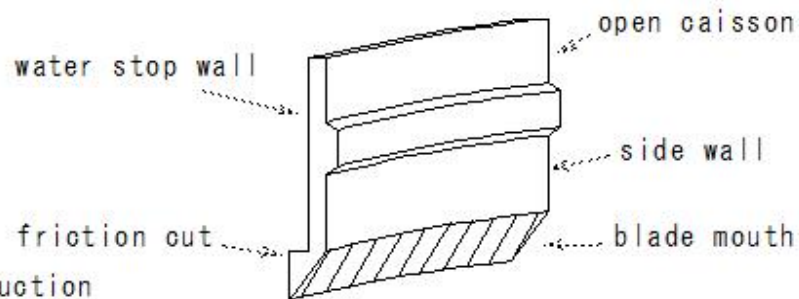


Reverse method

(M258)pile foundation-(caisson foundation)

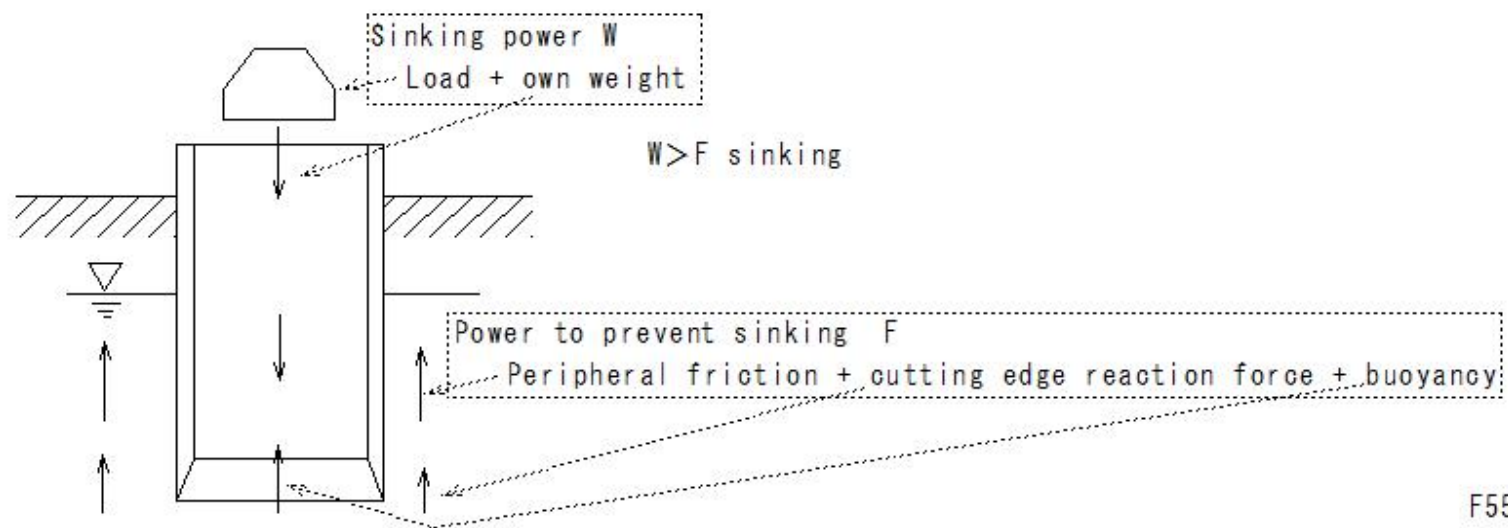
(M258)pile foundation-(open caisson foundation)

Foundation work
caisson foundation



① Circumferential friction - reduction

② Convert passive earth pressure to active earth pressure



(M259)pile foundation-(caisson foundation)

(M259)pile foundation-(open caisson foundation)

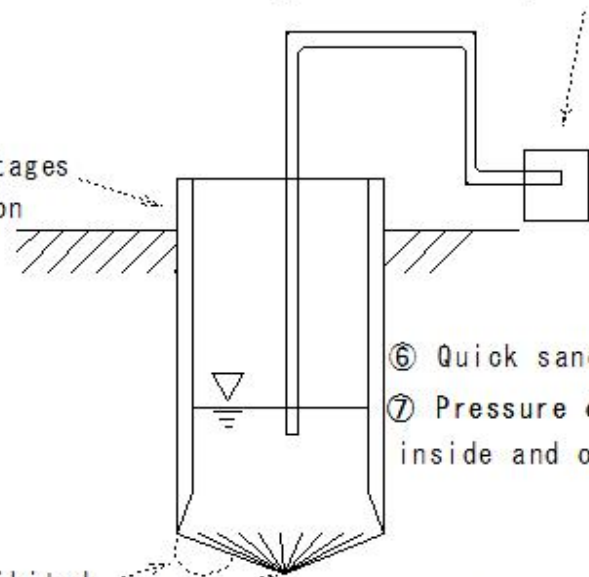
caisson foundation

- Construction of open caissons

sufficient control

- ① Caisson tilt - tends to occur in the early stages
- ② Ensuring concrete strength-starting excavation

⑤ Avoid drainage as much as possible



- ⑥ Quick sand phenomenon occurs
- ⑦ Pressure difference occurs inside and outside the caisson

③ Excess under the caisson blade mouth is prohibited.

④ Excavation should be done from the center.

F56

(M260)pile foundation-(caisson foundation)

(M260)pile foundation-(open caisson foundation)

caisson foundation

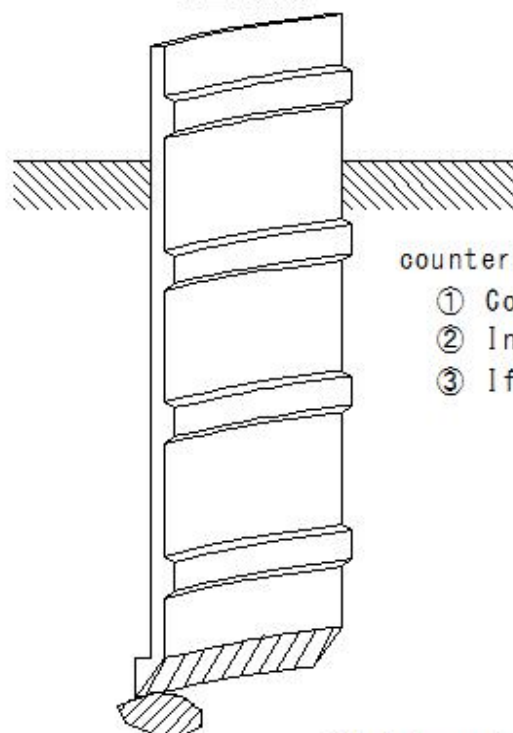
- Construction of open caissons

Load



Concrete block

- Gradually sinks in loaded

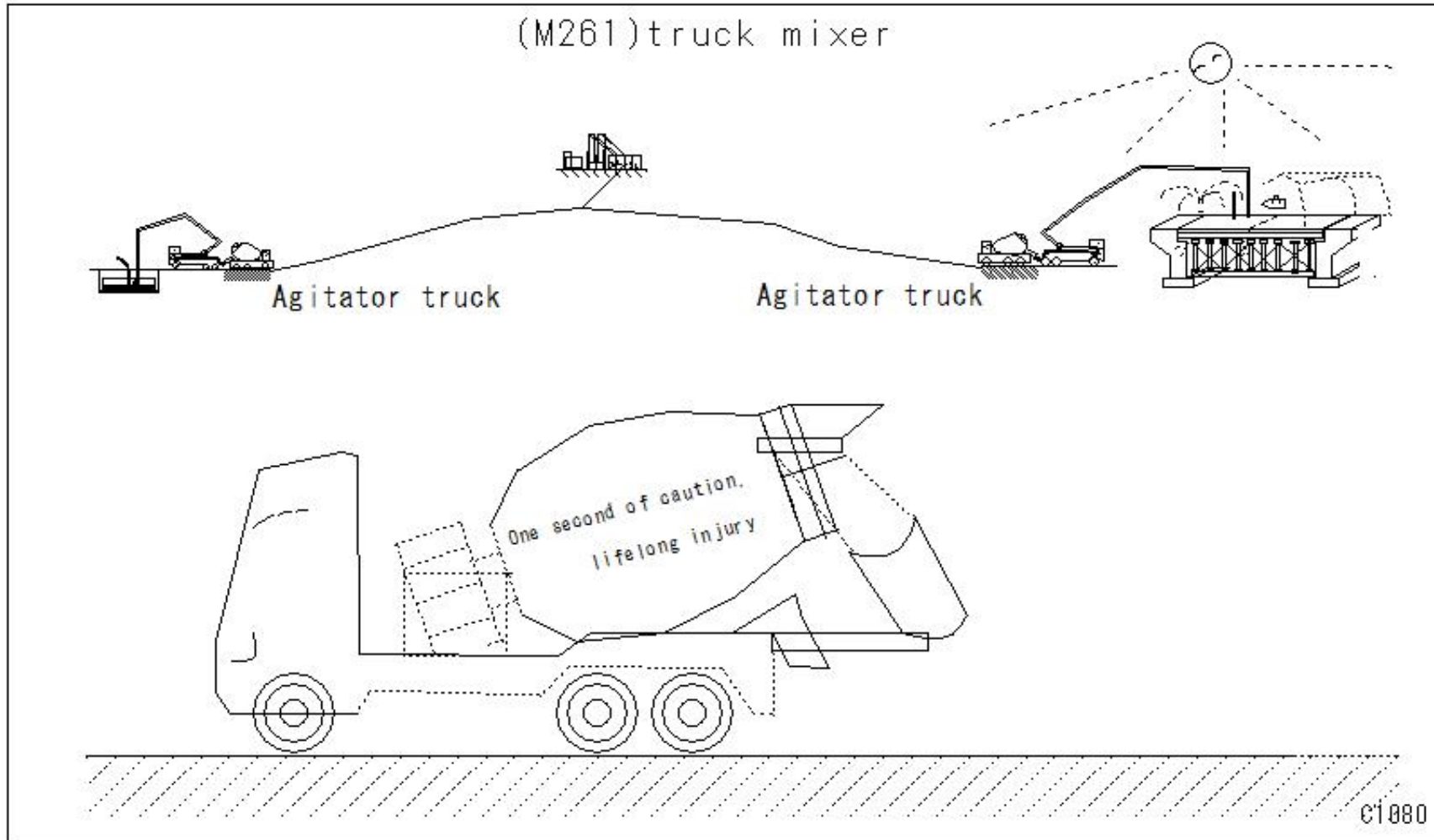


countermeasure

- ① Conduct a thorough soil investigation
- ② Internal drainage
- ③ If there is a large boulder, it will not sink.

- ④ Internal blasting - Avoid damaging the main body

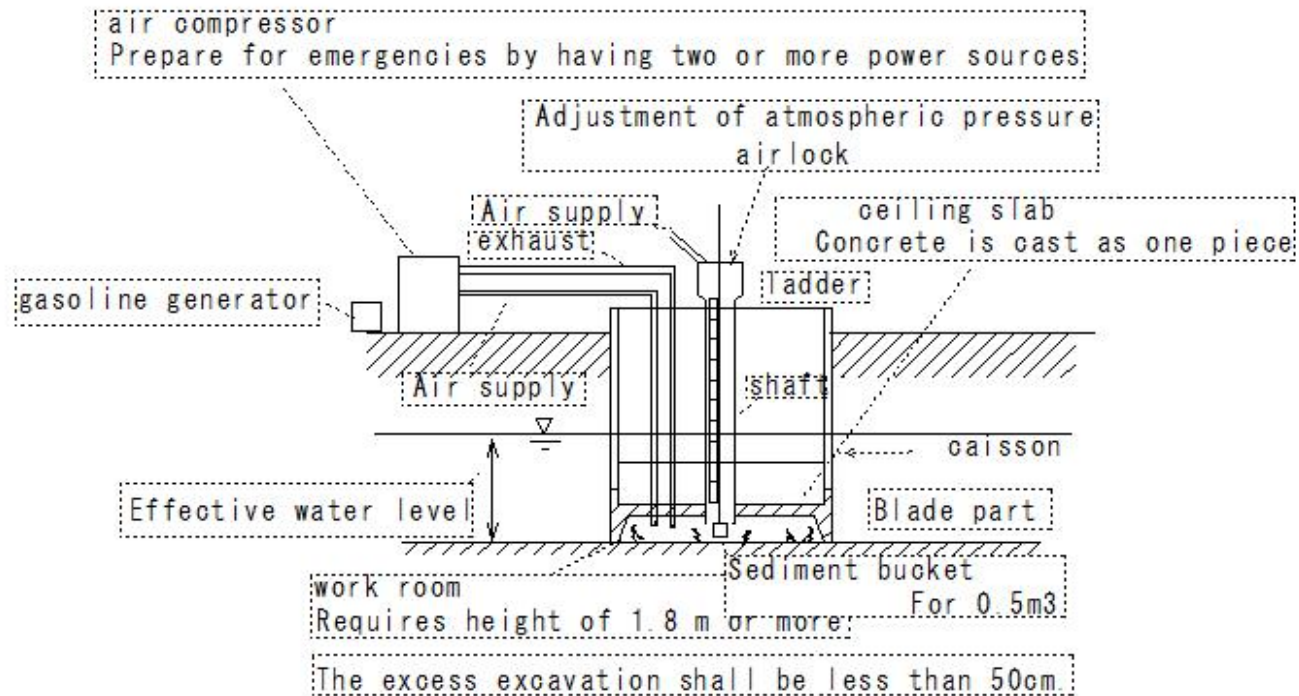
(M261)truck mixer



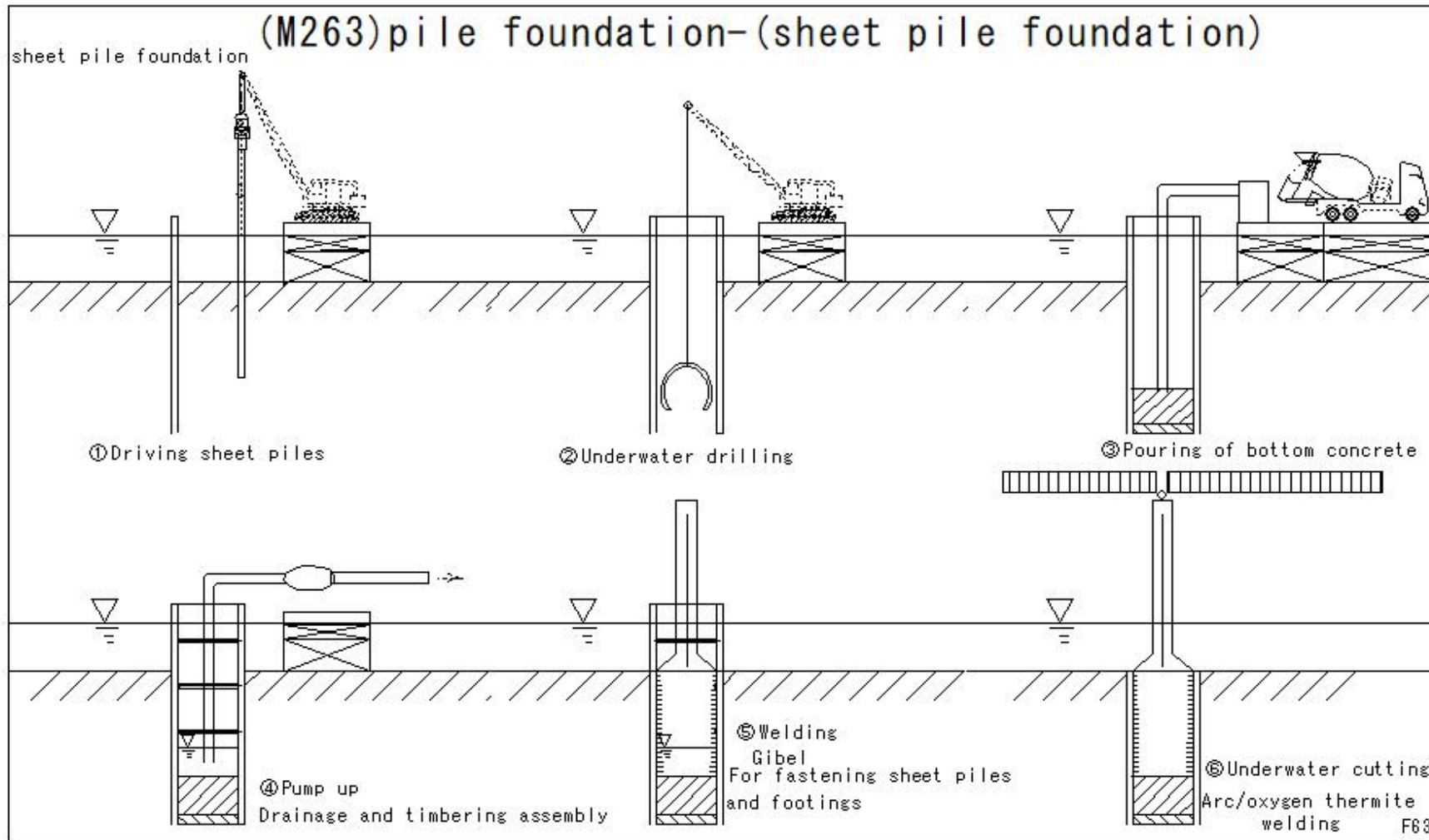
(M262)pile foundation-(pneumatic caisson)

(M262)pile foundation-(pneumatic caisson)

Foundation work
caisson foundation
pneumatic caisson



(M263)pile foundation-(sheet pile foundation)

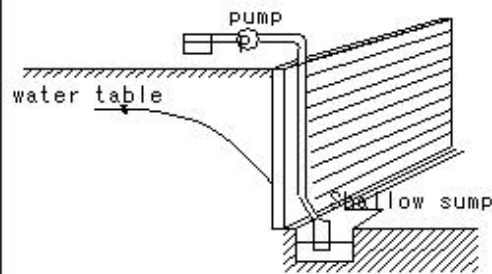


(M264)Foundation work-(Drainage method)

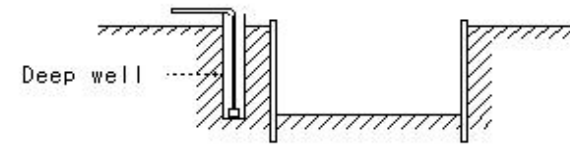
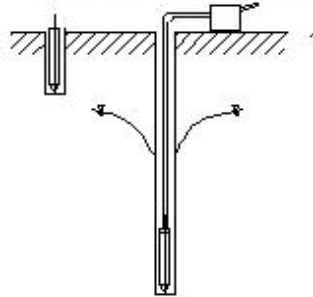
(M264) Foundation work- (Drainage method)

Drainage method

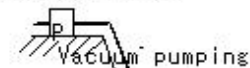
- Excavation - below groundwater level
- Pumping up groundwater - drying up of well water
- Decline in surrounding groundwater
- Surrounding area survey



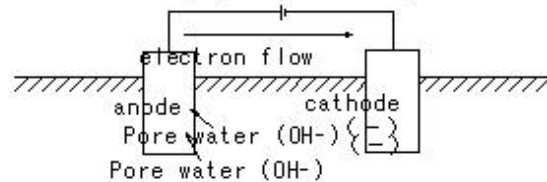
Well point construction method



Vacuum pumping



Electropenetration method
current flow (direct current)



F92
Strainer (filtering wire mesh) (steel pipe)

(M265)Foundation work-(Drainage method-Shallow sump)

(M265)Foundation work-(Drainage method-Shallow sump)

Drainage method

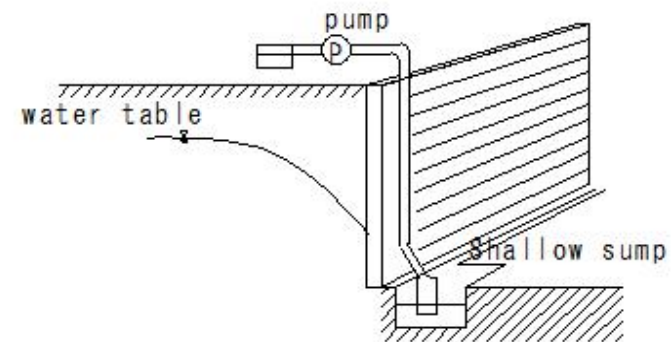
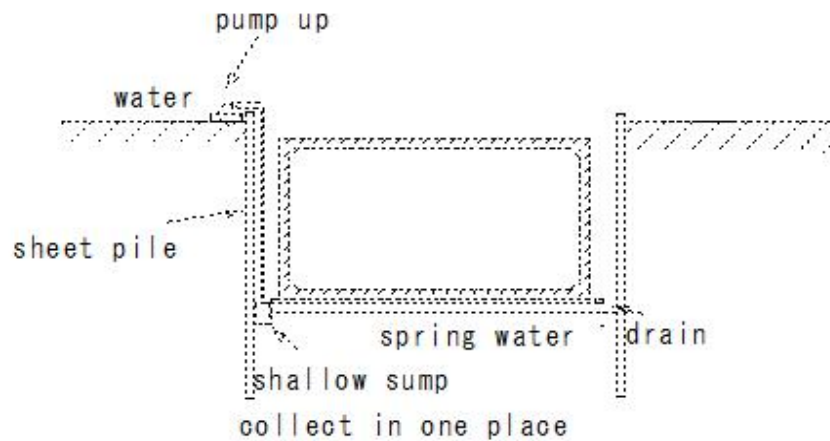
Shallow sump drainage method

Shallow sump

Shallow sump

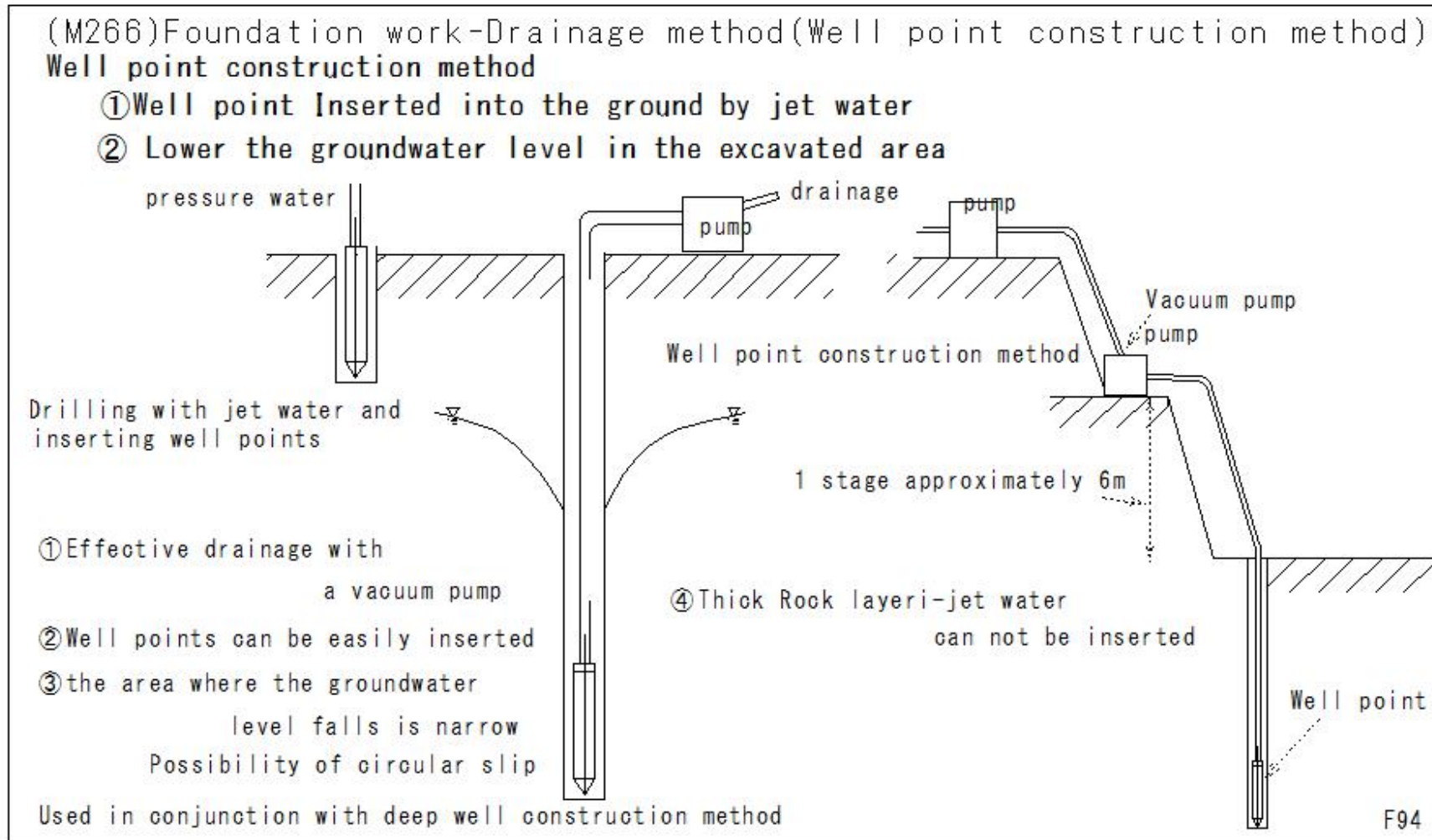
rainwater

- ① Less amount of groundwater flowing out
- ② Excavation of shallow ground



Construction method suitable for gravel layer

(M266)Foundation work-Drainage method(Well point construction method)



(M267)Foundation work-Drainage method(Deep well method)

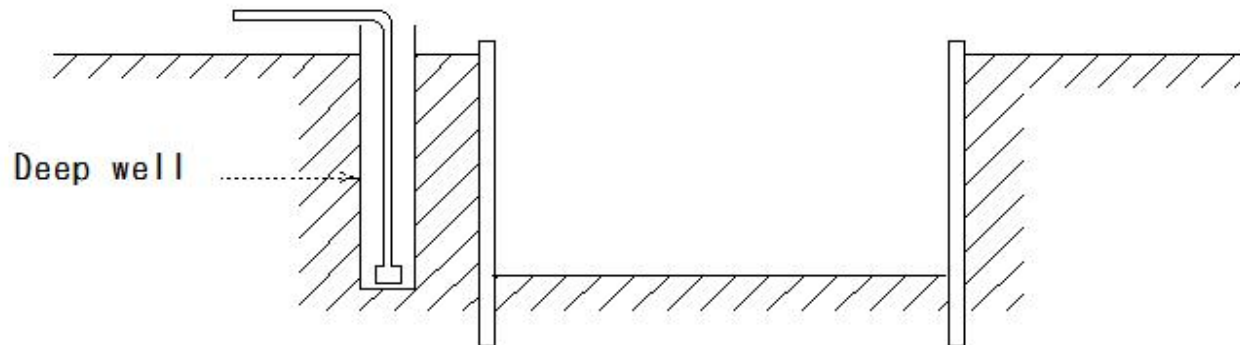
(M267)Foundation work-Drainage method(Deep well method)

Used in conjunction with deep well construction method

- ① Dig a deep well around the excavation part
- ② Pumping up water from a well and draining it
- ③ Groundwater level lowering method

location

- ④ Groundwater drop over a wide area
- ⑤ there is a possibility of heaving on the bottom of the excavation
- ⑥ the water permeability is large and the amount of drainage is large

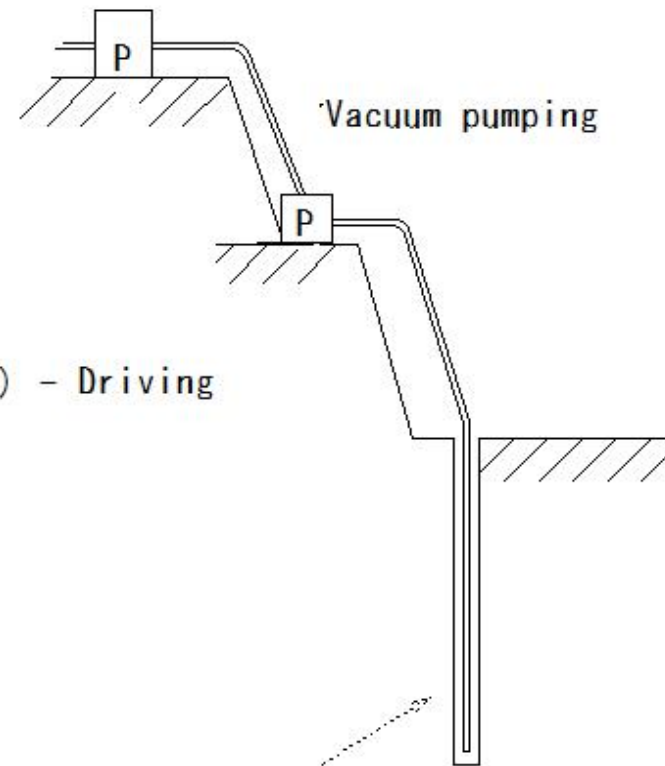


(M268)Foundation work-Drainage method(Deep well vacuum construction method)

(M268)Foundation work-Drainage method(Deep well vacuum construction method)

Deep well vacuum construction method

Vacuum pumping



Deep well vacuum construction method

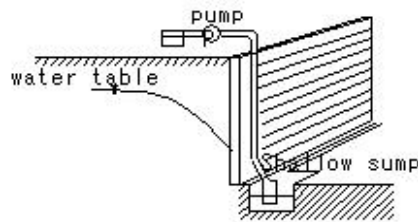
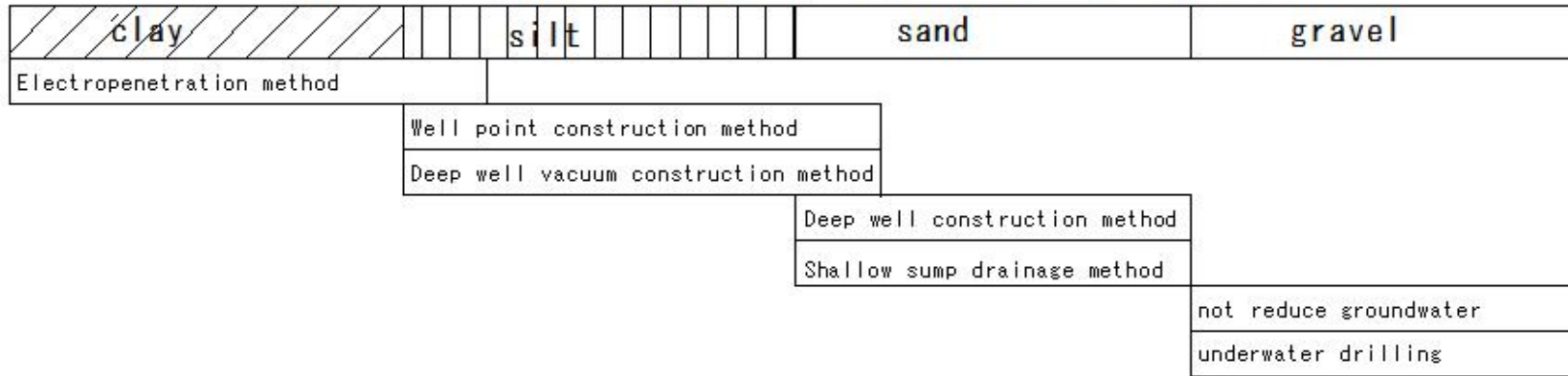
- ① Strainer (filtering wire mesh) (steel pipe) - Driving
- ② Several stages of pump installation
- ③ Vacuum pumping
- ④ the amount of water discharged is large

F96

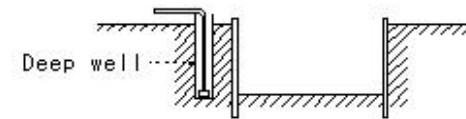
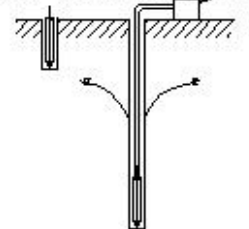
Strainer (filtering wire mesh) (steel pipe)

(M269)Foundation work-(Drainage method)

(M269) Foundation work-(Drainage method)



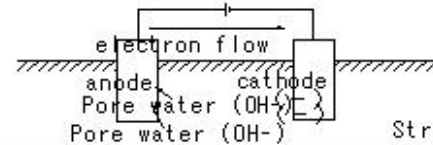
Well point construction method



Vacuum pumping

Vacuum pumping

Electropenetration method
current flow (direct current)



Strainer (filtering wire mesh) (steel pipe)

(M270)Construction plan for piles and caissons(Drop hammer)

(M270)Construction plan for piles and caissons(Drop hammer)

Types and contents of pile driving and hammering

① Drop hammer

- Weight of drop hammer: 1-3 times the weight of the pile
- Falling height: 1-2m
- Pile head protection: Heavy hammer
- Hold down the height of the fall

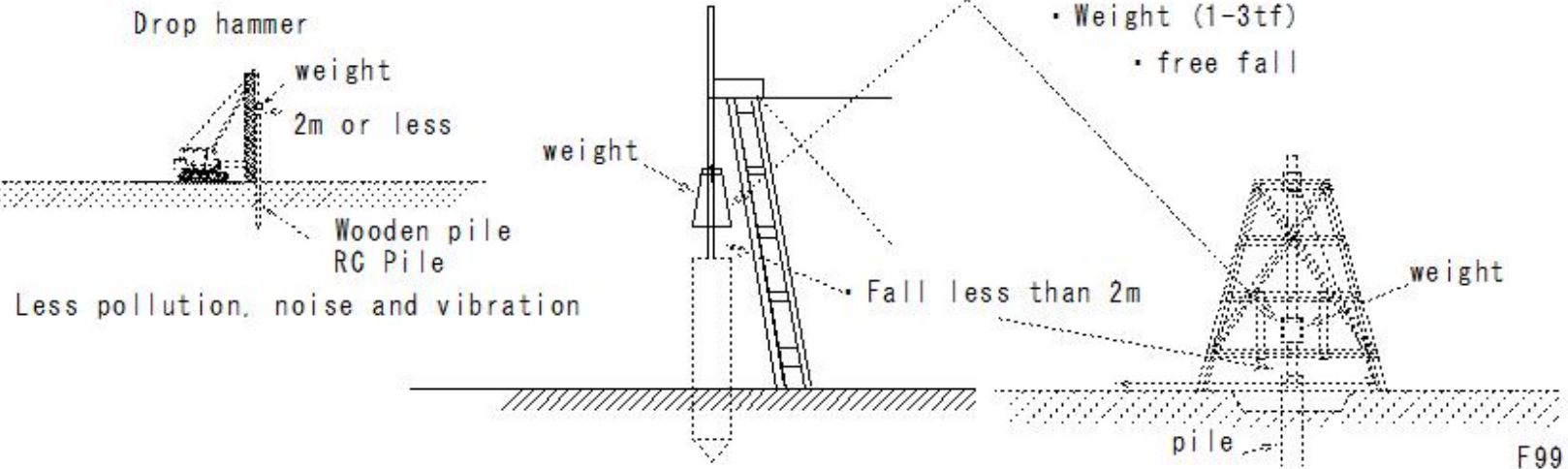
① Drop hammer

- Small cross section pile
- Equipment - Easy
- Easy to eccentricity

- Pile head: Damage prevention

- Weight of weight: 1-3 times the weight of the pile

- Weight (1-3tf)
- free fall



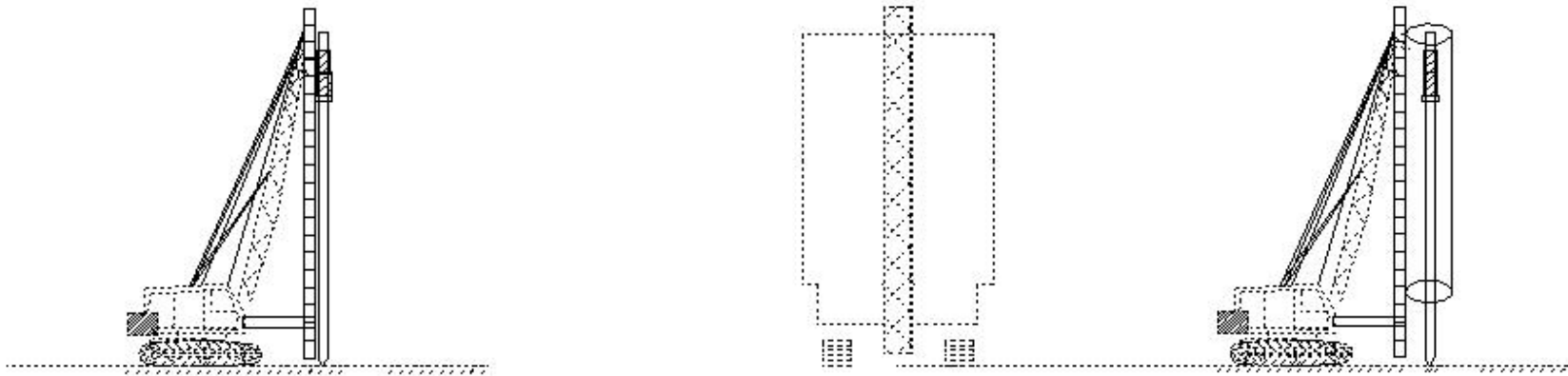
(M271)Construction plan for piles and caissons(Diesel hammer)

(M271)Construction plan for piles and caissons(Diesel hammer)

Types and contents of pile driving and hammering

- ② Diesel hammer
 - Falling ram
 - Inside cylinder gas explosion
 - Big impact energy
 - Ram size 1.26-6.0t

Diesel hammer



(M272)Construction plan for piles and caissons(Vibrohammer)

(M272)Construction plan for piles and caissons(Vibrohammer)

Types and contents of pile driving and hammering

③Vibrohammer

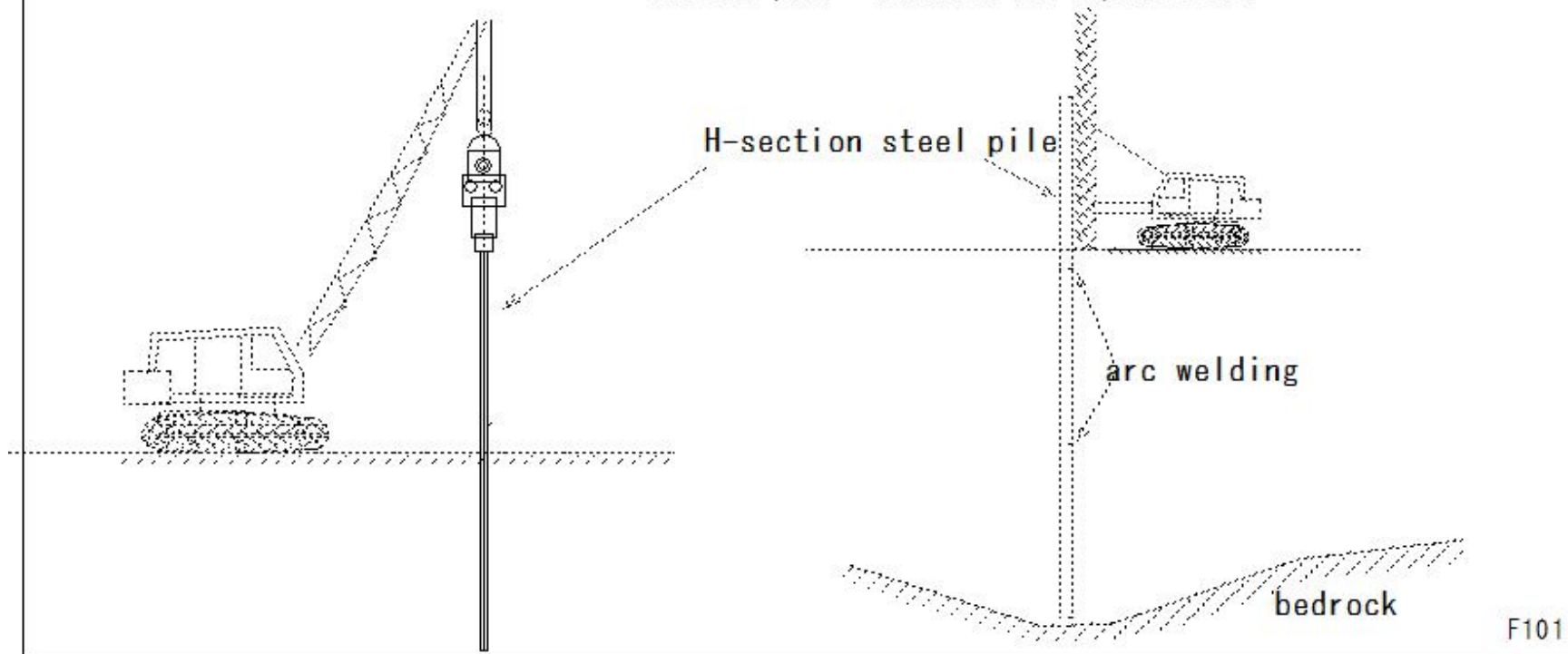
- Eccentric rotating body

- Can be applied to ground with an N value of 30 or less

Driving without damaging the pile head

- Steel sheet piles for temporary construction

- H steel pile - suitable for repeated use



(M273)Construction plan for piles and caissons(Test piles)

(M273)Construction plan for piles and caissons(Test piles)

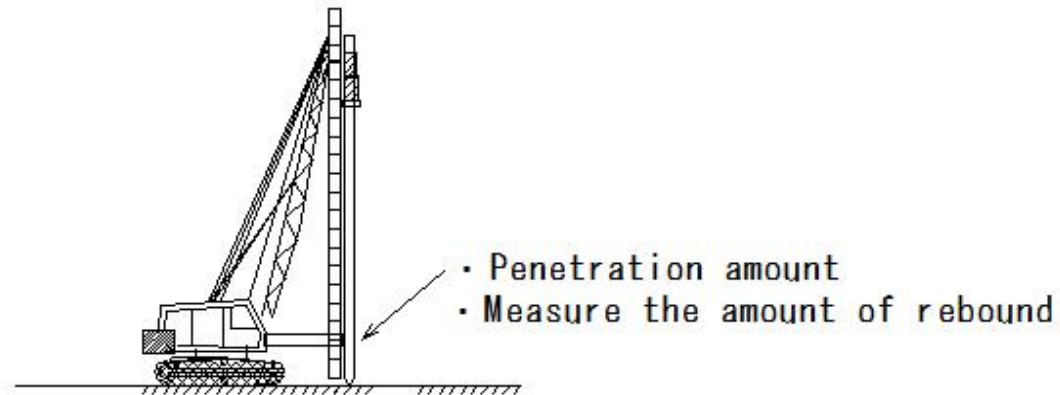
Geological survey by boring

Bearing capacity calculation

Determine the length of the pile

Soil conditions - Calculated bearing capacity - Actual bearing capacity - Difference

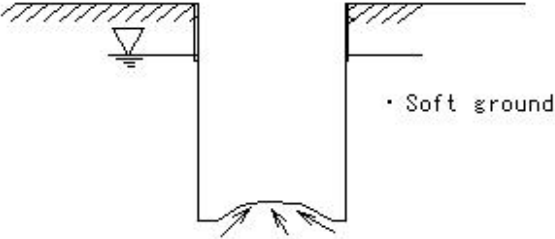
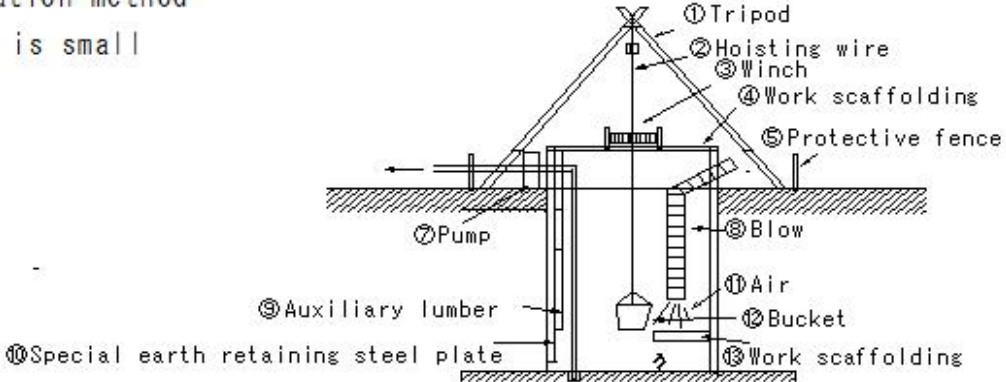
Construction: Stalled situation - Confirmation of supporting capacity through loading test



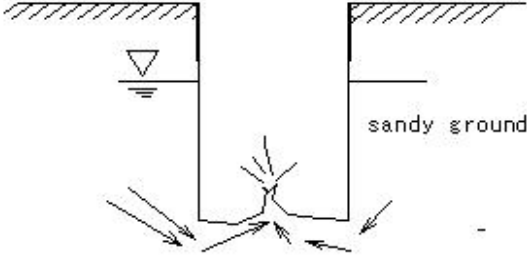
(M274)Construction plan for piles and caissons-cast-in-place pile(Deep foundation method)

(M274) Construction plan for piles and caissons-cast-in-place pile(Deep foundation method)

cast-in-place pile
 Deep foundation method
 Work space is small



• Water pressure - ground - push up
 • Heaving



underground water route
 Boiling

(M275)cast-in-place pile(Benoto method)

(M275)cast-in-place pile(Benoto method)

cast-in-place pile

Benoto method

Sand layer 5m or more below the groundwater level - does not move

Difficult with large stones

pile foundation

cast-in-place pile

② Benoto method

• France: Benoto - Developed

All-casing method

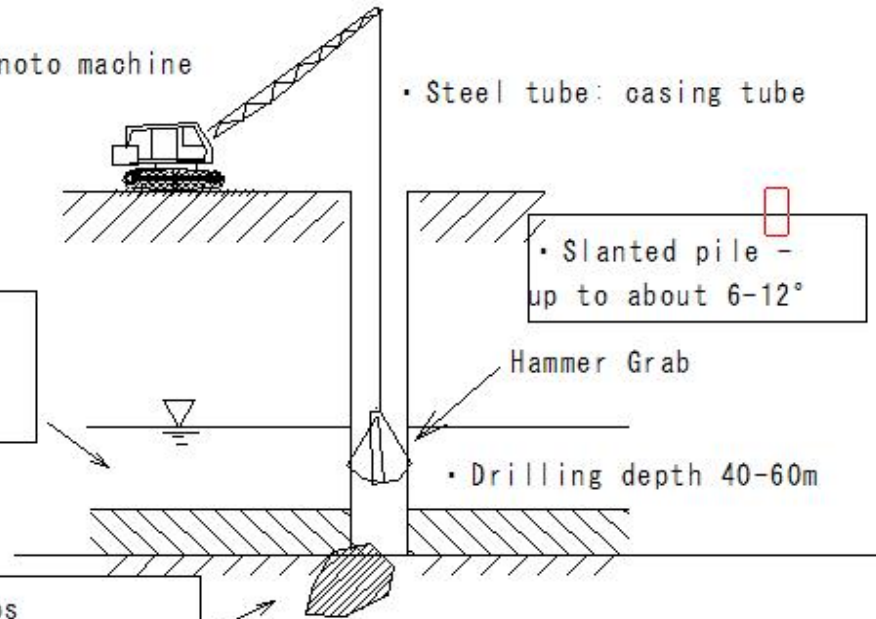
Benoto method

• Fine sand layer containing water
5m below the groundwater level
construction impossible

big "rolling stone"

• Large boulders and wood chips
construction impossible

Benoto machine



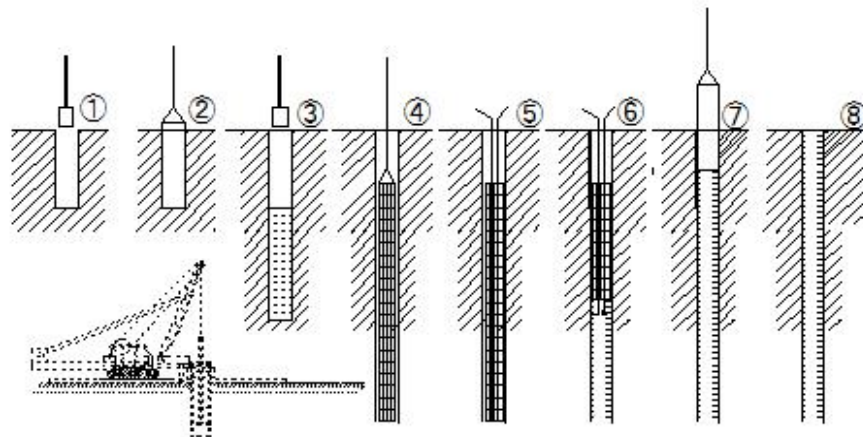
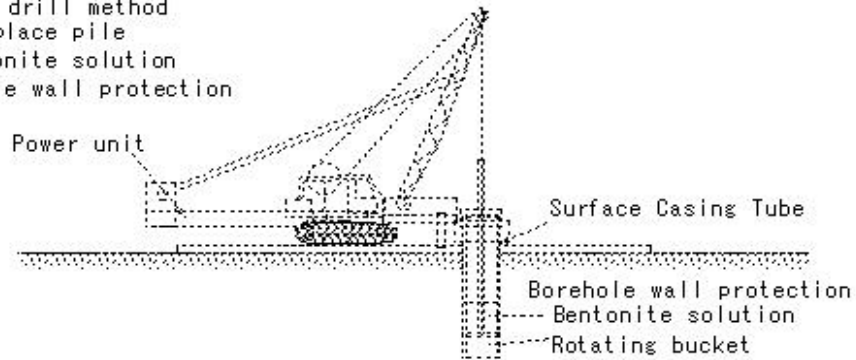
(M276) cast-in-place pile(Earth drill method)

(M276) cast-in-place pile(Earth drill method)

cast-in-place pile
Earth drill method

earth drill method
In-place pile
Bentonite solution
Borehole wall protection

Stabilizer is required in sand layer
Depth approximately 27m



- ① Drilling
- ② Casing tube insertion
- ③ Bentonite solution - injection
- ④ Erection of rebar
- ⑤ Built-in tremmy tube rebar
- ⑥ Ready-mixed concrete pouring
- ⑦ Casing tube pull-out
- ⑧ Sediment reburials

(M277) cast-in-place pile (Reverse method)

(M277) cast-in-place pile (Reverse method)

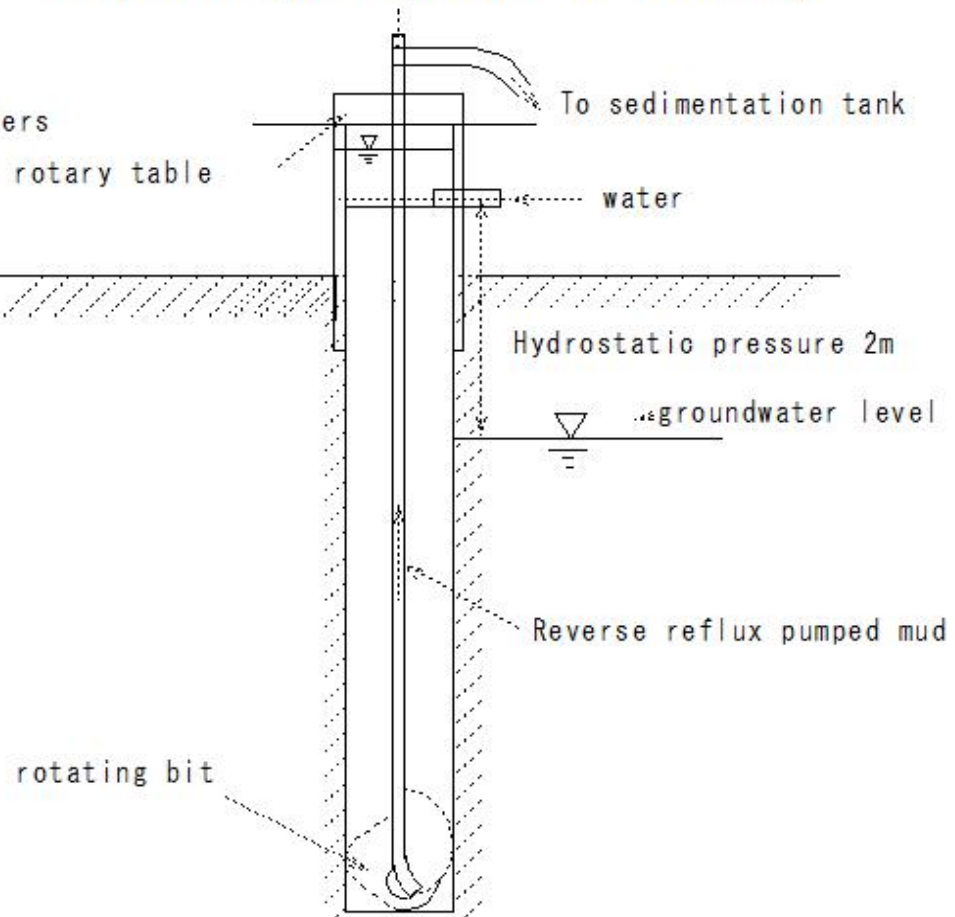
cast-in-place pile

Reverse method

Good for long and large diameters

Sludge treatment - problems

suction pump



(M278)cast-in-place pile(Open caisson foundation)

(M278)cast-in-place pile(Open caisson foundation)

cast-in-place pile

caisson foundation

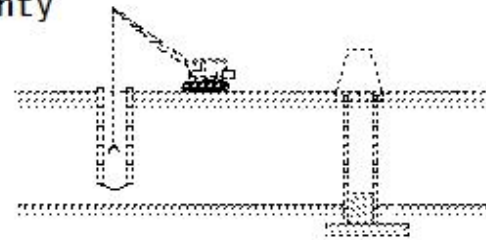
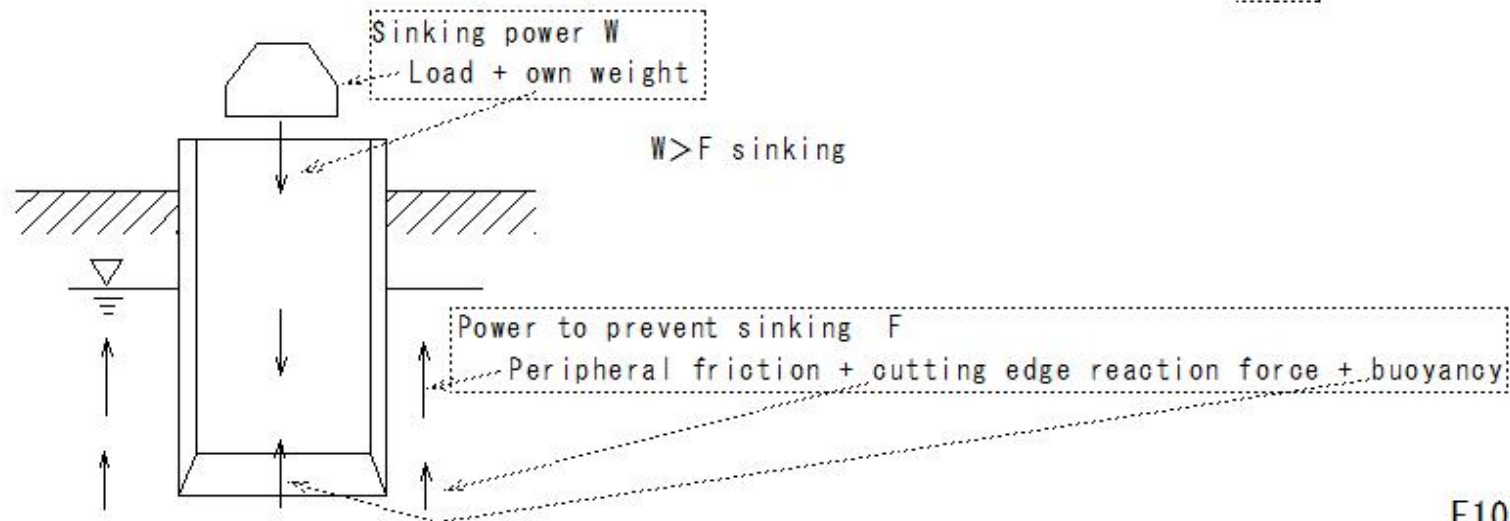
① Open caisson foundation

Open caisson: Underwater excavation - poor certainty
relatively easy

Construction cost - cheap

① Circumferential friction - reduction

② Convert passive earth pressure to active earth pressure



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(M279)cast-in-place pile(Pneumatic caisson construction method)

(M279)cast-in-place pile(Pneumatic caisson construction method)

(M279) cast-in-place pile(Pneumatic caisson construction method)

cast-in-place pile

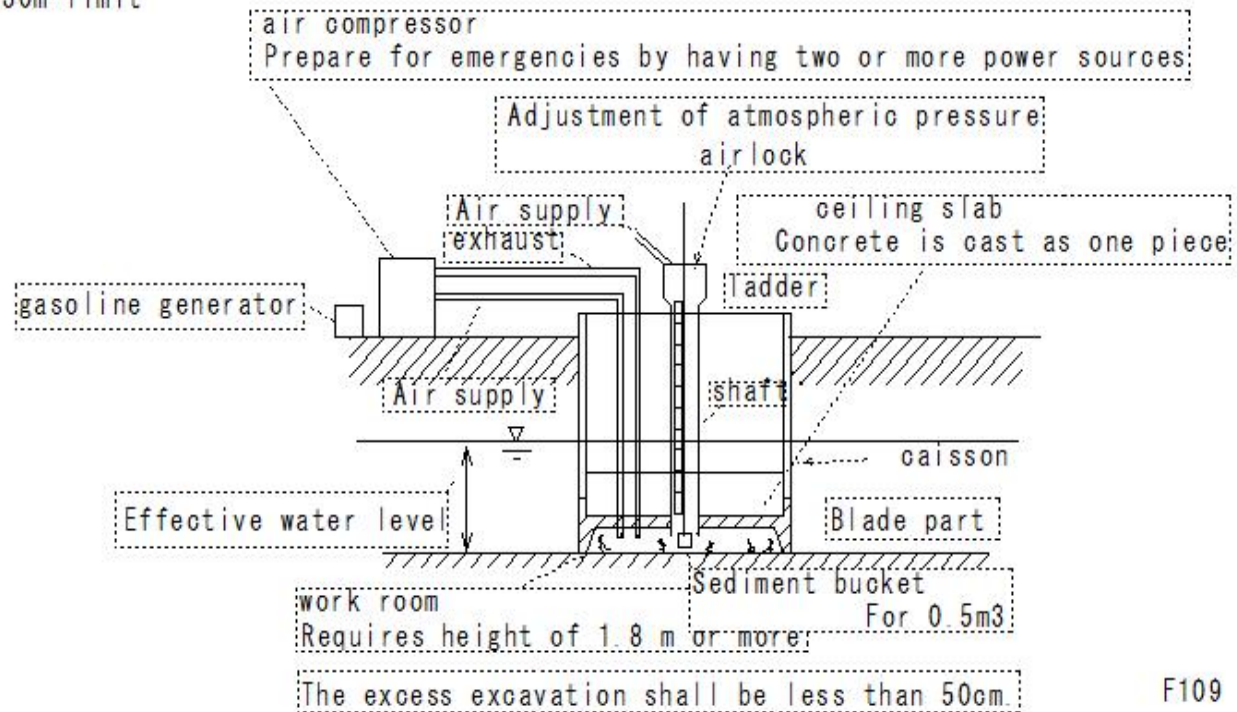
Pneumatic caisson method

- High pressure - drainage
- Drilling in dry conditions
- Manual excavation
- Groundwater level 30m-limit

② Pneumatic caisson

Construction certainty

Foundations of long bridges, etc.



(M280)Foundation construction machinery(Ready-made piles)

(M280)Foundation construction machinery(Ready-made piles)

Construction plan for piles and caissons

Foundation construction machinery

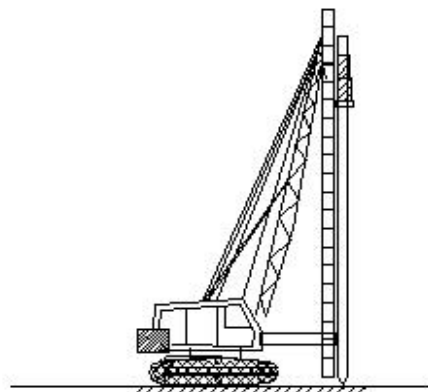
①Ready-made piles

Impact construction method

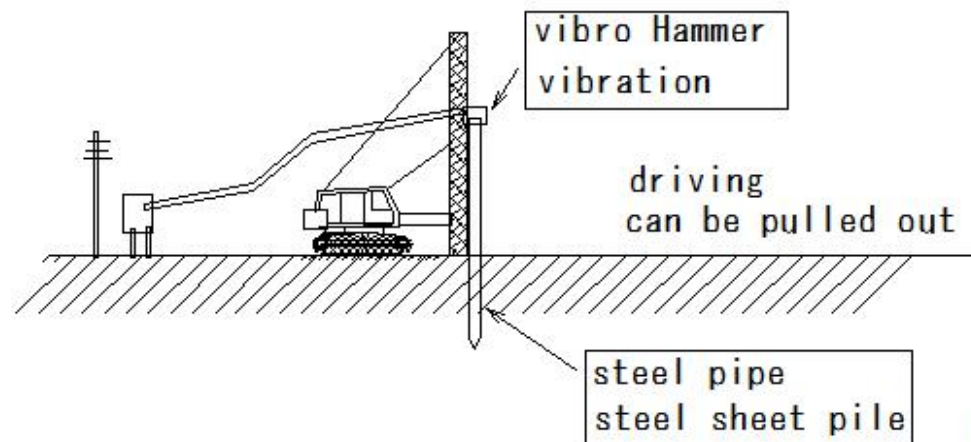
Vibration method

Press-in method

Combined construction method



Diesel hammer



vibro Hammer
vibration

driving
can be pulled out

steel pipe
steel sheet pile

F110

(M281)Foundation construction machinery(Cast-in-place piles)

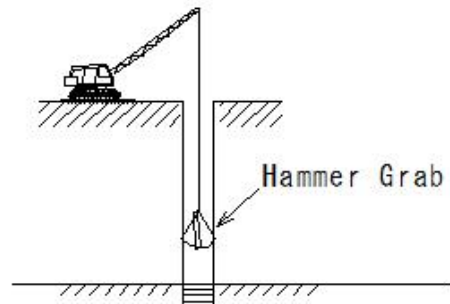
(M281)Foundation construction machinery(Cast-in-place piles)

Construction plan for piles and caissons

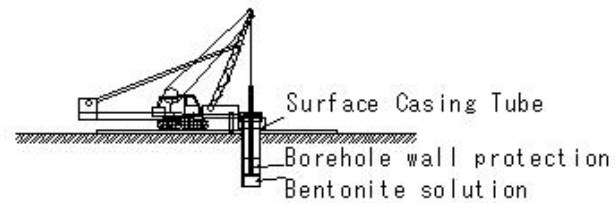
Foundation construction machinery

② Cast-in-place piles

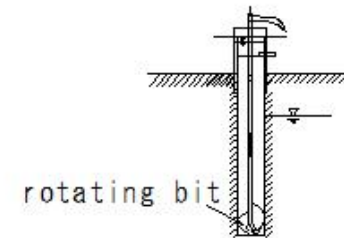
All-casing method (Benoto method)



earth drill method



Reverse circulation method



(M282) Foundation construction machinery (Benoto method)

(M282) Foundation construction machinery (Benoto method)

Construction plan for piles and caissons

Foundation construction machinery

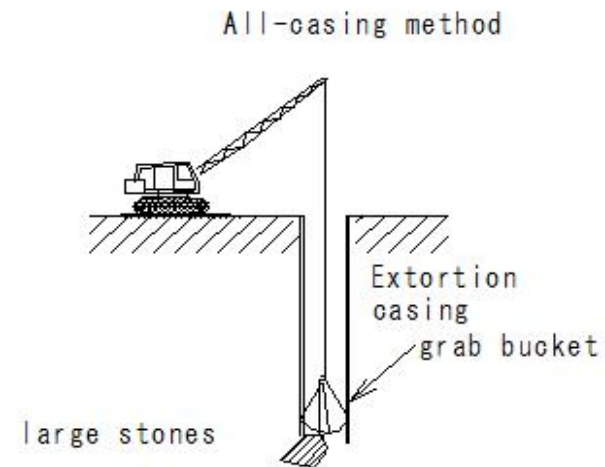
- Benoto method
- Large diameter pile
- 6 degree and 12 degree diagonal piles - possible

Strong Points

- Hard ground can be excavated
- Soft ground, no landslides
- Completed pile - no cracks

weak point

- Large machine required
- Casing tube - difficult to pull out
- Difficult to excavate with large stones



(M283)Foundation construction machinery(Earth drill method)

(M283)Foundation construction machinery(Earth drill method)

Construction plan for piles and caissons

Foundation construction machinery

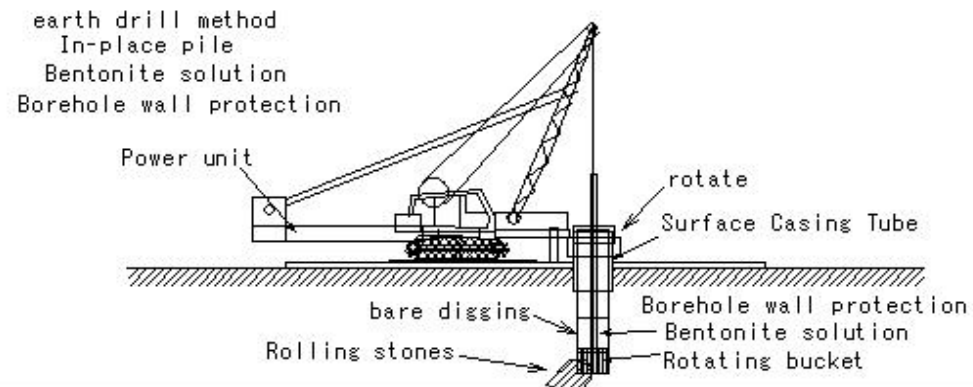
Earth drill method

Strong Points

- The price of piles is low
- Mobility available
- Supporting layer - excavated sand - can be confirmed

weak points

- Large machine required
- Rolling stones - excavation - difficult
- Concrete loss - large amount
- Difficult excavated soil treatment



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(M284)Foundation construction machinery(Reverse circulation method)

(M284)Foundation construction machinery(Reverse circulation method)

Construction plan for piles and caissons

Foundation construction machinery

- Reverse circulation method

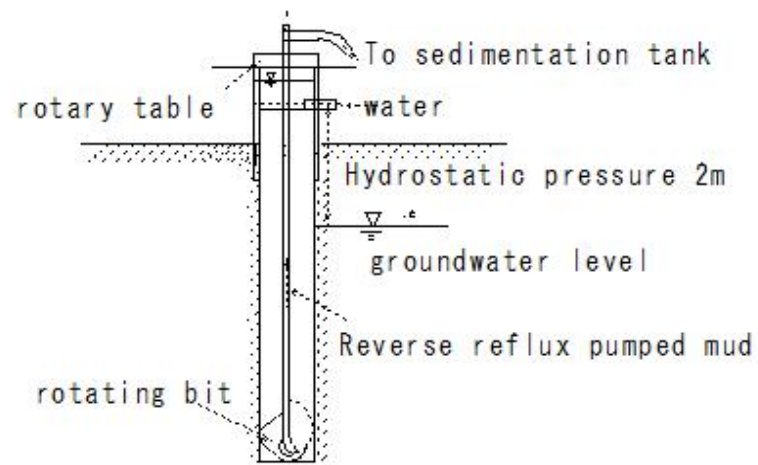
Strong Points

- ① Preventing hole wall collapse due to muddy water
- ② Excavation depth-large
- ③ Pore size -freely selectable

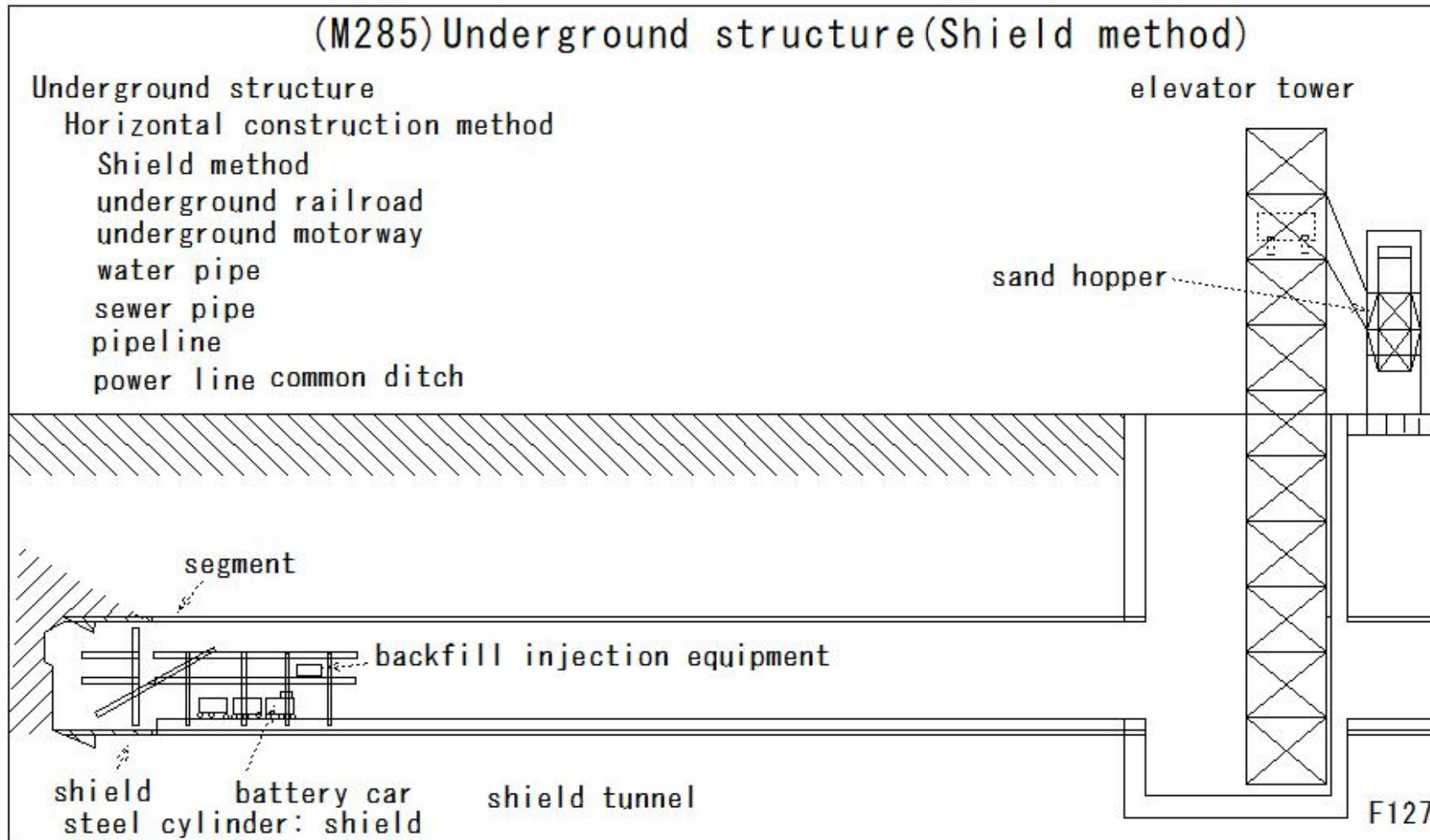
weak points

- ① Water Sedimentation tank - required
- Narrow space - disadvantage
- ② Obstacles - Difficult to excavate
- ③ Permeable layer - water level drop -
hole wall - collapse

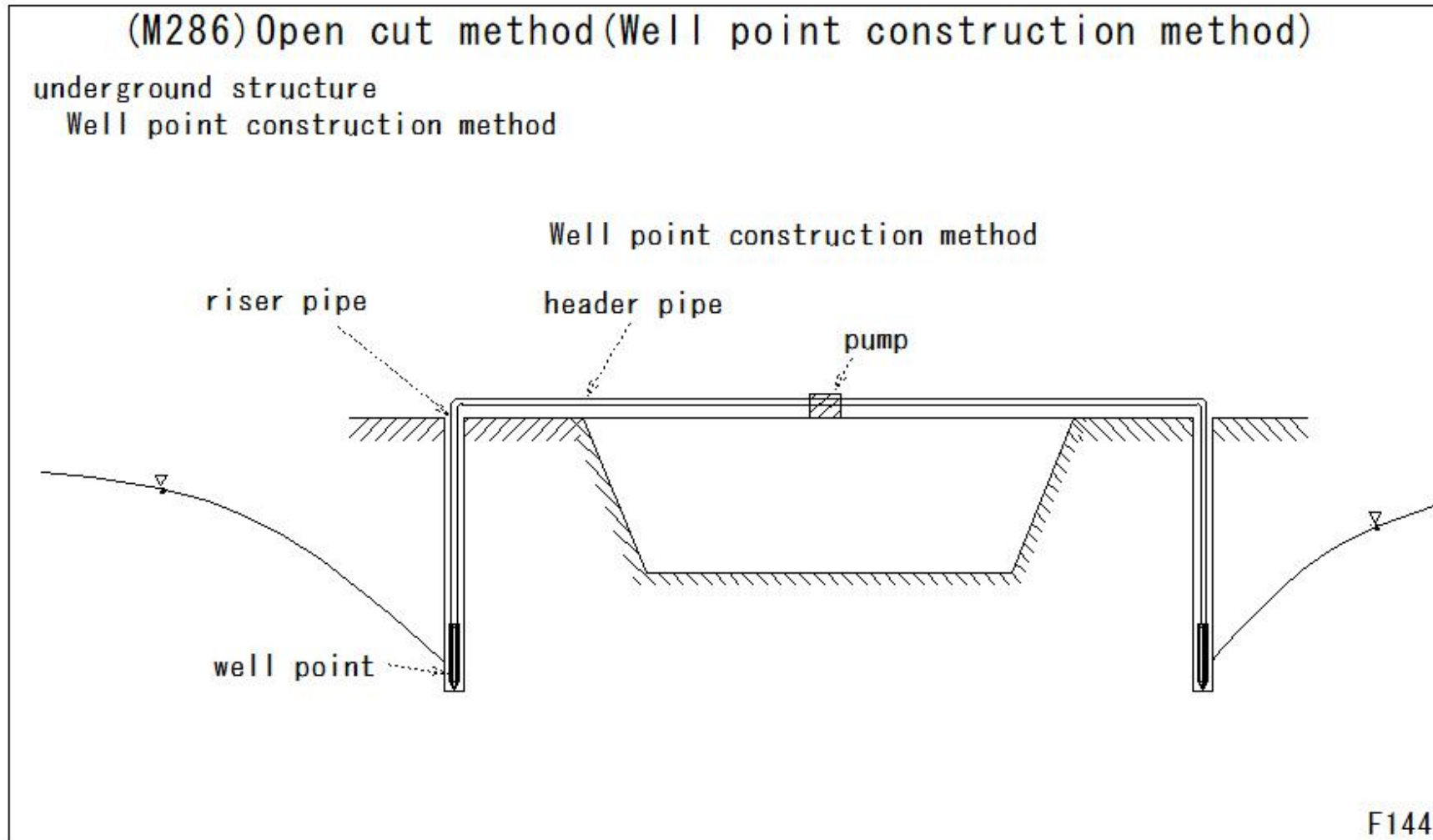
Reverse circulation method



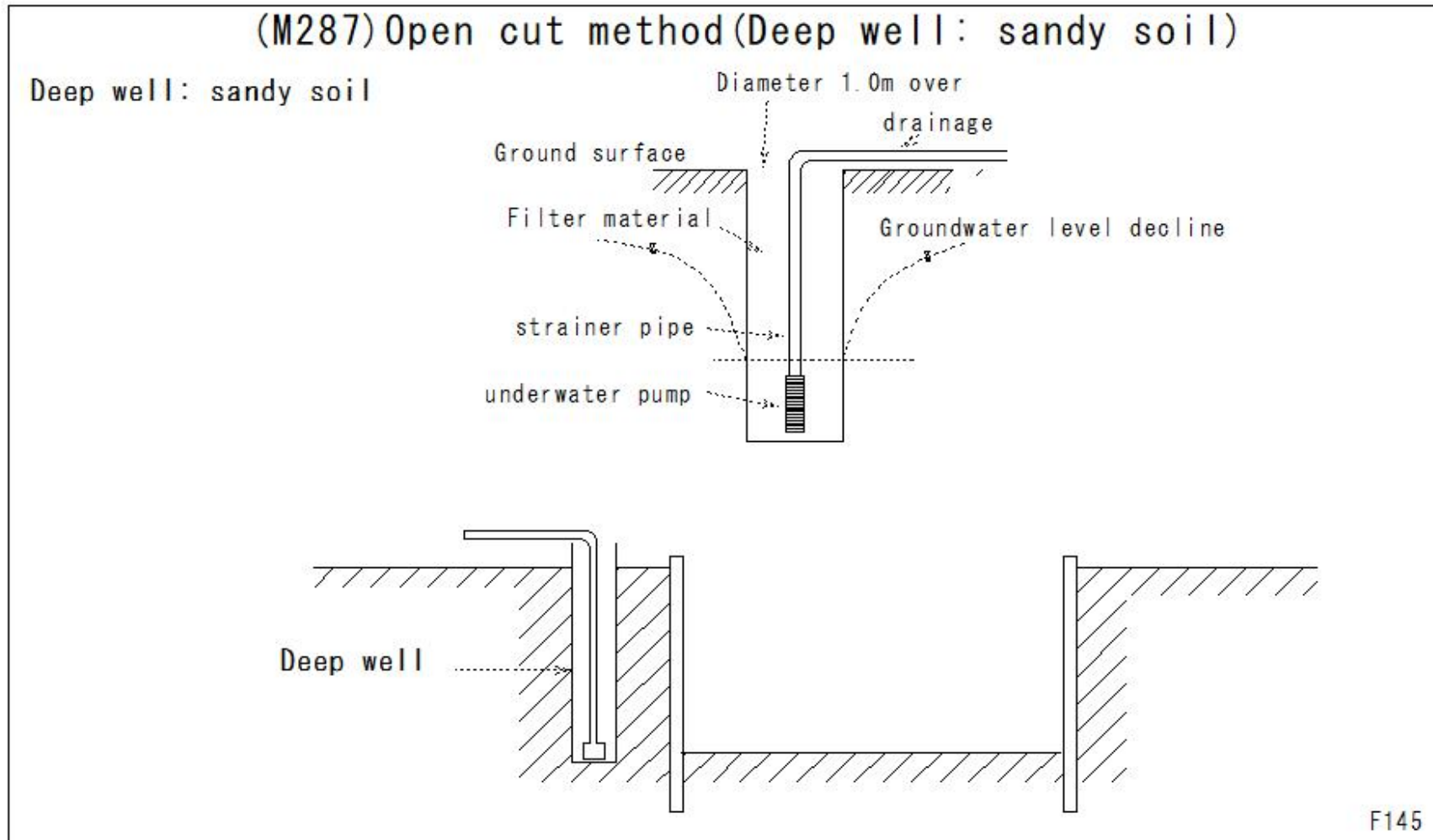
(M285)Underground structure(Shield method)



(M286)Open cut method(Well point construction method)



(M287)Open cut method(Deep well: sandy soil)

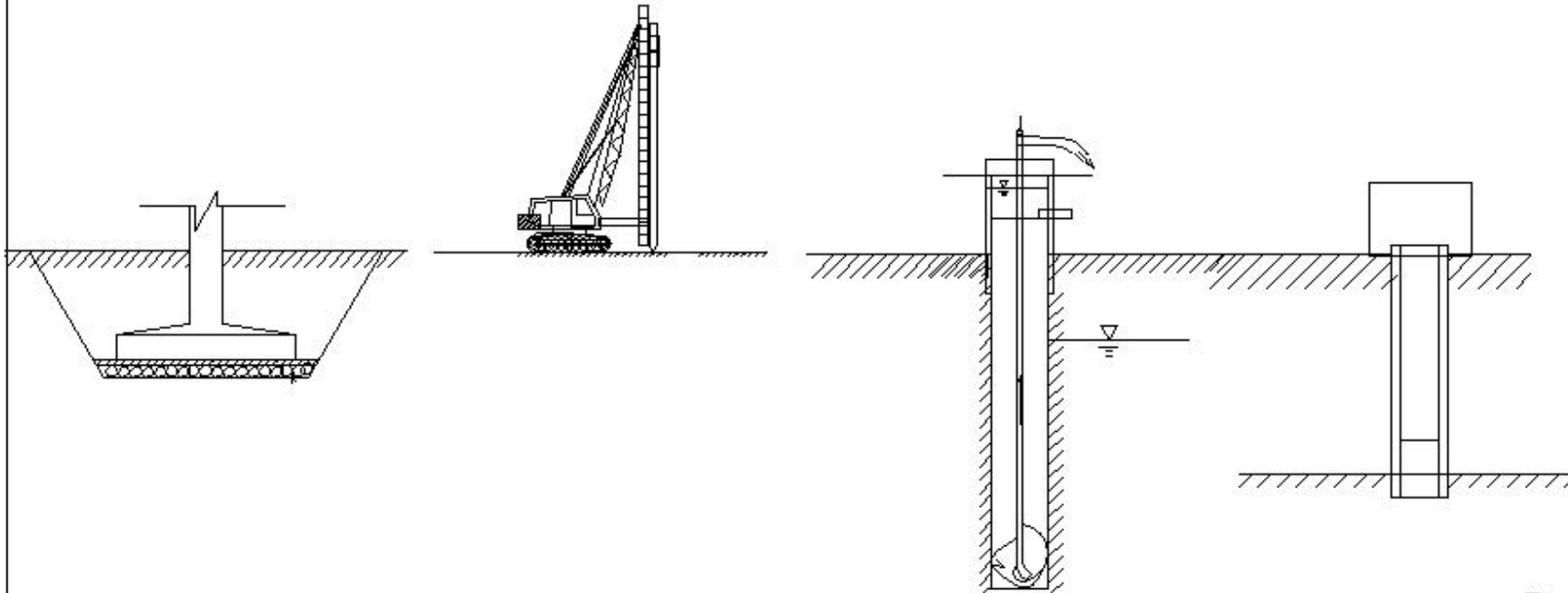


(M288)Types of foundation work

(M288)Types of foundation work

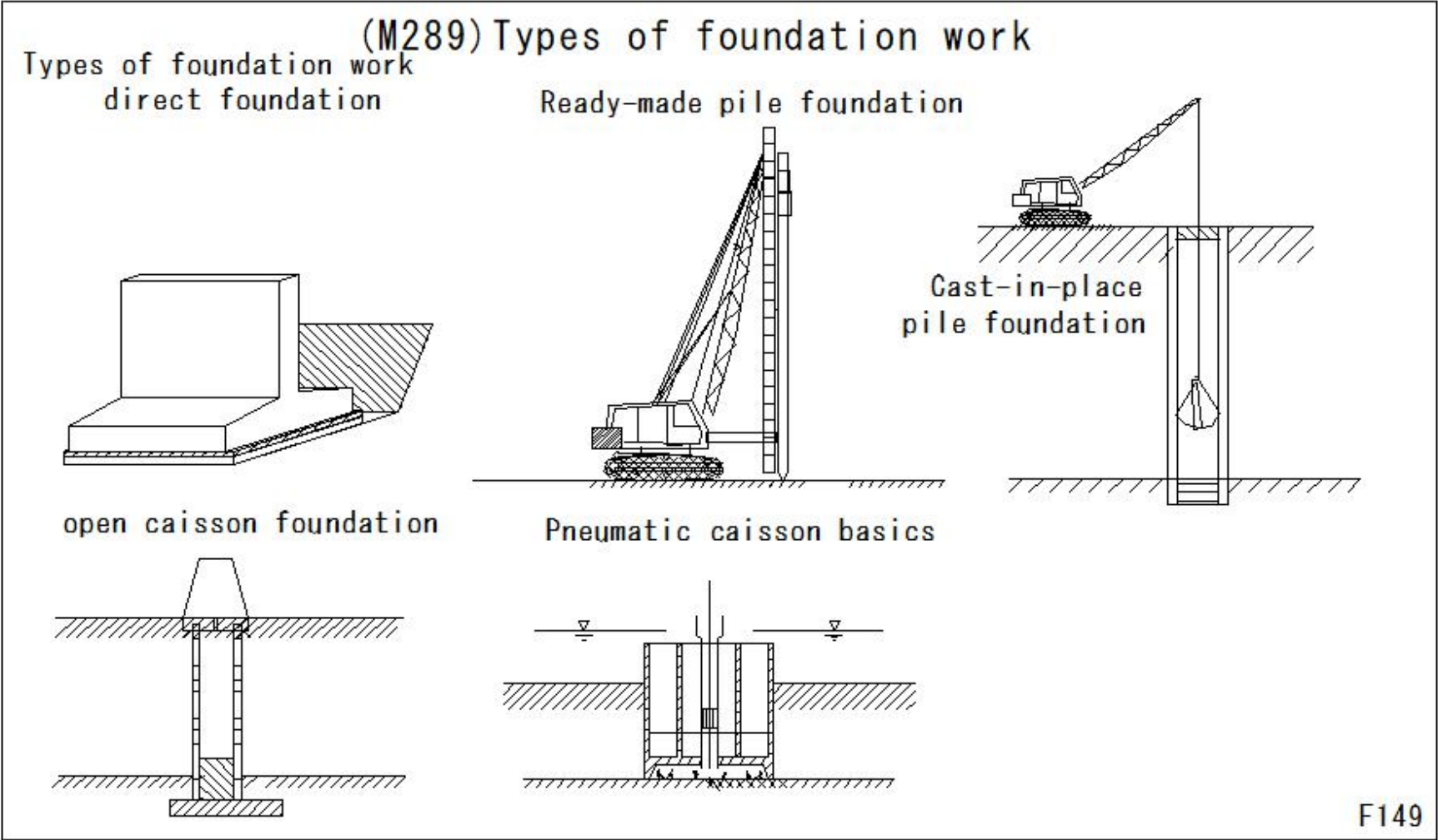
Types of foundation work

- Direct foundation
- Ready-made piles (RC PC pile)
- pile foundation
- Cast-in-place piles
- caisson foundation



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(M289)Types of foundation work



(M290)Types of foundation work(Ready-made pile foundation)

(M290)Types of foundation work(Ready-made pile foundation)

Types of foundation work

Ready-made pile foundation

• advantages

Steps: Less work Cost: cheap

Construction period: short

• Disadvantages

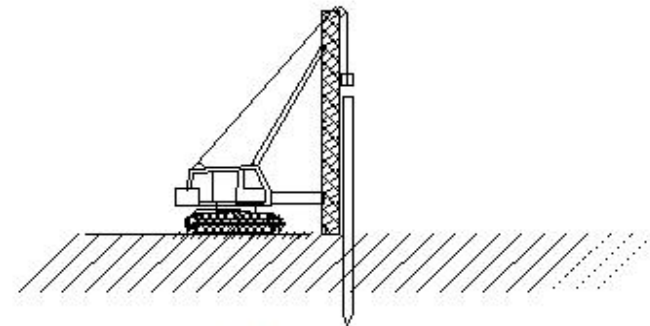
Geological confirmation: impossible

Noise/vibration: large

Cobblestone: Difficult to construct

• Classification by construction method

Wooden pile, RC pile, PC pile, steel pile



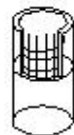
RC pile



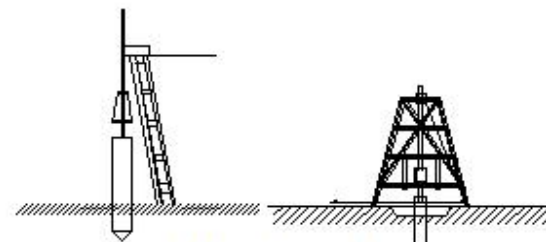
RC pile



H steel pile



steel pile



Wooden pile

(M291)Types of foundation work(cast-in-place pile foundation)

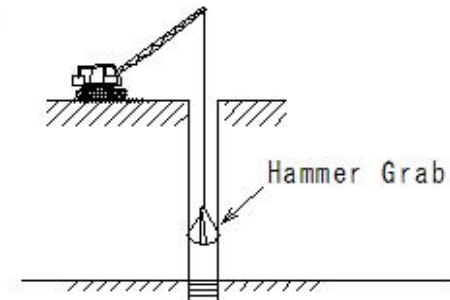
(M291)Types of foundation work(cast-in-place pile foundation)

Types of foundation work

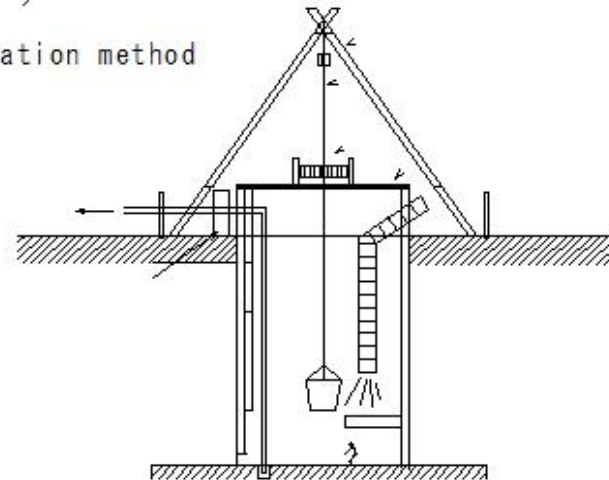
cast-in-place pile

- advantages
 - Noise/vibration: low
 - Supporting capacity: sure
- Disadvantages
 - Step: A lot of work
 - Cost: high
- Classification by construction method

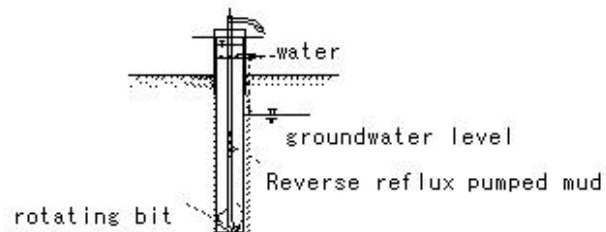
All-casing method
Benoto pile



Deep foundation method



Reverse circulation method



(M292)Types of foundation work(caisson foundation)

(M292)Types of foundation work(caisson foundation)

Types of foundation work

caisson foundation

open caisson foundation

Pneumatic caisson basics

• advantages

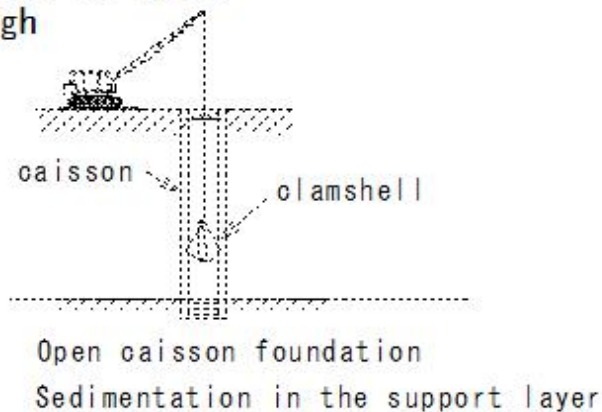
Large supporting force and horizontal resistance force can be obtained.

Geological confirmation: impossible

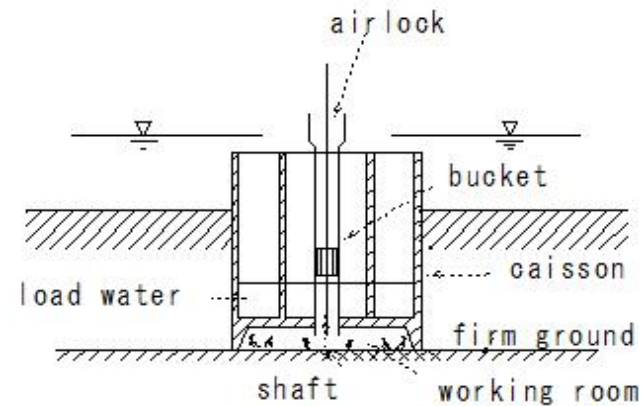
• Disadvantages

Step: a lot of work

Cost: high



Open caisson



Pneumatic caisson

(M293)foundation work(ready-made piles)

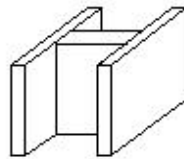
(M293)foundation work(ready-made piles)

ready-made piles

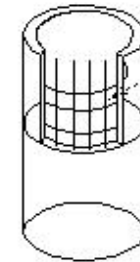
- ①RC pile, PC pile, H-shaped steel pile, steel pipe pile
- ②Noise/vibration construction pollution
Urban - Difficult to construct
- ③No noise/vibration - press-in method/jet method



steel pipe

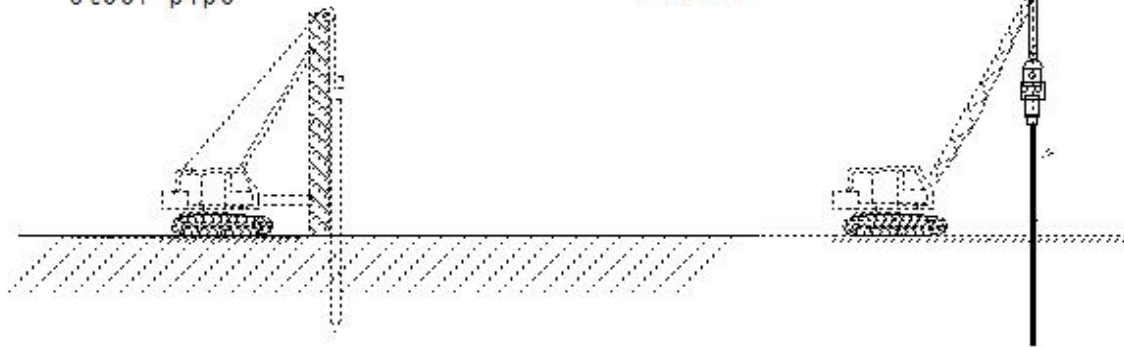


H steel



Rebar

Rebar RC

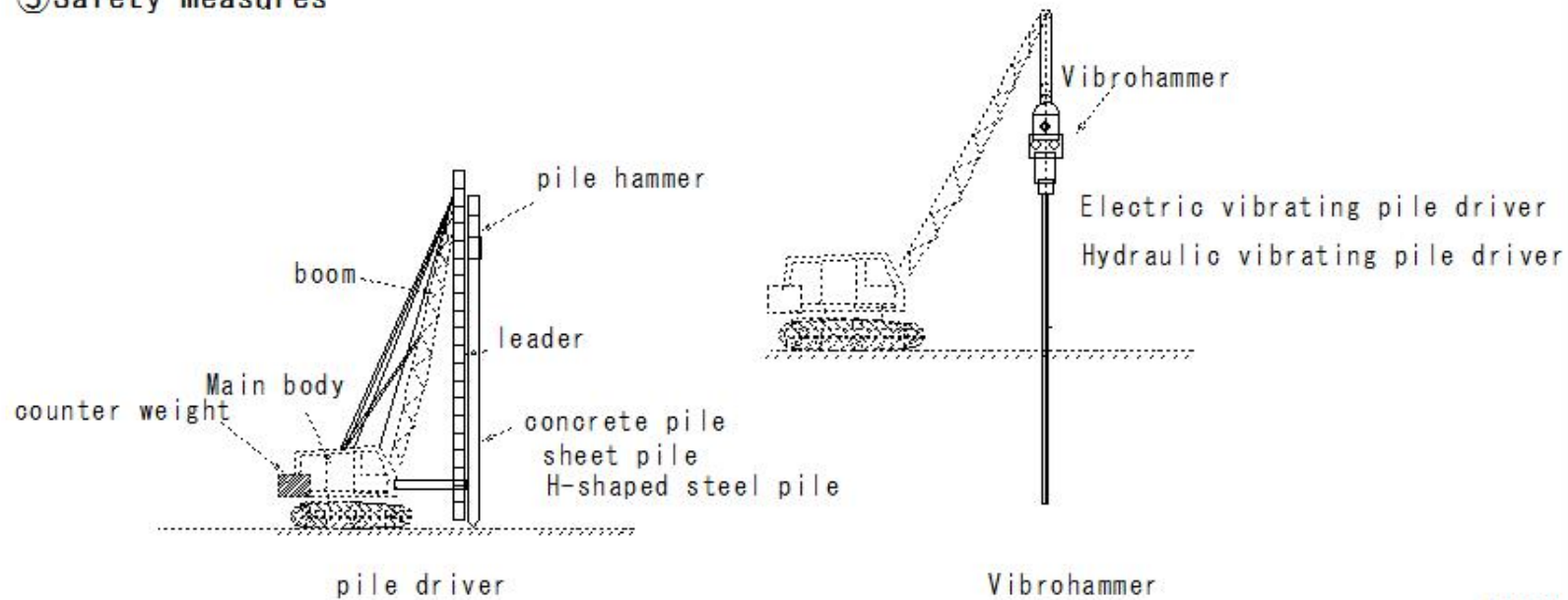


(M294) foundation work(ready-made piles)

(M294) foundation work(ready-made piles)

Features of ready-made piles

- ① Factory production, high quality
- ② Construction - Easy Construction speed - Fast
- ③ Construction management - Easy Construction cost - Cheap
- ④ Noise Control Act Pile driving work 85 dB or less
- ⑤ Safety measures



(M295) foundation work(built-in construction method)

(M295) foundation work(built-in construction method)

Construction method of ready-made piles

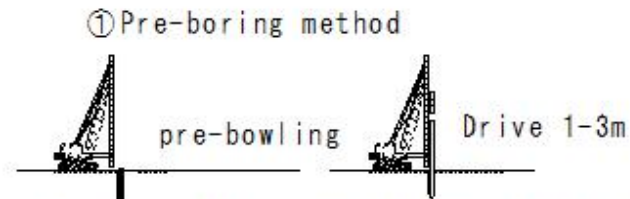
built-in construction method

Noise and vibration prevention

① Pre-boring method

② Hollow excavation pile method

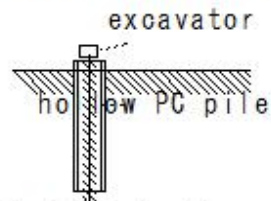
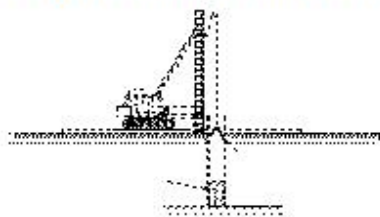
③ Jet method



Dig the hole for the ready-made pile with an earth auger etc.

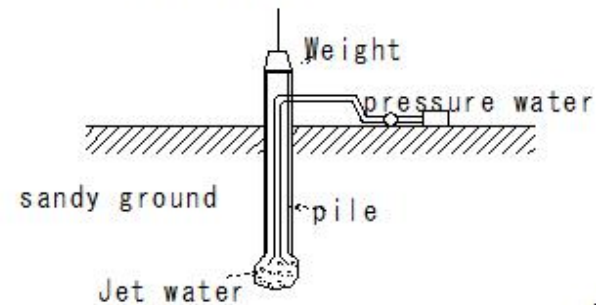
Place concrete in case not pouring

② Hollow excavation pile method



prefabricated pile

③ Jet method

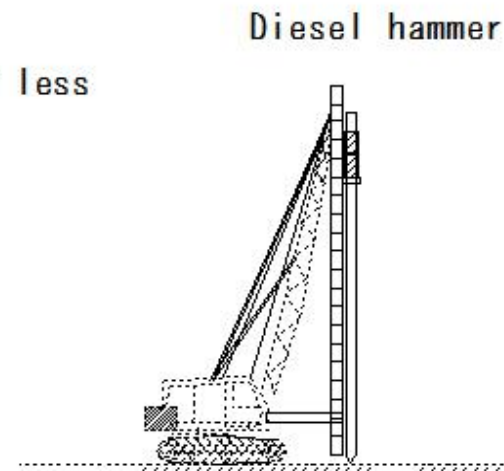


(M296)foundation work(Impact construction method for ready-made piles)

(M296)foundation work(Impact construction method for ready-made piles)

Impact construction method for ready-made piles

- ①Pile weight 1-3 times
- ②Fall height 2? or less
- ③Pile driving from the center to the outside
- ④Number of blows Steel pile 3000 times or less
PC pile 2000 times or less
RC pile or less 1000 times or less
- ⑤Pile driving prevention
Penetration amount per blow - 2mm or less



Driving ready-made piles

(M297)foundation work(diesel hammer)

(M297) foundation work(diesel hammer)

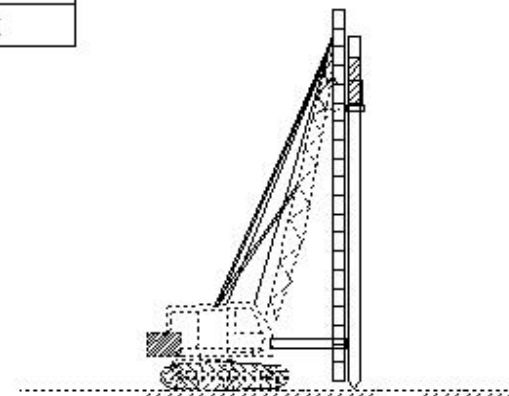
Impact construction method for ready-made piles

Driving method for ready-made piles

Impact construction method
• diesel hammer

• Construction method	Diesel engine - piston driving
• noise	big
• vibration	big
• Construction speed	fast
• advantages points	Low-fuel consumption
	Easy to operate
	Good mobility
• Disadvantages	Weak layer - does not start

Diesel hammer



F180

(M298)foundation work(steam hammer)

steam hammer

Impact construction method for ready-made piles

Driving method for ready-made piles

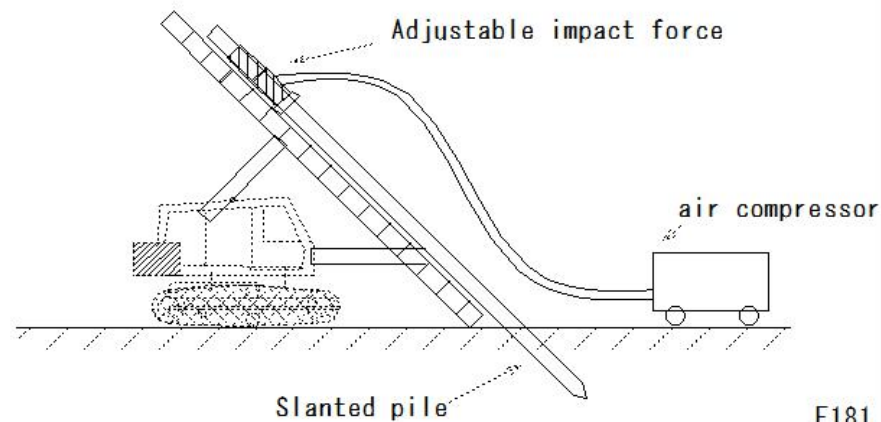
Impact construction method

steam hammer

· Construction method	Steam pressure - piston - driving
· noise	big
· vibration	big
· Construction speed	fast
· Strong Points	Impact force - adjustable
· Disadvantages	Fire/soot

Steam hammer/air hammer

- Equipment - large scale
- Many piles
- Slanted piles can be driven underwater



(M299) foundation work(drop hammer)

foundation work(drop hammer)

impact construction method for ready-made piles

Driving method for ready-made piles

Impact construction method

drop hammer

• Construction method	Hammer Gravity Fall - Driving
•noise	big
•vibration	few
• Construction speed	slow
• Strong Points	Fewer breakdowns
• Disadvantages	prone to eccentricity

(M299) foundation work (drop hammer)

pile foundation

Driving ready-made piles

Drop hammer

• Small cross section pile

• Equipment - Easy

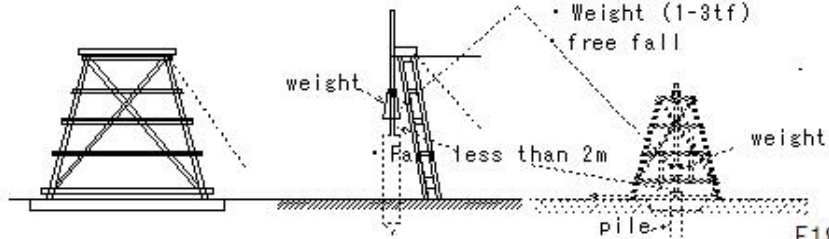
• Easy to eccentricity

• Pile head: Damage prevention

• Weight of weight: 1-3 times the weight of the pile

• Weight (1-3tf)

free fall



F182

(M300) foundation work(vibration method)

foundation work(vibration method)

Impact construction method for ready-made piles

Driving method for ready-made piles

vibration method

• Construction method	vibro hammer
• noise	small
• vibration	big
• Construction speed	usually
• Strong Points	Suitable for soft ground
• Disadvantages	Electrical equipment – required

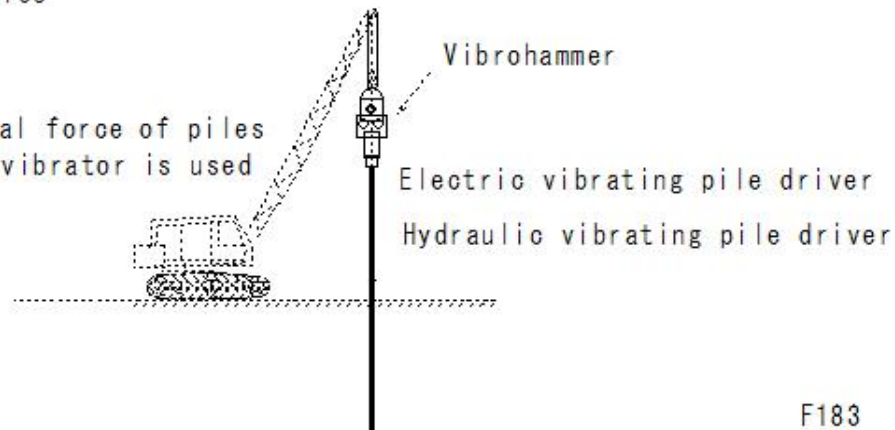
(M300) foundation work (vibration method)

pile foundation

Driving ready-made piles

④ Vibro hammer

- Strong vibration
- Good for soft ground
- Decrease in frictional force of piles
 - High frequency vibrator is used



F183

(M301) foundation work(Press-in method)

(M301) foundation work(Press-in method)

Impact construction method for ready-made piles

Driving method for ready-made piles

Press-in method

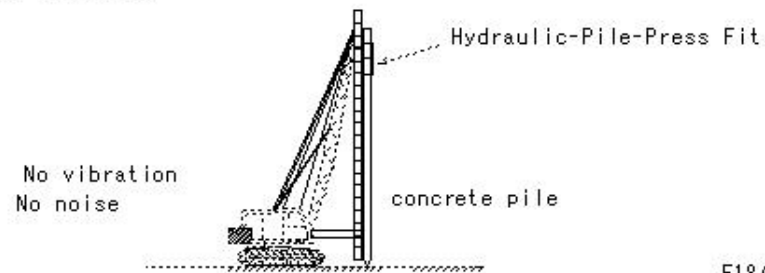
· Construction method	hydraulic jack
· noise	none
· vibration	none
· Construction speed	usually
· Strong Points	For both driving and pulling
· Disadvantages	Use only straight sections

(M301) foundation work (Press-in method)

pile foundation

Pollution measures for ready-made piles

Hydraulic hammer press-in method



F184

(M302) foundation work (Jet method: injection)

foundation work (Jet method: injection)

Impact construction method for ready-made piles

Driving method for ready-made piles

Jet method: injection

• Construction method	Excavation by jet stream
• noise	none
• vibration	none
• Construction speed	usually
• Strong Points	For both driving and pulling
• Disadvantages	Water equipment - required

(M302) foundation work (Jet method: injection)

pile foundation

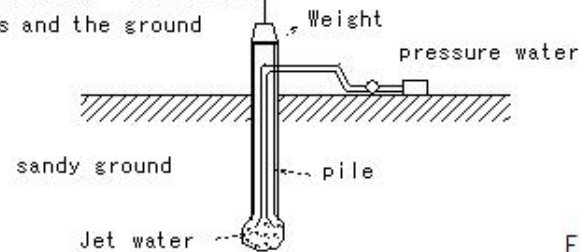
Pollution measures for ready-made piles

Jet method

Sand ground - High pressure water - Injection - Excavation

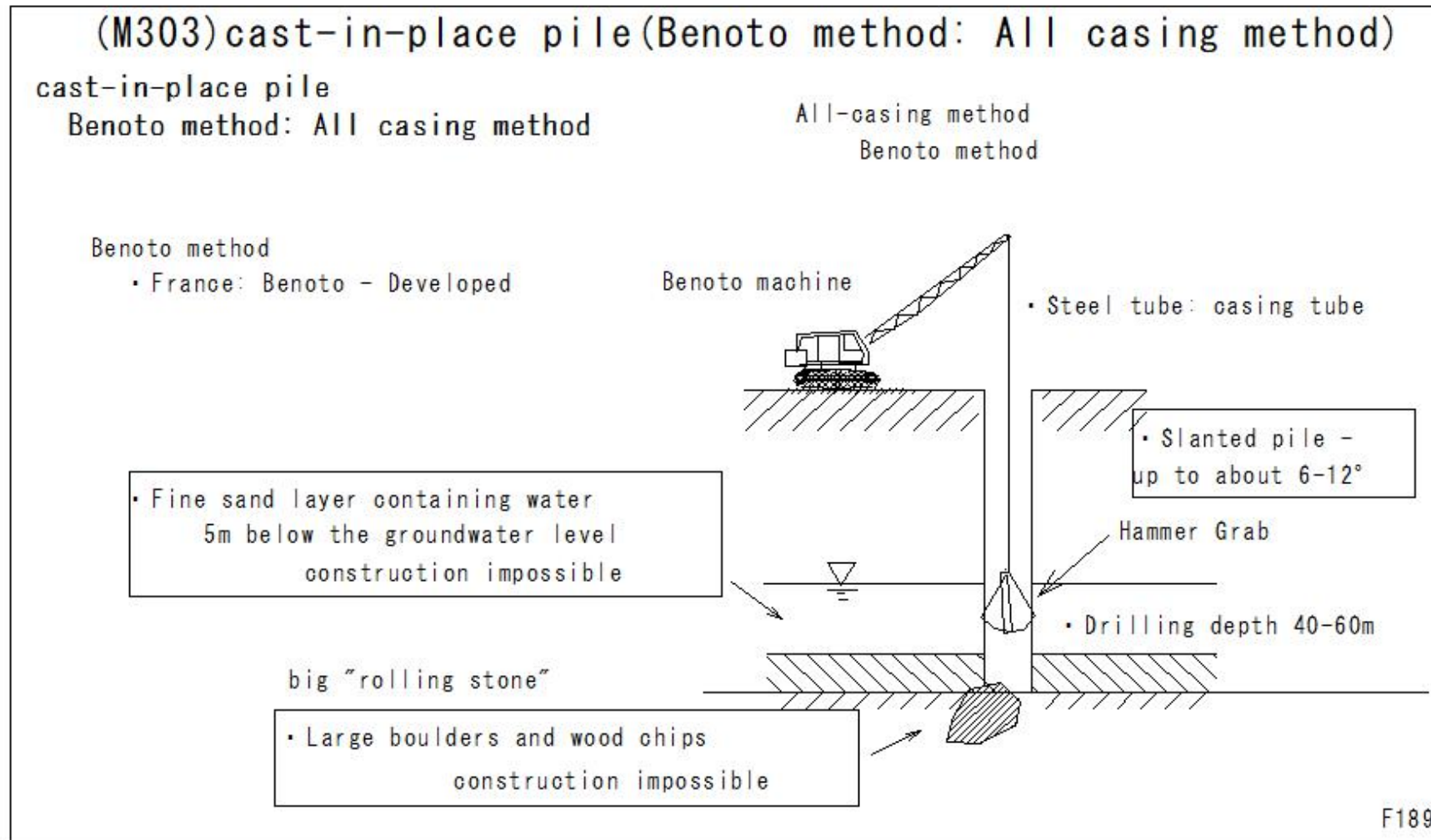
Eliminate friction between piles and the ground

Pile-press fit



F185

(M303)cast-in-place pile(Benoto method: All casing method)



(M304)cast-in-place pile(Earth drill method)

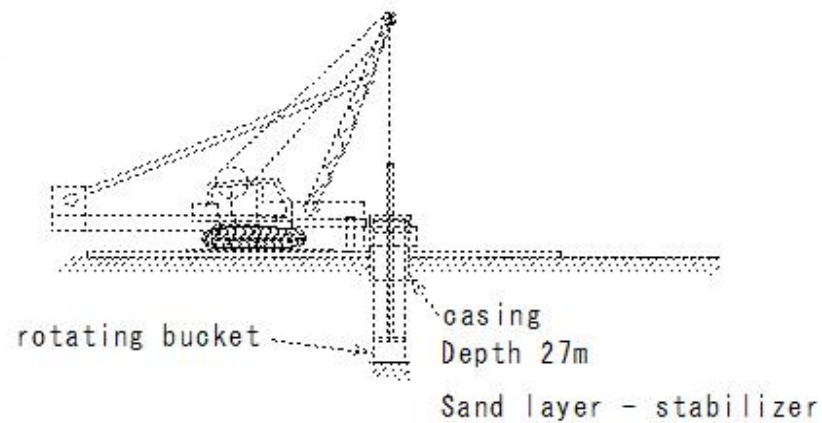
(M304) cast-in-place pile(Earth drill method)

cast-in-place pile
Earth drill method

Earth drill method

- Rotating bucket - excavation
- Construction speed - fast
- Low cost
- Drilling depth - 27m
- Suitable for clay layer
- Weak sandy ground - bentonite solution (stabilizing liquid)

Earth drill method



F190

(M305)cast-in-place pile(Reverse construction method)

(M305) cast-in-place pile (Reverse construction method)

cast-in-place pile

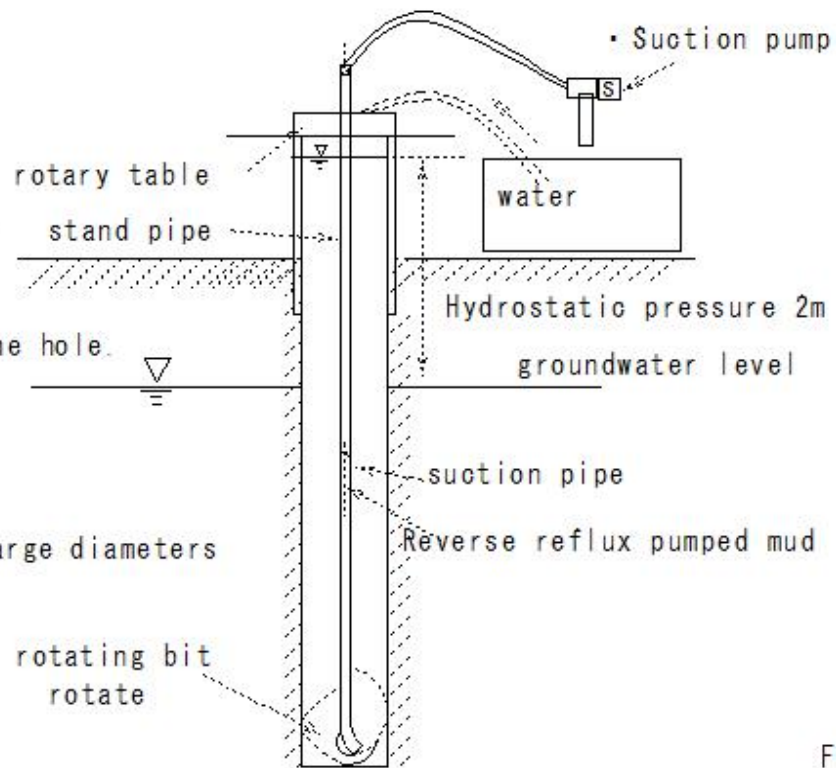
Reverse method

Reverse circulation method

- Big pile driving
- Continuous drilling
- Large boulders, pressurized water, underground water - construction difficult
- Water construction possible
- The water level inside the hole is 2m higher than the water level outside the hole.

- Good for long and large diameters

rotating bit



(M306)cast-in-place pile(Deep foundation method)

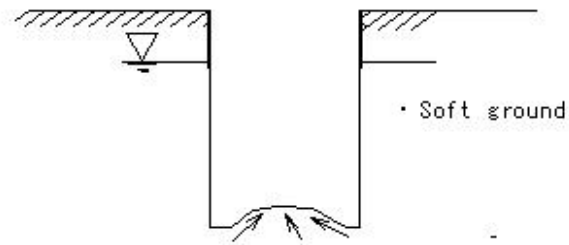
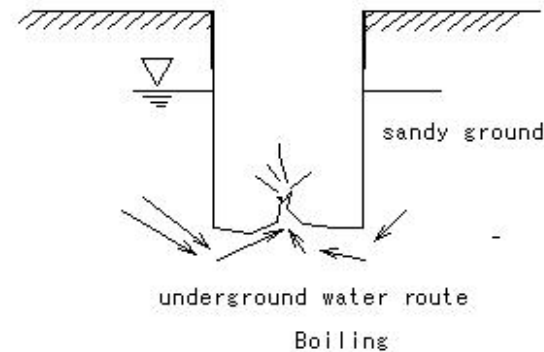
(M306) cast-in-place pile (Deep foundation method)

cast-in-place pile

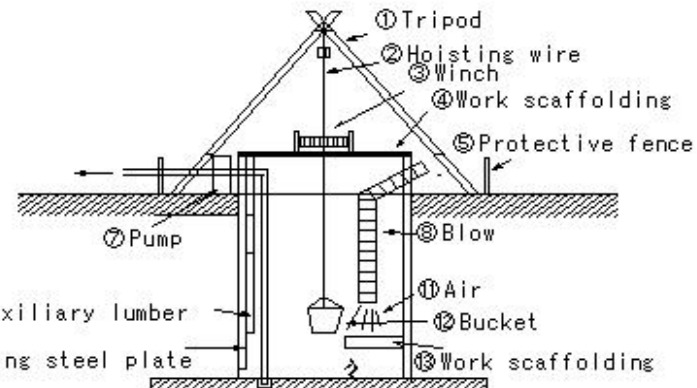
Deep foundation method

Deep foundation construction method

- Manual excavation
- Groundwater exclusion
- Possible to blast leaves of rolling stones
- Drainage construction - boiling and heaving
- Confirmation of soil bearing capacity - easy



- Water pressure - ground - push up
- Heaving

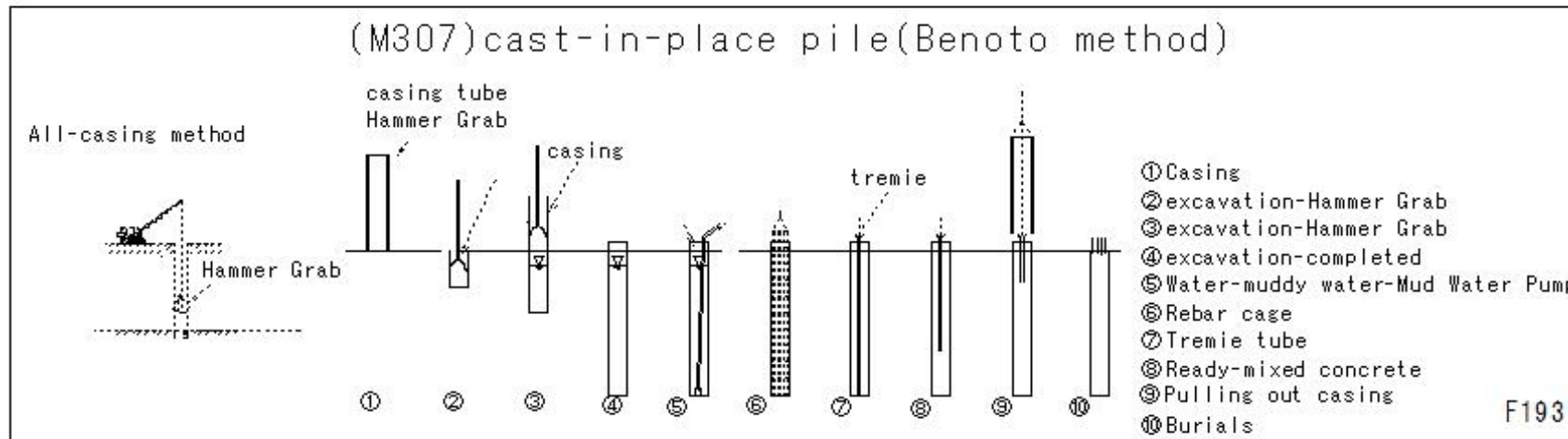


F192

(M307)cast-in-place pile(Benoto method)

cast-in-place pile(Benoto method)

cast-in-place pile construction method	cast-in-place pile construction method	mechanical drilling	Benoto method
Excavation method	hammer grab	bucket	
hole wall retention	casing tube		
Pile diameter	80-200cm		
Depth: limit	About 40m		
Soil conditions			
Clay/silt layer	○		
sand layer	△		
Gravel/rock layer	△		
cobblestone layer	△		
soft rock	x		

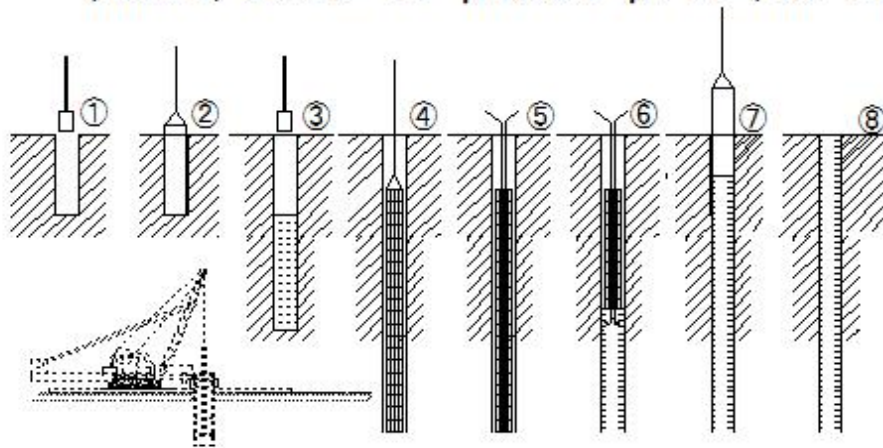


(M308)cast-in-place pile(Earth drill method)

cast-in-place pile(Earth drill method)

cast-in-place pile	cast-in-place pile
construction method	construction method mechanical drilling Earth drill method
Excavation method	rotating bucket
hole wall retention	Bare digging/mud water pressure
Pile diameter	80-120cm
Depth: limit	About 60m
Soil conditions	
Clay/silt layer	○
sand layer	△
Gravel/rock layer	△
cobblestone layer	x
soft rock	x

(M308) cast-in-place pile (Earth drill method)



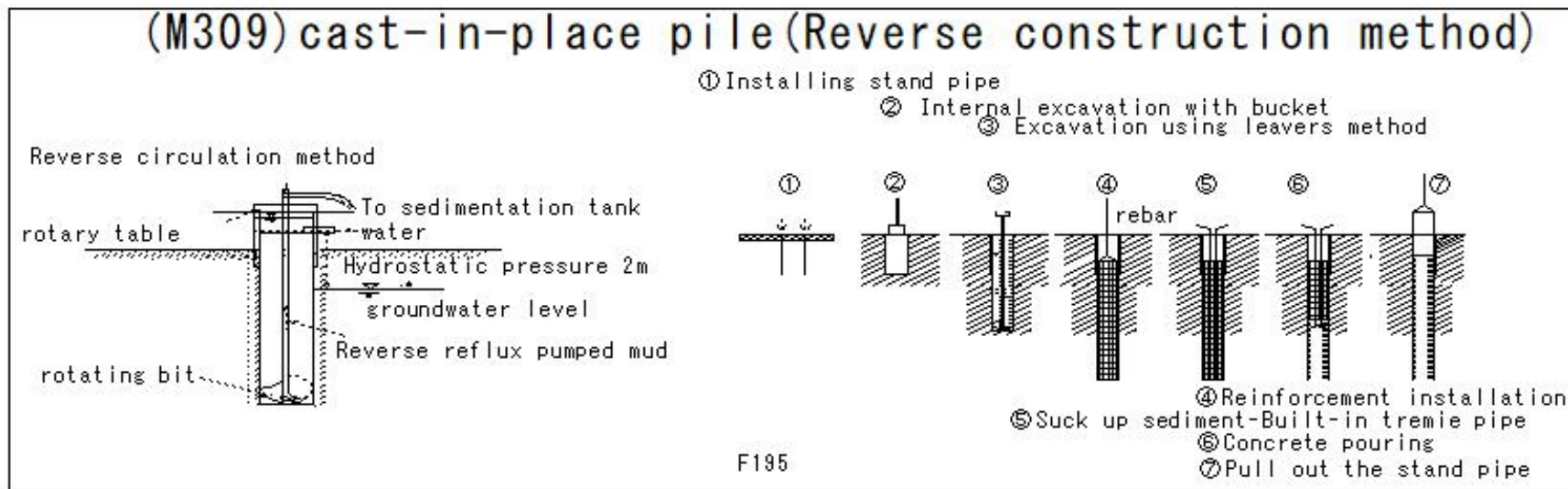
- ① Drilling
- ② Casing tube insertion
- ③ Bentonite solution - injection
- ④ Erection of rebar
- ⑤ Built-in tremmy tube rebar
- ⑥ Ready-mixed concrete pouring
- ⑦ Casing tube pull-out
- ⑧ Sediment reburial

F194

(M309)cast-in-place pile(Reverse construction method)

(M309)cast-in-place pile(Reverse construction method)

cast-in-place pile	cast-in-place pile
construction method	construction method
	mechanical drilling
	Reverse construction method
Excavation method	rotating bit
hole wall retention	hydrostatic pressure
Pile diameter	80-200cm
Depth: limit	Approximately 27m, no slam
Soil conditions	
Clay/silt layer	○
sand layer	○
Gravel/rock layer	△
cobblestone layer	△
soft rock	x

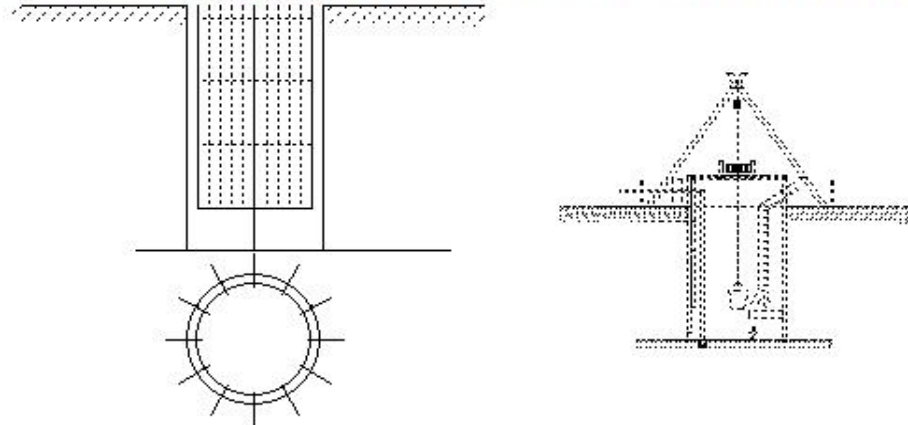


(M310)cast-in-place pile(Deep foundation method)

(M310)cast-in-place pile(Deep foundation method)

cast-in-place pile construction method	cast-in-place pile construction method manual excavation Deep foundation method
Excavation method hole wall retention	manual excavation Special mountain retaining steel plate
Pile diameter	140-300cm
Depth: limit	About 30m
Soil conditions	
Clay/silt layer	○
sand layer	○
Gravel/rock layer	○
cobblestone layer	○
soft rock	x

(M310) cast-in-place pile (Deep foundation method)



F196

(M311)cast-in-place pile

(M311) cast-in-place pile

pile foundation

Construction management of cast-in-place piles

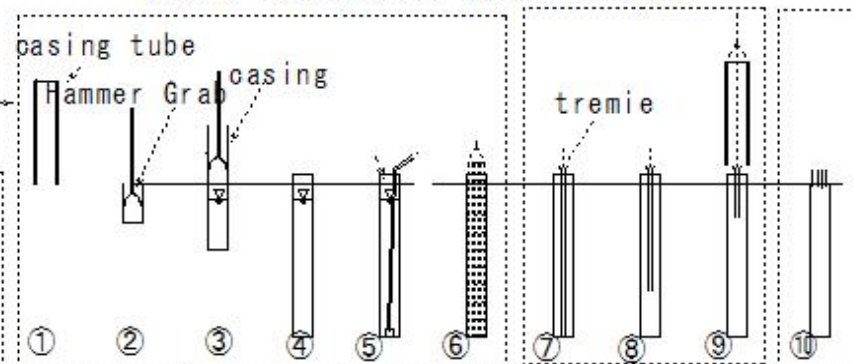
① Construction of Benoto piles

① Insert reinforcing bar cage
Groundwater casing

② Underwater concrete placement (slump 17cm, cement amount 370kgf/m³ or more)
tremie tube is flanged and watertight.
Raise the casing approximately 2m to protect the hole wall
Insert about 2 m on top of concrete

③ Slime (cutting residue) Mixed with muddy water
concrete curing
Must not be harmful due to temperature, load, shock, etc.
• Pile head
Add about 0.5m extra
there is muddy water, it is about 1m

Benoto Earth Drill Reverse Method



(M312) cast-in-place pile (open caisson foundation)

(M312) cast-in-place pile (open caisson foundation)

Cast-in-place piles - construction

open caisson foundation

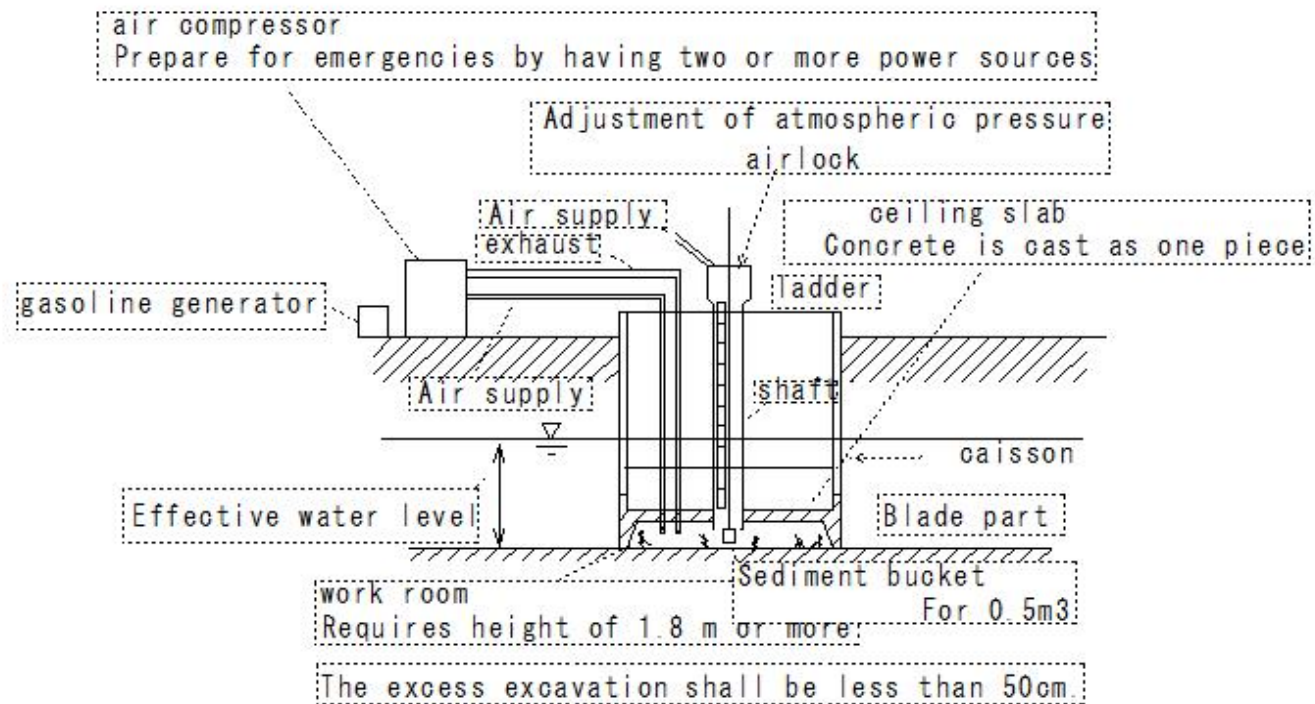
- ① Lower end of the caisson: Installation of the cutting edge hardware
Rebar formwork
- ② Concrete placement
- After curing - formwork - removal
- ③ Ground excavation - caisson sinking
- ④ Low concrete pouring
- ⑤ Caisson - Filling - Lid concrete: Superstructure construction



(M313)cast-in-place pile(Pneumatic caisson)

(M313) cast-in-place pile (Pneumatic caisson)

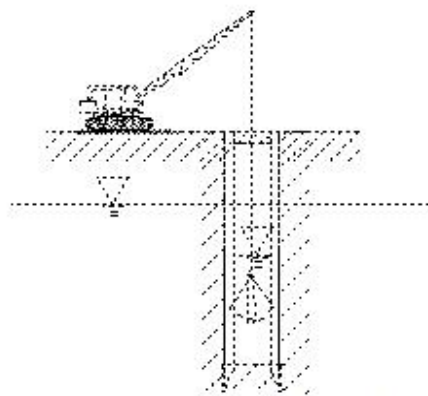
Cast-in-place piles - construction
Pneumatic caisson



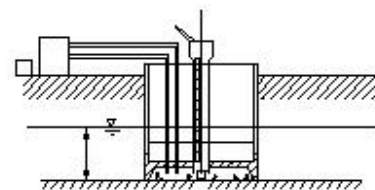
(M314)cast-in-place pile

(M314) cast-in-place pile

Cast-in-place piles - construction		
	open caisson foundation	pneumatic caisson
temporary equipment	easy	Complex: Expensive
Pollution	no problem	noise
Surrounding ground	Groundwater - decline	Surrounding ground - no impact
	Loosen the surrounding ground	
Construction	Depth - 60m	Depth -40m



open caisson foundation



pneumatic caisson

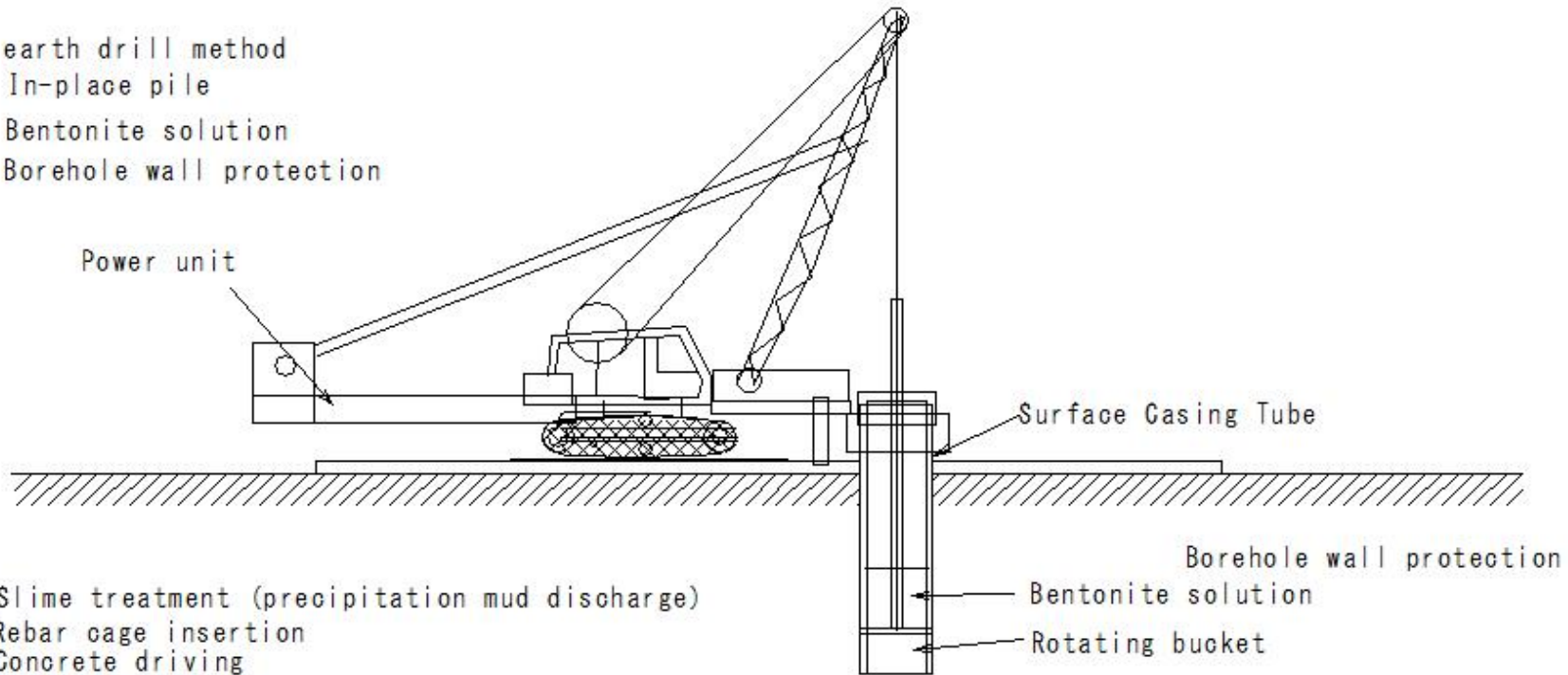
F200

(M315)earth drill method

(M315)earth drill method

earth drill method
In-place pile
Bentonite solution
Borehole wall protection

Power unit

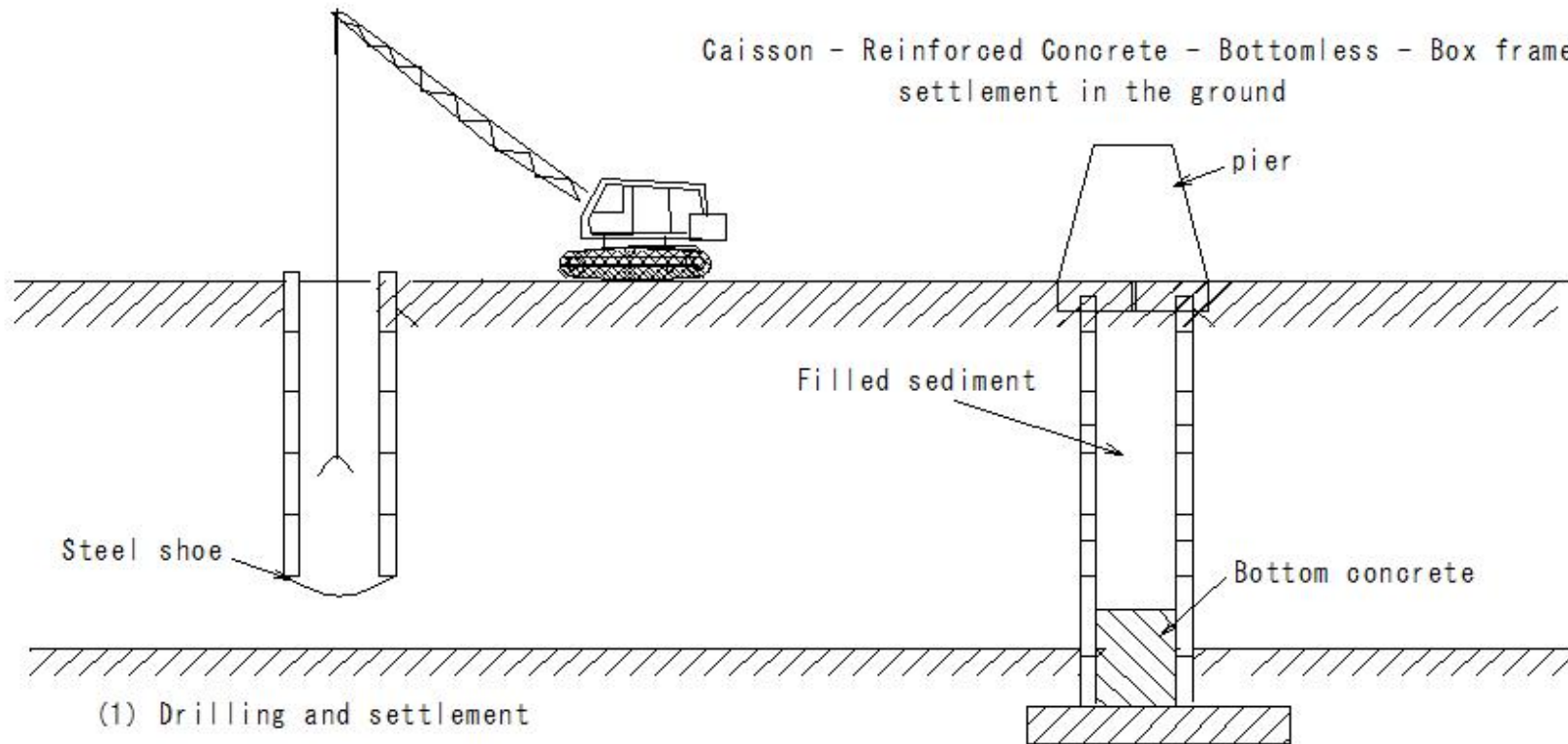


Slime treatment (precipitation mud discharge)
Rebar cage insertion
Concrete driving
Pile diameter 0.8-1.2m.
Pile length 35-60m.
Construction speed - fast
Less noise and vibration

(M316)caisson foundation

(M316) caisson foundation

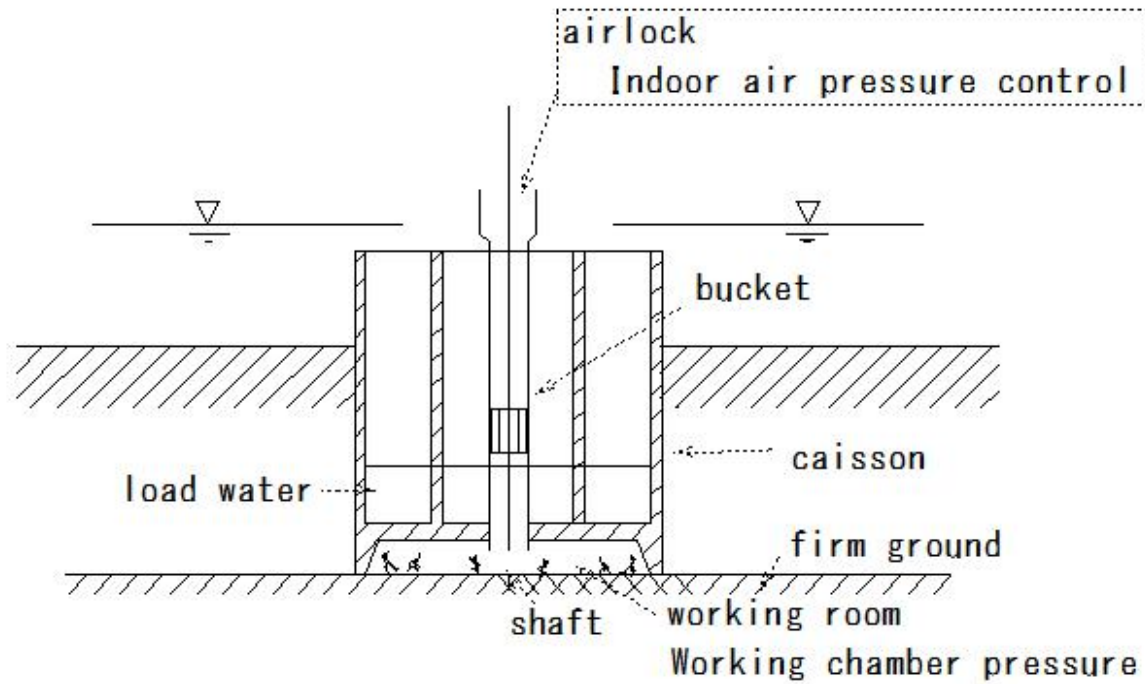
Caisson - Reinforced Concrete - Bottomless - Box frame
settlement in the ground



(M317)air lock

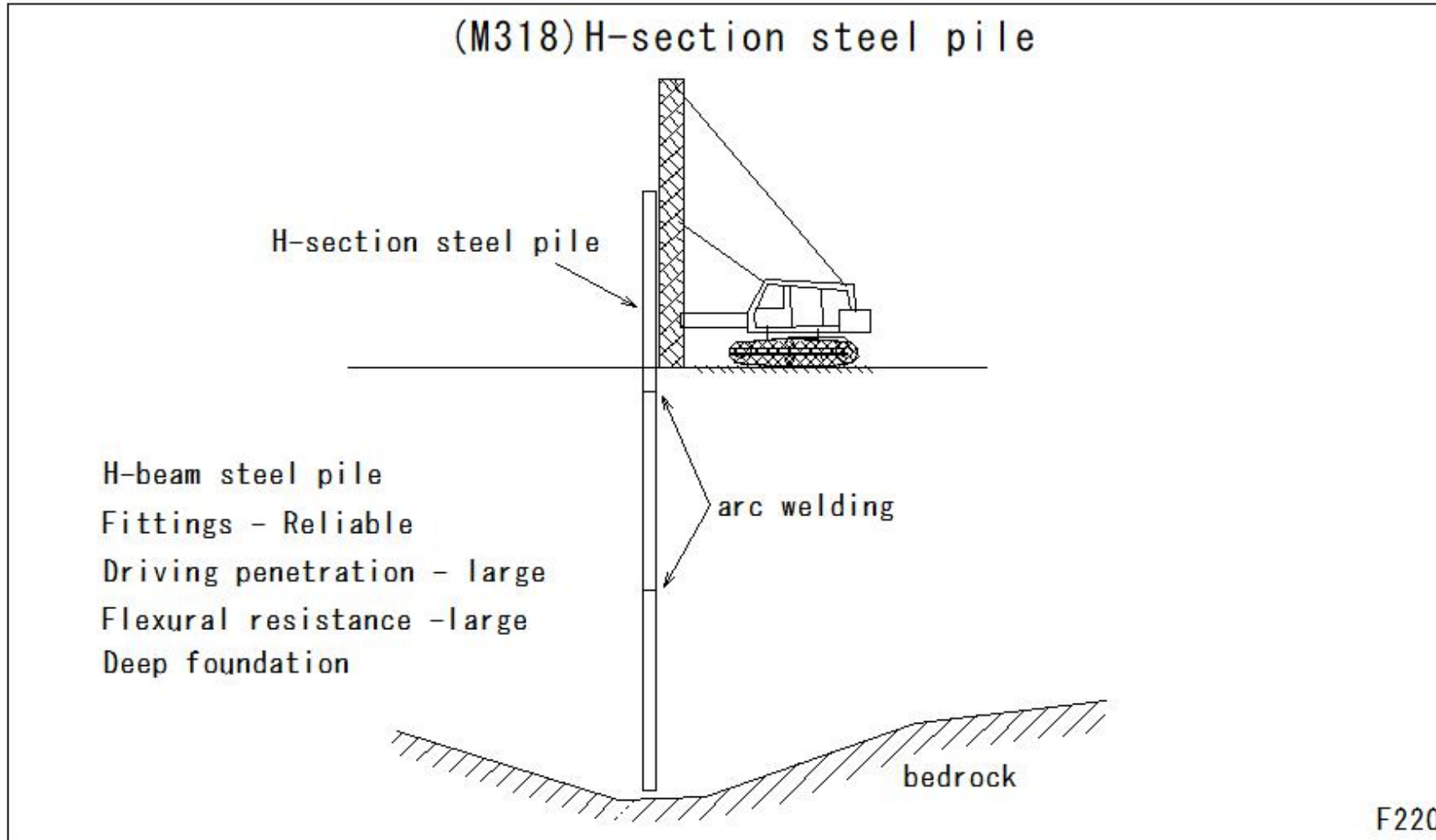
(M317)air lock

Caisson foundation
Pneumatic Caisson
Pneumatic method



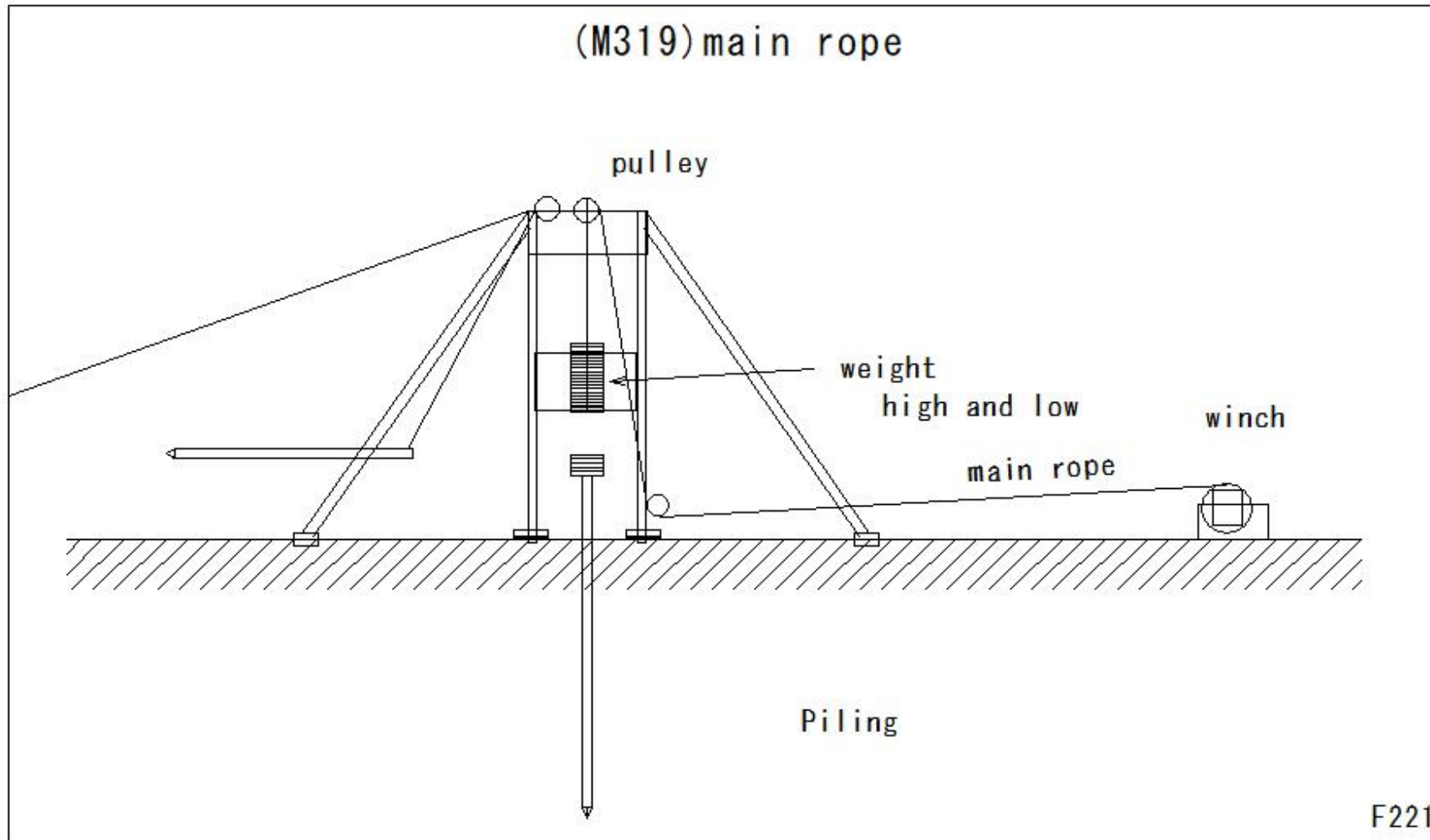
F218

(M318)H-section steel pile

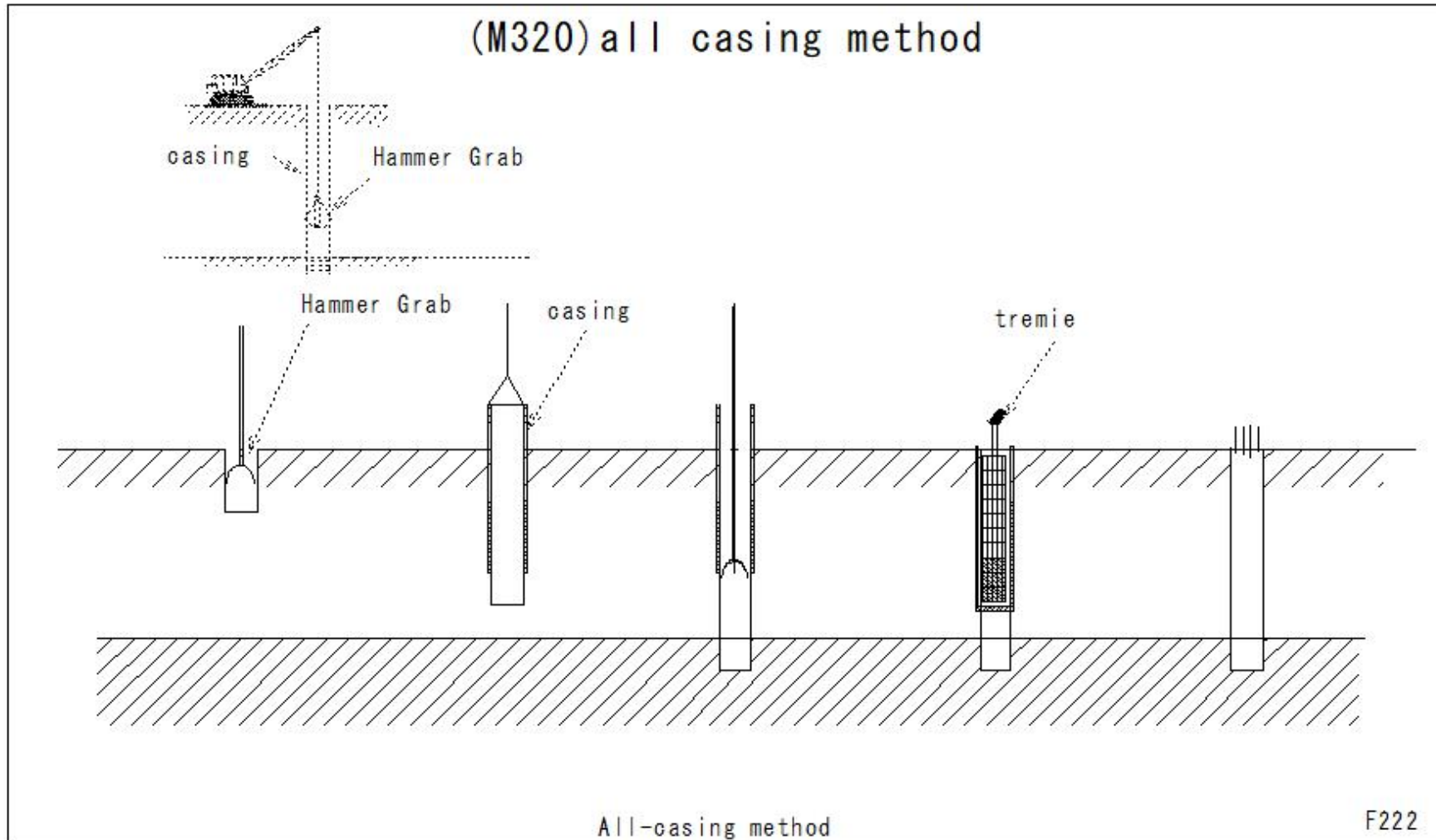


(M319)main rope

(M319)main rope

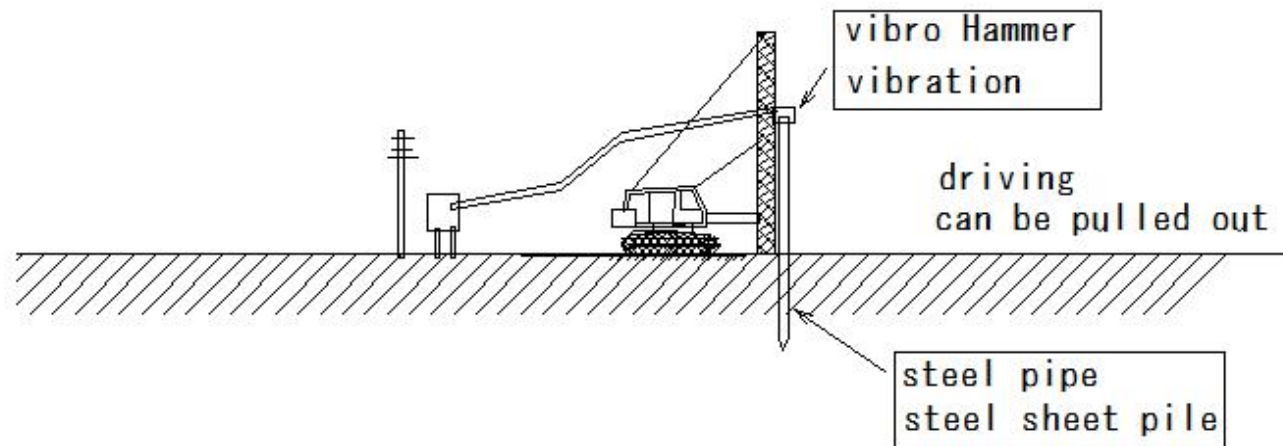


(M320)all casing method



(M321)pile-driver

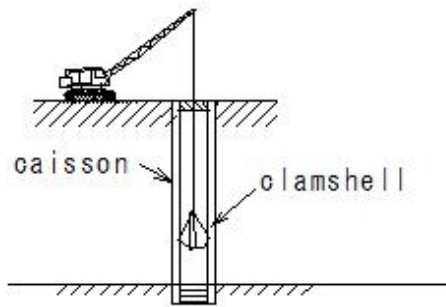
(M321)pile-driver



F225

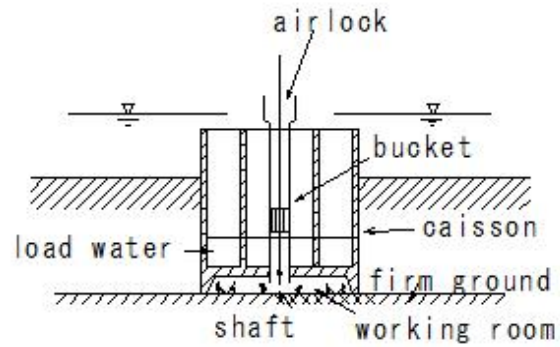
(M322)Caisson foundation

(M322) Caisson foundation



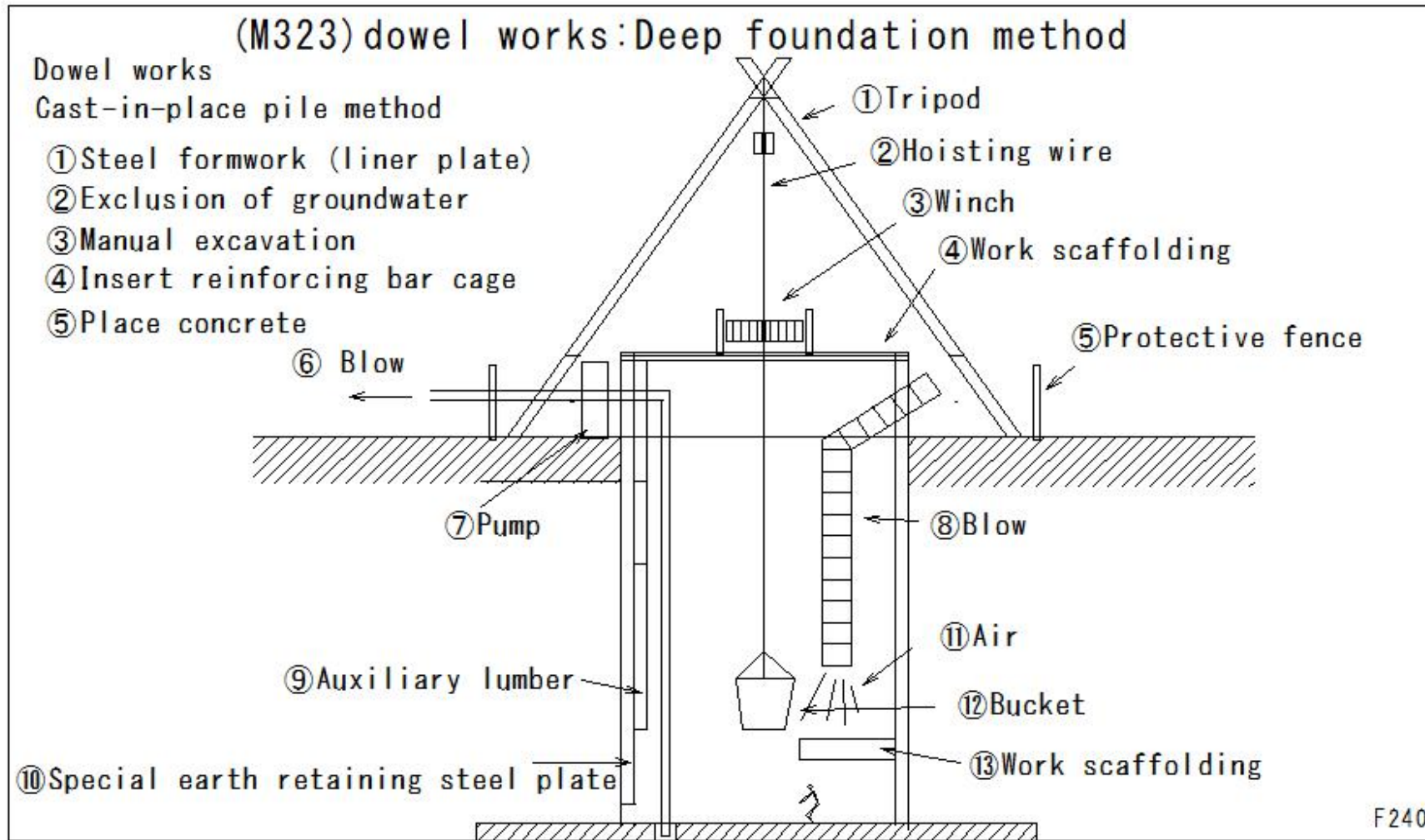
Open caisson foundation

Sedimentation in the support layer



Pneumatic caisson

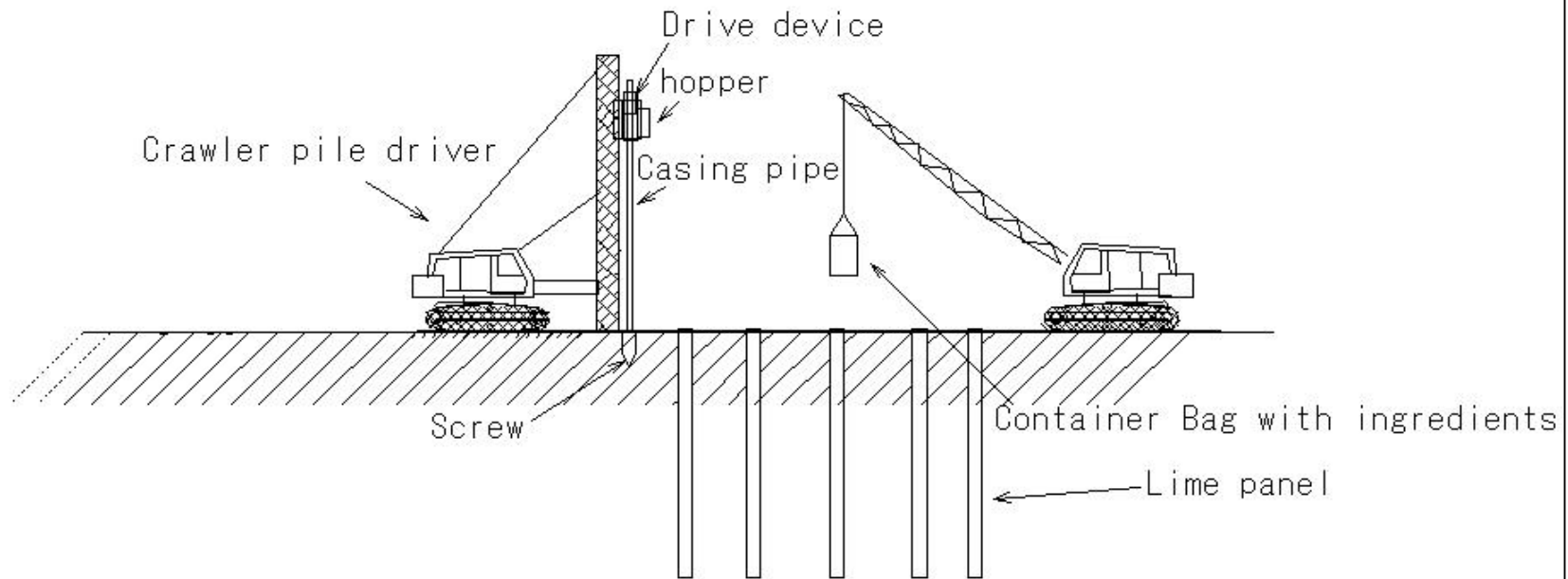
(M323)dowel works:Deep foundation method



(M324)lime pile

(M324) lime pile

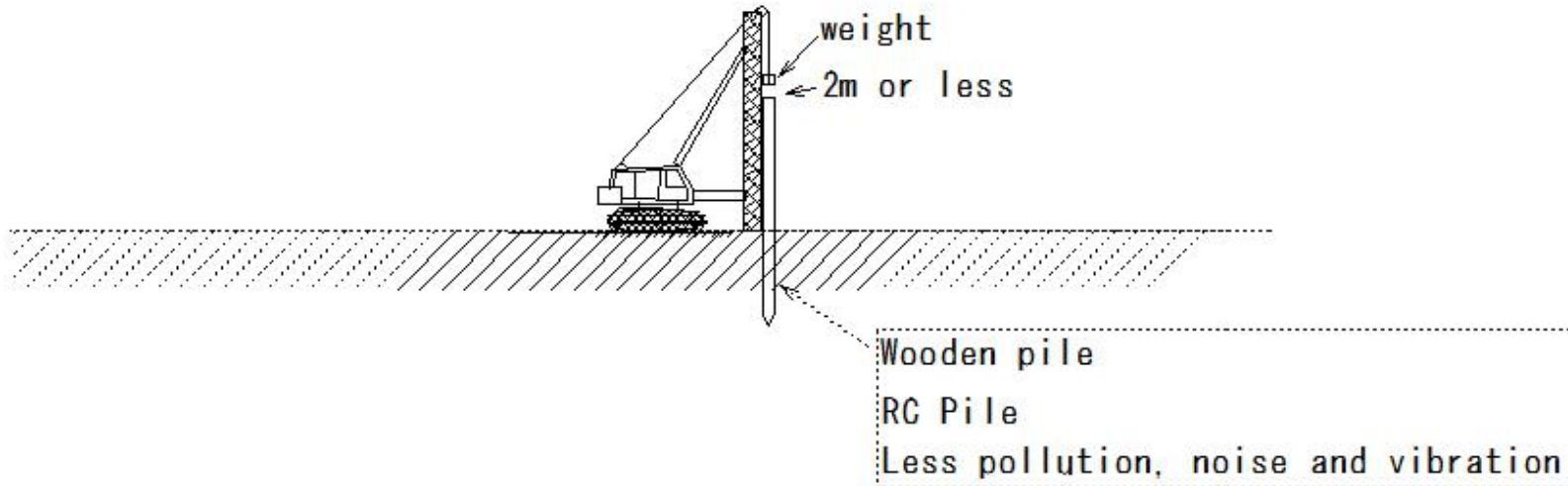
Lime pile method



(M325)drop hammer

(M325) drop hammer

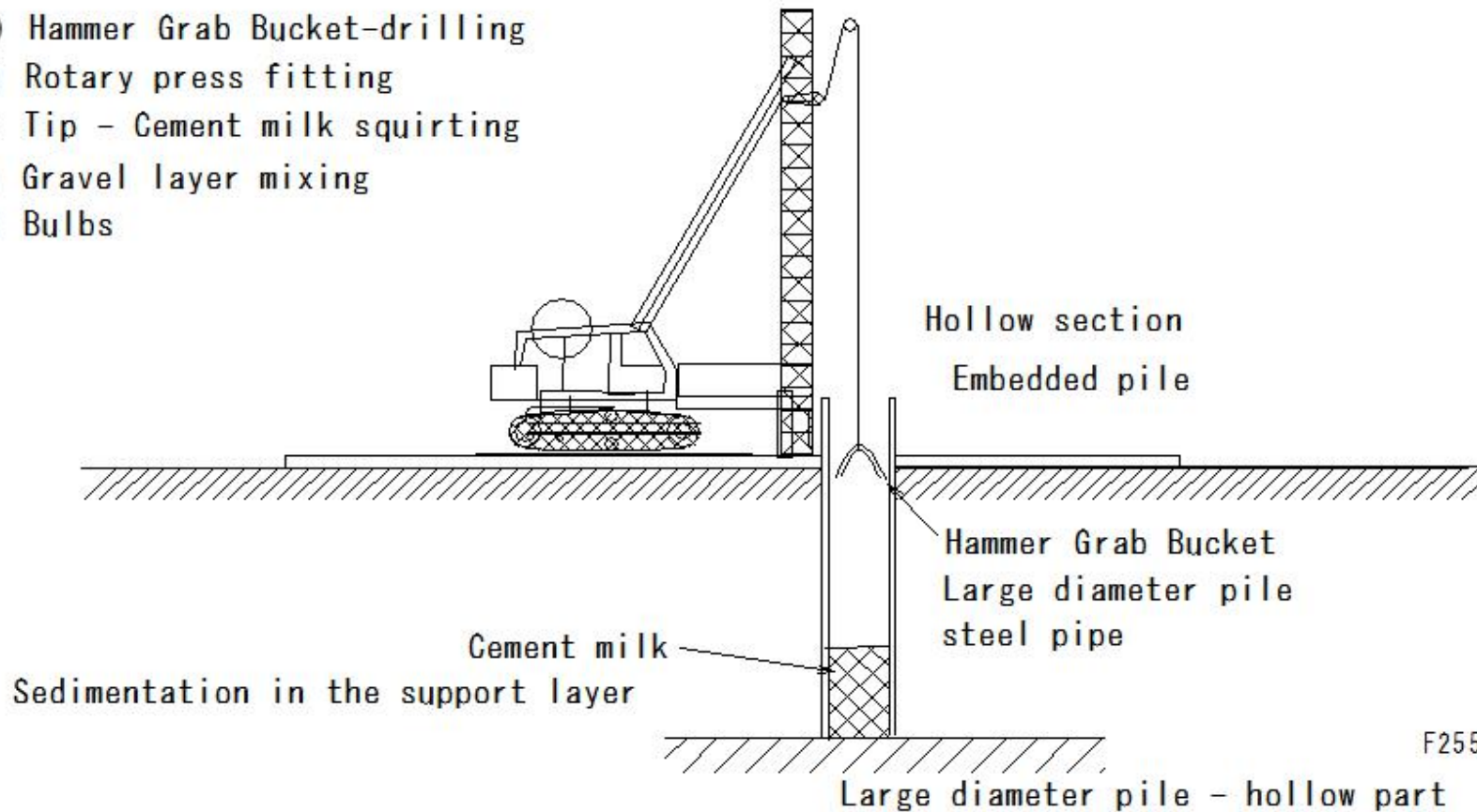
Drop hammer



(M326)Hollow excavation pile method

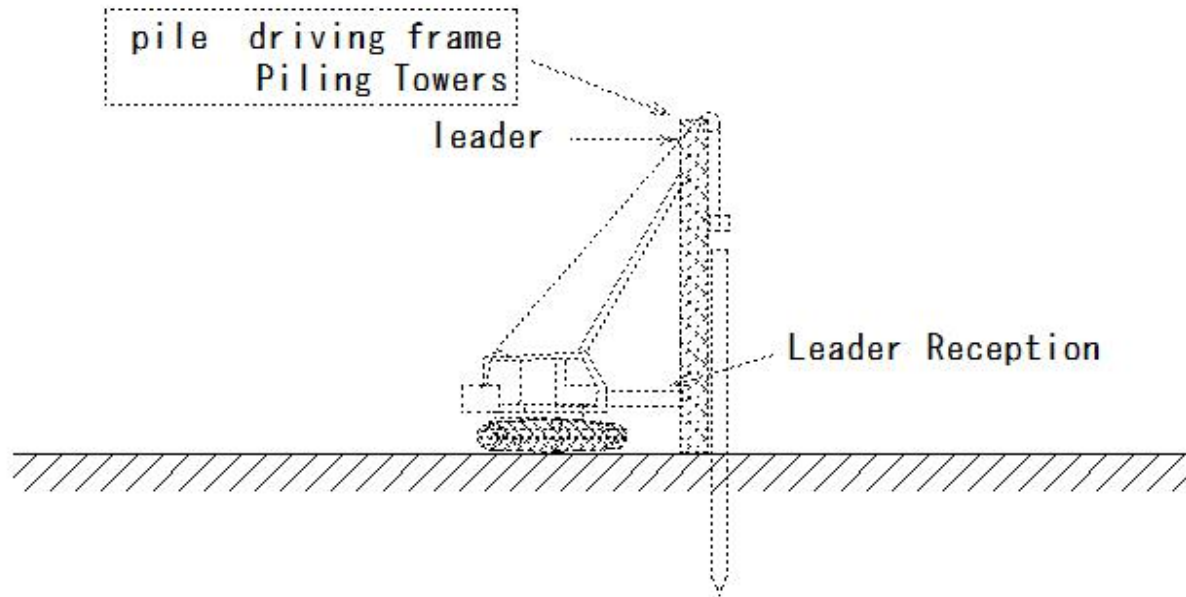
(M326)Hollow excavation pile method

- (1) Hammer Grab Bucket-drilling
- (2) Rotary press fitting
- (3) Tip - Cement milk squirting
- (4) Gravel layer mixing
- (5) Bulbs



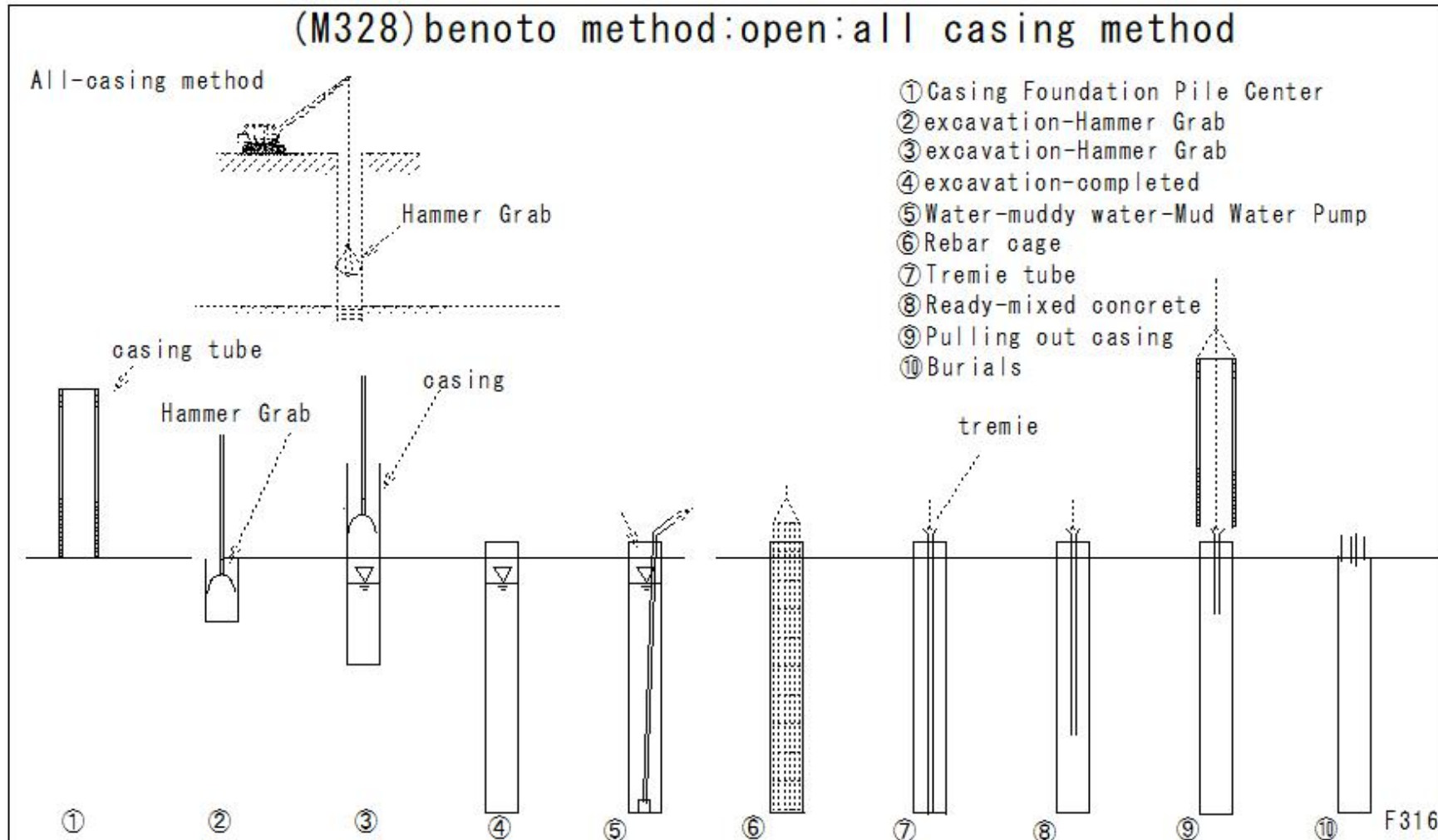
(M327)pile driving frame

(M327)pile driving frame

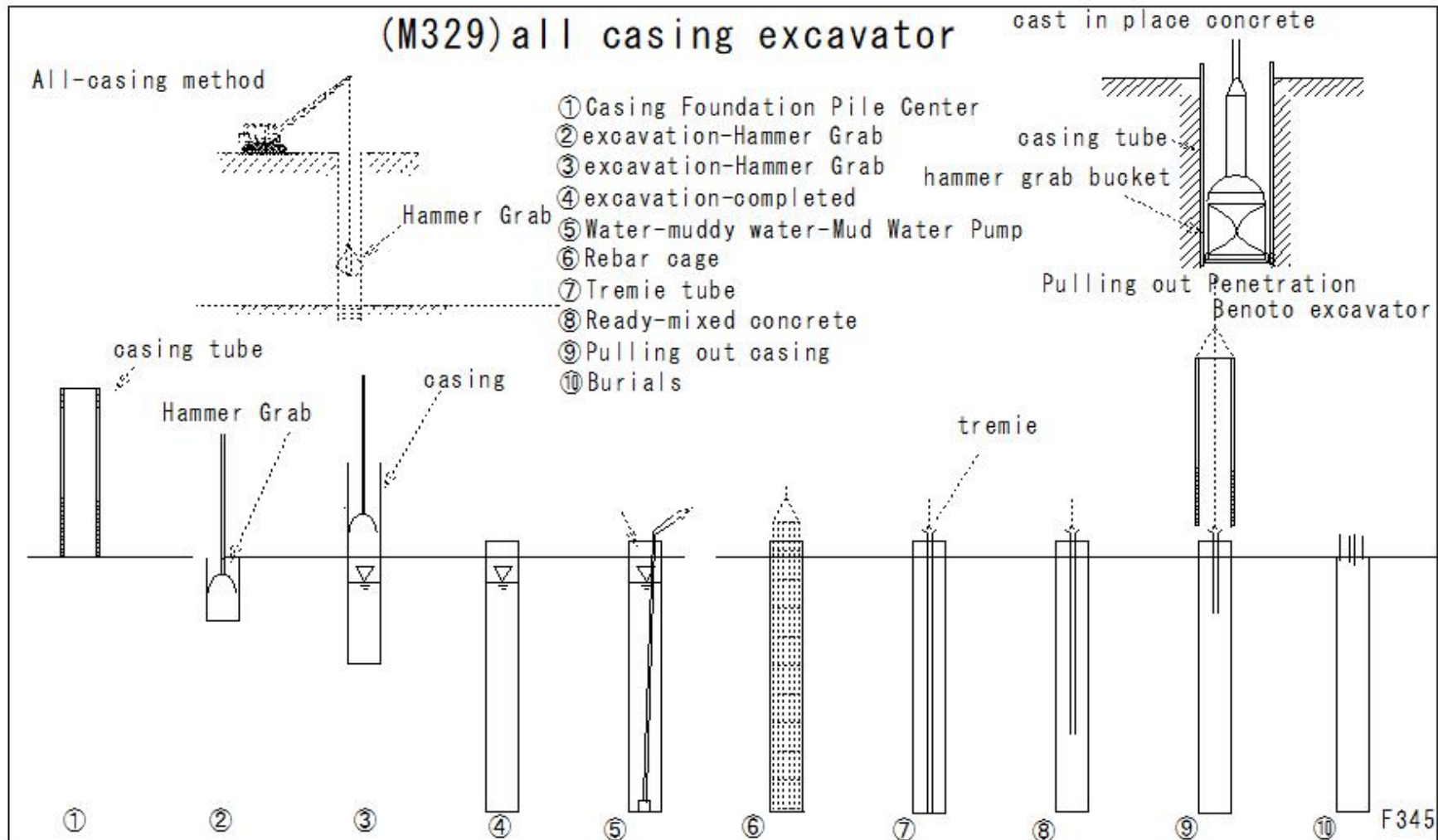


Crawler-type

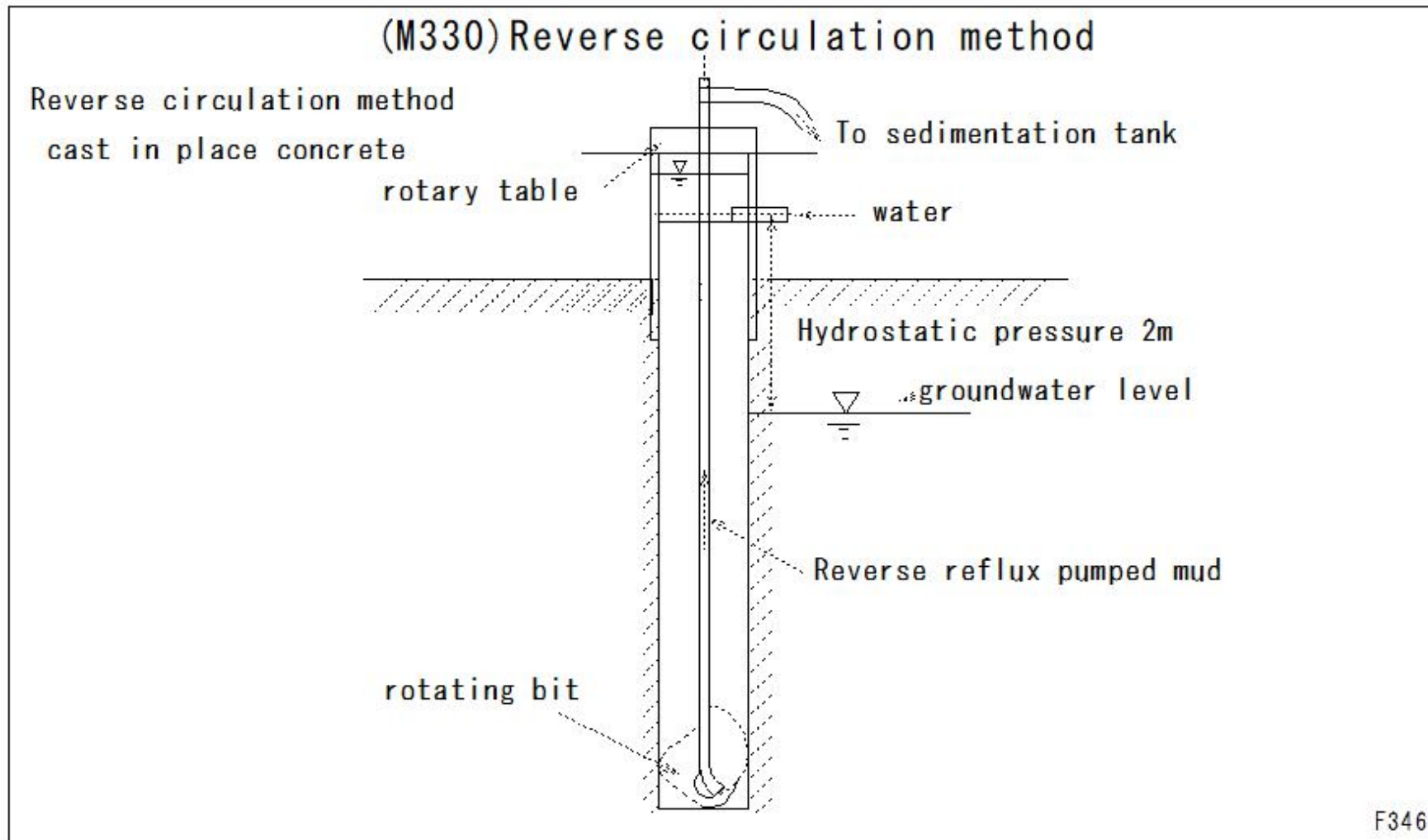
(M328)benoto method:open:all casing method



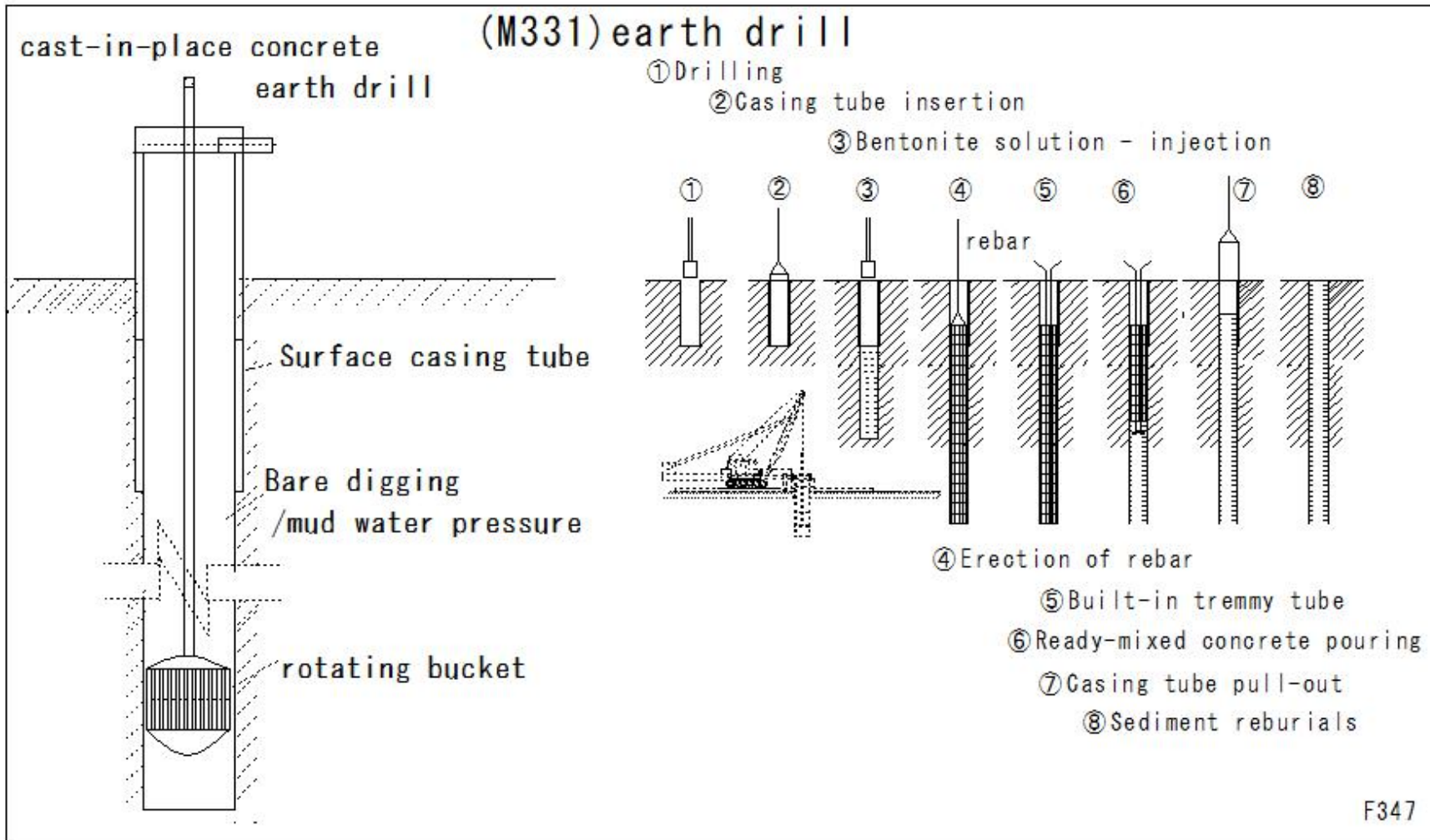
(M329)all casing excavator



(M330)Reverse circulation method



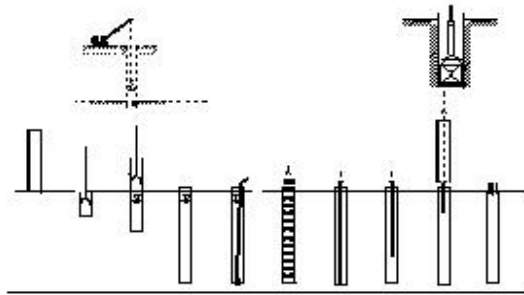
(M331)earth drill



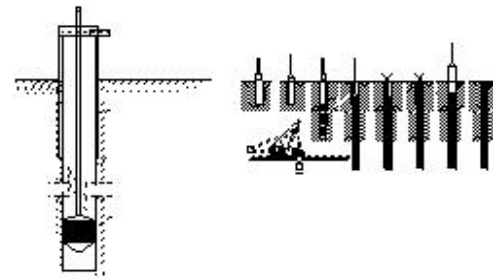
(M332) cast in place concrete

(M332) cast in place concrete

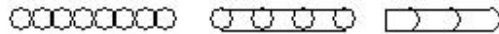
① All casing construction method



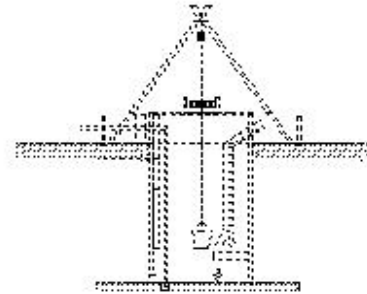
② Earth drill method



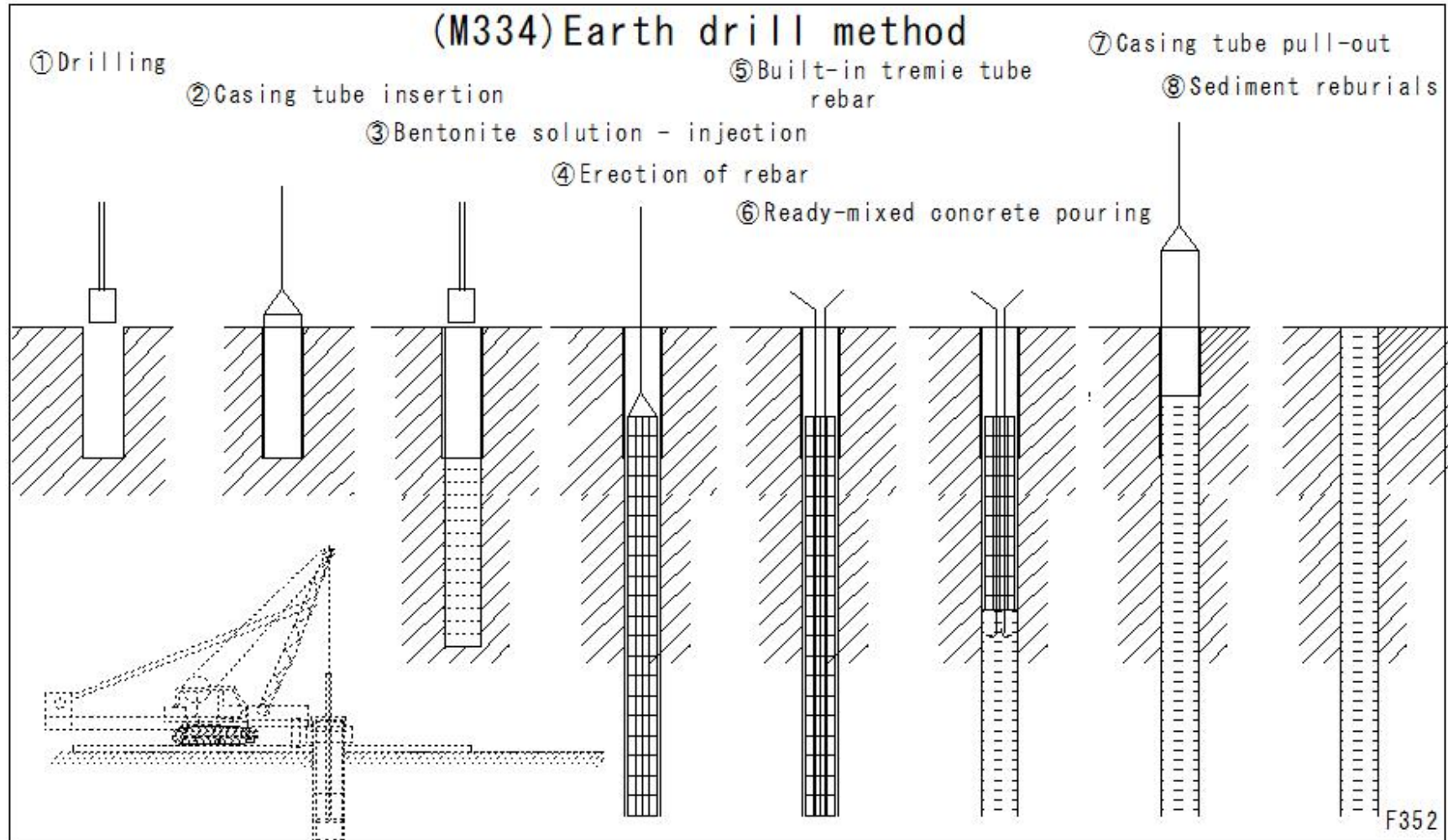
③ Underground continuous wall pile method



④ Deep foundation



(M334)Earth drill method



(M335)Reverse circulation methodd

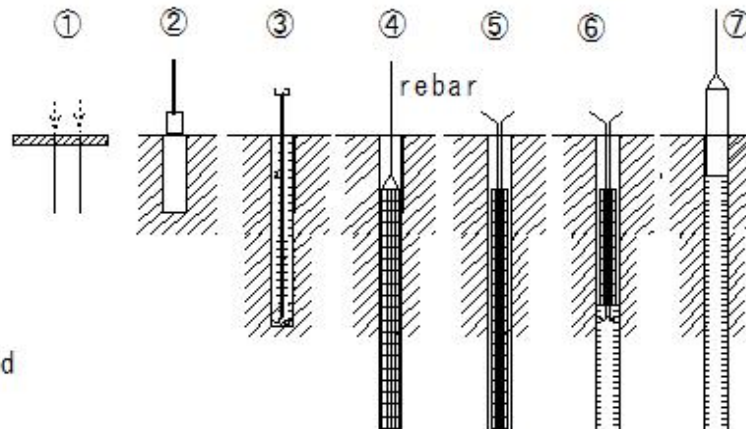
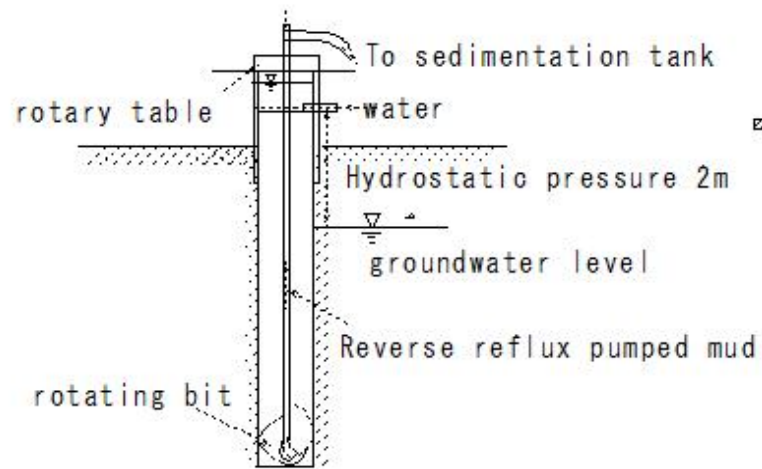
(M335) Reverse circulation methodd

① Installing stand pipe

② Internal excavation with bucket

③ Excavation using leavers method

Reverse circulation method



④ Reinforcement installation

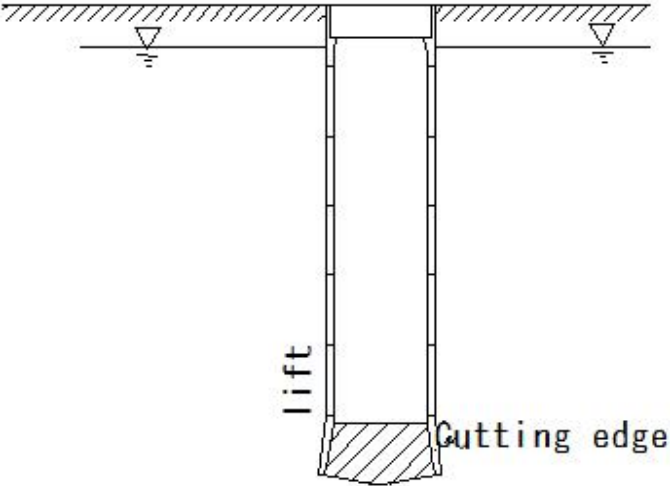
⑤ Suck up sediment-Built-in tremie pipe

⑥ Concrete pouring

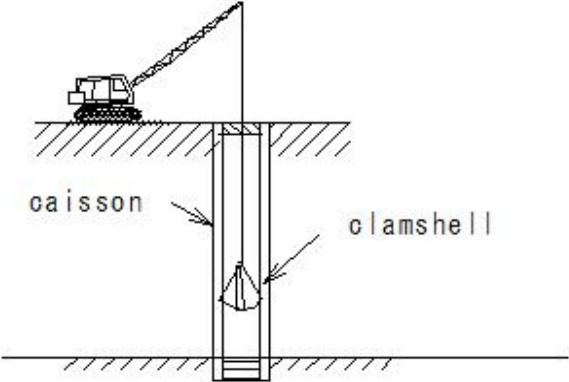
⑦ Pull out the stand pipe

(M336)caisson excavation workng foundation-open caisson

(M336) caisson excavation workng foundation-open caisson



Open caisson



Open caisson foundation

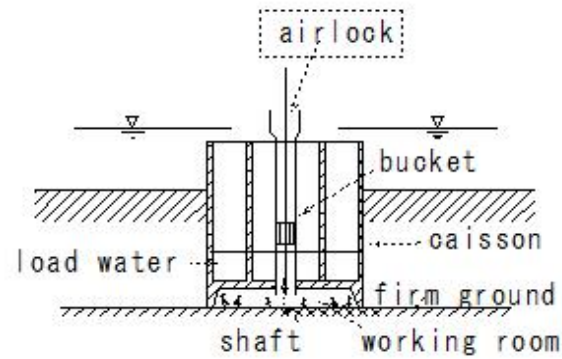
Sedimentation in the support layer

(M337)pneumatic caisson-air lock

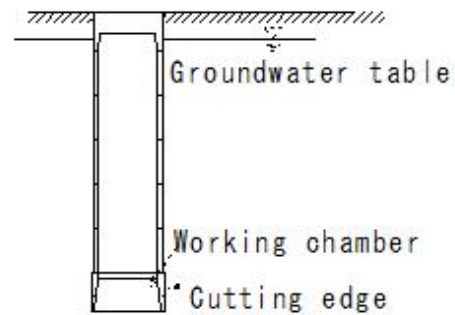
(M337)pneumatic caisson-air lock



Open caisson foundation
Sedimentation in the support layer



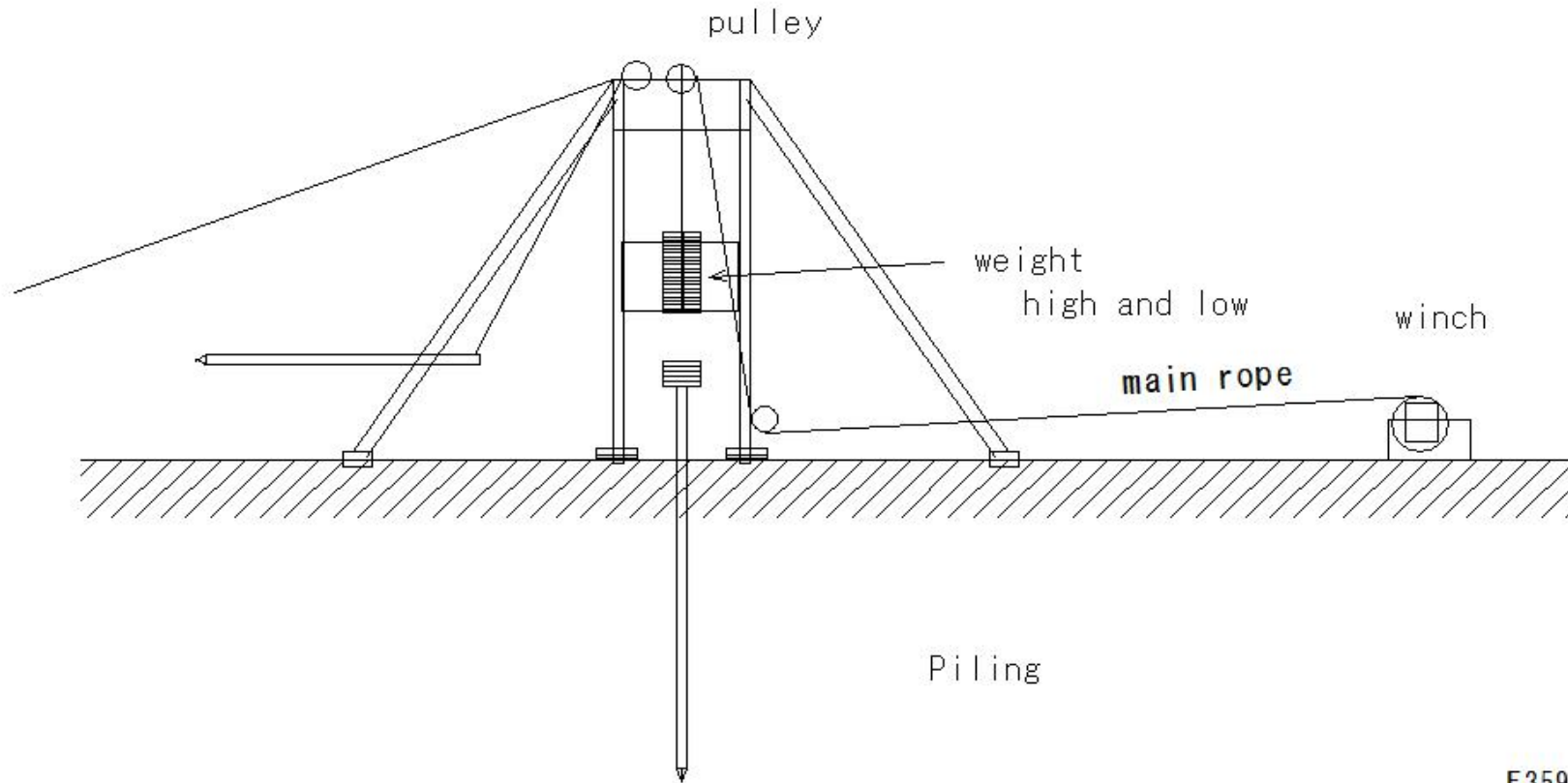
Pneumatic caisson



Pneumatic caisson

(M338)Piling

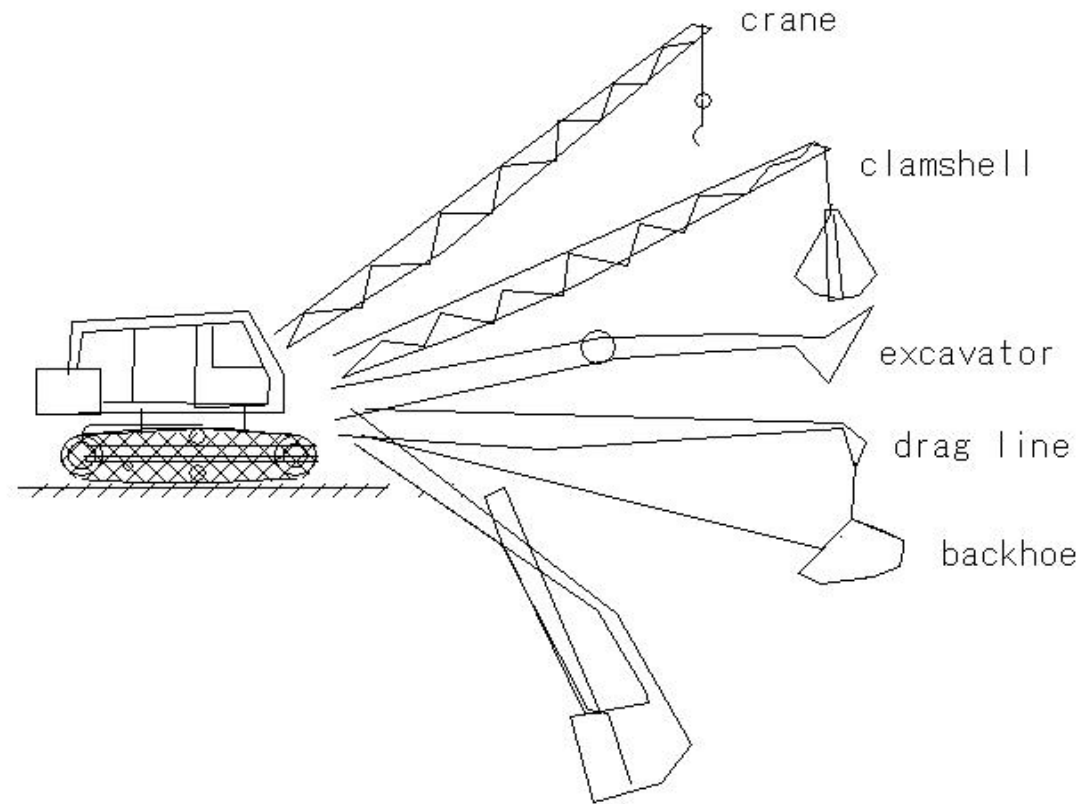
(M338) Piling



F359

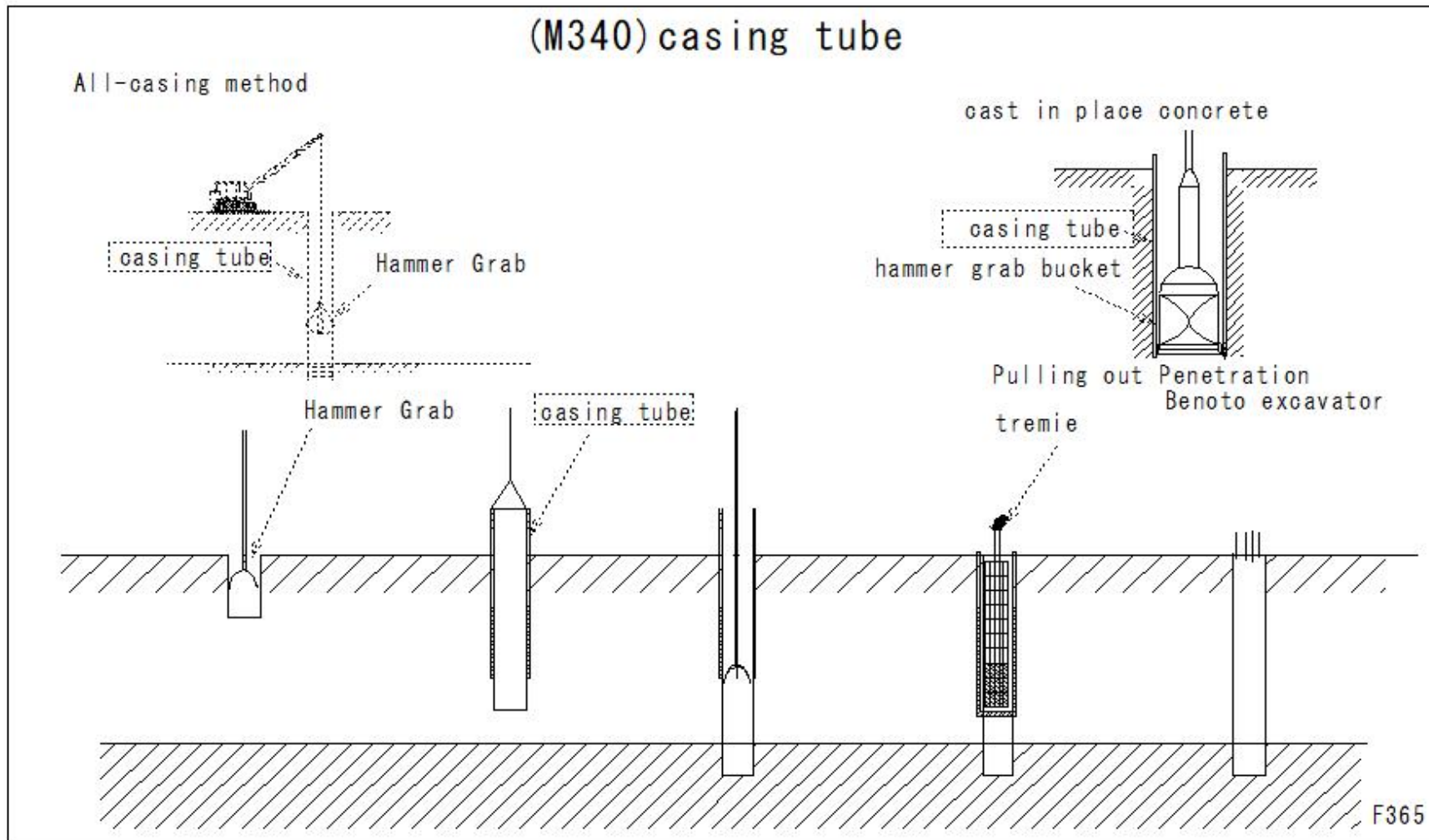
(M339)crawler crane

(M339) crawler crane



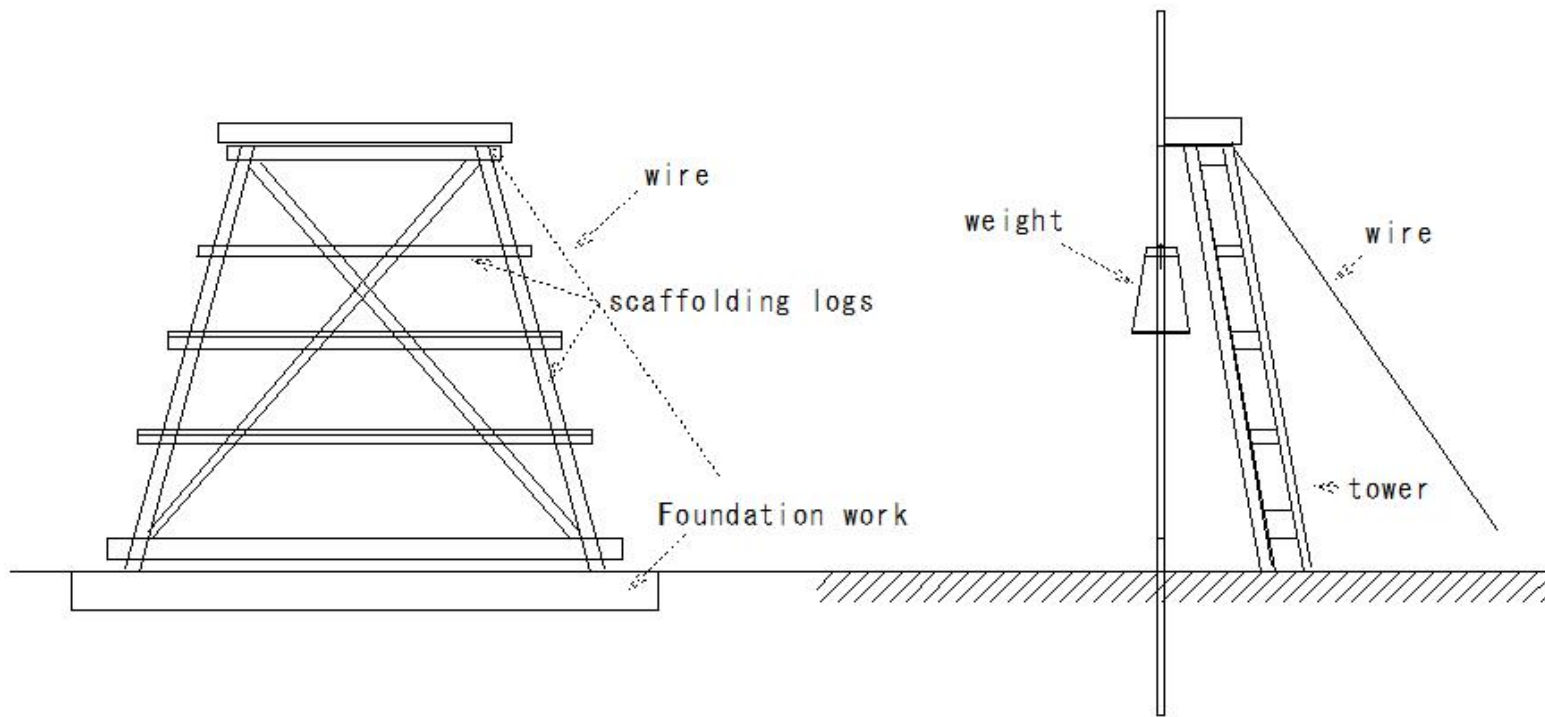
F364

(M340)casing tube



(M341) pilina

(M341) piling



F369

(M342)deep foundation method

(M342)deep foundation method

deep foundation method

circular vertical shaft

manual excavation

drilling

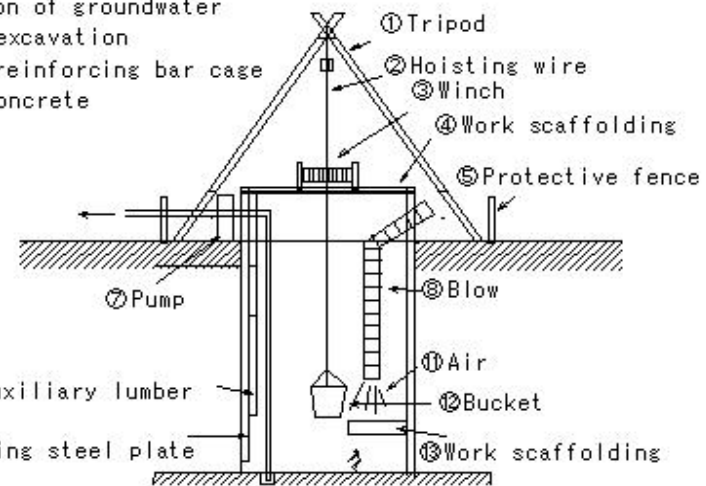
liner plate

D=1.2-3.0m

Dowel works

Cast-in-place pile method

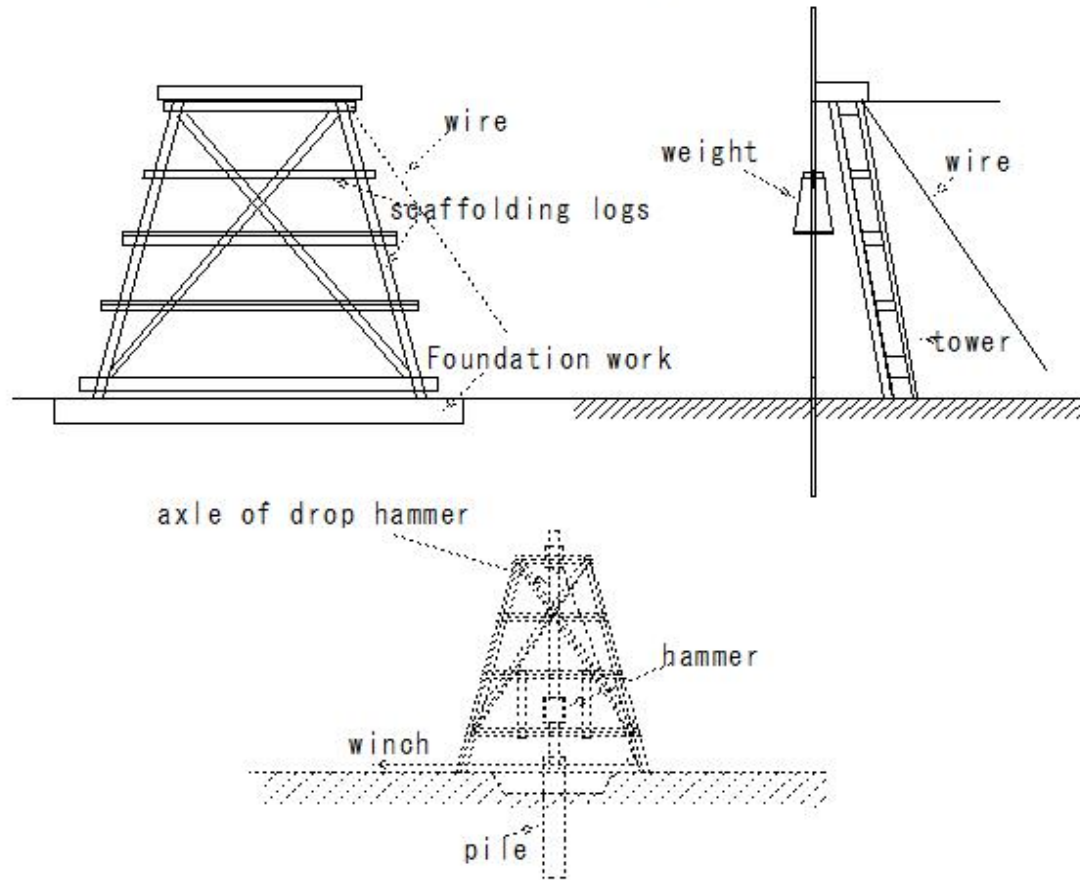
- ① Steel formwork (liner plate)
- ② Exclusion of groundwater
- ③ Manual excavation
- ④ Insert reinforcing bar cage
- ⑤ Place concrete
- ⑥ Blow



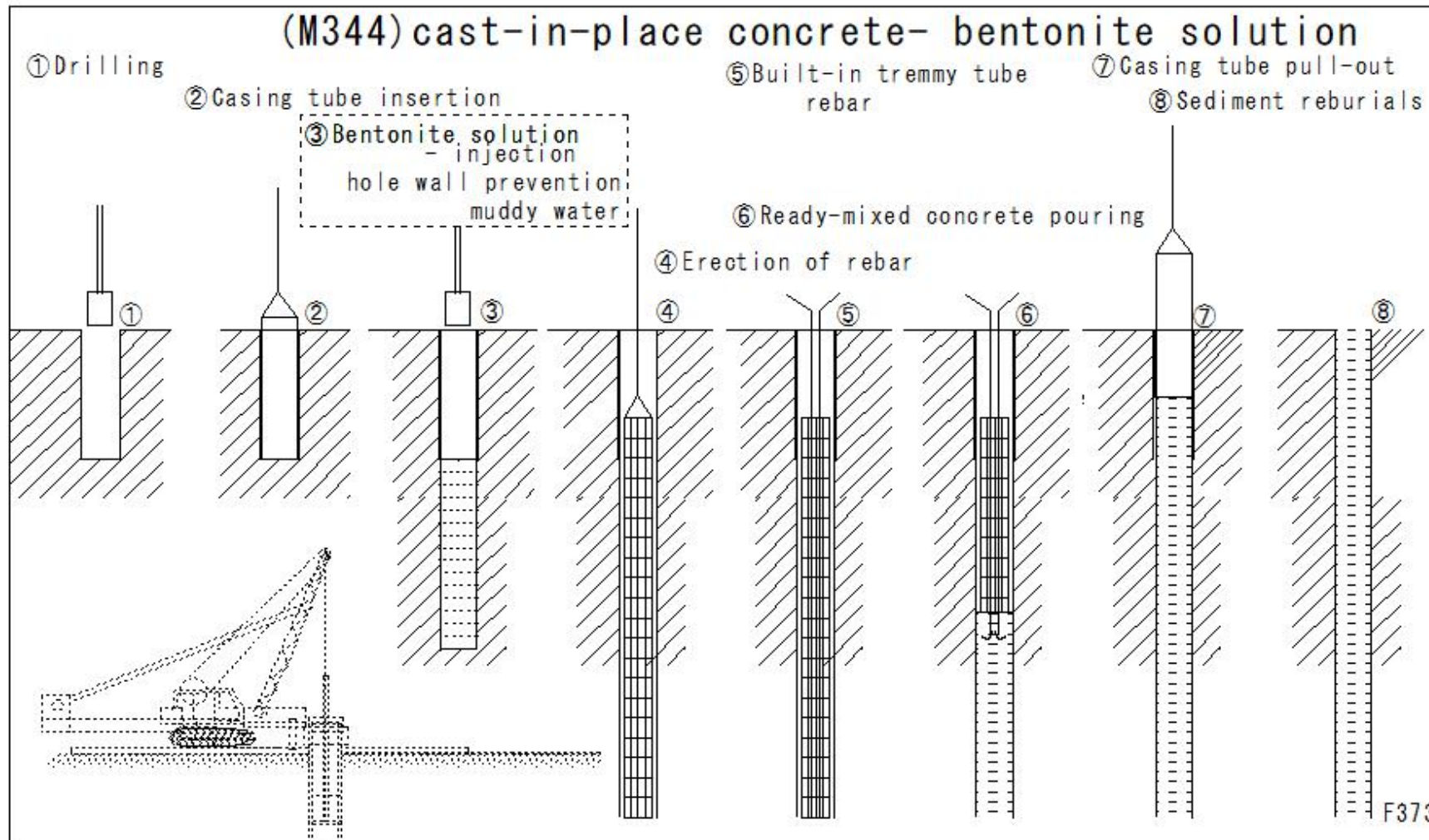
⑩ Special earth retaining steel plate

(M343)piling

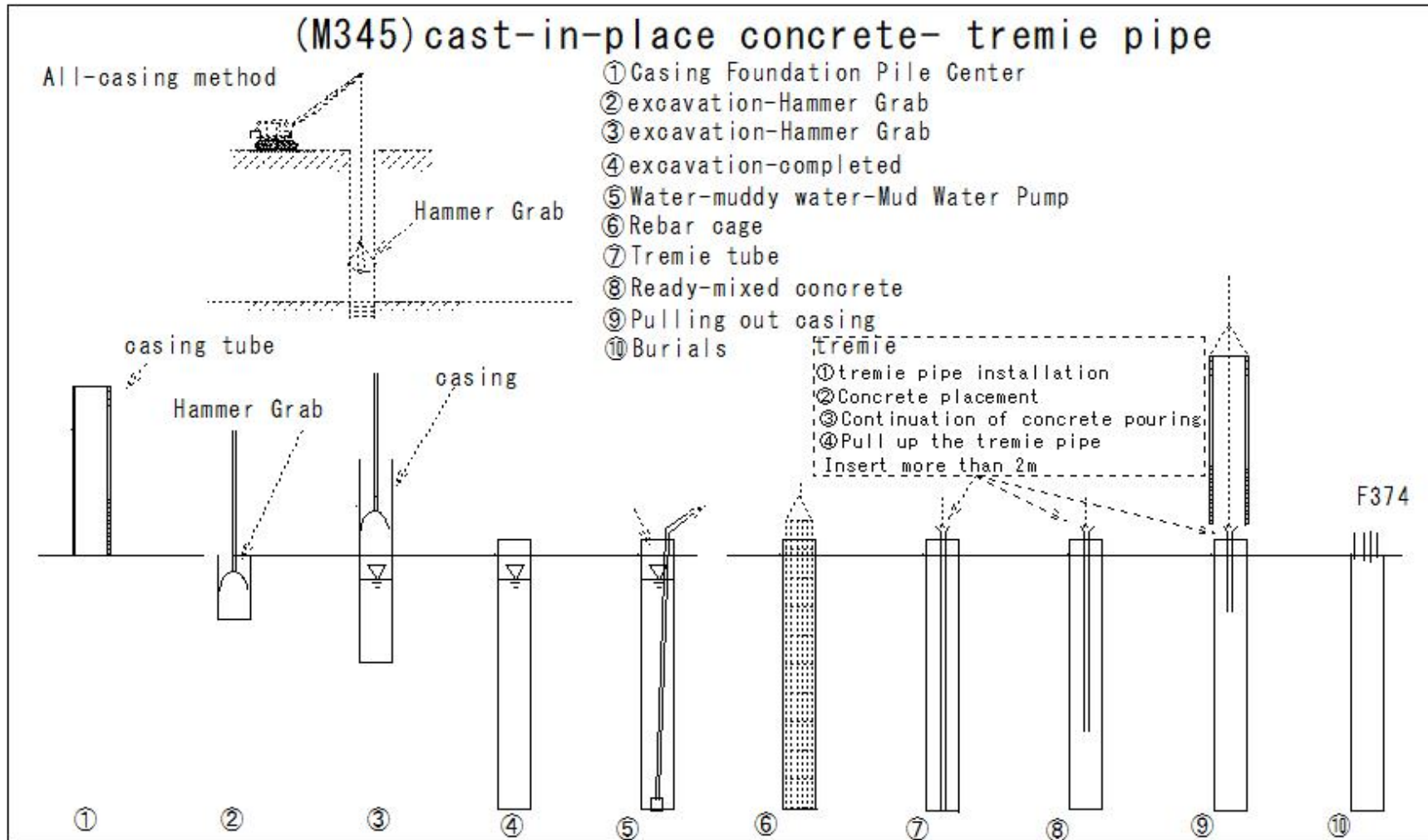
(M343) piling



(M344) cast-in-place concrete- bentonite solution

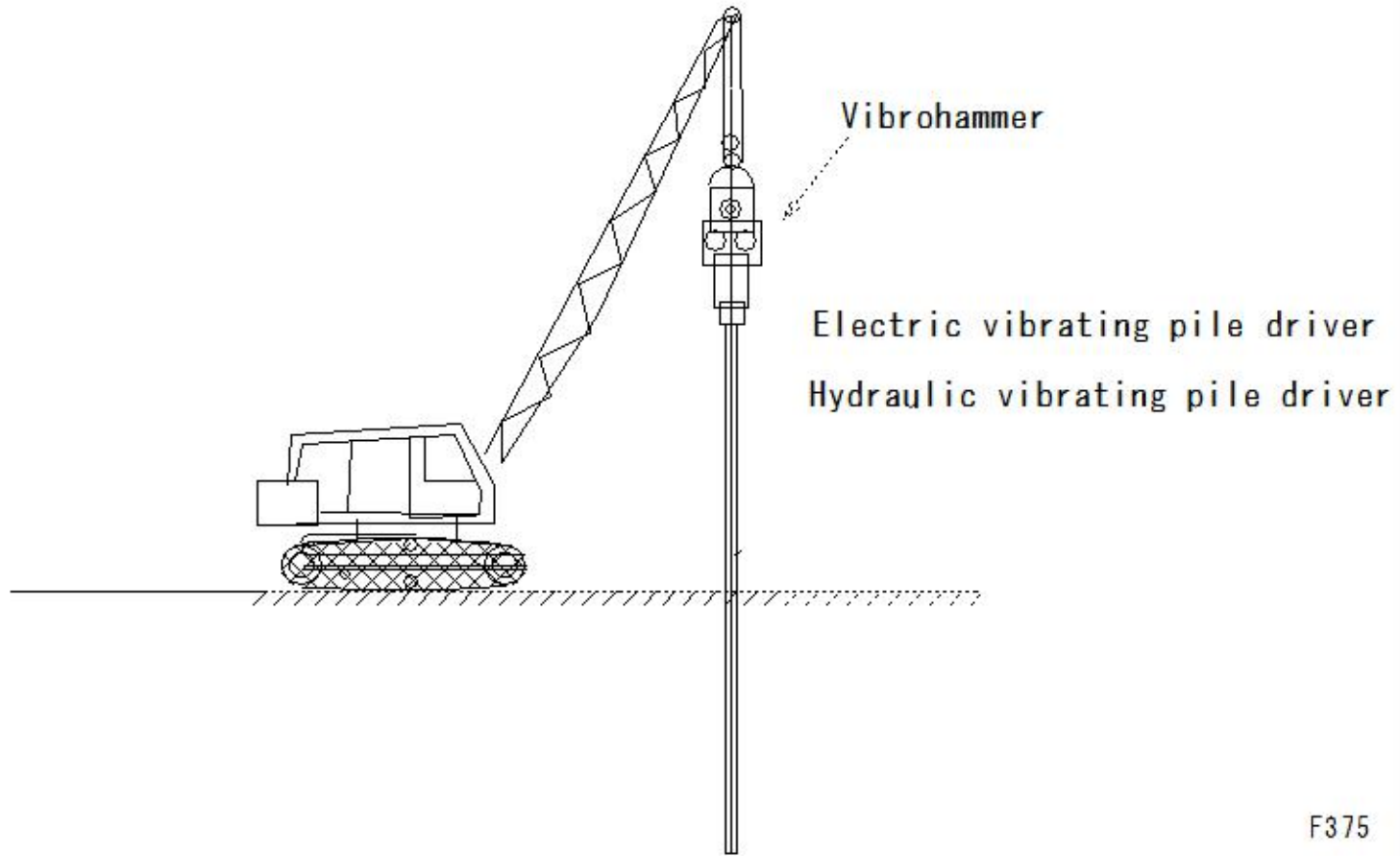


(M345) cast-in-place concrete- tremie pipe



(M346)Vibrohammer method

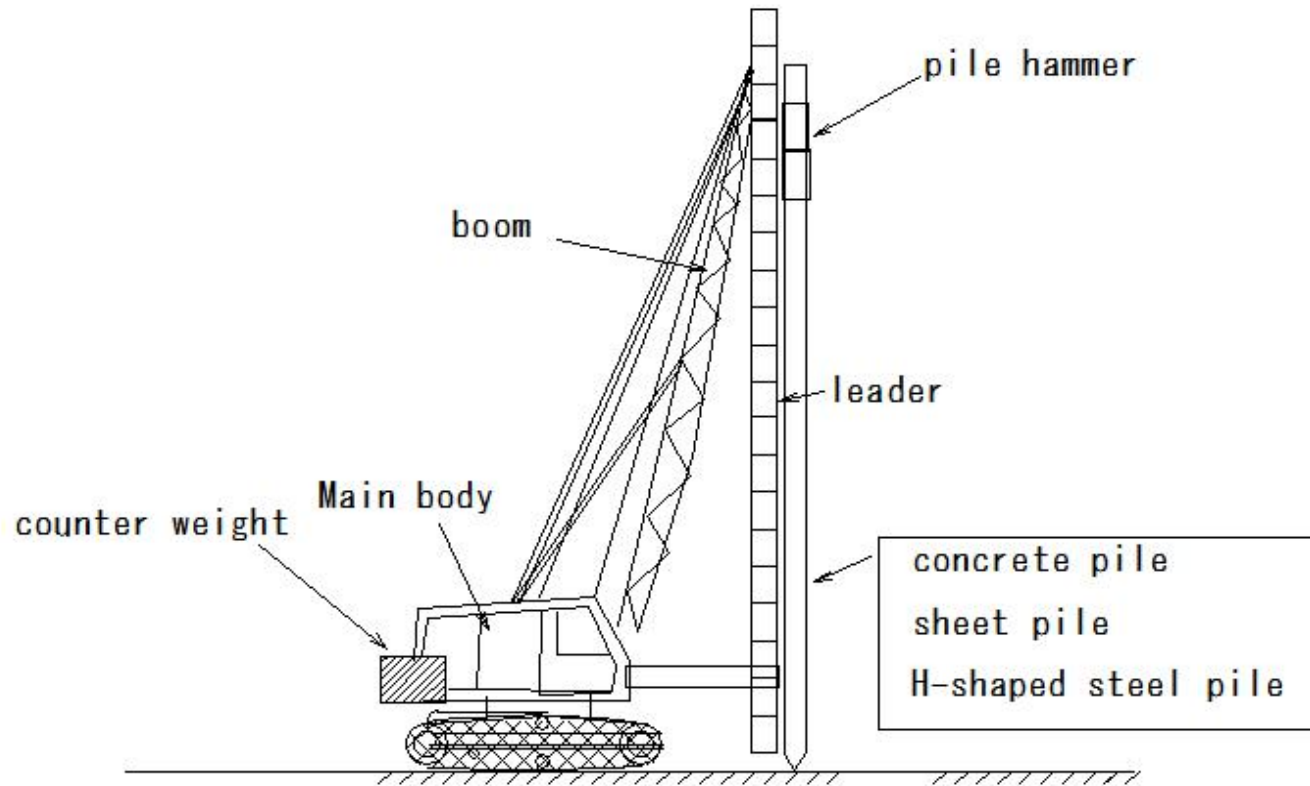
(M346)Vibrohammer method



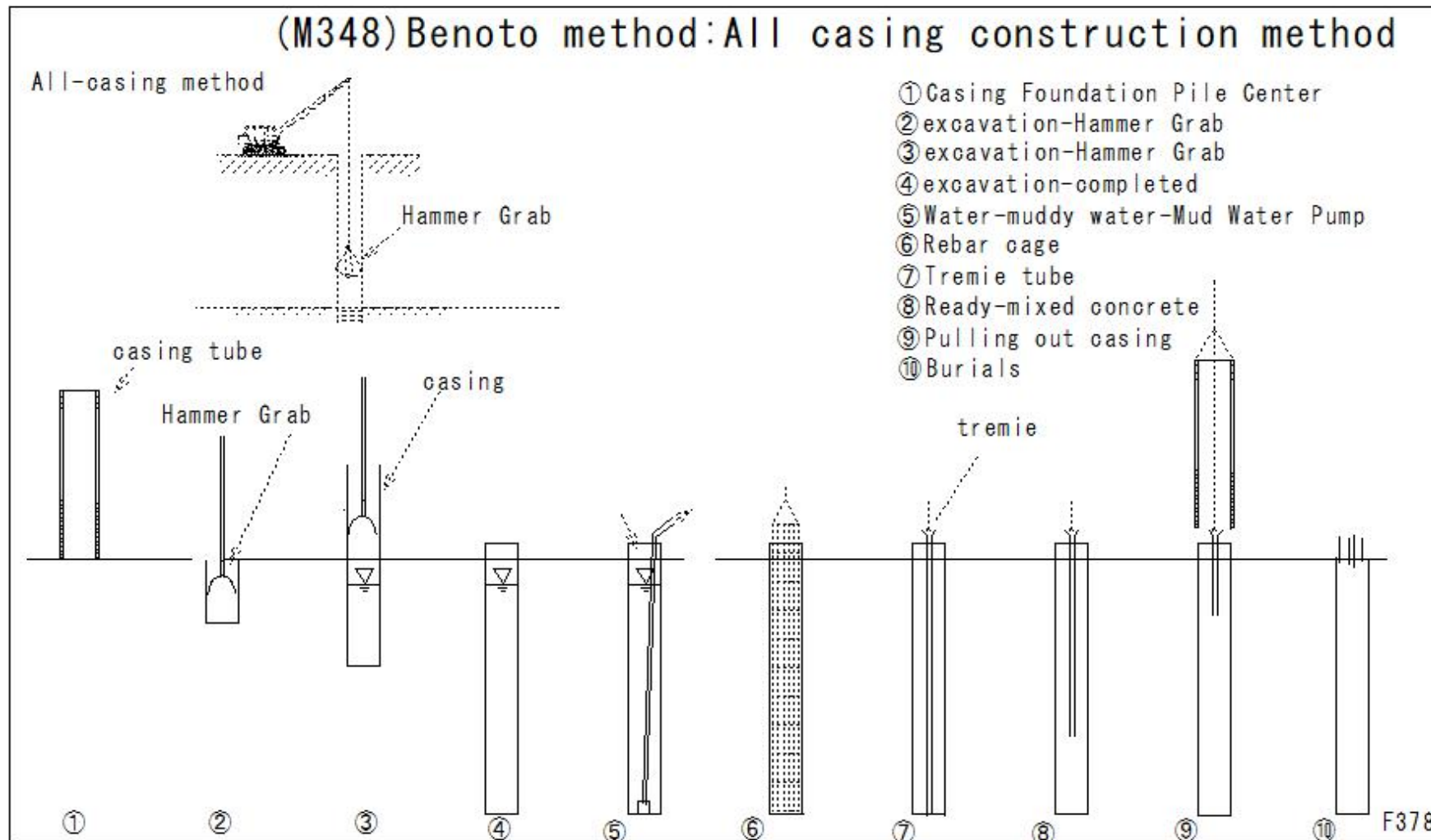
F375

(M347)pile driver

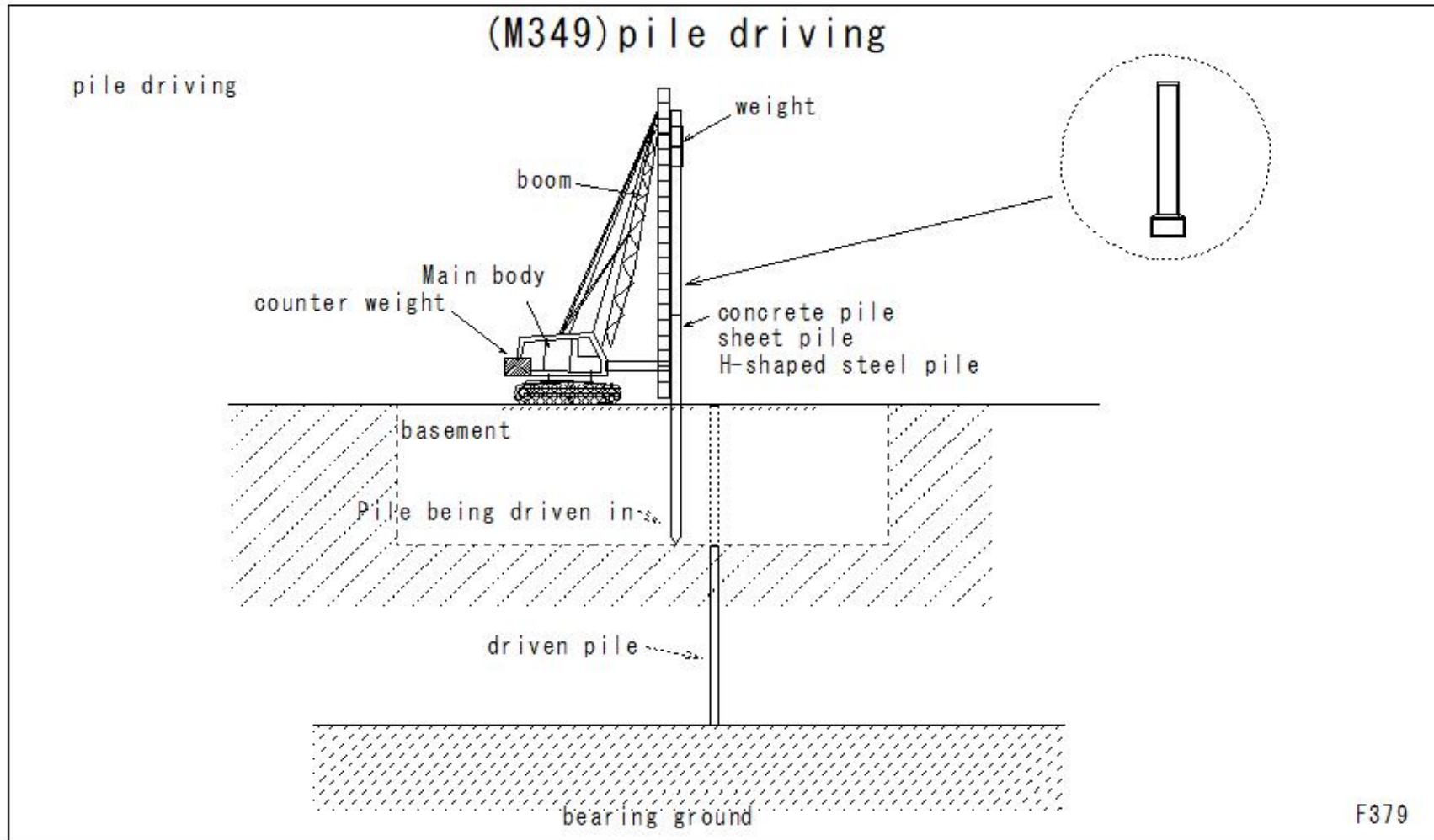
(M347)pile driver



(M348) Benoto method: All casing construction method



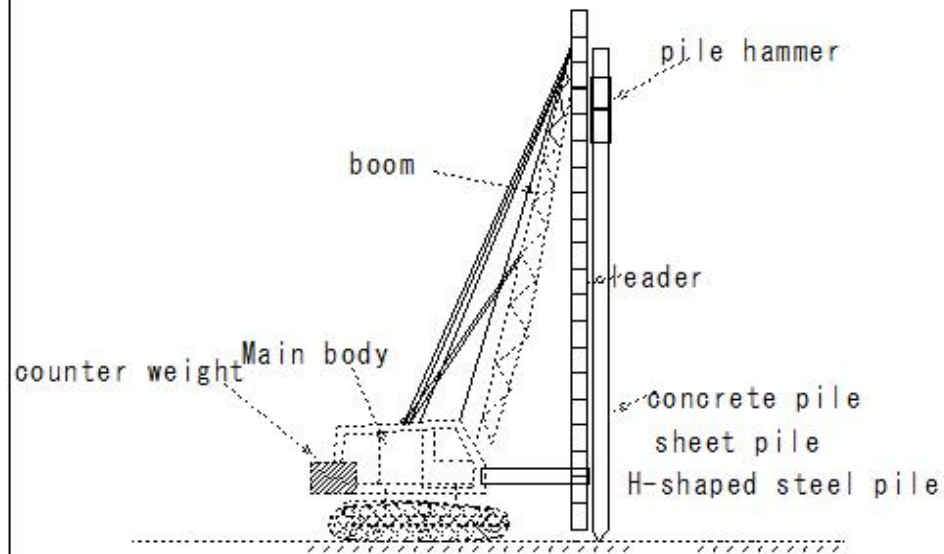
(M349)pile driving



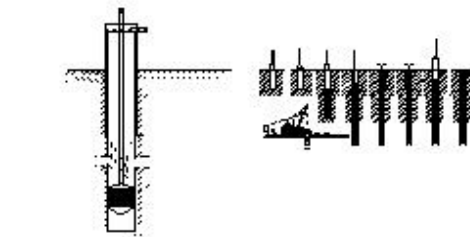
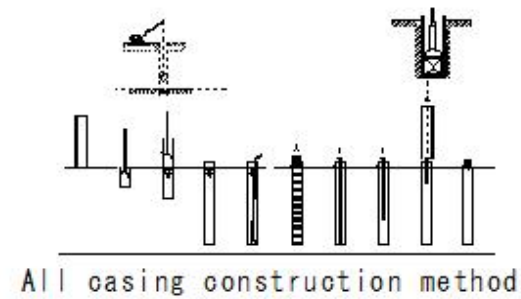
(M350)Foundation work-(Ready-made pile foundation)-Cast-in-place pile foundation

(M350)Foundation work-(Ready-made pile foundation)-Cast-in-place pile foundation

Ready-made pile foundation

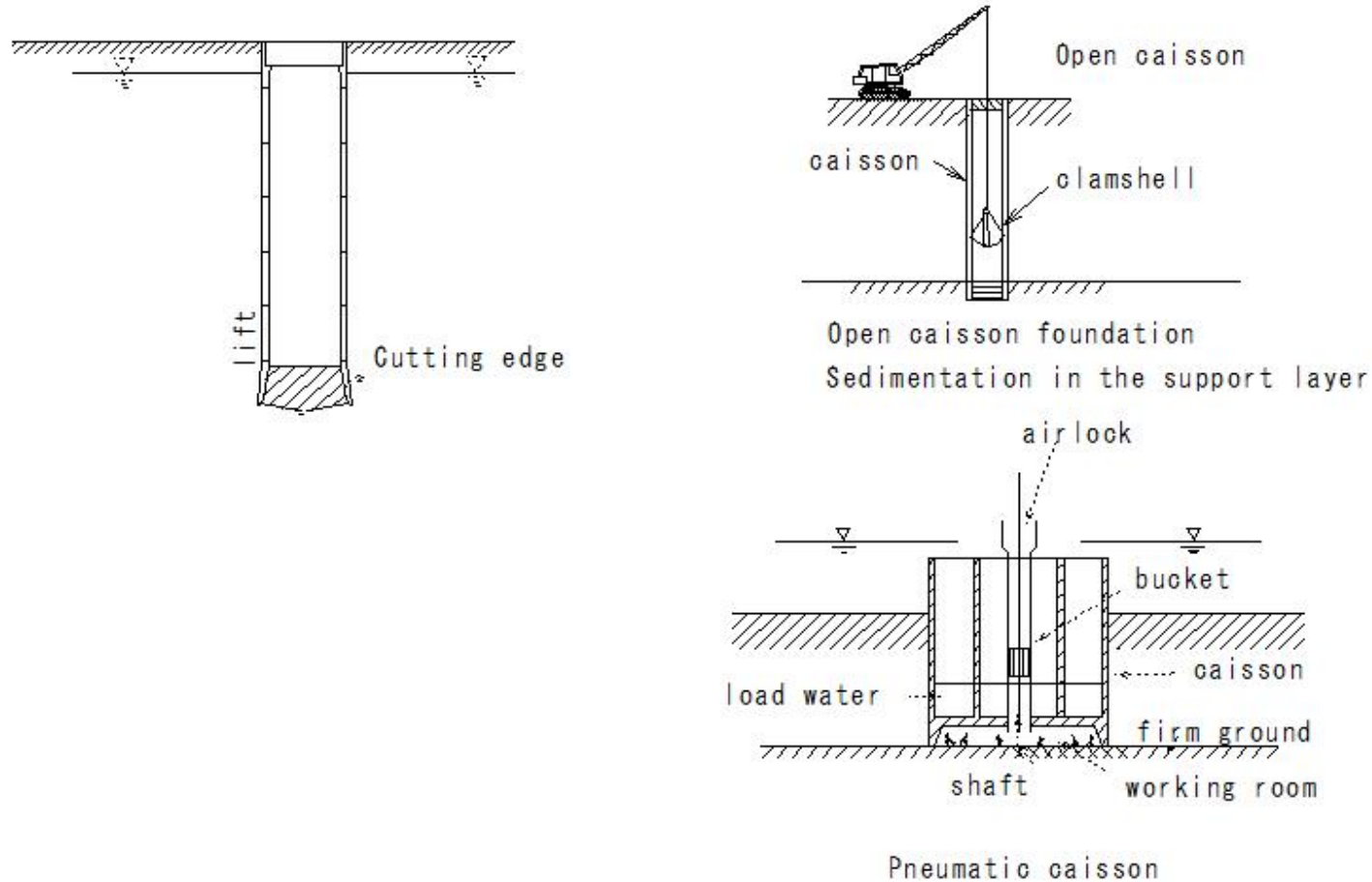


Cast-in-place pile foundation



(M351) Foundation work-open caisson-pneumatic caisson

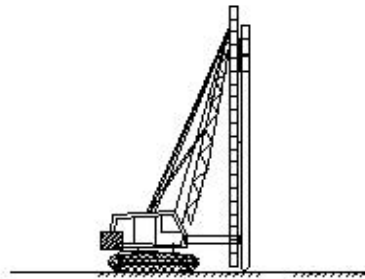
(M351) Foundation work-open caisson-pneumatic caisson



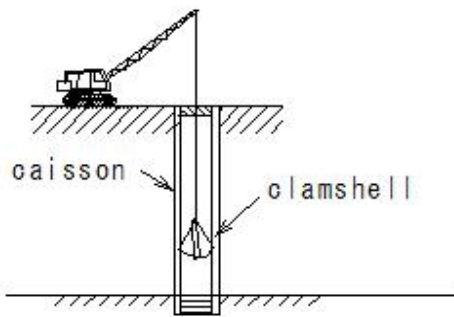
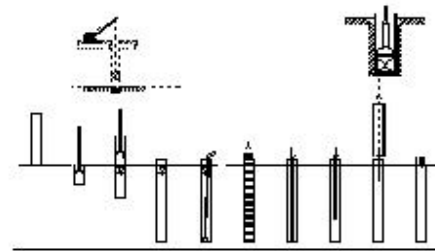
(M352)Foundation work-Deep foundation

(M352)Foundation work-Deep foundation

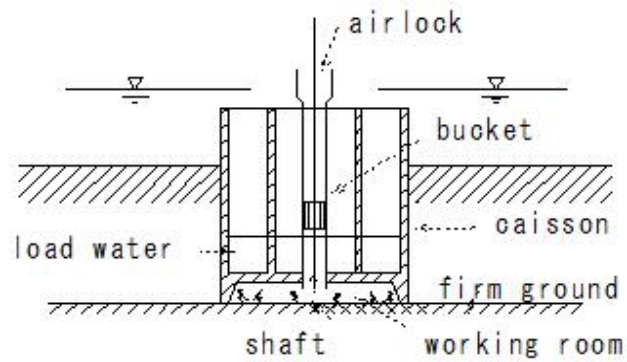
Ready-made pile foundation



All casing construction method



Open caisson foundation

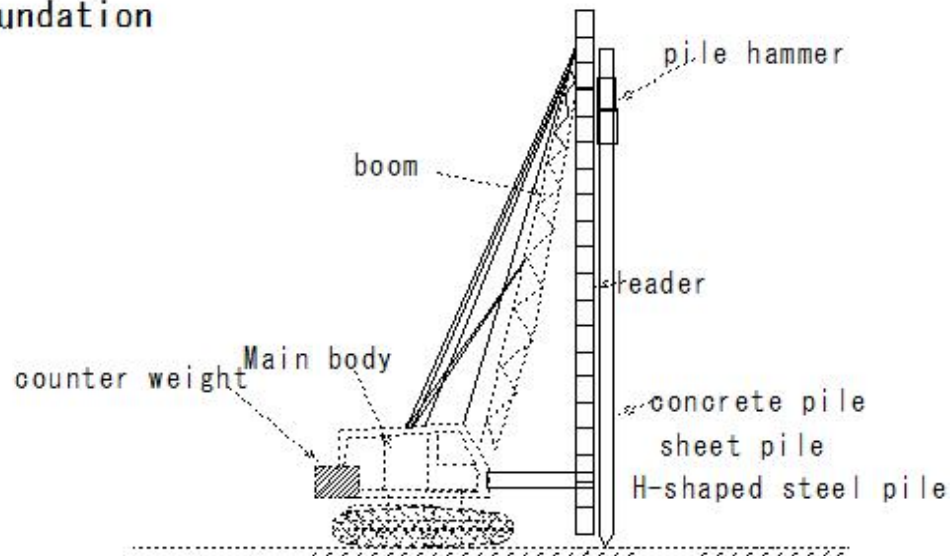


Pneumatic caisson

(M353)Foundation work-pile foundation-ready-made piles

(M353)Foundation work-pile foundation-ready made piles

pile foundation



good points

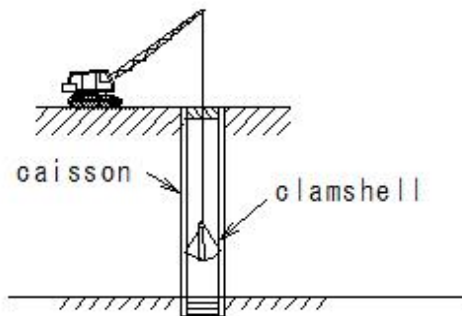
- Preparation - little
- cost- cheap
- Construction period - short

bad points

- Geological confirmation - impossible
- Noise/vibration - loud
- Cobblestone - Difficult to construct

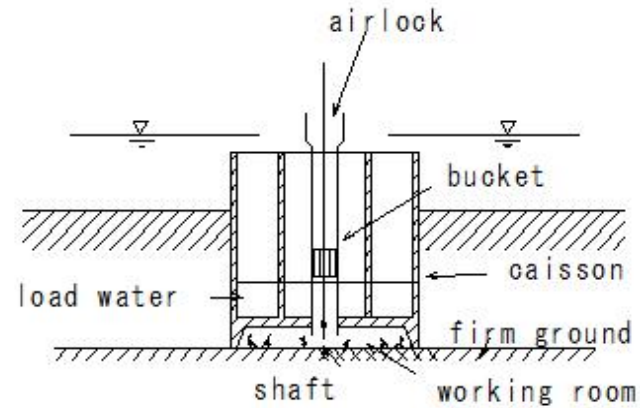
(M354) Foundation work-pile foundation-caisson foundation

(M354) Foundation work-pile foundation-caisson foundation



Open caisson foundation
Sedimentation in the support layer

Open caisson



Pneumatic caisson

good points

- Supporting capacity/horizontal resistance force - large
- Geology - confirmation - possible

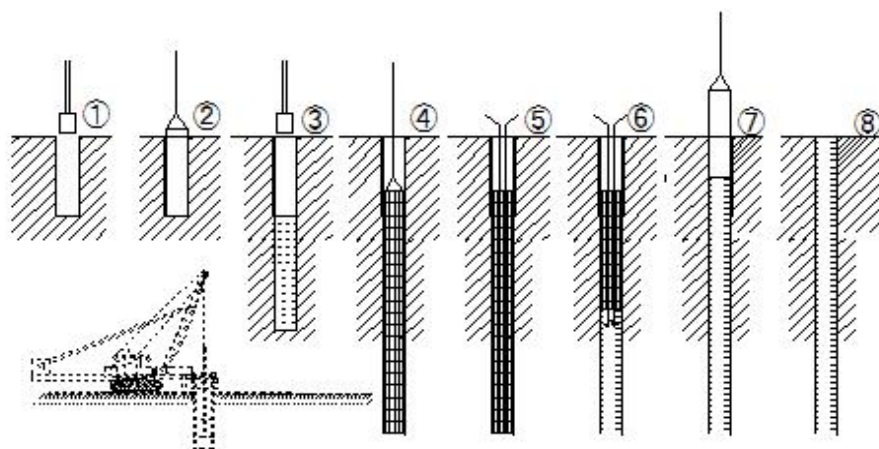
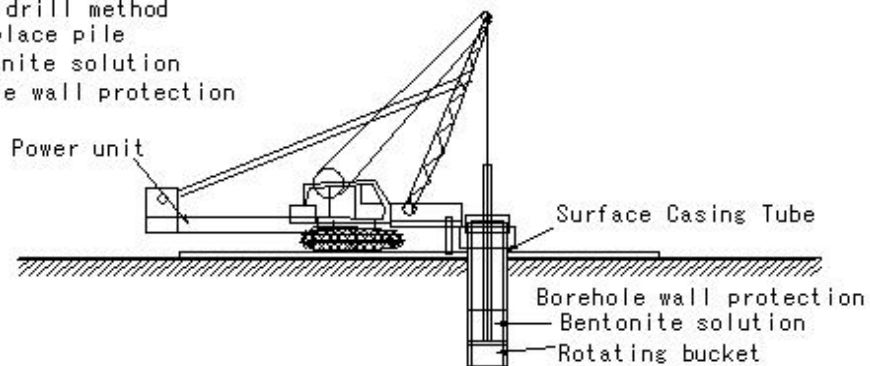
bad points

- Preparation - big
- cost is high

(M355)cast-in-place pile Earth drill method

(M355) cast-in-place pile Earth drill method

earth drill method
In-place pile
Bentonite solution
Borehole wall protection

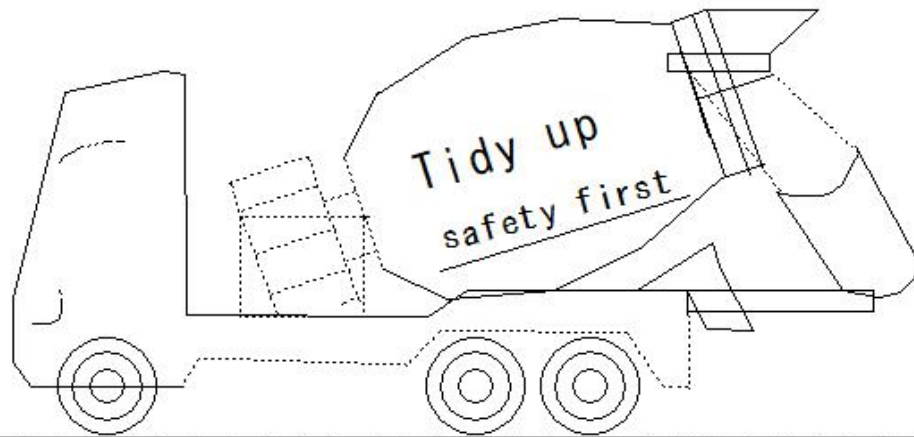
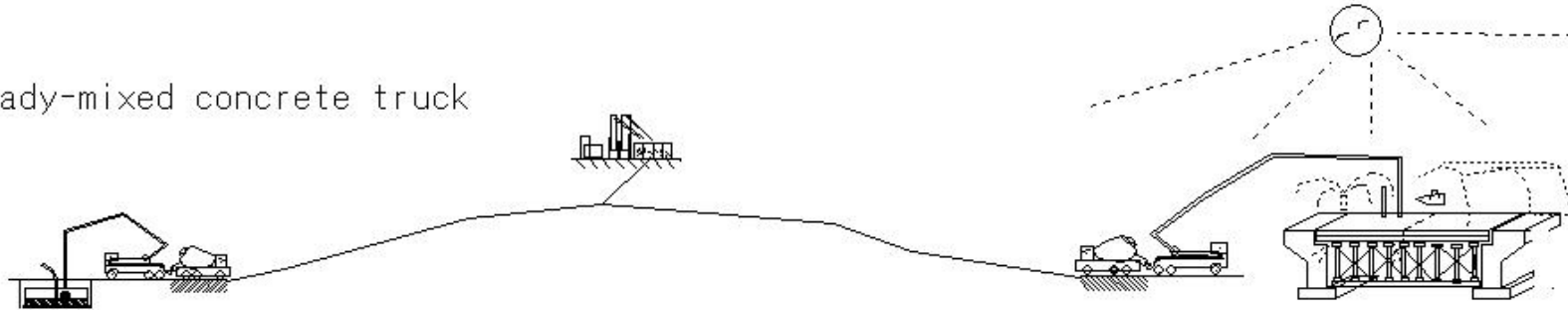


- ① Drilling
- ② Casing tube insertion
- ③ Bentonite solution - injection
- ④ Erection of rebar
- ⑤ Built-in tremie tube rebar
- ⑥ Ready-mixed concrete pouring
- ⑦ Casing tube pull-out
- ⑧ Sediment reburials

(M356)agitator truck

(M356) agitator truck

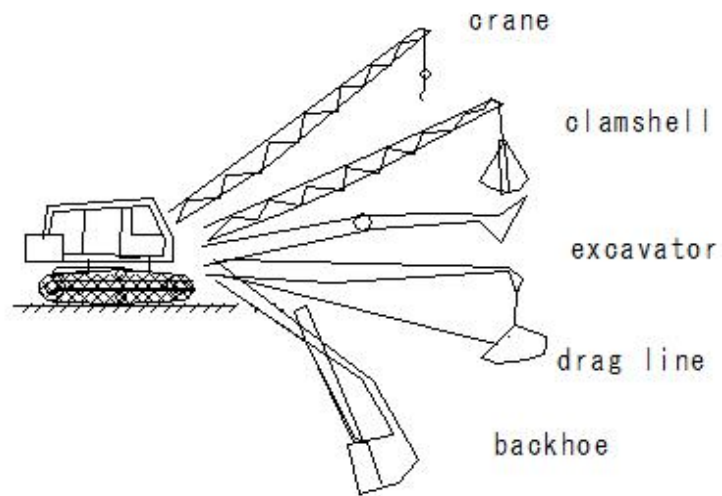
ready-mixed concrete truck



(M357)attachment

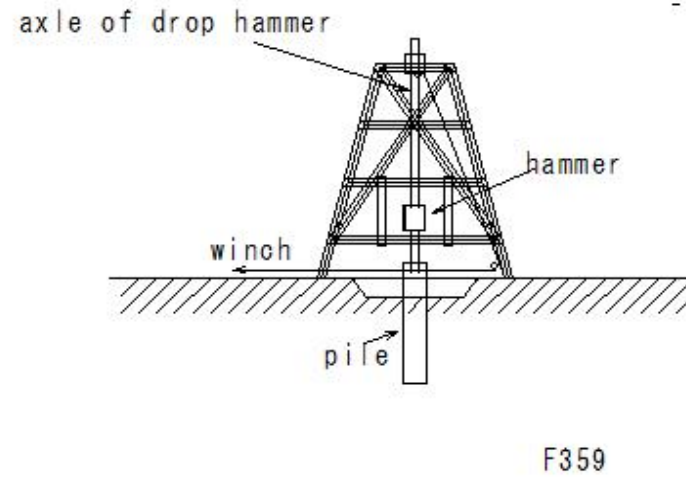
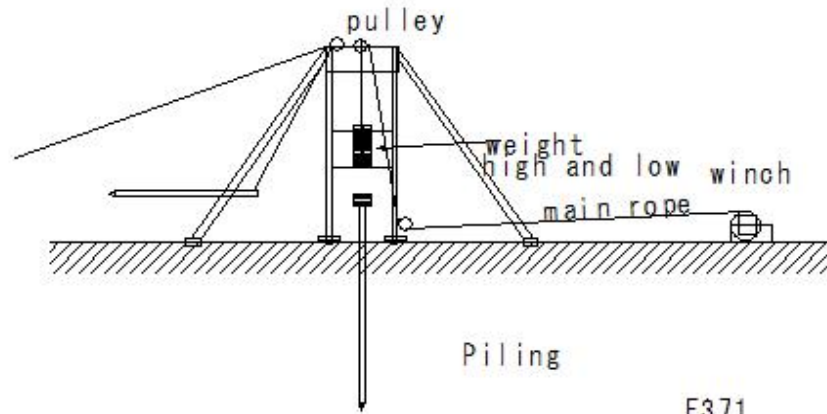
(M357) attachment

attachment



(M358)winch

(M358)winch



(M359)guy derrick crane

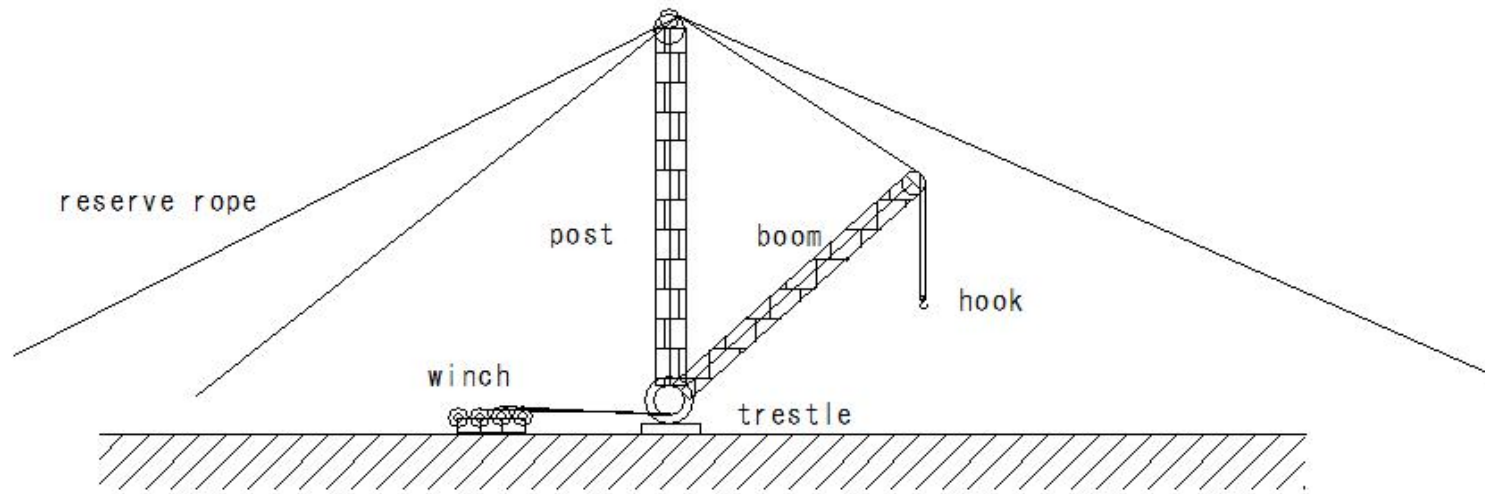
(M359)guy derrick crane

guy derrick crane

Fixed swivel crane that can rotate 360 degrees

Steel frame assembly work

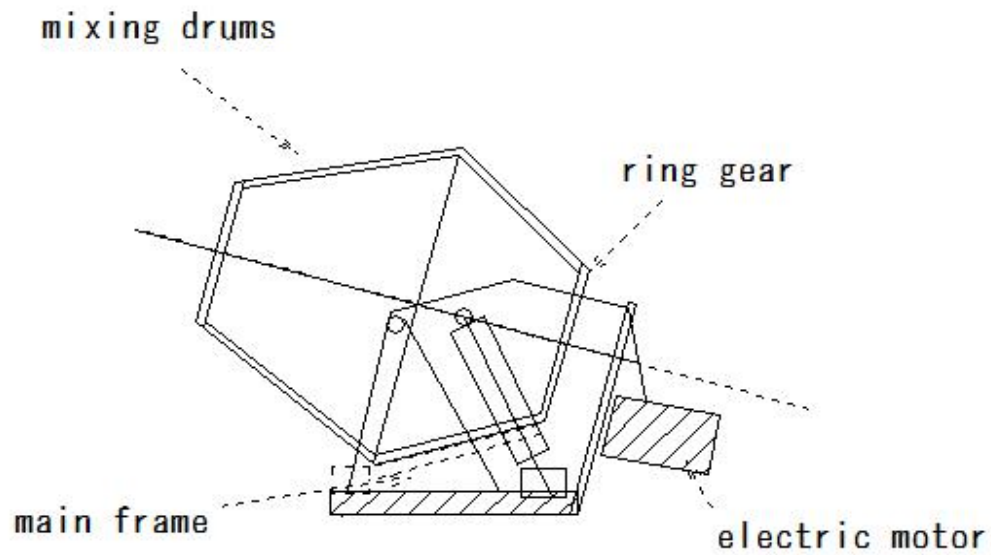
port cargo handling



(M360)tilting mixer

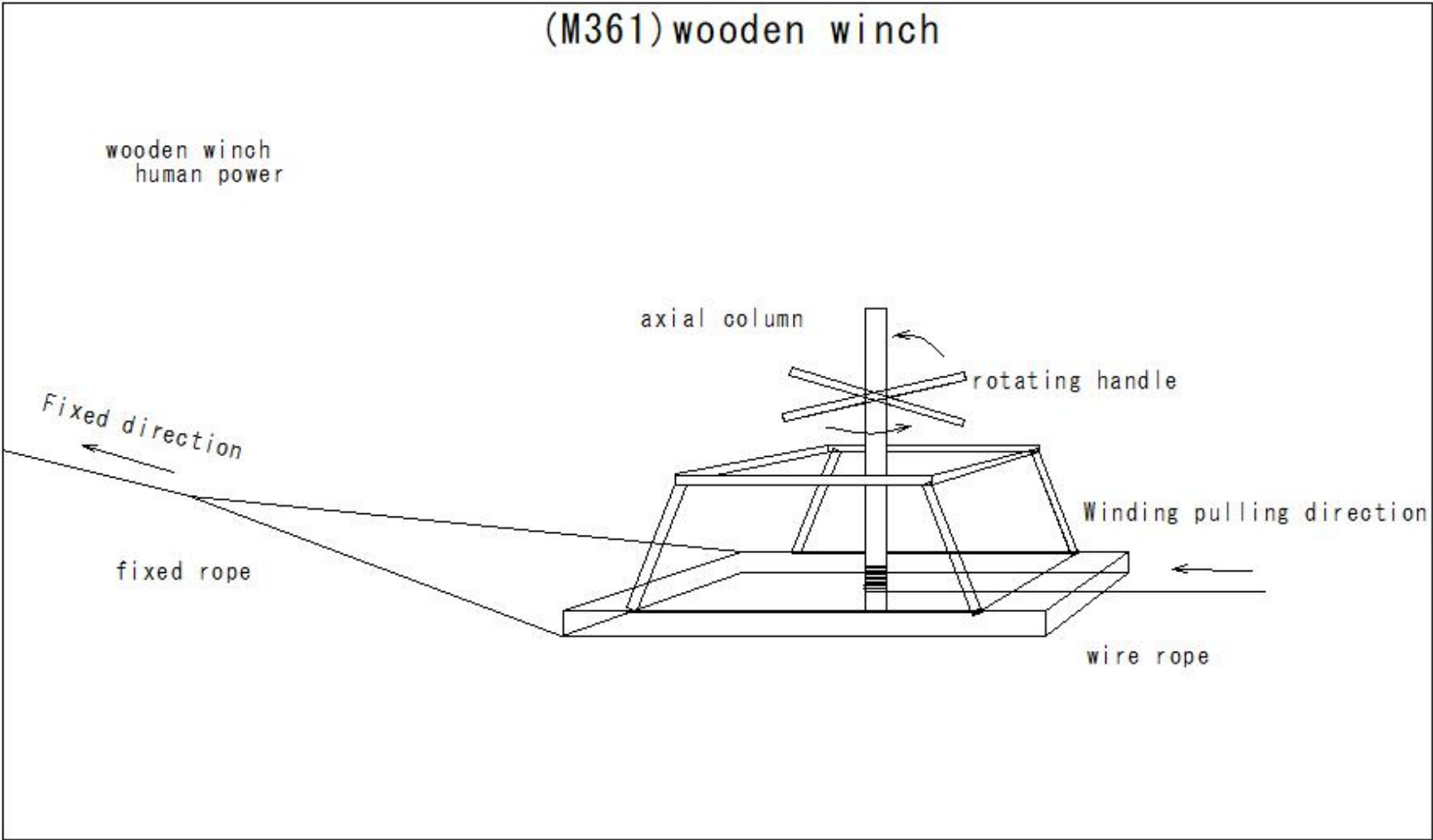
(M360)tilting mixer

tilting mixer
gravity stirrer mixer

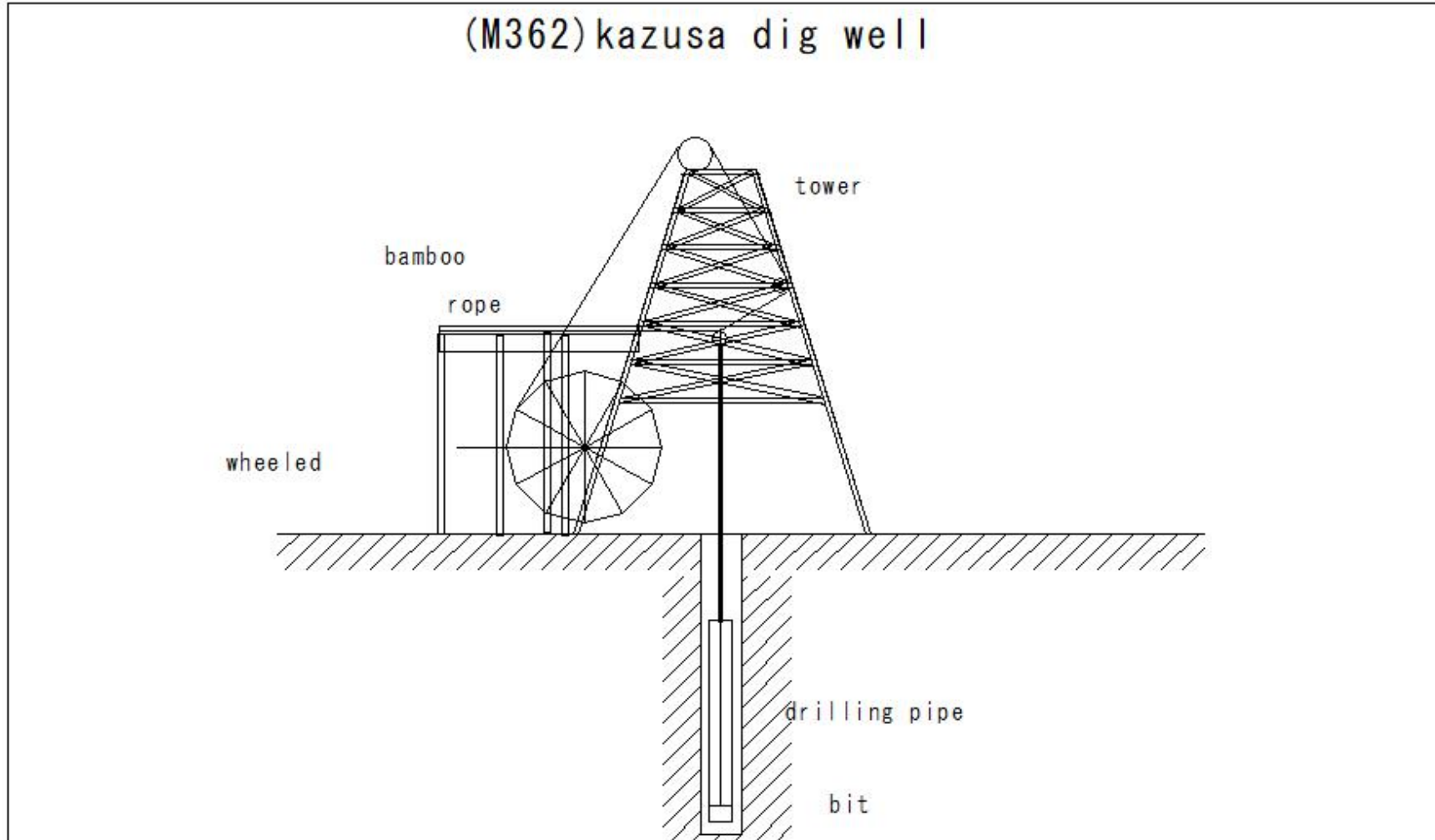


Gravity agitator mixer

(M361)wooden winch



(M362)kazusa dig well



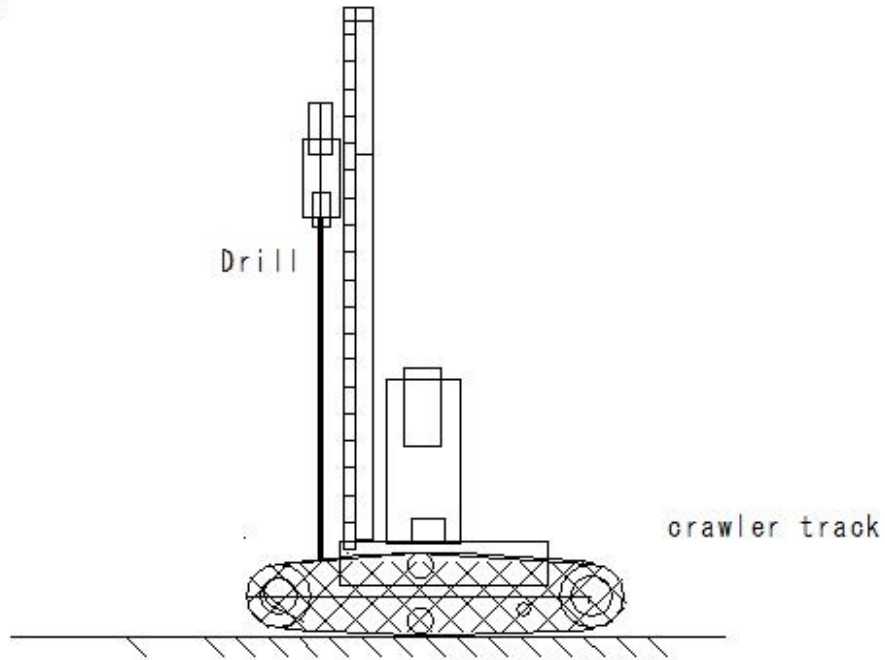
(M363)crawler drill

(M363) crawler drill

crawler drill

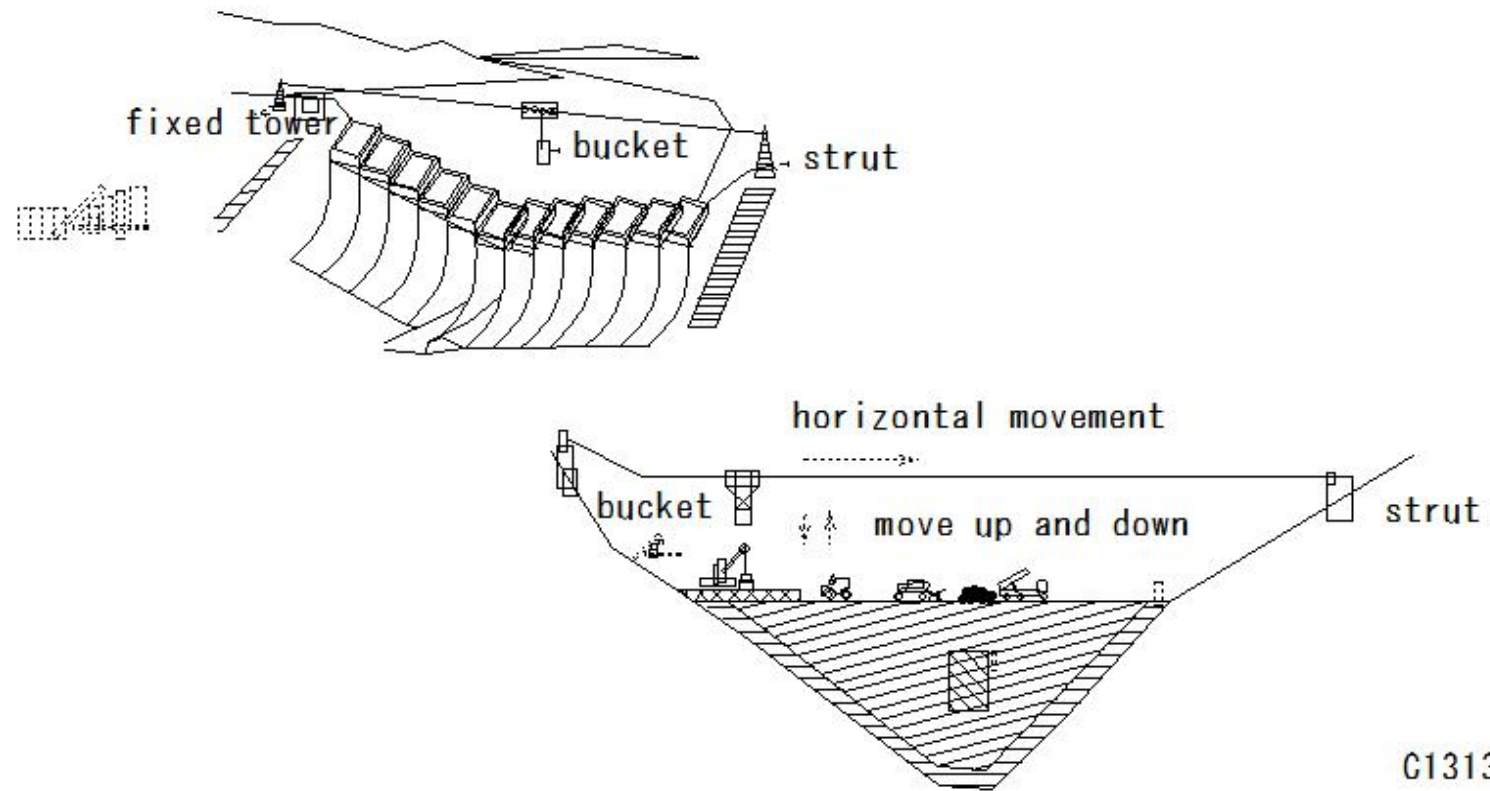
drilling for blasting

drilling machine



(M364) Cable crane

(M364) Cable crane



(M365)Cable crane

(M365) Cable crane

③ Cable erection construction method

Diagonal hanging cable construction method

Bridge
Steel bridge erection

Scope of application - wide

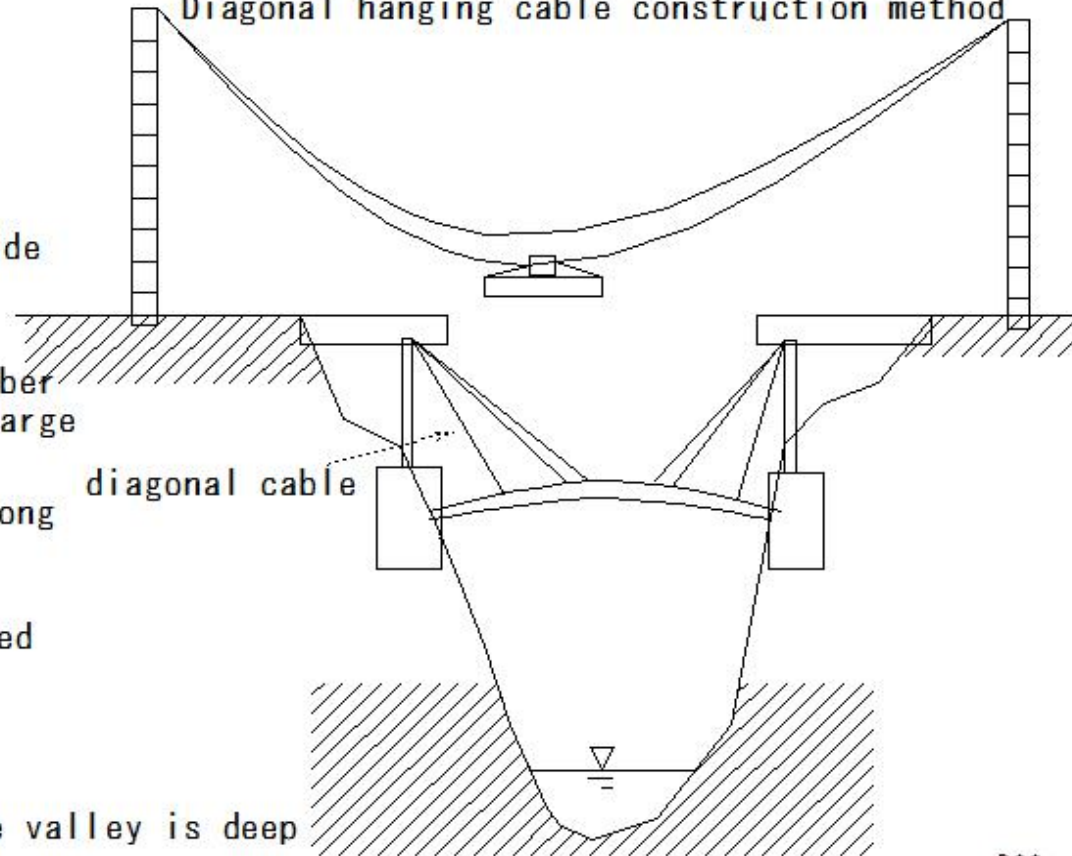
- Long span

Disadvantage

- Difficult to adjust camber
- Temporary equipment - large
- Difficulty in erection
- Construction period - long

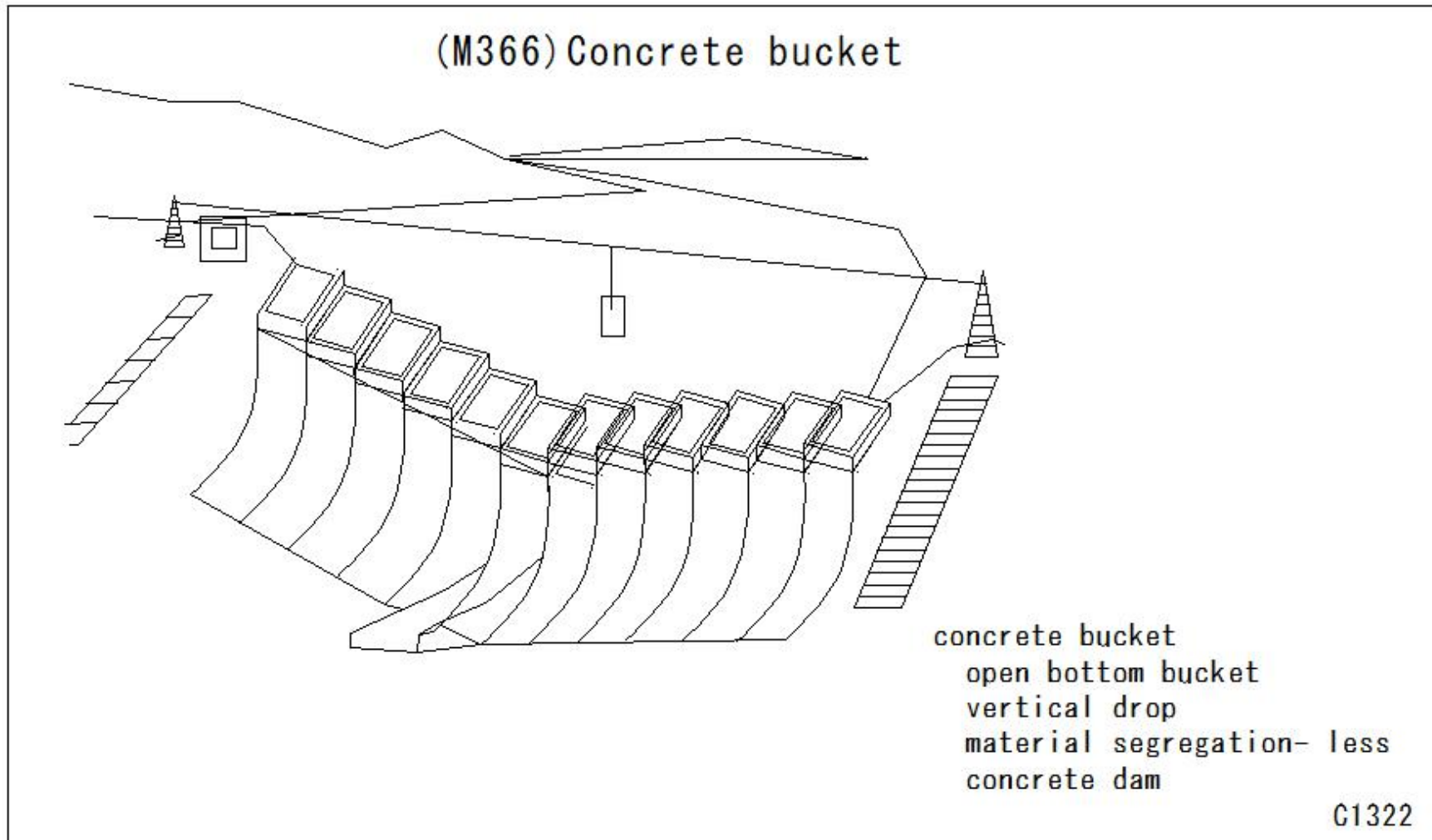
advantage

- Stress-free erection
- Scaffolding -not required

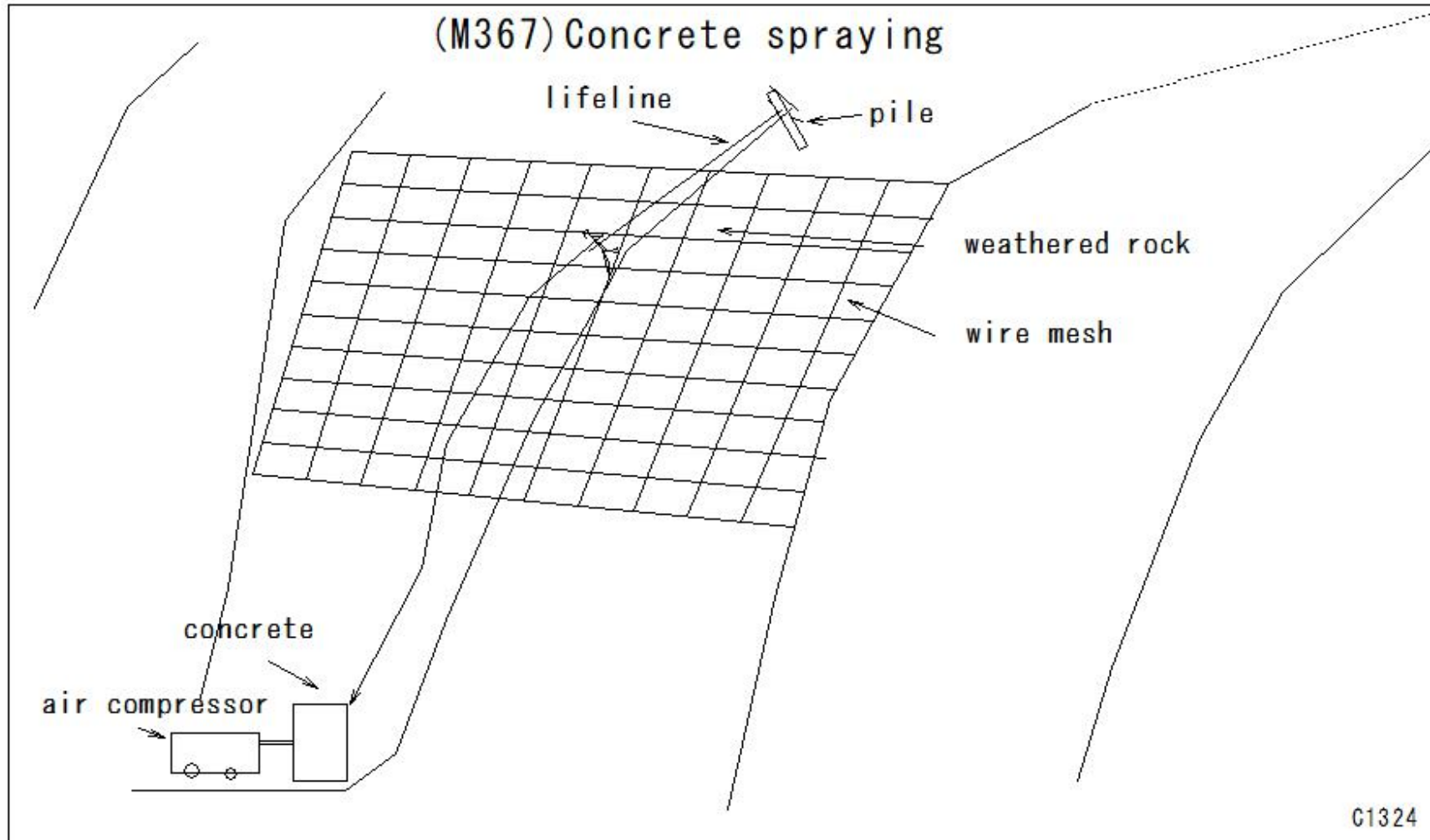


Good -the valley is deep

(M366)Concrete bucket

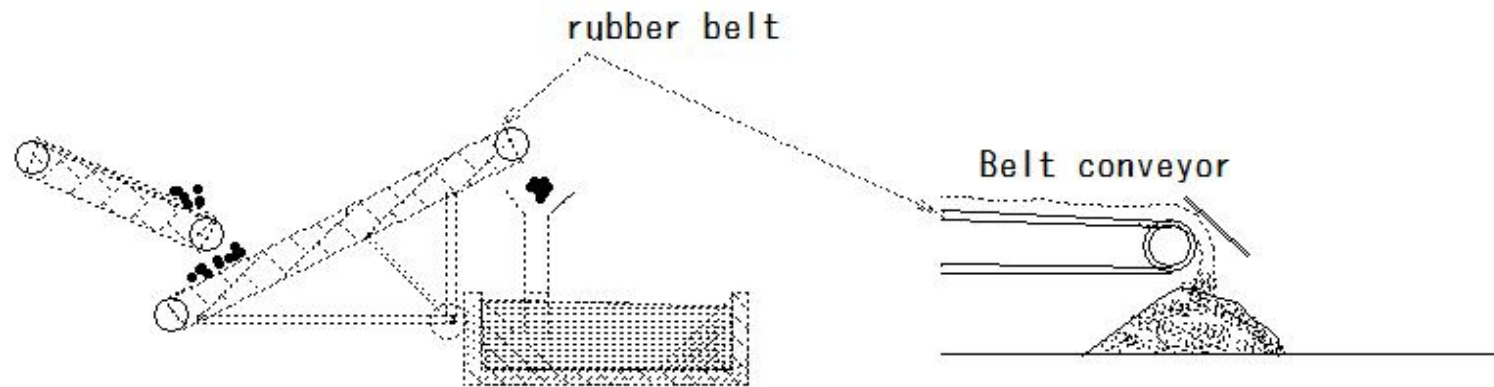


(M367)Concrete spraying



(M368)Conveyor

(M368) Conveyor

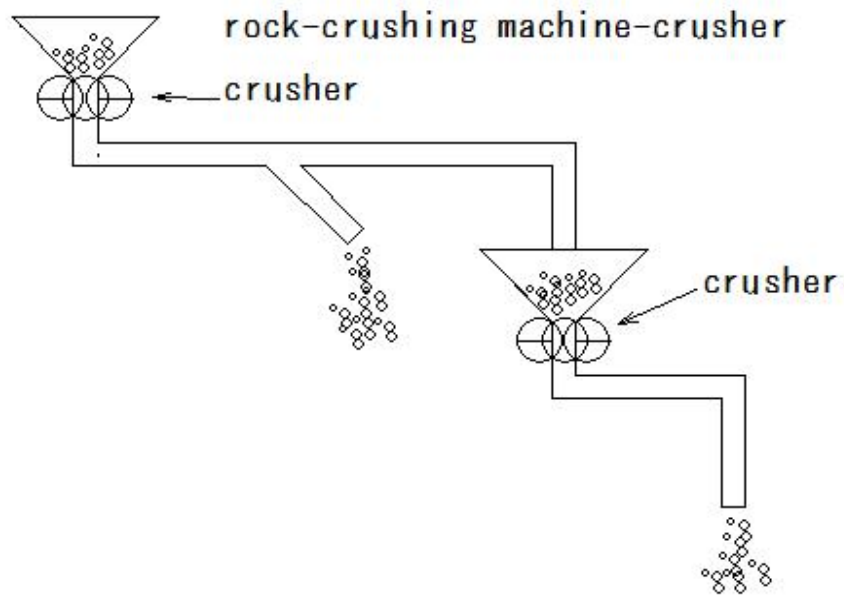


① Continuous transport equipment

(M369)Crusher

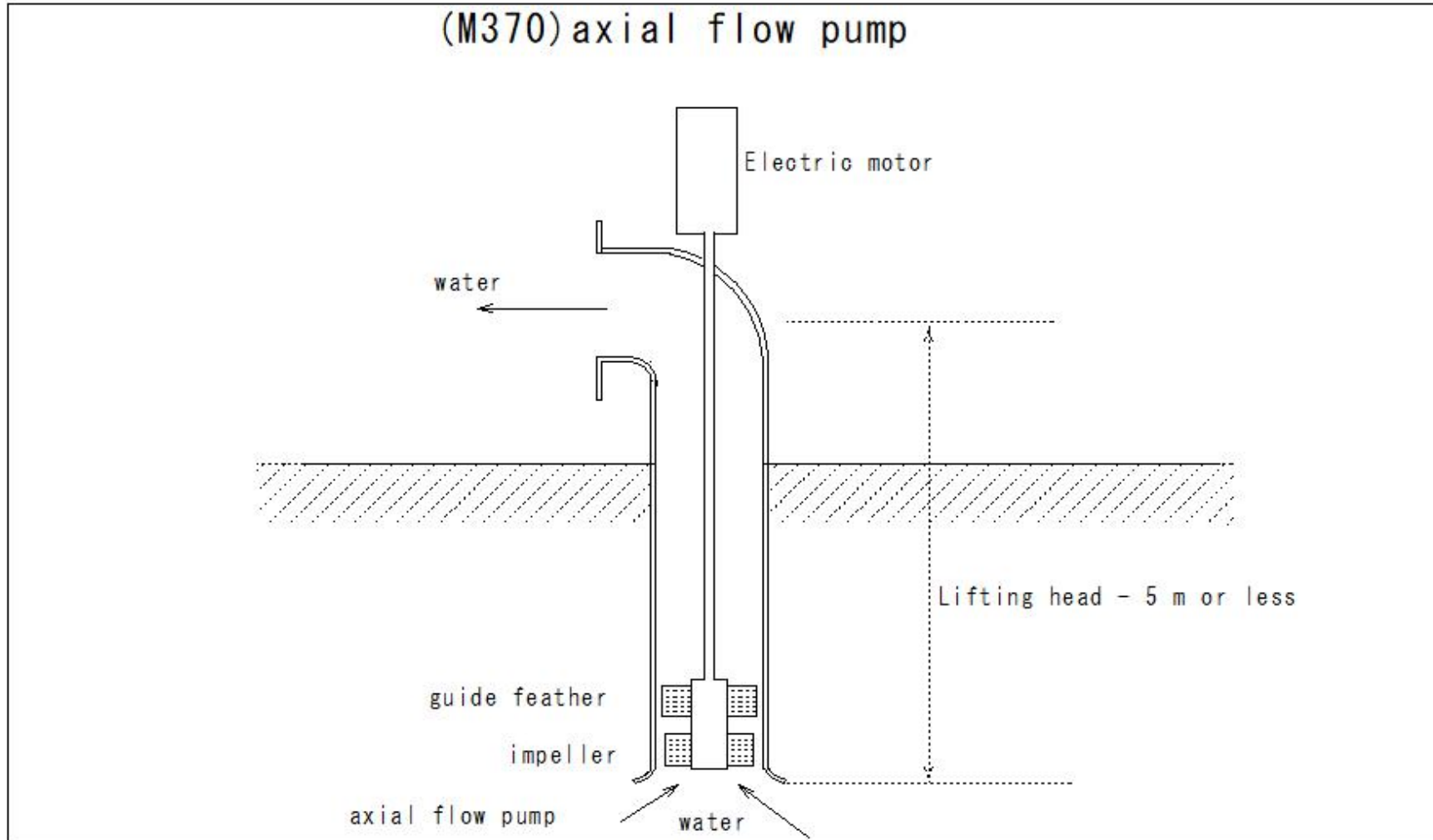
(M369) Crusher

Crusher



G1330

(M370)axial flow pump

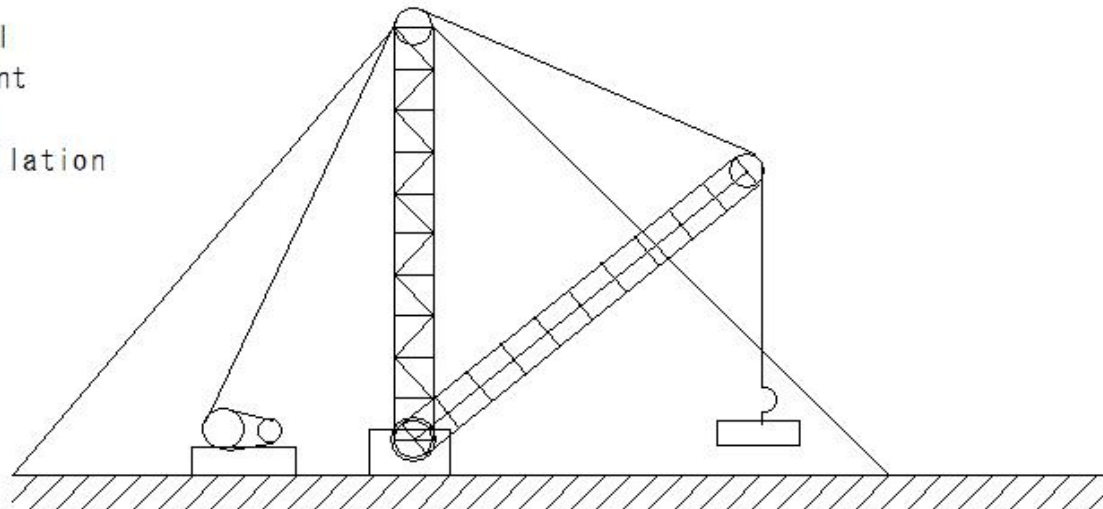


(M371)jib crane

(M371) jib crane

jib crane

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



(M372)dredging(Pump dredger)

(M372) dredging (Pump dredger)

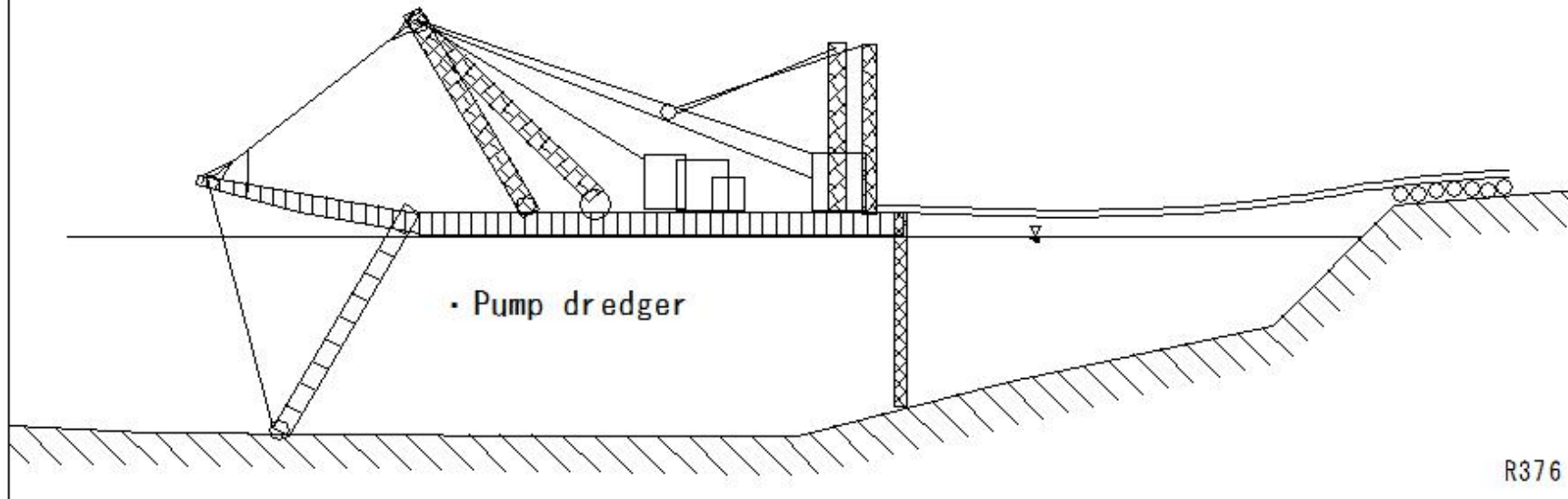
dredging

① Pump dredger

Suction up dirt etc. with a pump

Digging soil involves transportation and disposal work

working dredger



R376

(M373)dredging(Bucket dredger)

(M373) dredging (Bucket dredger)

dredging

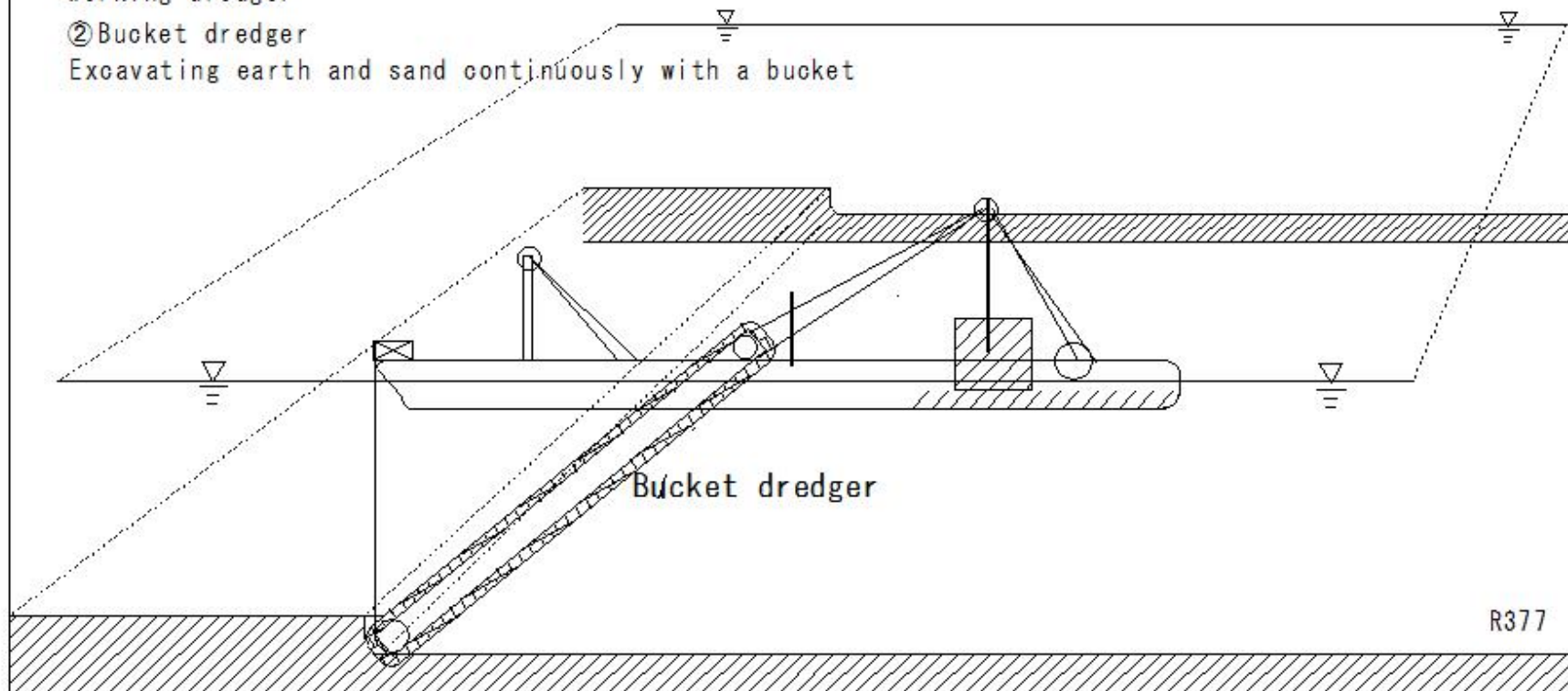
Digging soil involves transportation and disposal work

- Involves transportation and disposal work

working dredger

② Bucket dredger

Excavating earth and sand continuously with a bucket



(M374)dredging(Grab dredger)

(M374) dredging (Grab dredger)

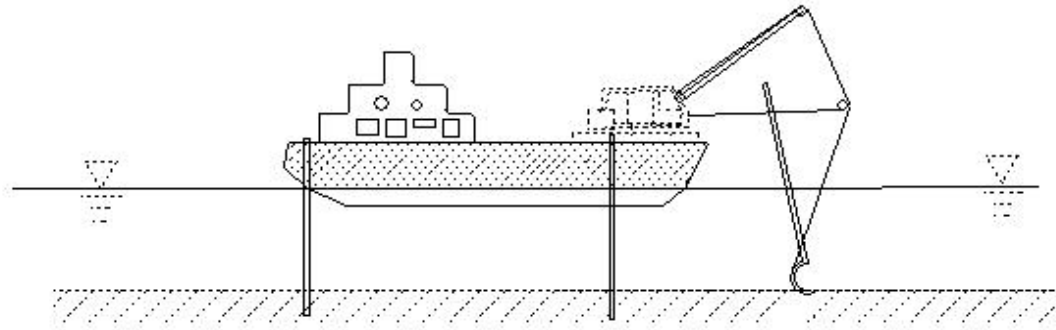
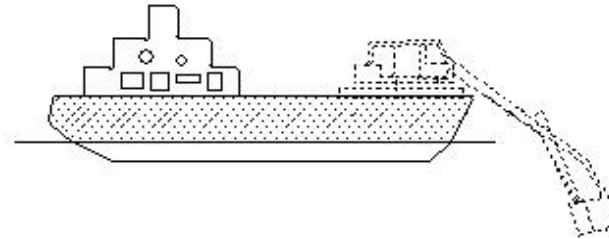
dredging

Digging soil involves transportation and disposal work

- Involves transportation and disposal work
- working dredger

④ Dipper dredger

Excavating hard soil with a dipper



Dipper dredger

(M375)dredging(Dipper dredger)

(M375) dredging (Dipper dredger)

dredging

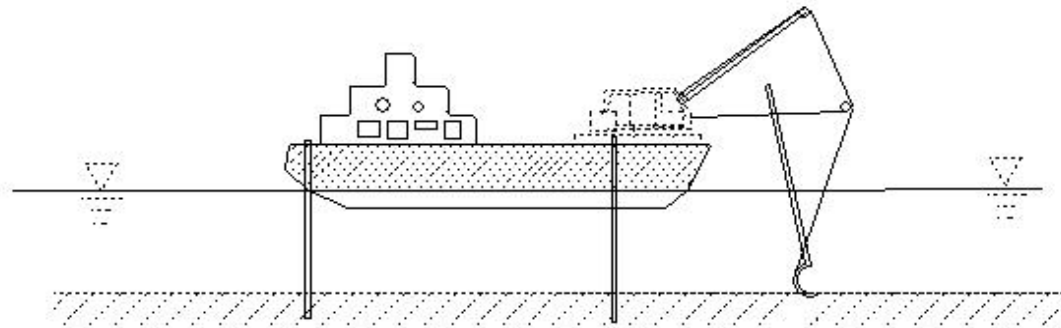
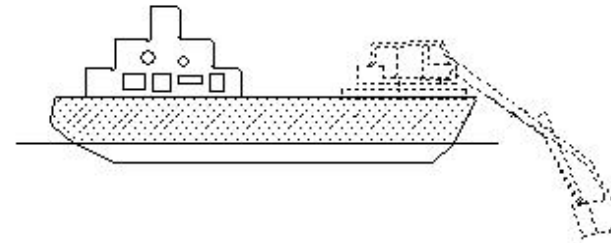
Digging soil involves transportation and disposal work

- Involves transportation and disposal work

working dredger

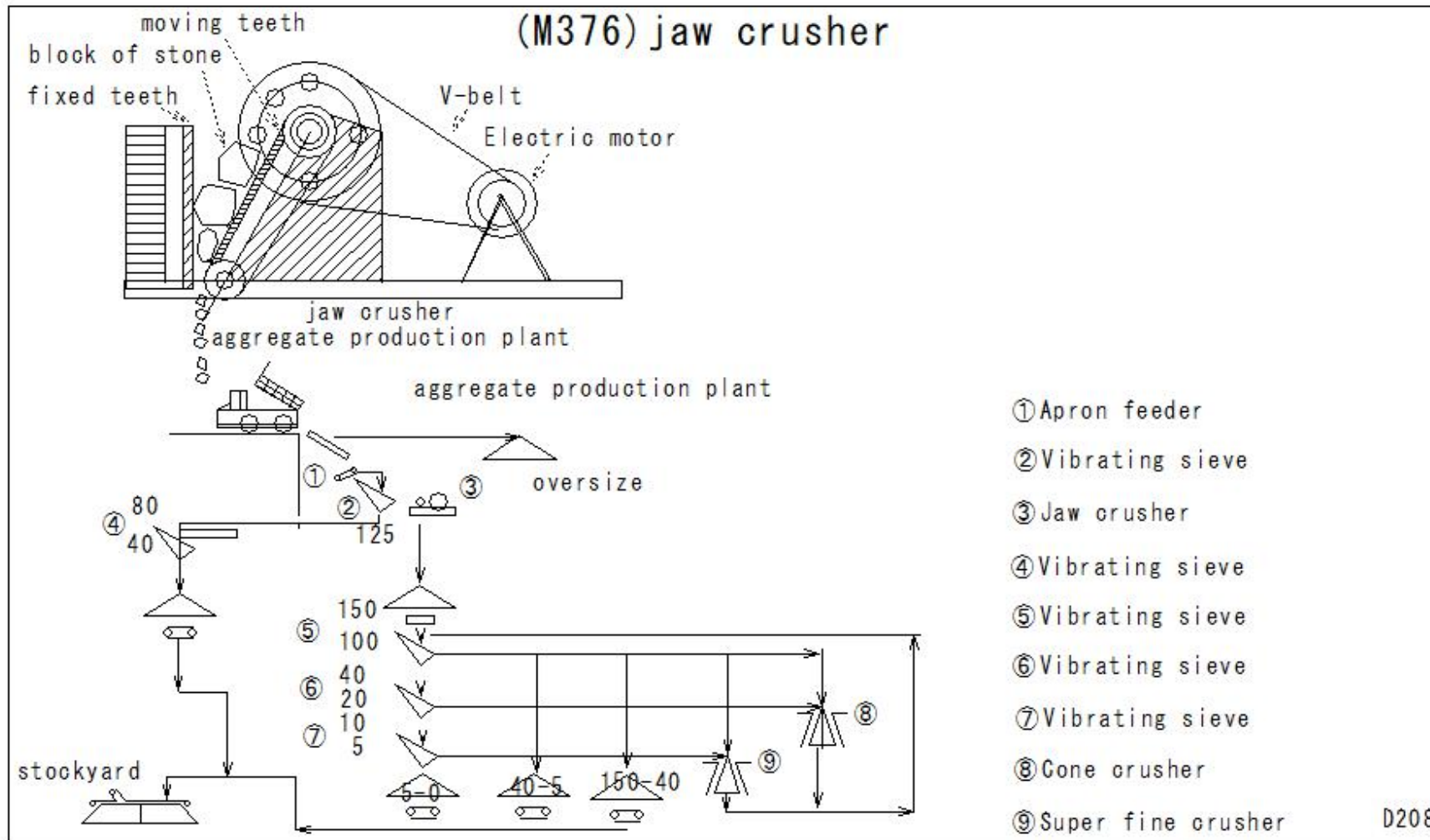
④ Dipper dredger

Excavating hard soil with a dipper



Dipper dredger

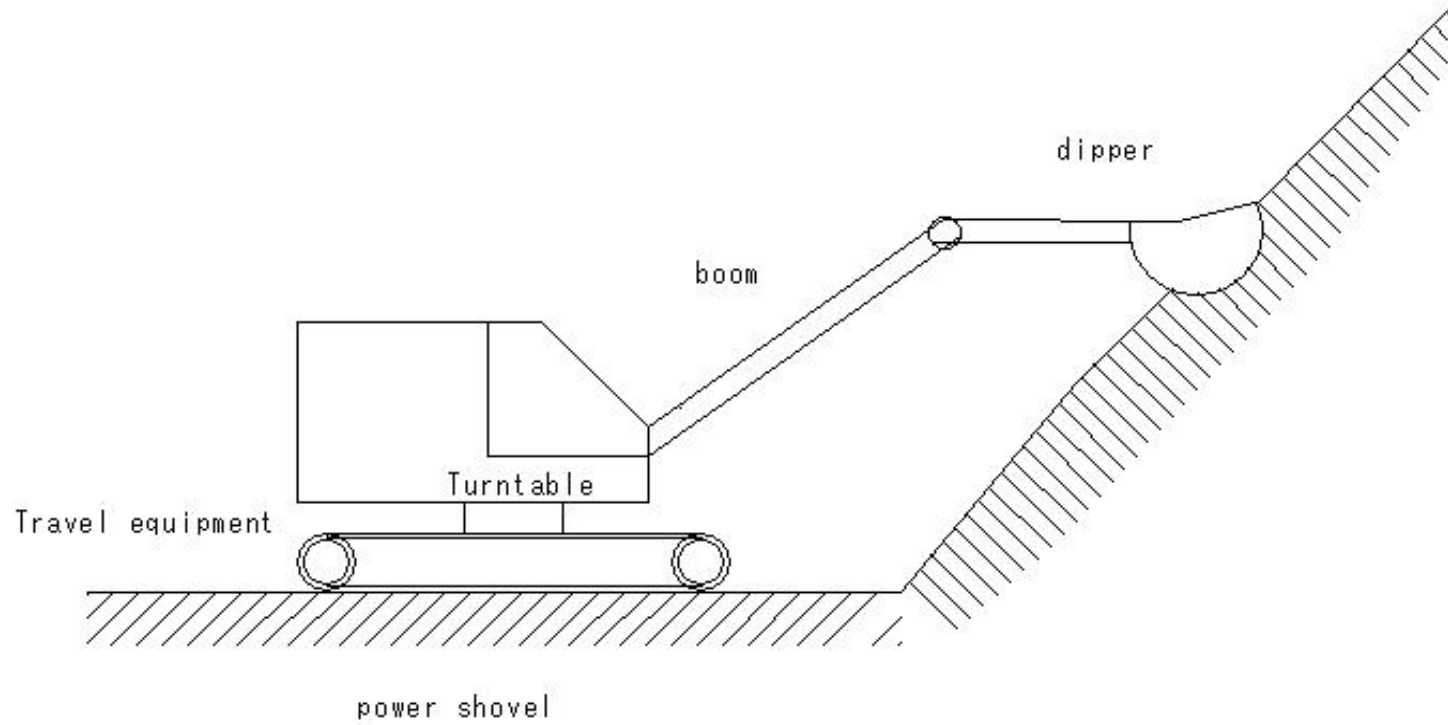
(M376)jaw crusher



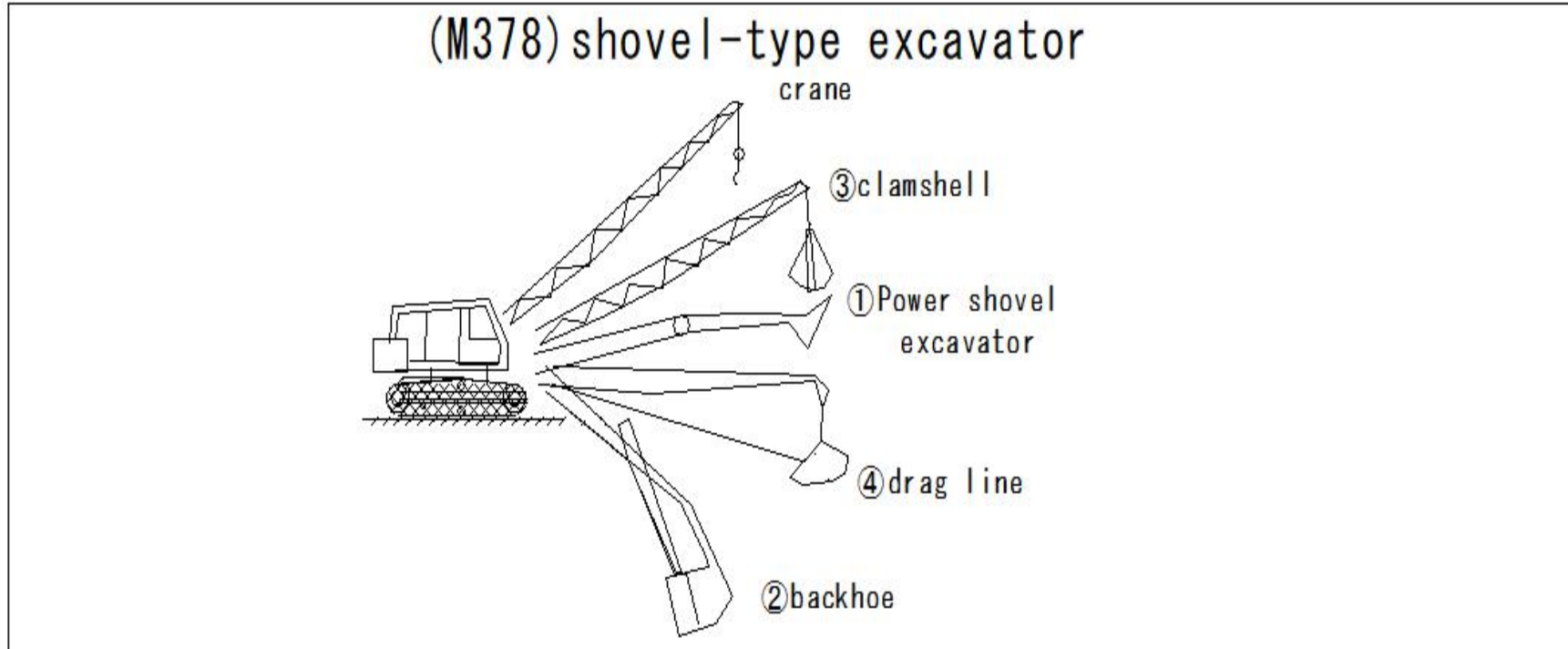
(M377)excavator

(M377)excavator

excavator



(M378)shovel-type excavator

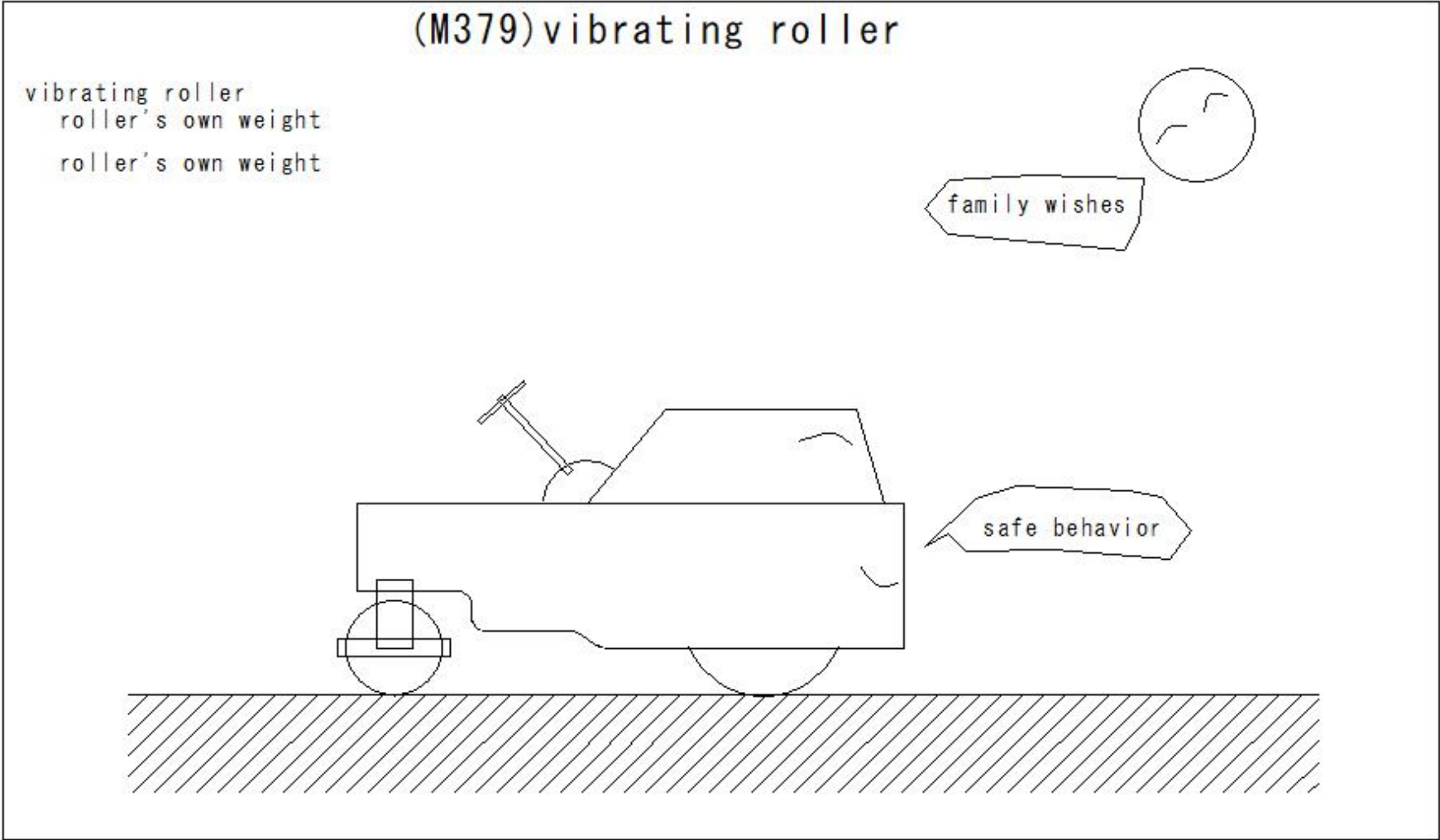


(M378)shovel-type excavator

Shovel type excavator

attachment	digging power	drilling location	Accuracy	underwater
①Power shovel	big	expensive	high	Not possible
②Backhoe	big	low	high	Possible
③Clamshell	small	high low deep	middle	Possible
④Drag line	small	wide low	small	Possible

(M379)vibrating roller



(M380)scraper

(M380) scraper

scraper

Excavation, loading, transportation, leveling

Consistent work

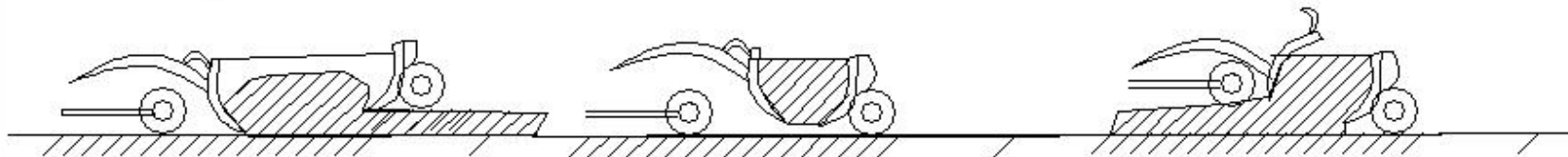
earthmoving machinery

transportation

leveling(spreading)

Everyone's wishes

Right and left okay!
Front and back are good!



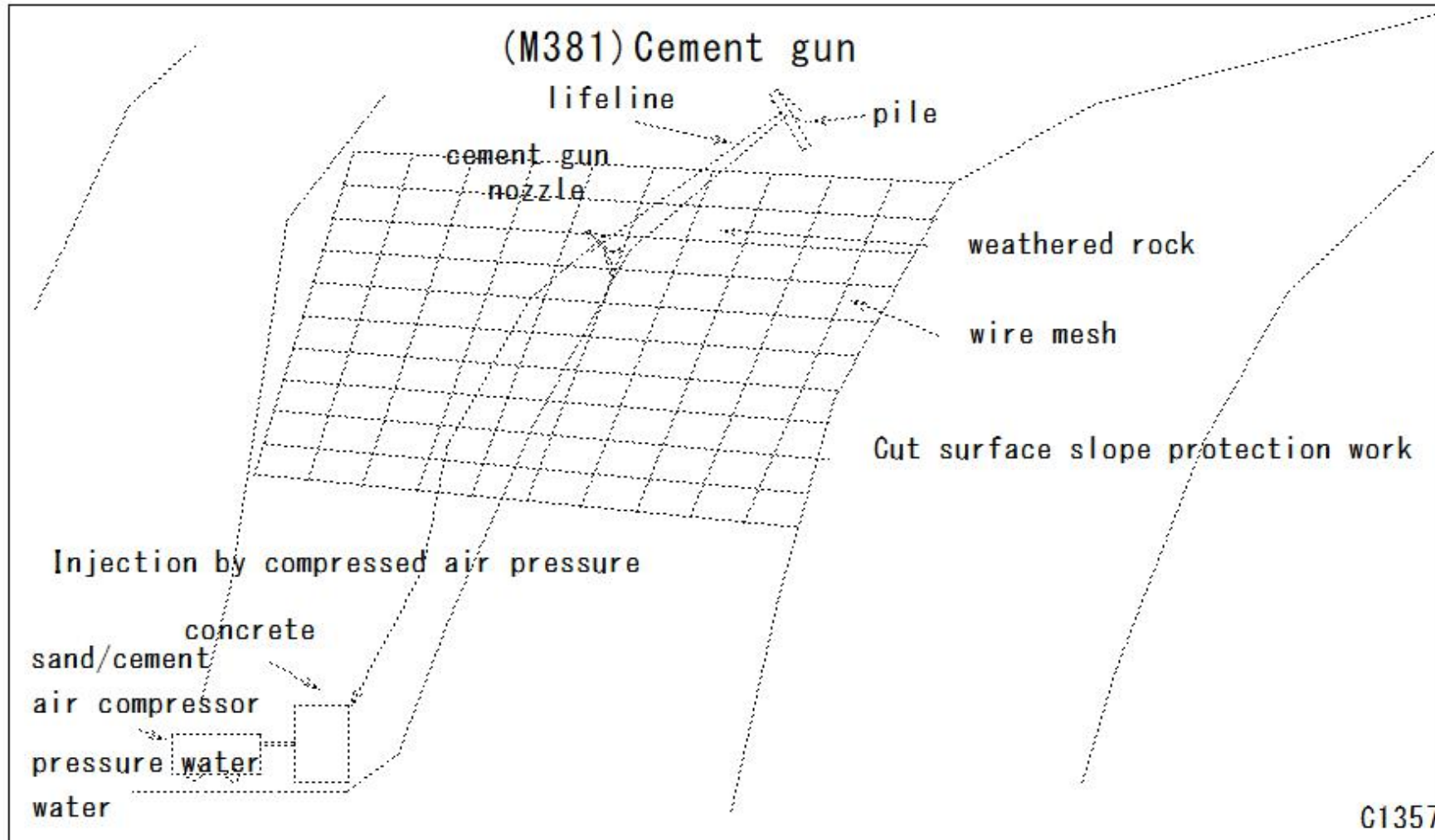
① Excavation/loading

② Transportation

③ Unrolling

E307

(M381)Cement gun



(M382)soil stabilizer

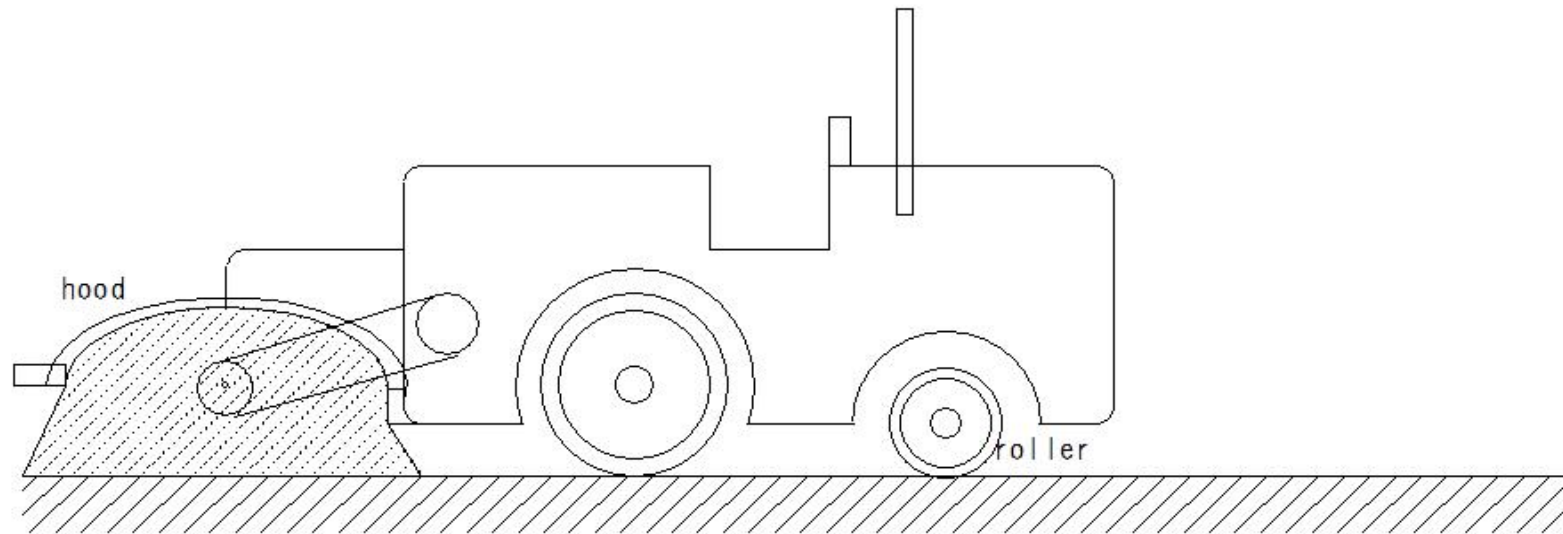
(M382)soil stabilizer

soil stabilizer

crush the soil

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

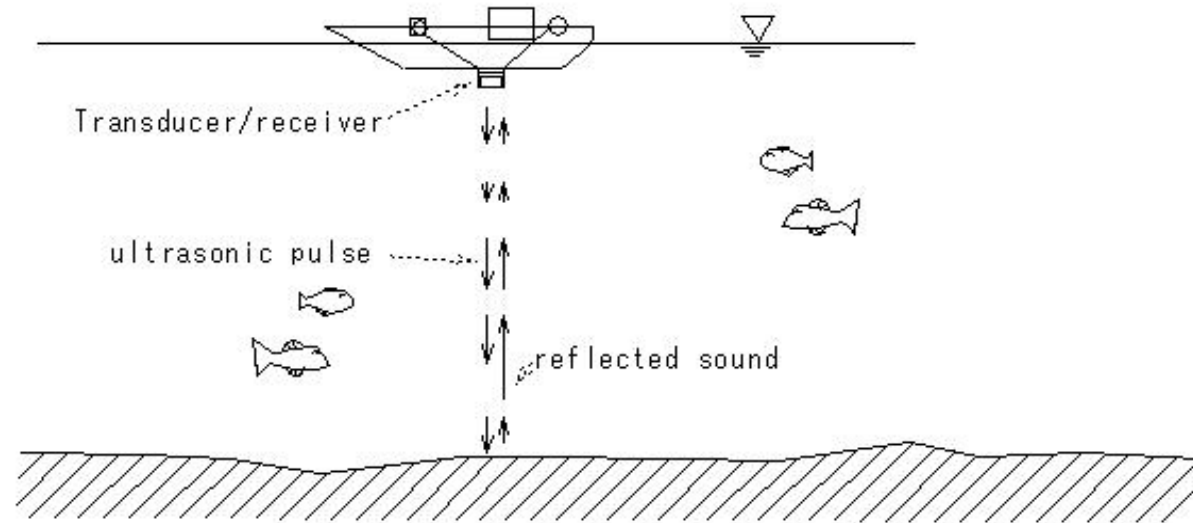
Uniform mixing and compaction



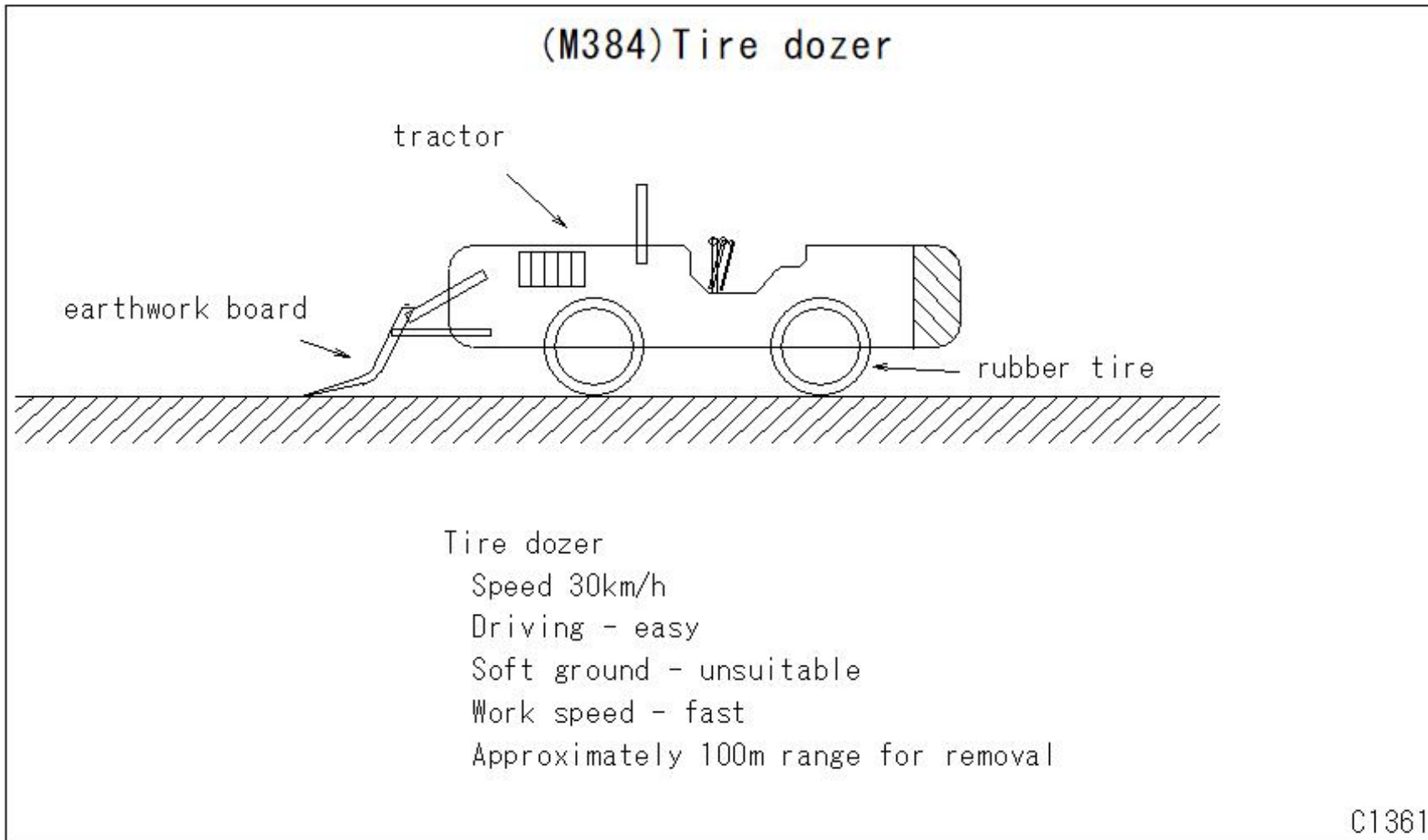
(M383)sounding machine

(M383)sounding machine

sounding machine
Water depth measurement



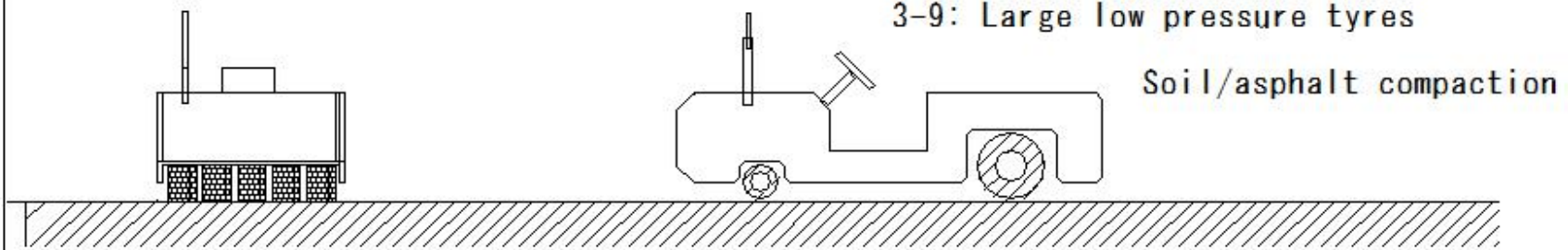
(M384)Tire dozer



(M385)Tire roller

(M385)Tire roller

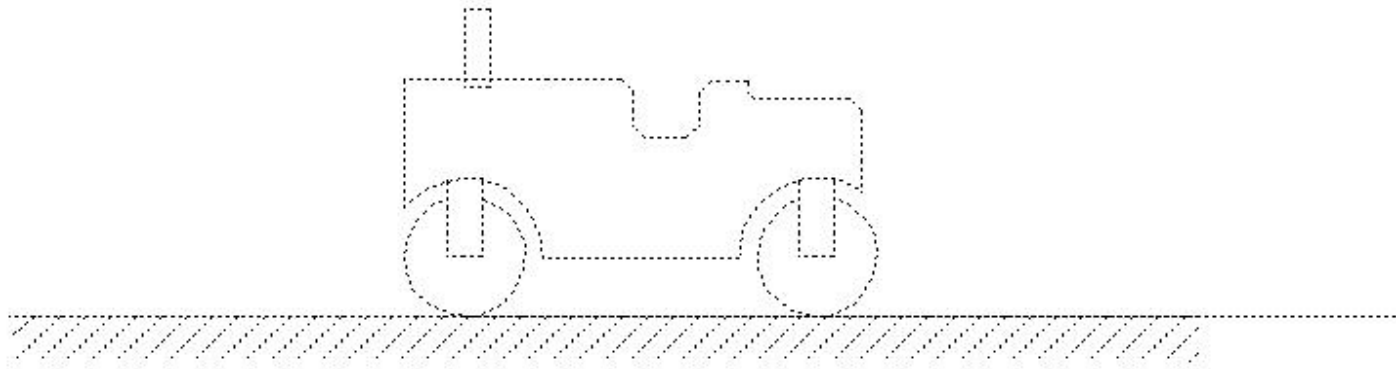
Tire roller



G1362

(M386)Tandem roller

(M386) Tandem roller



tandem roller

front/rear wheels

one iron wheel

asphalt/surface layer - flat

iron wheel roller

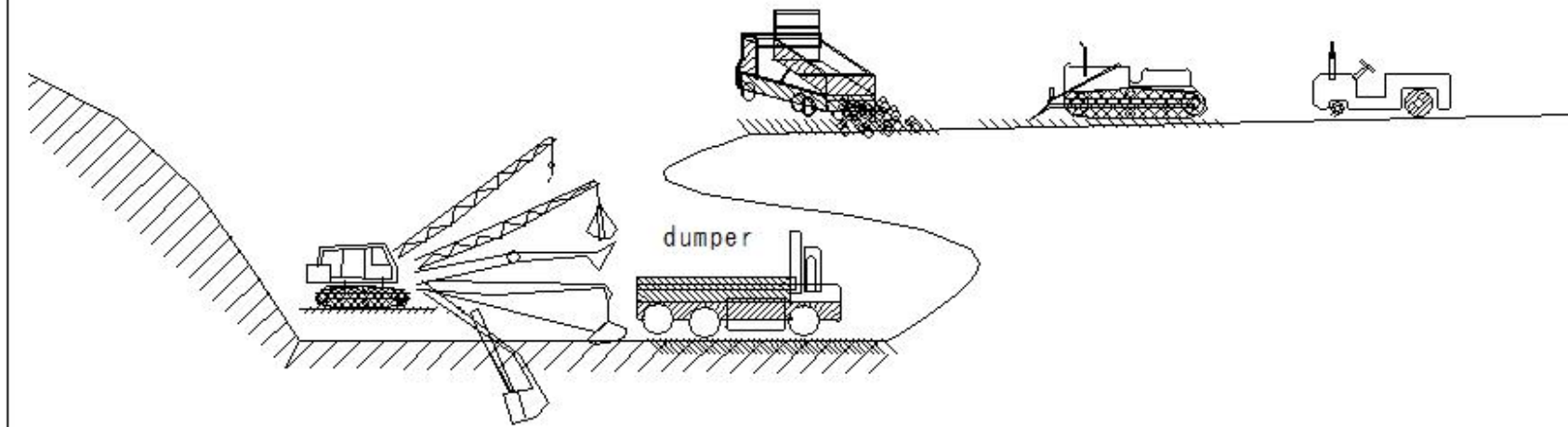
two-wheel two-wheel type

C1366

(M387)dumper

(M387) dumper

dumper
Sediment transport machine



E331

(M388)tamping roller

(M388)tamping roller

tamping roller

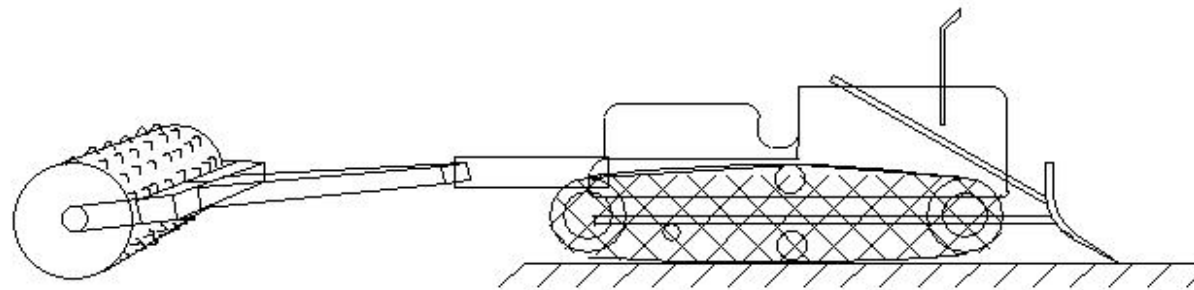
Numerous protrusions on iron phosphorus

tractor

tamping roller

Compaction of hard clay soil

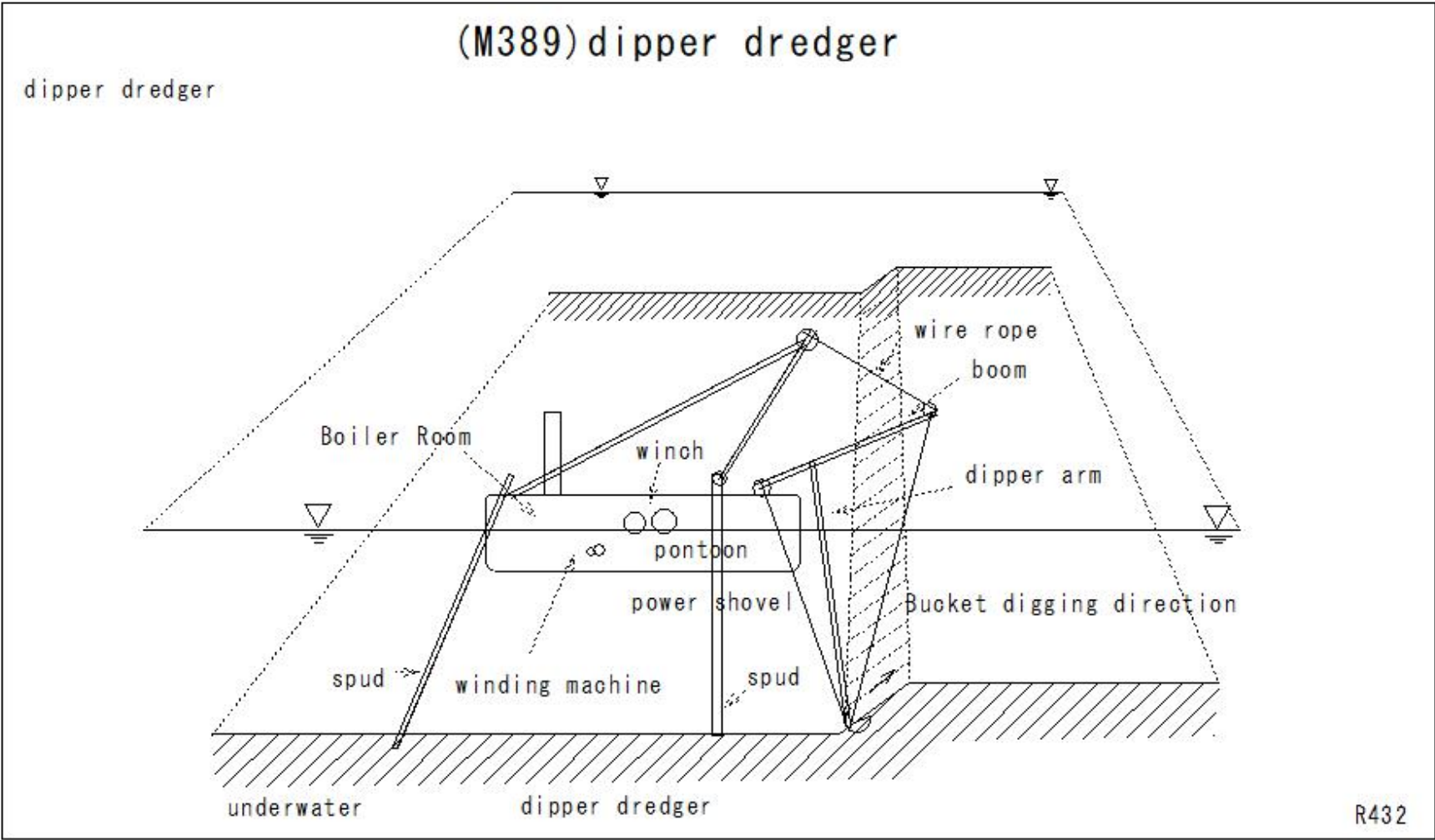
Compact the inside of the clayey soil layer



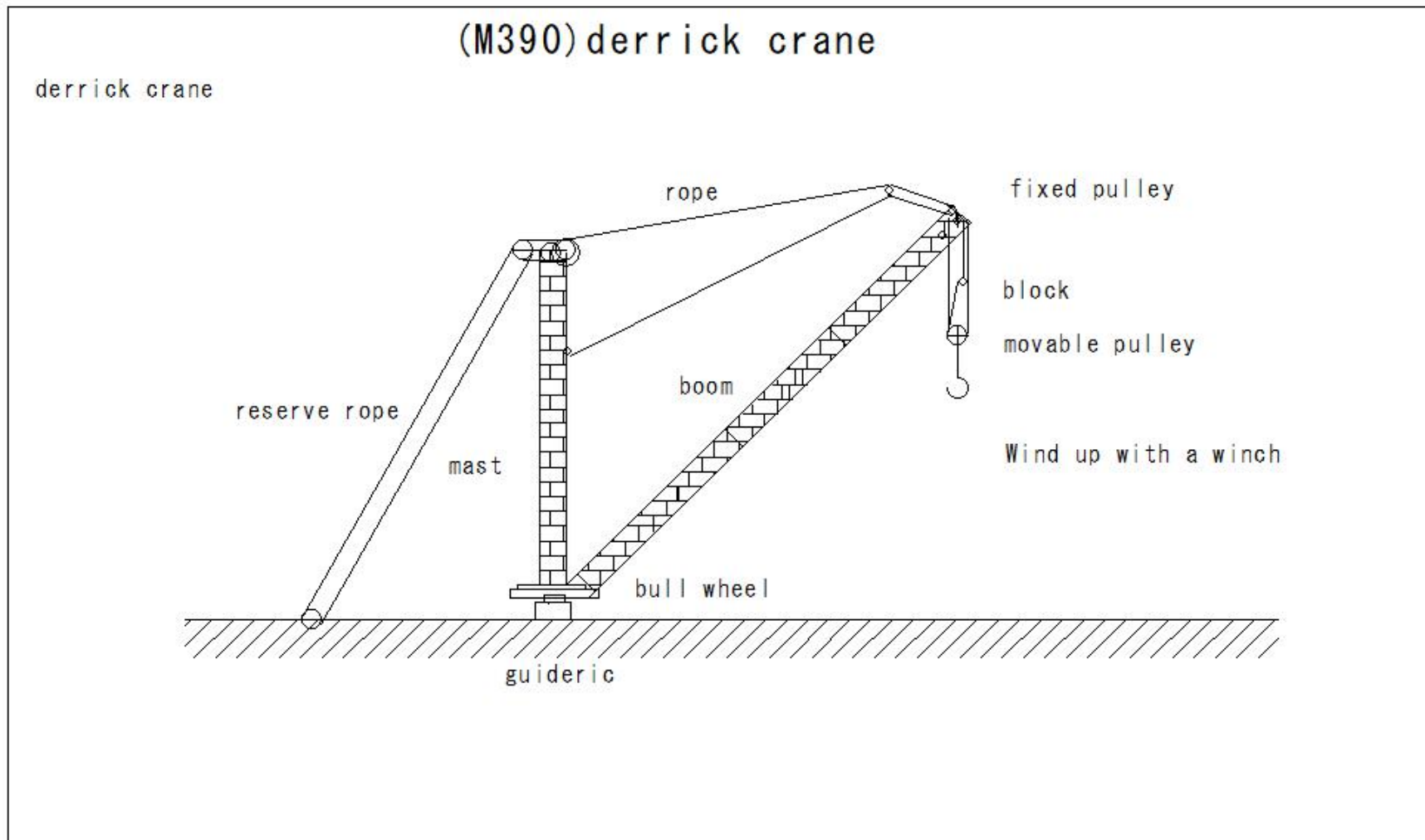
Tamping roller

E314

(M389)dipper dredger



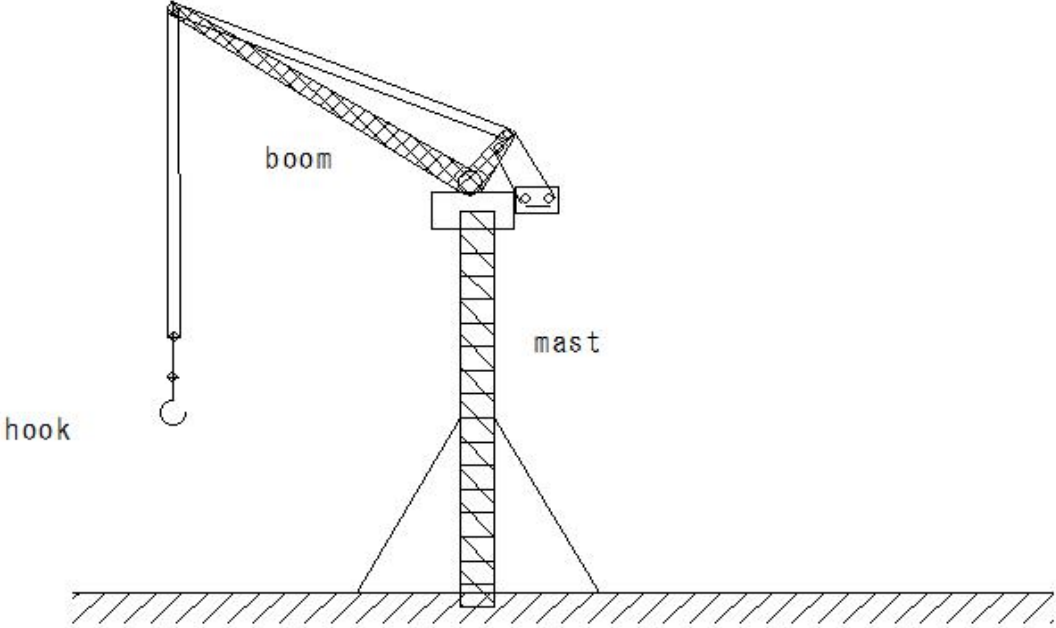
(M390)derrick crane



(M391) tower crane

(M391) tower crane

tower crane



(M392)tractor

(M392) tractor

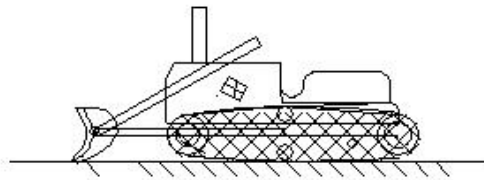
tractor

crawler type

tire type

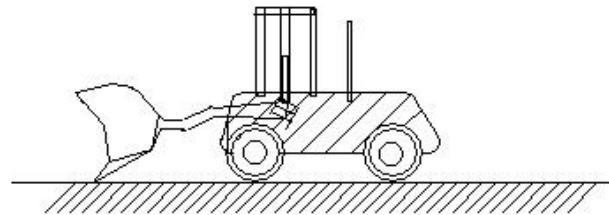
internal combustion engine

caterpillar type



Crawler type tractor excavator

E291



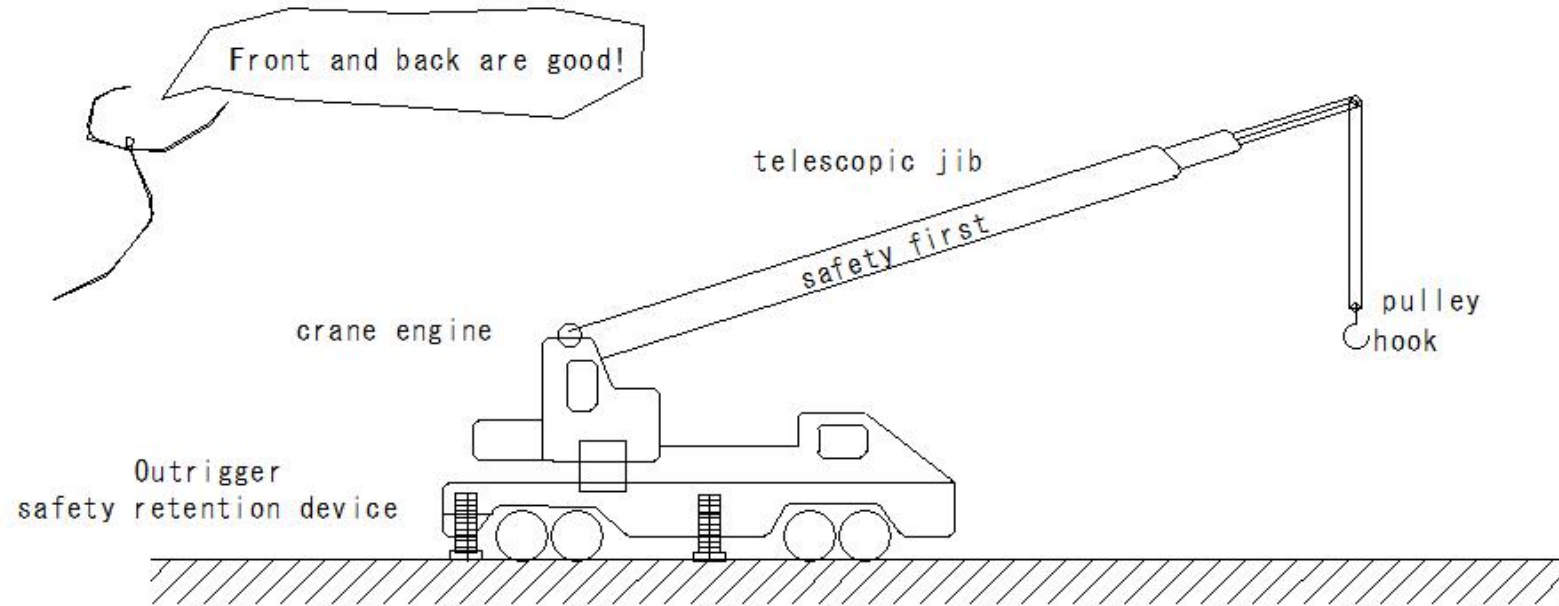
tractor excavator

E292

(M393)truck-crane

(M393) truck-crane

truck crane



(M394)trailer

(M394) trailer

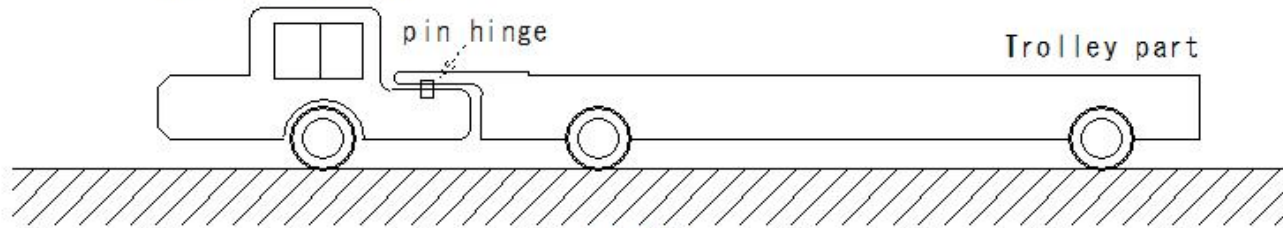
Trailer

Length 18m
34t or less

Tractor section

pin hinge

Trolley part



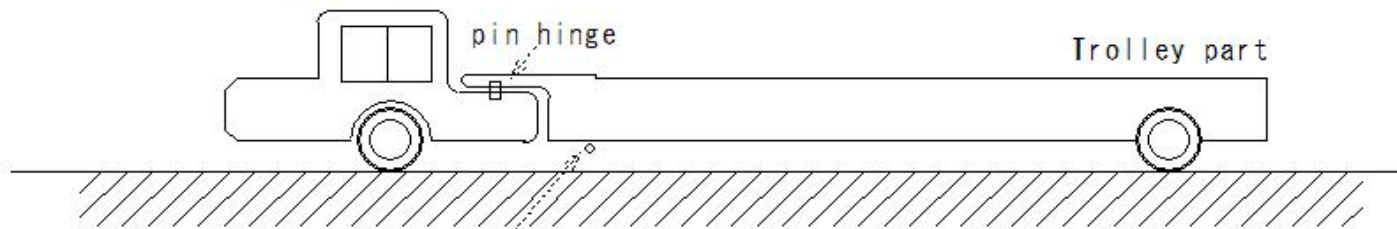
Full Trailer

Length 16.5m
34t or less

Tractor section

pin hinge

Trolley part

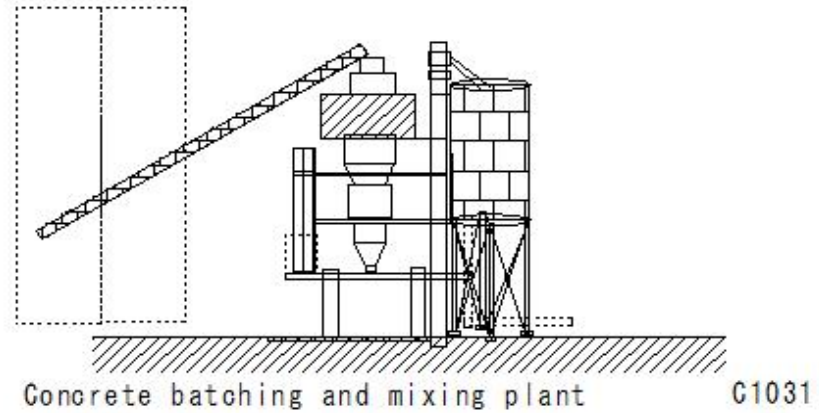
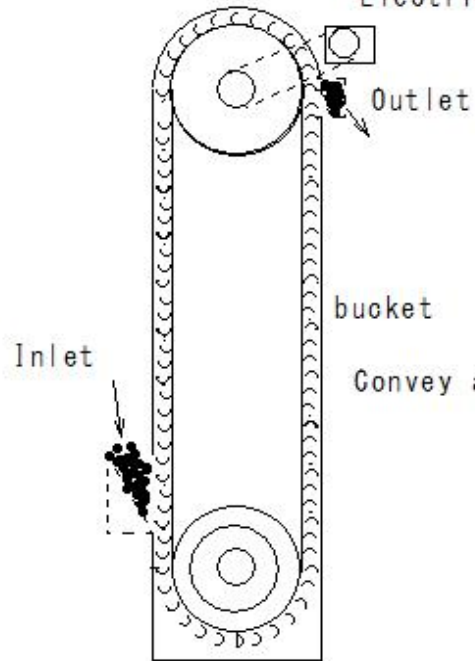


Self-supporting training wheels Semi-trailer

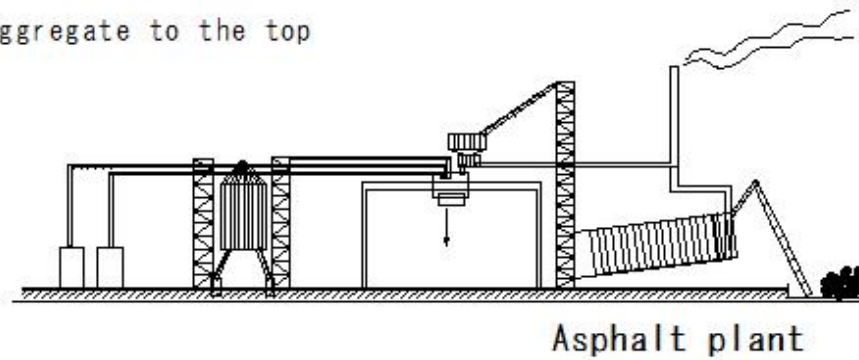
(M395)bucket elevator

(M395) bucket elevator

bucket elevator
Concrete/asphalt plant
Electric motor



Convey aggregate to the top



(M396)edge cutting pipe jacking

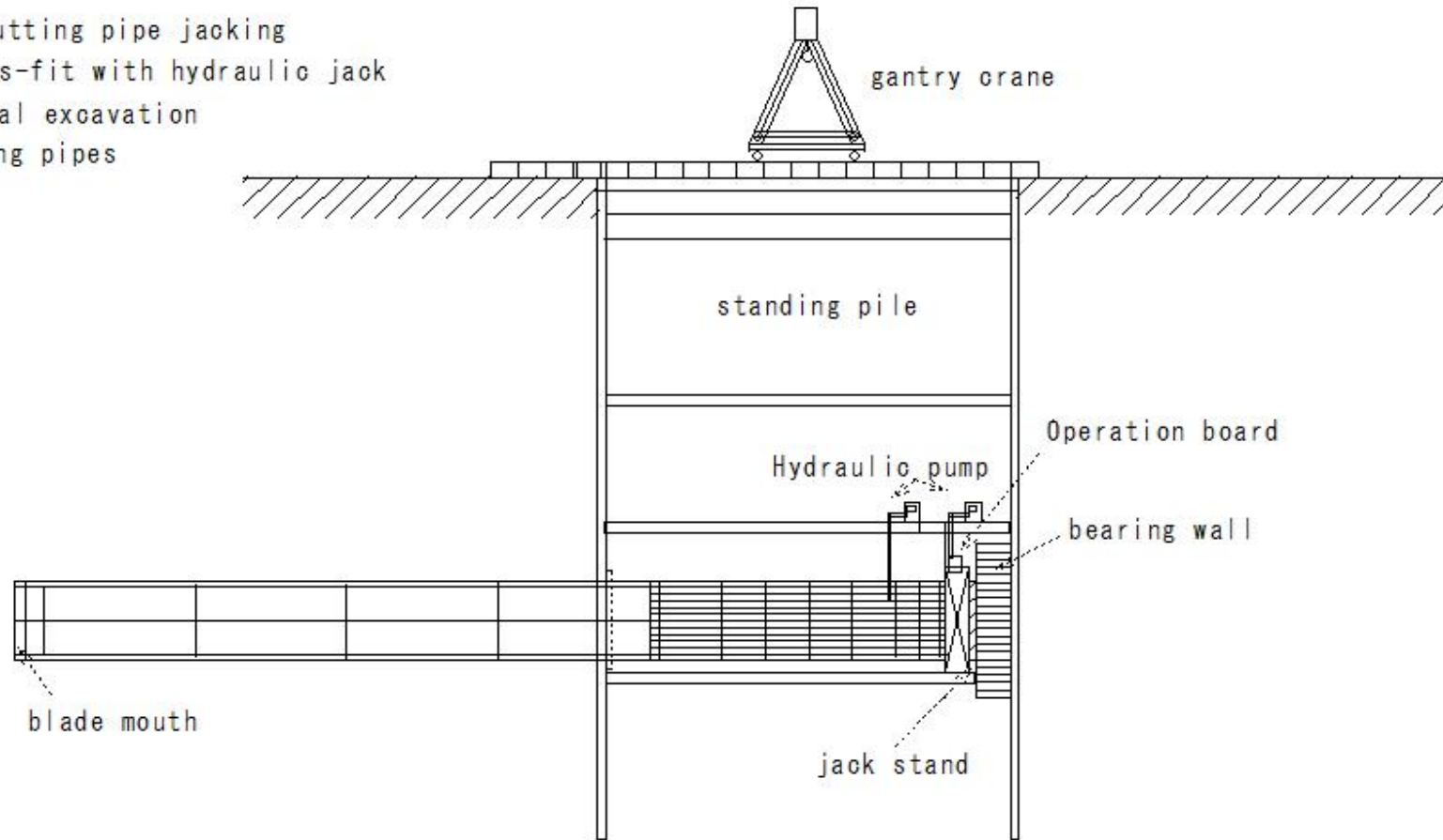
(M396)edge cutting pipe jacking

edge cutting pipe jacking

Press-fit with hydraulic jack

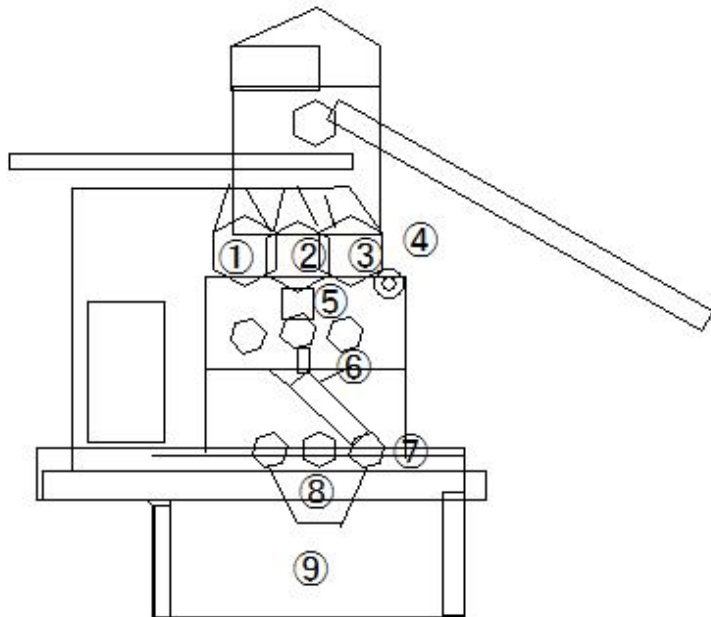
manual excavation

laying pipes



(M397)Batcher plant

(M397)Batcher plant



Batcher plant

Weigh automatically

Mixing

Fresh concrete

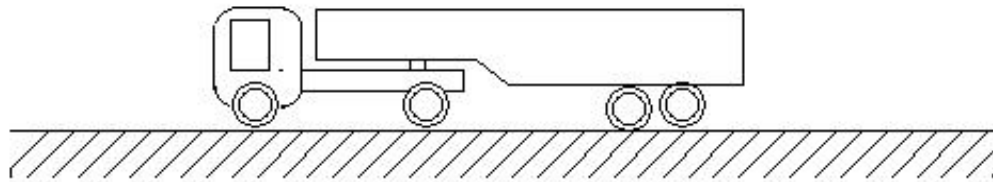
- ① Gravel
- ② Cement
- ③ Sand
- ④ Storage bin
- ⑤ Weighing device
- ⑥ Collecting hopper
- ⑦ Mixer
- ⑧ Concrete hopper
- ⑨ Bucket agitator

(M398)trailer

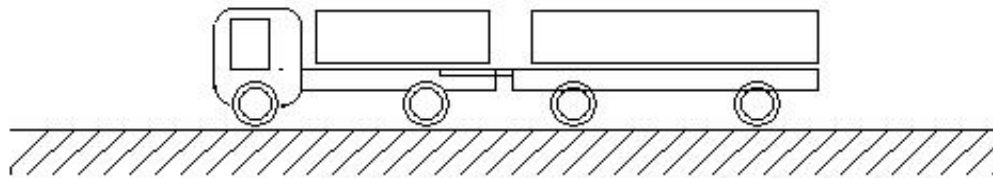
(M398)trailer

trailer

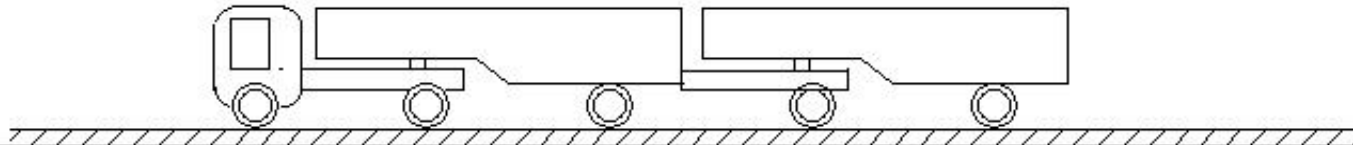
① Semi-trailer



② full trailer



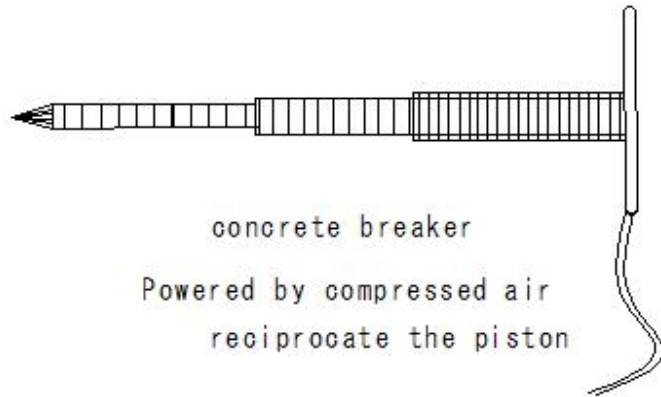
③ Doubles trainer



(M399)hammer drill

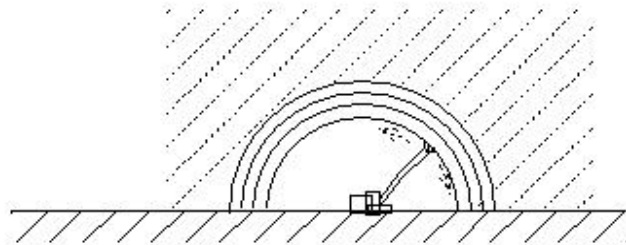
(M399) hammer drill

hammer drill
concrete breaker
concrete crusher
bedrock excavation



(M400)Shot crete

(M400) Shot crete



tunnel

slope surface-stable

spraying

slope protection work

excavation surface

cement + sand+water

①Wet type

spraying - Perpendicular to face

②Dry type

cover for long distance transport

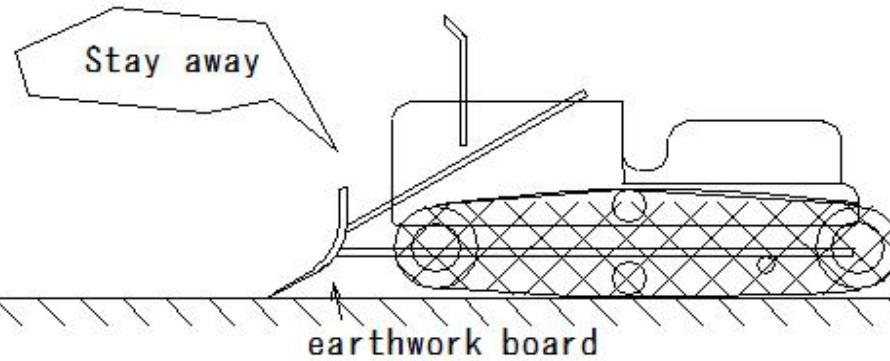
a lot of bounce

G1384

(M401) Bulldozer

bulldozer

(M401) Bulldozer



① Earth and sand excavation

② Short-distance transportation

③ Spread evenly

④ Land leveling

⑤ Compaction

⑥ Deforestation

⑦ Dozing

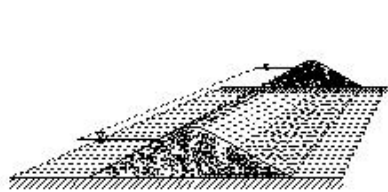
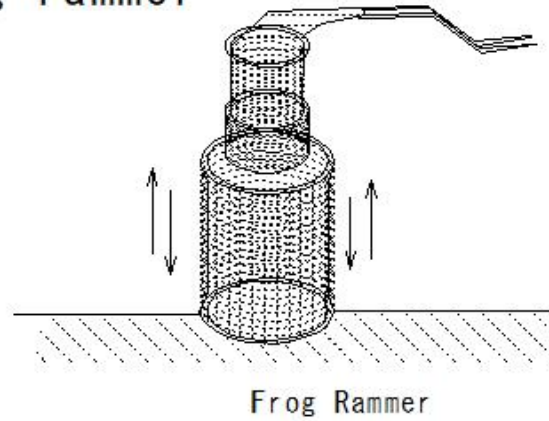
⑧ Snow removal

⑨ Tire type / crawler type

(M402)frog rammer

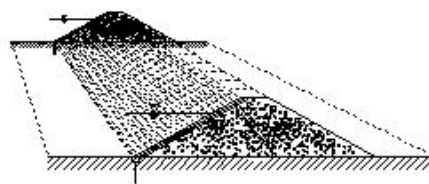
Frog Rammer
earth dam construction
Compaction over a wide area
large rammer

(M402) frog rammer



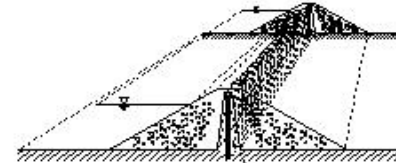
Uniform type

R591



Surface impermeable wall type

R592

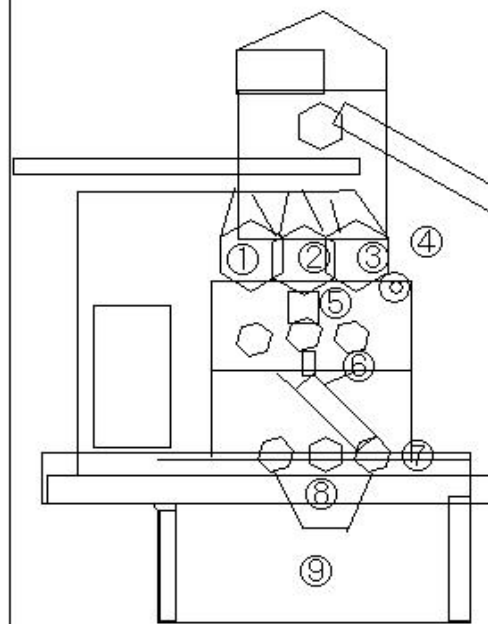


artificial material core

R593

(M403)hopper

(M403) hopper



Batcher plant

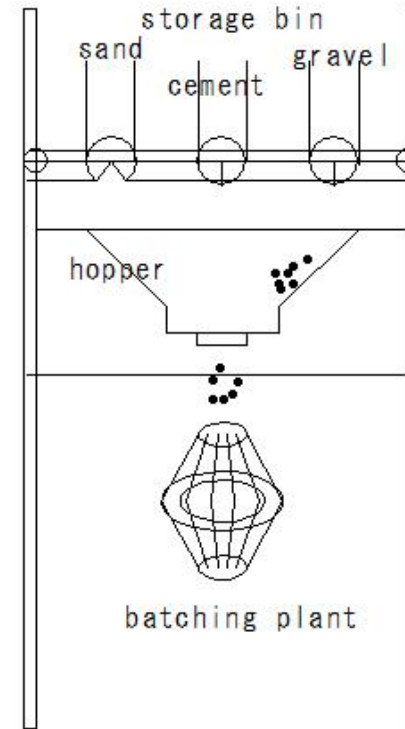
Weigh automatically

Mixing

Fresh concrete

- ①Gravel
- ②Cement
- ③Sand
- ④Storage bin
- ⑤Weighing device
- ⑥Collecting hopper
- ⑦Mixer
- ⑧Concrete hopper
- ⑨Bucket agitator

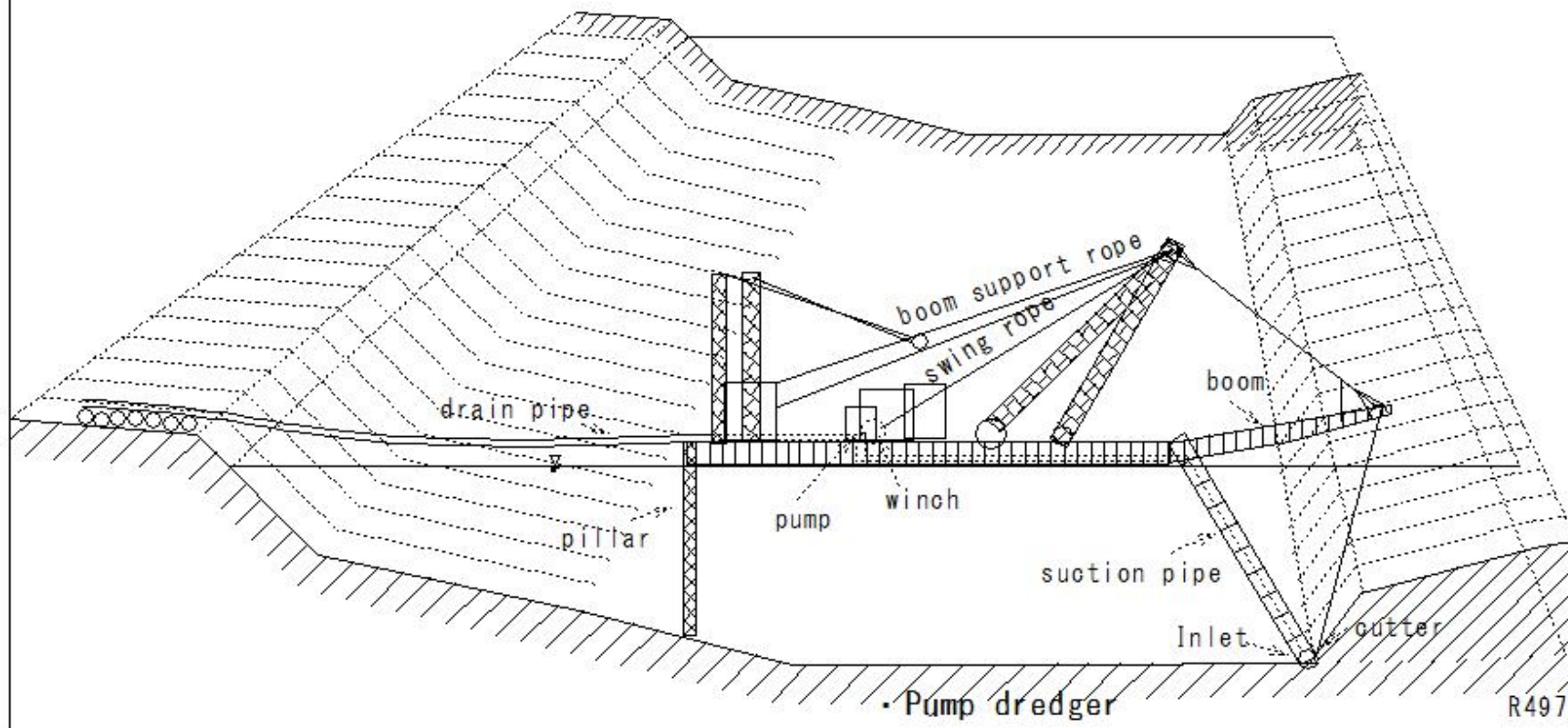
C1378



(M404)suction dredger(pump dredger)

(M404) suction dredger (pump dredger)

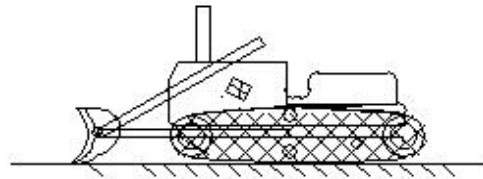
suction dredger(pump dredger)



(M405)Tractor excavator(attachment)

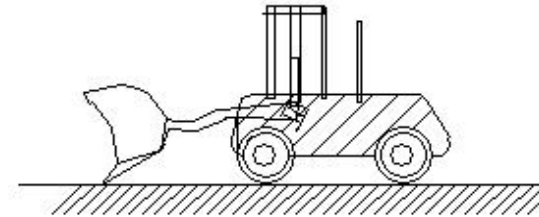
(M405)Tractor excavator(attachment)

Tractor excavator(attachment)
loading bucket



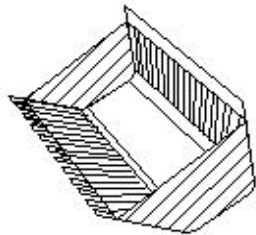
Crawler type tractor excavator

E291

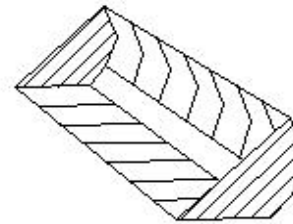


tractor excavator

E292



① Standard bucket
For standard work

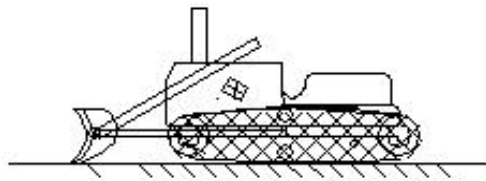


② Slag bucket
For slag treatment in ironworks

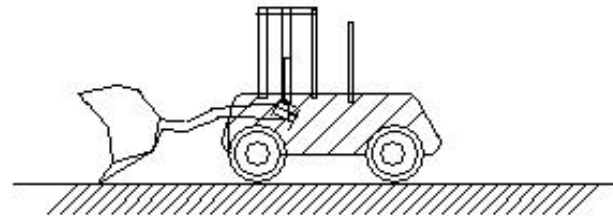
(M406)Tractor excavator(attachment)

(M406)Tractor excavator(attachment)

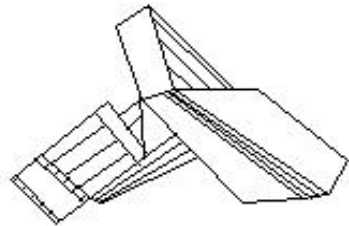
Tractor excavator attachment
loading bucket



Crawler type tractor excavator
E291

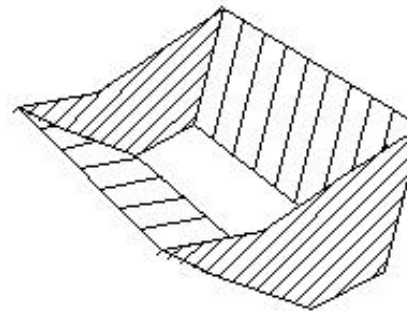


tractor excavator
E292



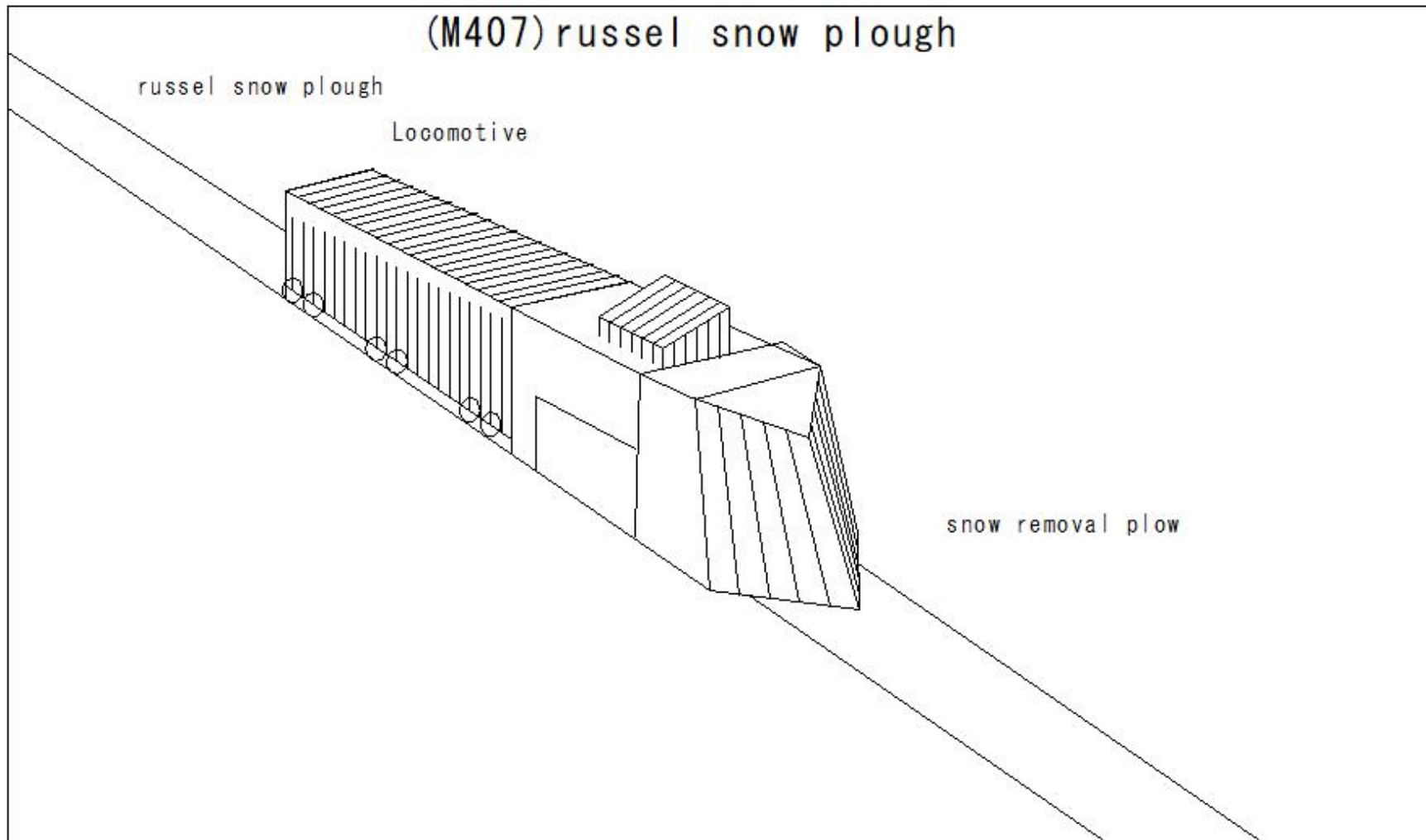
③ Side dump bucket

A bucket that can also dump to the left
and right sides of the vehicle.



④ Rock bucket: Bucket for rocks

(M407)russel snow plough



(M408)rammer

(M408) rammer

rammer

impact

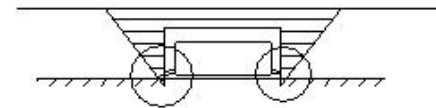
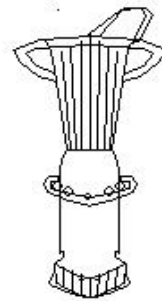
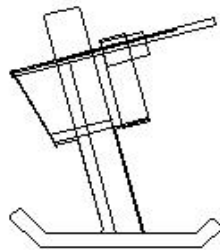
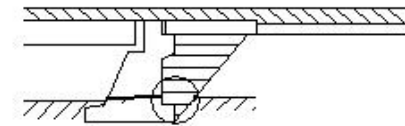
compact the soil

narrow place

Own weight (60-100kg)

Impact number: 50-60 times/min

gasoline engine



Rammer

E359

(M409)crawler

(M409) crawler

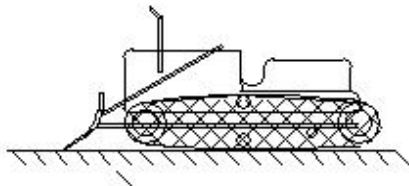
crawler

Features

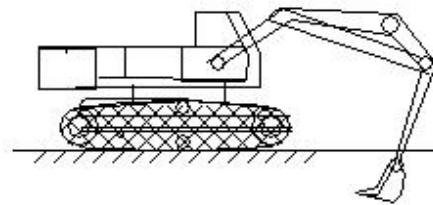
- Ground pressure - small
- soft ground
- steep slope
- uneven ground
- snow work

Working speed - slow

a lot of wear and tear on the tracks.

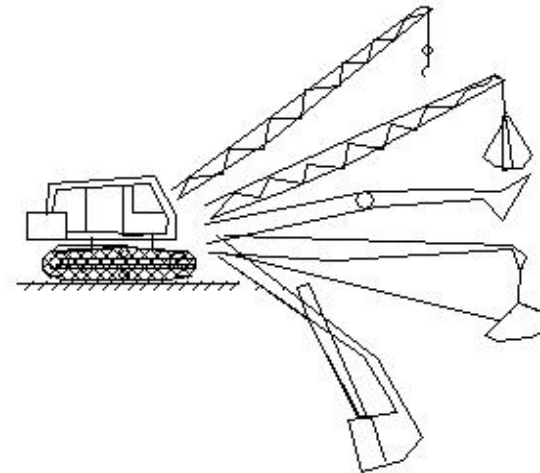


M11



Crawler type

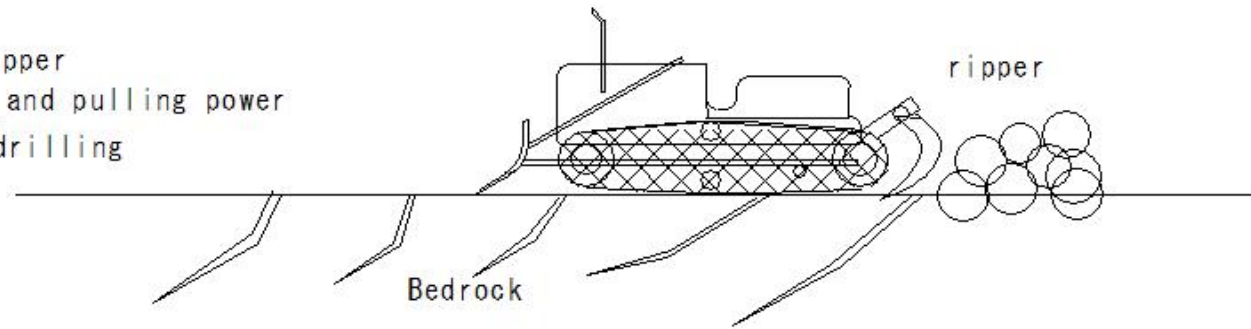
M12



(M410)ripper

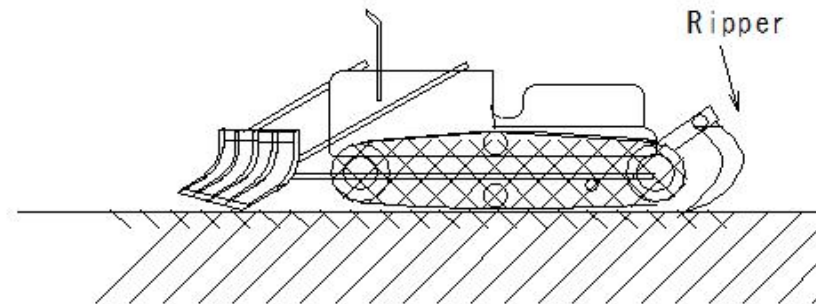
(M410) r ipper

ripper
medium hard rock
excavation
attachment
operator
hydraulic ripper
Dead weight and pulling power
continuous drilling



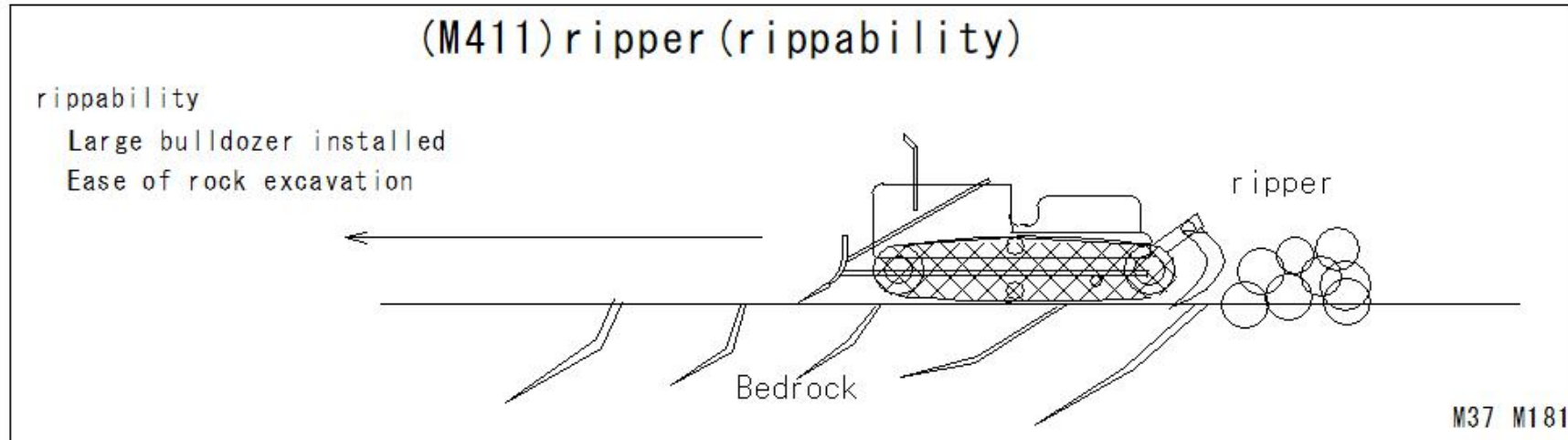
Rake dozer

E304



E349

(M411)ripper(rippability)



(M411)ripper(rippability)
rippability
Large bulldozer installed
rippability

Elastic wave velocity of the ground (m/sec)

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

(M412)mixing work on the way

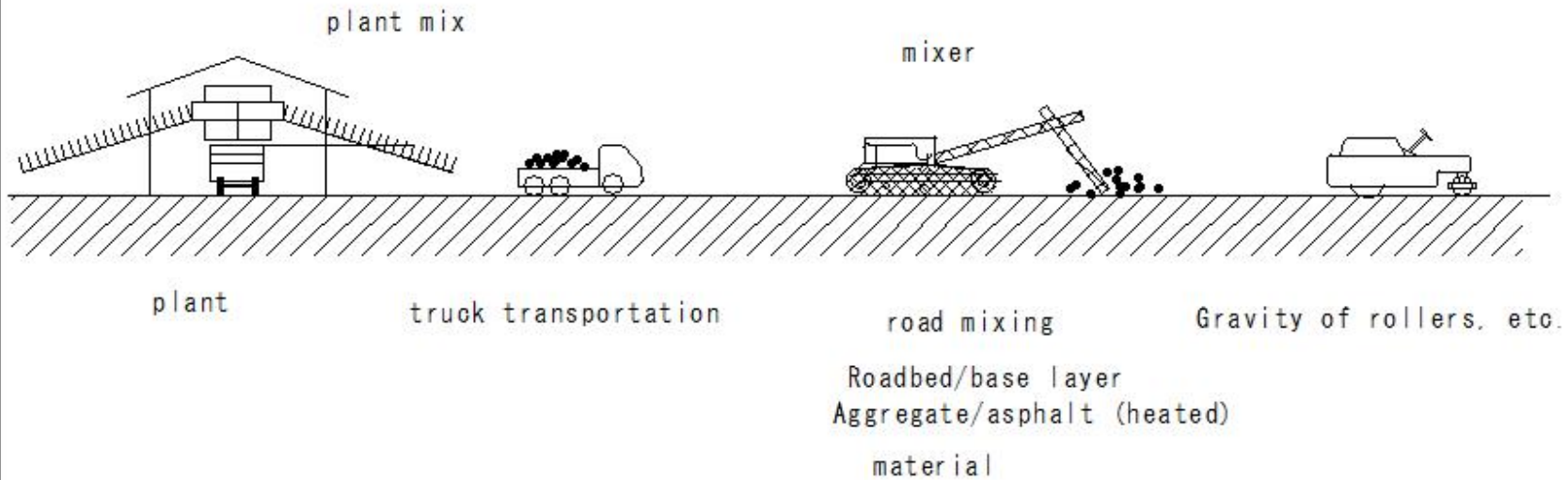
(M412)mixing work on the way

mixing work on the way

roadbed material

asphalt mixture

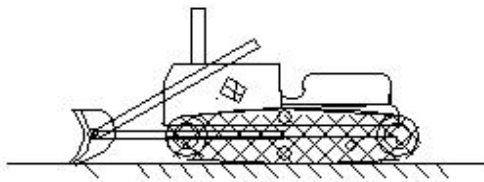
Directly on the roadbed - Mixing - Compaction



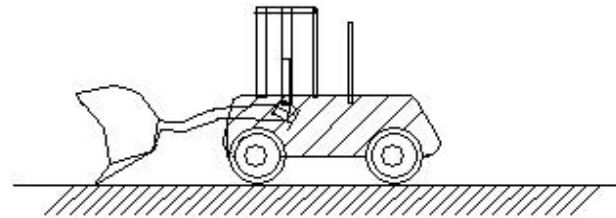
(M413)Tractor excavator(attachment)

(M413) Tractor excavator (attachment)

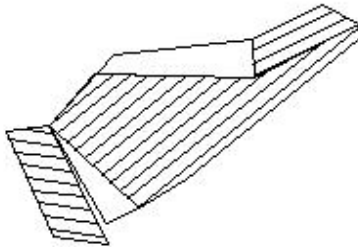
Tractor excavator attachment
loading bucket



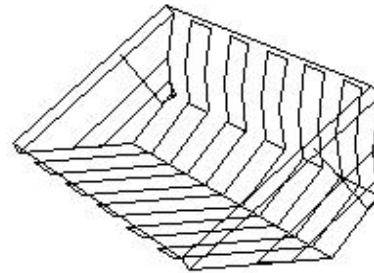
Crawler type tractor excavator
E291



tractor excavator
E292



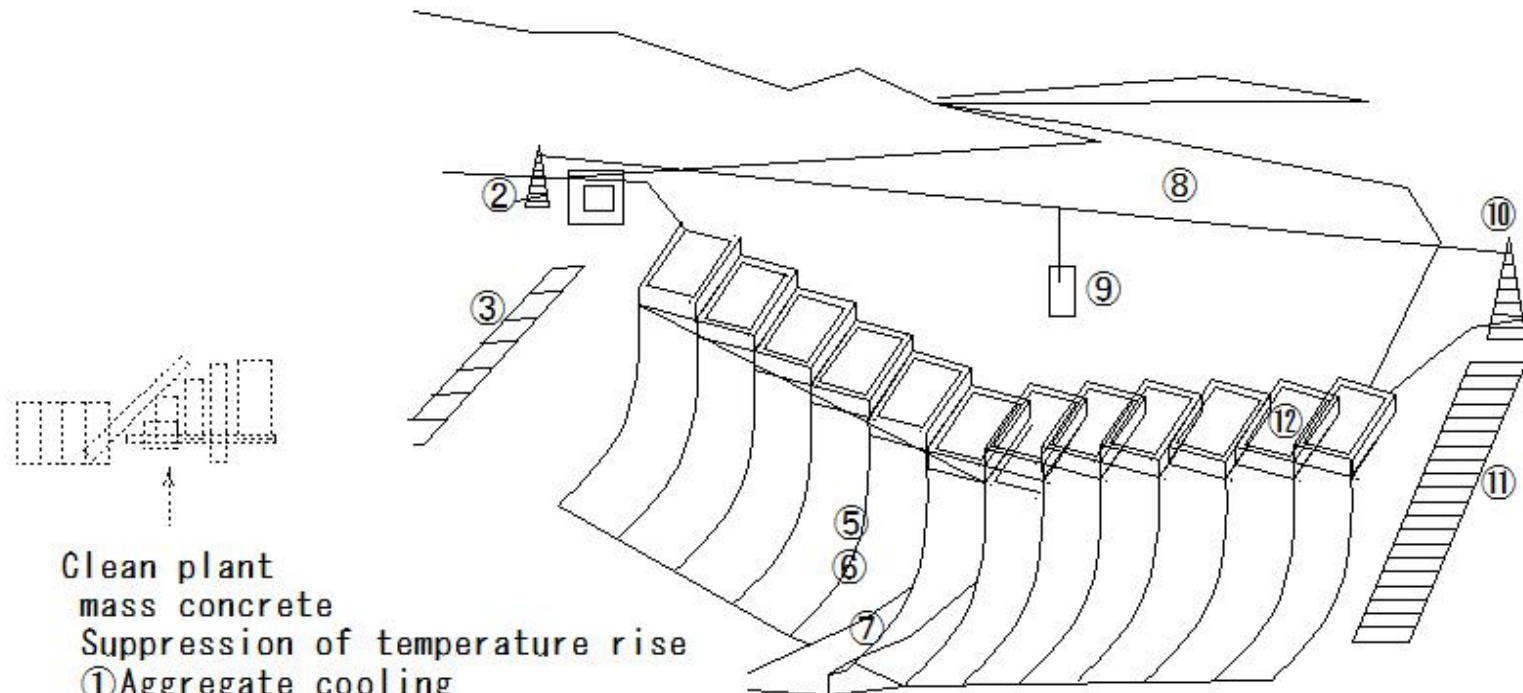
⑤ Multi-purpose bucket: For general work: drossing, topsoil stripping, land leveling



⑥ Skeleton bucket: Can excavate large rocks from loose earth and sand.

(M414)clean plant

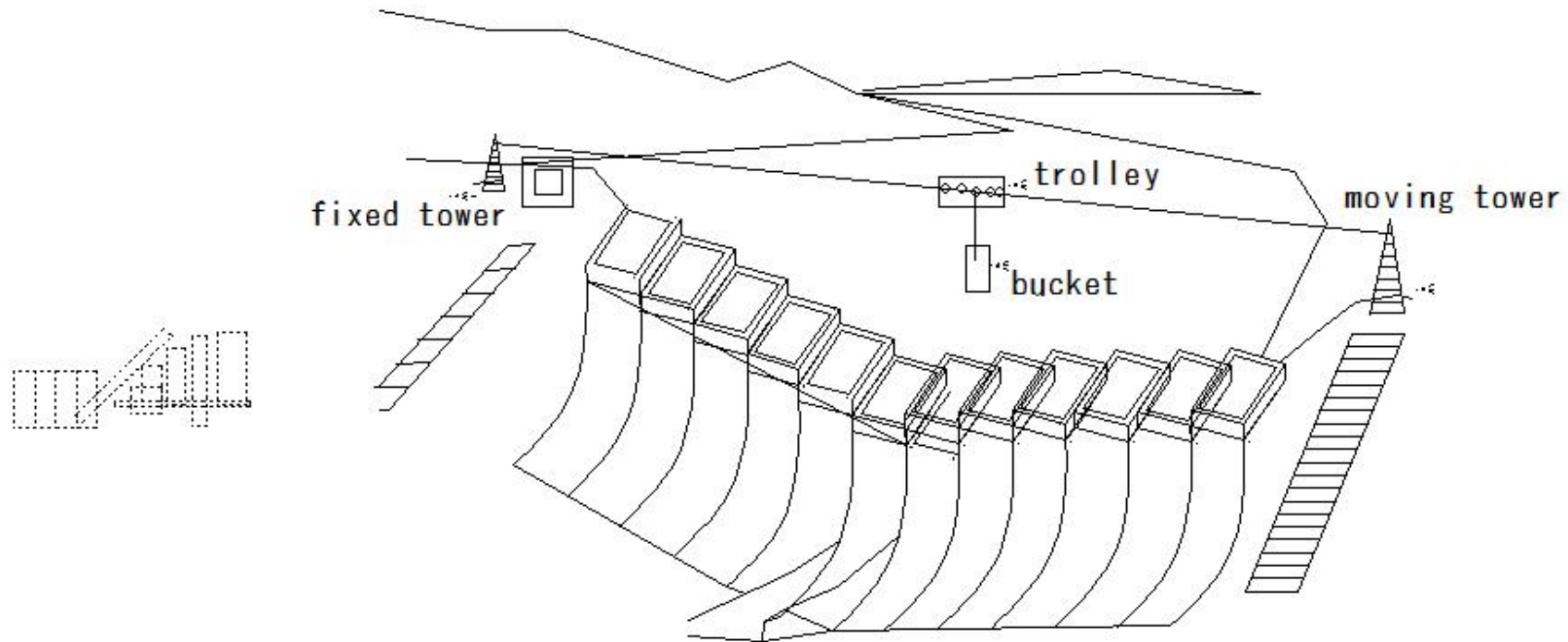
(M414) Clean plant



- Clean plant
mass concrete
Suppression of temperature rise
- ①Aggregate cooling
 - ②Mixing water cooling: Pre-cooling
 - ③Pipe cooling

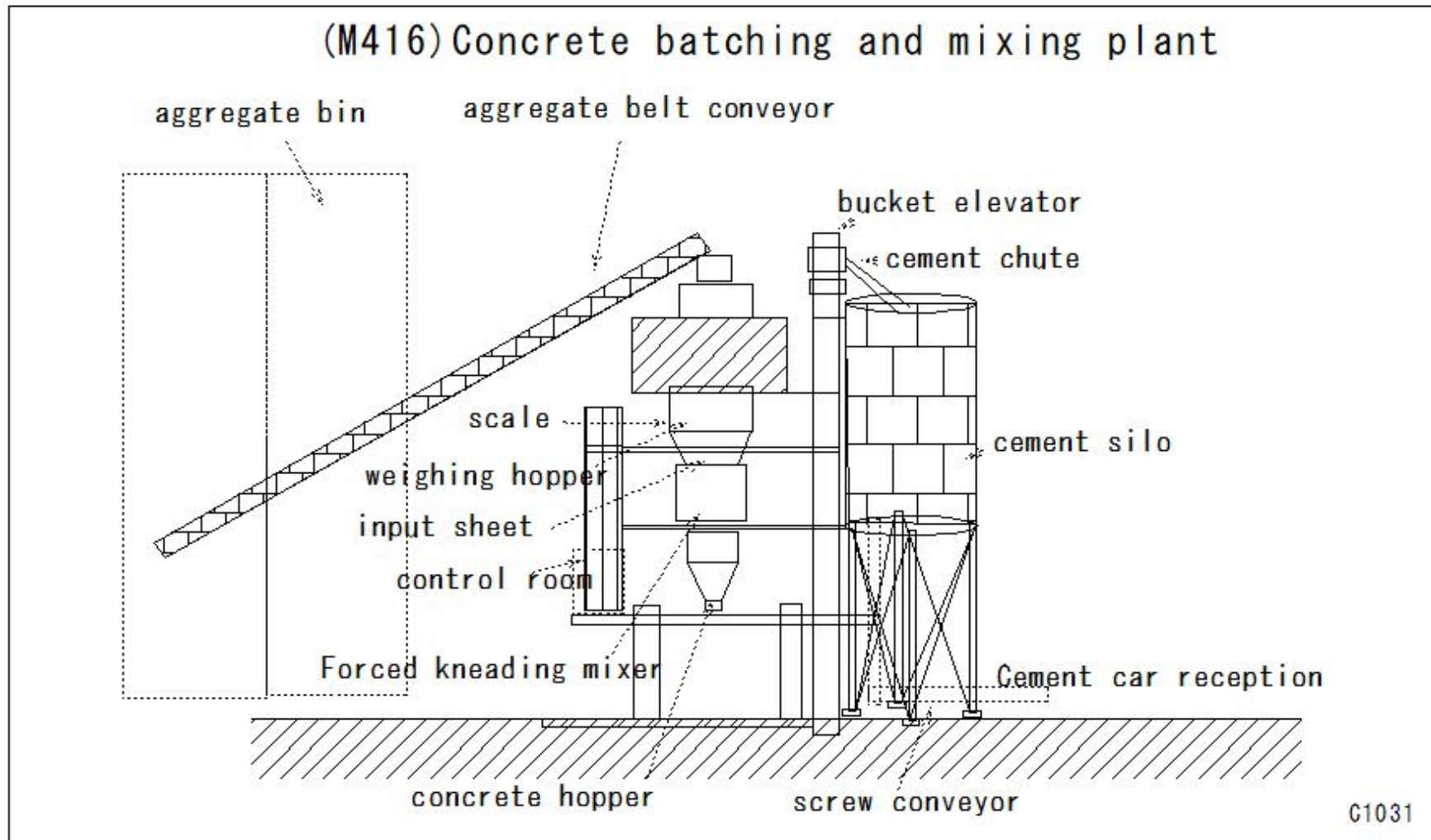
(M415)Cable crane

(M415) Cable crane



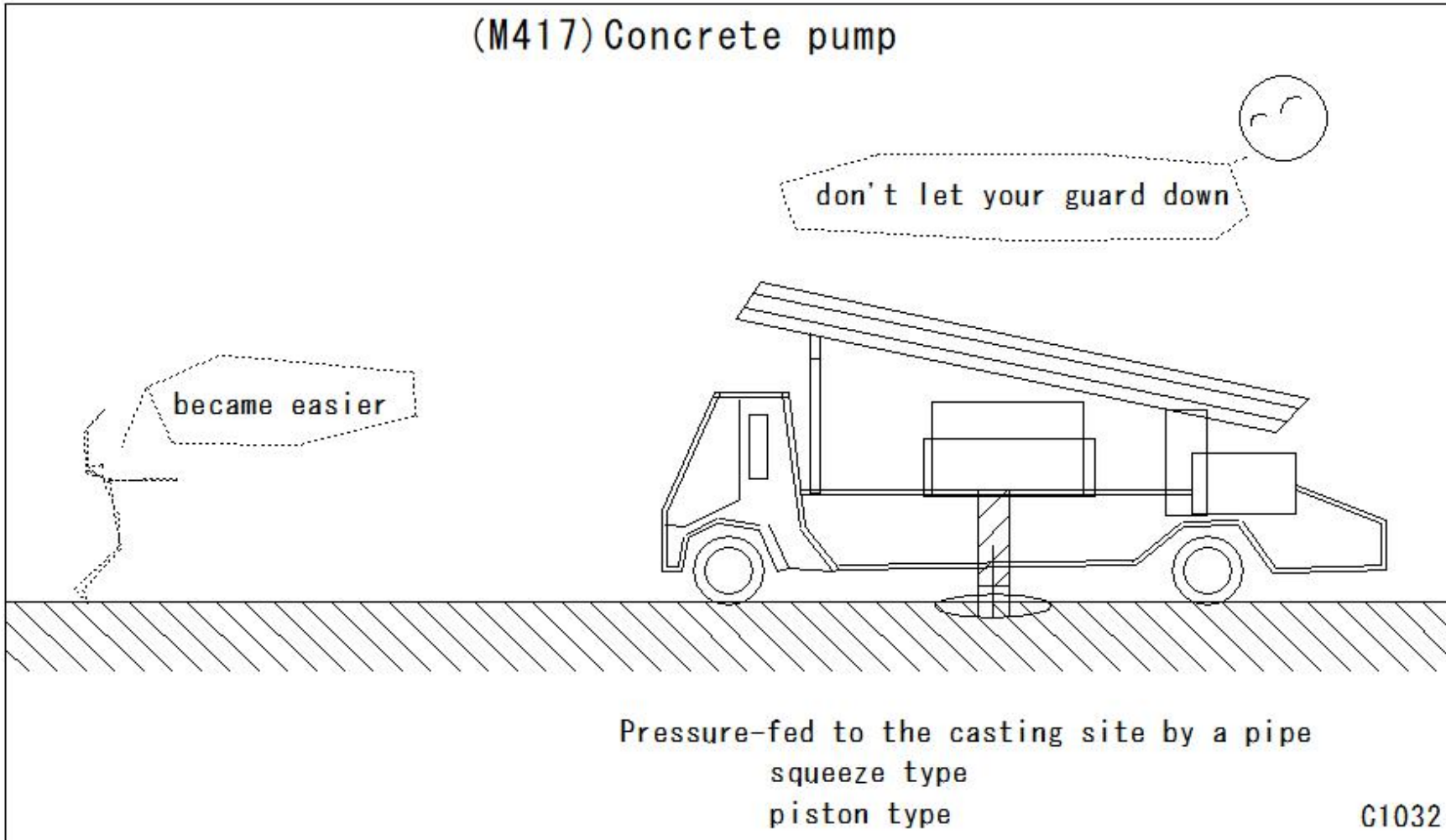
C1019

(M416)Concrete batching and mixing plant



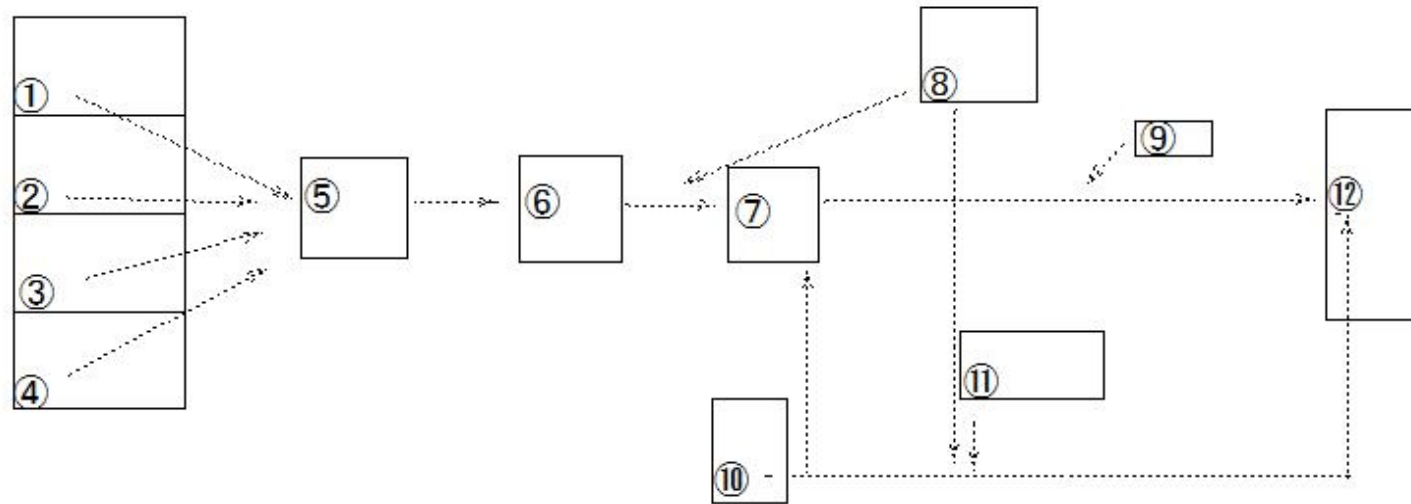
(M417)Concrete pump

(M417) Concrete pump



(M418)Wet-type shot crete

(M418)Wet-type shot crete



- ① fine aggregate
- ② coarse aggregate
- ③ cement
- ④ water
- ⑤ mixer
- ⑥ agitator

- ⑦ concrete spraying machine
- ⑧ accelerating agent
- ⑨ material hose-nozzle
- ⑩ compressor
- ⑪ Injection by compressed air
pressure (5-7kg/cm²)

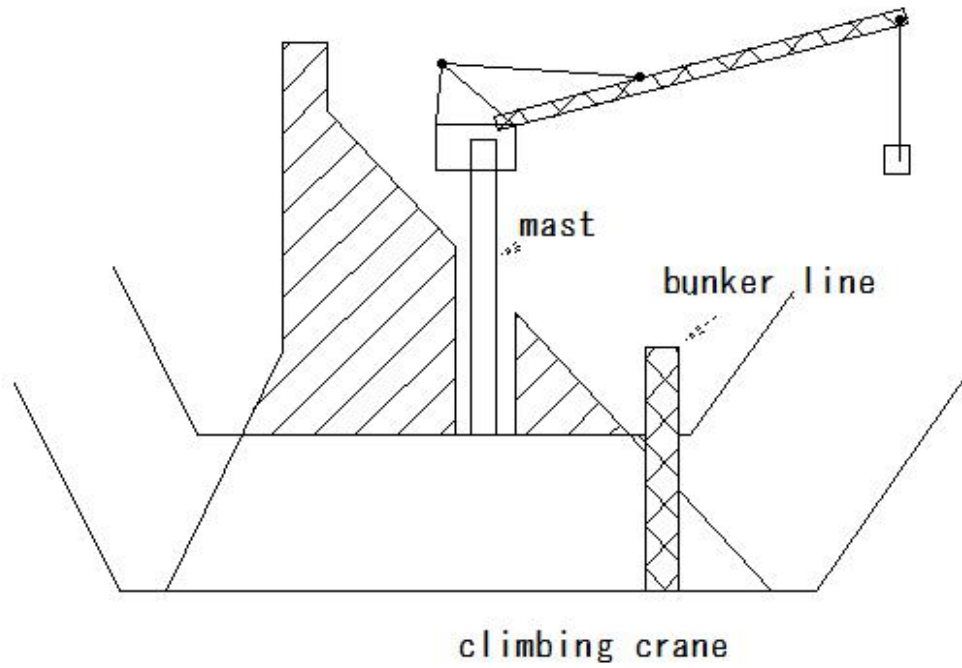
- ⑫ nozzle

C1035

(M419)fixed jib crane

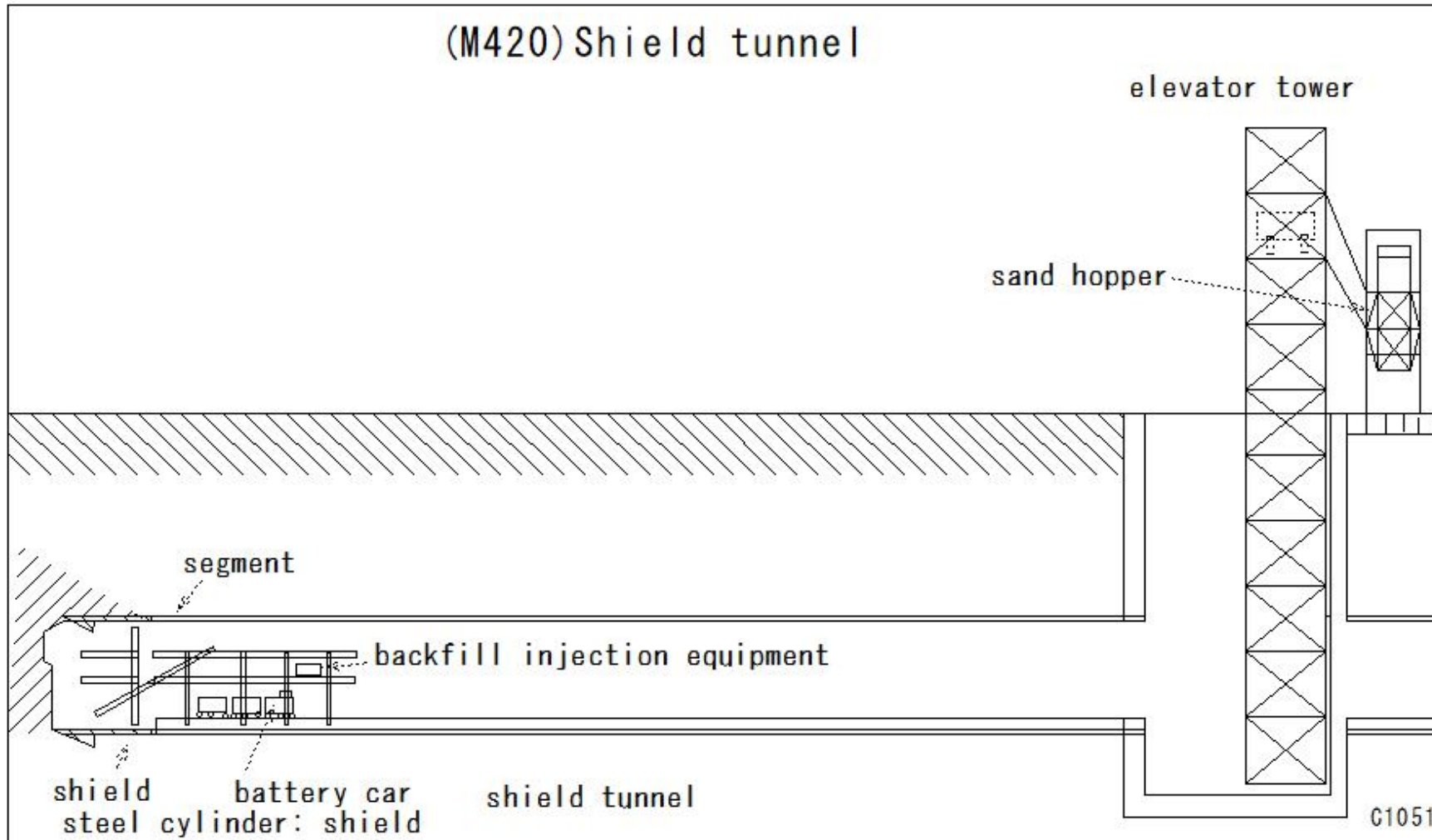
(M419)fixed jib crane

fixed jib crane



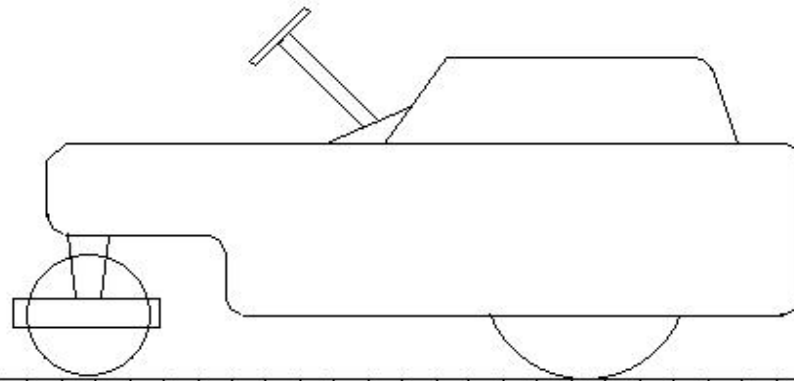
C1036

(M420)Shield tunnel



(M421)Vibrating roller

(M421)Vibrating roller



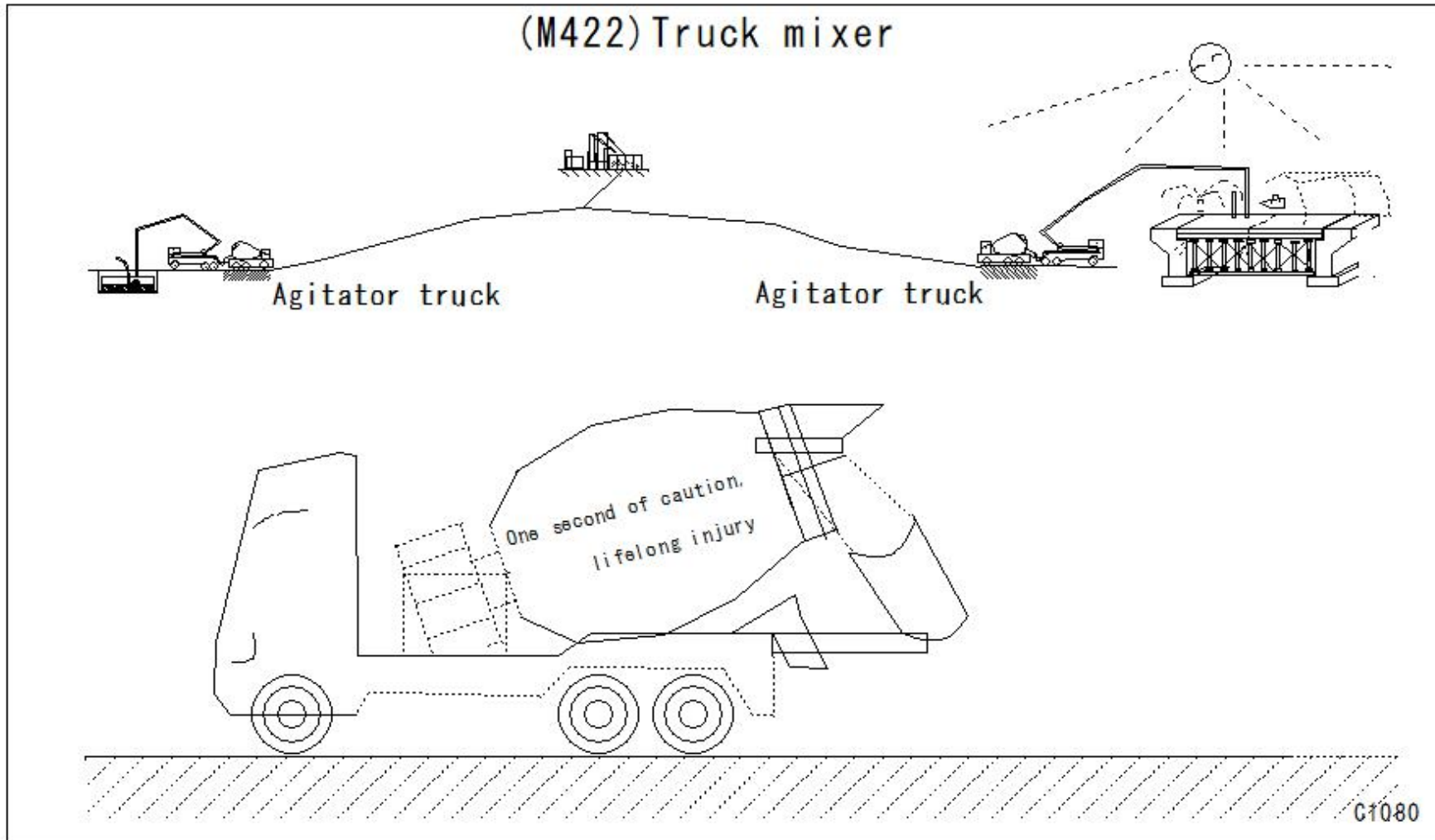
iron wheel roller

asphalt pavement

fill dam: earthwork

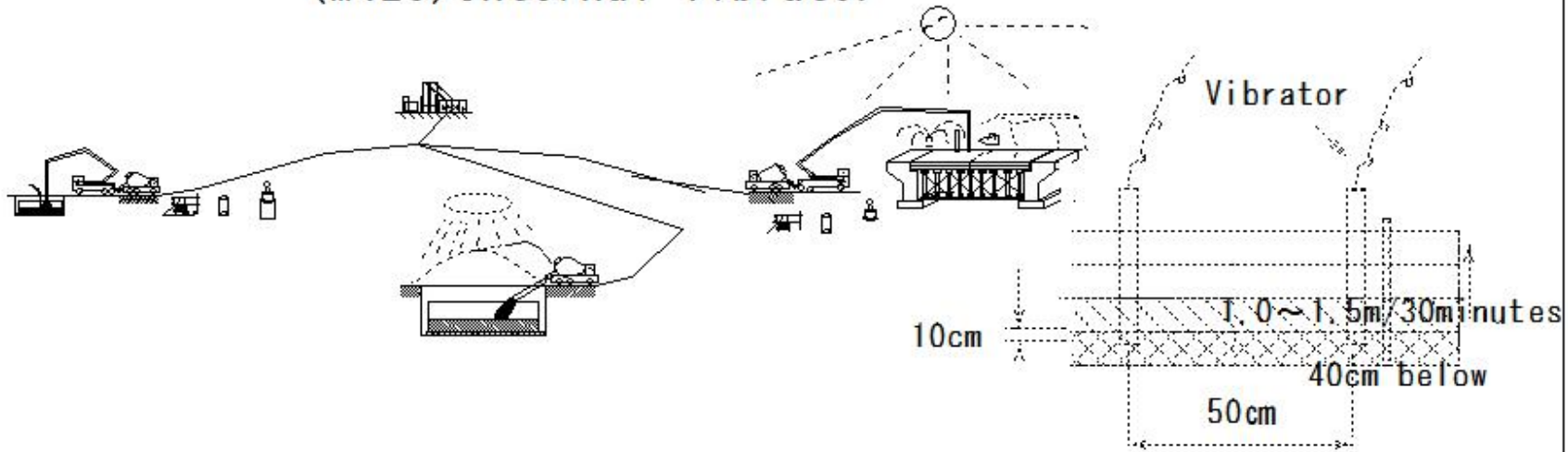
C1052

(M422)truck mixer



(M423)Internal vibrator

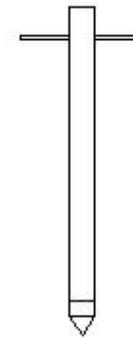
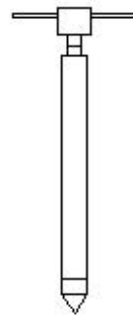
(M423) Internal vibrator



①Flexible



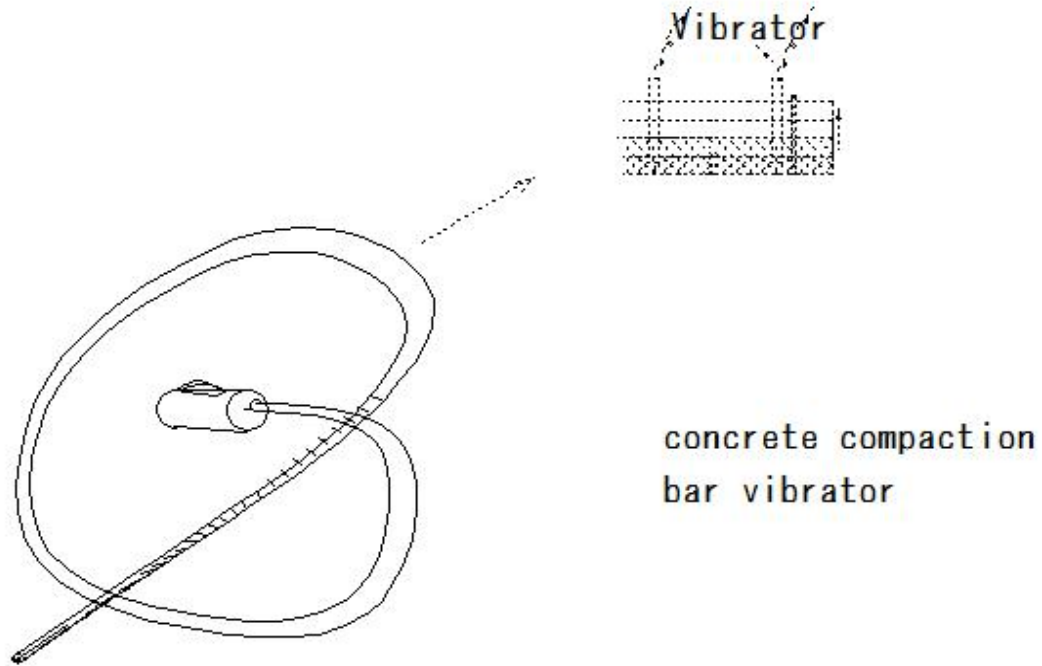
③Built-in direct-coupled motor



C1081

(M424)concrete compaction

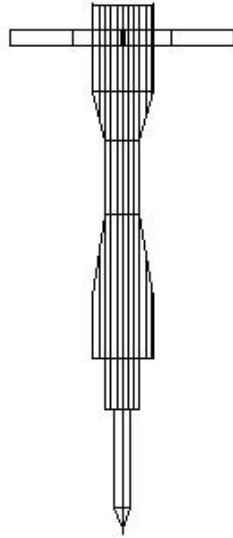
(M424)concrete compaction



G1102

(M425)breaker

(M425) Breaker



concrete and rock crushing
electric hammer
working time restrictions

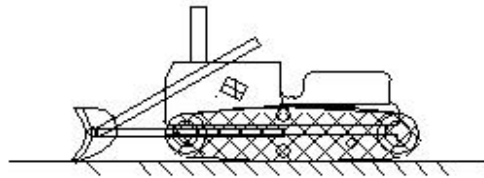
C1133

(M426)Tractor excavator(attachment)

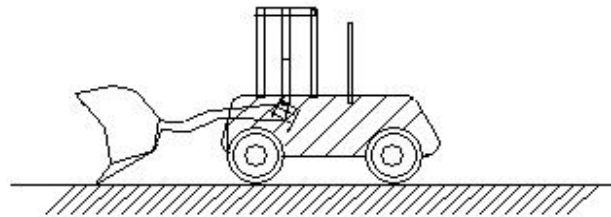
(M426) Tractor excavator (attachment)

Tractor excavator attachment

loading bucket



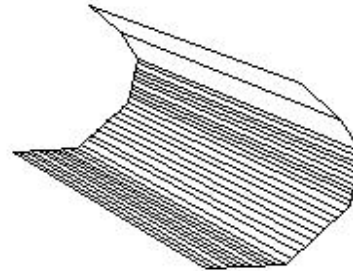
Crawler type tractor excavator
E291



tractor excavator
E292



⑦ fork: Fork for handling wood

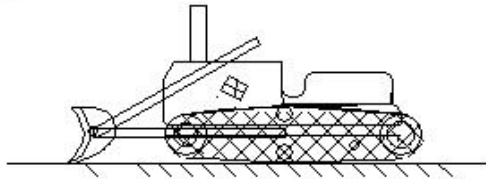


⑧ Dump bucket on both sides: Rib bucket

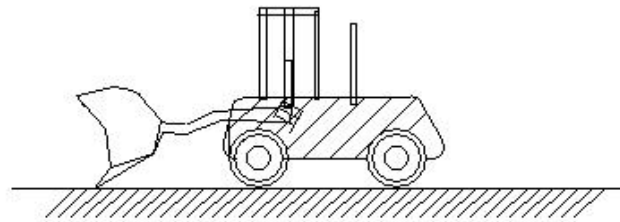
(M427)Tractor excavator(attachment)

(M427)Tractor excavator (attachment)

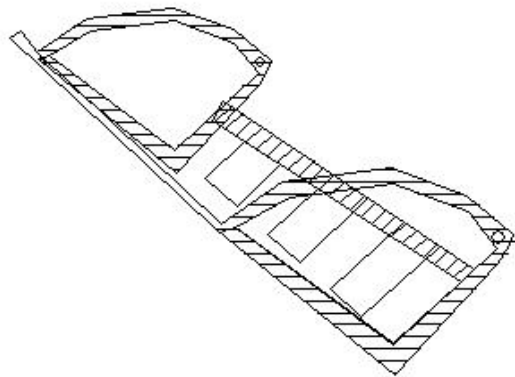
Tractor excavator attachment
loading bucket



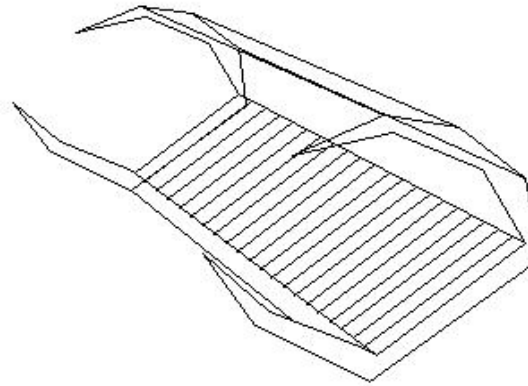
Crawler type tractor excavator
E291



tractor excavator
E292



⑨Log fork: Fork for handling logs



⑩Top clamp: Attached to log fork ramp fork:
Push the load in from the top and secure it.